APPENDIX Q: ENVIRONMENTAL REPORT SUPPORTING AN APPLICATION FOR A 404 PERMIT FOR LOWER BOIS D'ARC CREEK RESERVOIR

Q-1: FINAL ENVIRONMENTAL REPORT SUPPORTING AN APPLICATION FOR A 404 PERMIT FOR LOWER BOIS D'ARC CREEK RESERVOIR

Q-2: APPENDIX A - PROBABLE MAXIMUM FLOOD ANALYSIS, LOWER BOIS D'ARC CREEK RESERVOIR

Q-3: APPENDIX B - THE ECONOMIC, FISCAL AND DEVELOPMENTAL IMPACTS OF THE PROPOSED LOWER BOIS D'ARC RESERVOIR PROJECT (2004), AND UPDATED ASSESSMENTS (2007 AND 2012)

These documents may be found in Appendix E of the FEIS for the Lower Bois d'Arc Creek Reservoir

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THIS DOCUMENT MAY BE FOUND IN APPENDIX J OF THE FEIS FOR THE LOWER BOIS D'ARC CREEK RESERVOIR

Q-6: APPENDIX E - NATIONWIDE PERMIT 12 UTILITY LINE ACTIVITIES

FINAL Environmental Report Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir

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June 2008

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NTD06128

Executive Summary

This report was prepared by Freese and Nichols, Inc. for the North Texas Municipal Water District (NTMWD) in support of an application for a U.S. Army Corps of Engineers Section 404 permit for the proposed Lower Bois d'Arc Creek Reservoir. The reservoir would be located on Bois d'Arc Creek northeast of the city of Bonham in Fannin County, Texas. The project would develop a reliable water supply for the rapidly growing demands of the NTMWD and its customers.

Purpose and Need

The NTMWD provides wholesale treated water to customers within a nine-county area in North-Central, Texas. The area served by the NTMWD is one of the fastest growing regions in the country. Population served by NTMWD has increased from 32,000 when the District was formed in 1951 to about 1.5 million today, and this growth is expected to continue. Population projections developed by the state of Texas show the NTMWD's service population more than doubling to 3.3 million over the next 50 years.

To meet this anticipated growth and increased water demands, the NTMWD is actively promoting water conservation measures with its member and customer cities, and NTMWD is currently implementing the largest wastewater reuse program in the State. Even with advanced conservation measures and increases in wastewater reuse, the NTMWD's current water supplies fall short of meeting the long-term projected demands. By 2020 the NTMWD will have a projected water shortage of 90,000 acre-feet per year, increasing to 318,000 acre-feet per year by 2060.

The proposed Lower Bois d'Arc Creek Reservoir is one of several projects the NTMWD is pursuing to address these shortages. To serve the rapidly growing northern sector of the NTMWD's service area a new northern water treatment plant is needed by 2017. The Lower Bois d'Arc Creek Reservoir will be the primary supply source for this new water plant.

Analysis of Alternatives

The proposed Lower Bois d'Arc Creek Reservoir is located on Bois d'Arc Creek in the Red River Basin in Fannin County, Texas. At its conservation pool, the reservoir will store

367,609 acre-feet of water. The estimated firm yield of the project is 126,200 acre-feet per year. Based on the projected needs of NTMWD, water from this project would be fully utilized shortly after 2030.

Four main categories of water supply alternatives were evaluated in addition to the no action alternative and the proposed project. These categories included 1) new supply from four new (undeveloped) reservoirs, 2) transport of water from sixteen existing reservoirs, 3) new supply from two groundwater sources, and 4) desalination of brackish water from two sources. In addition, water conservation measures that have not been adopted by the NTMWD were reviewed.

Lower Bois d'Arc Creek Reservoir is the preferred alternative based on economic and environmental factors and the ability to satisfy the purpose and need for the project. Long-term, water supply from the Lower Bois d'Arc Creek Reservoir is one of the least costly alternatives available to the NTMWD. It also has comparatively fewer long-term environmental impacts associated with lower energy use and water treatment.

Practicable alternatives that meet the purpose and need for the project are limited. Other new reservoir sites have similar or greater environmental impacts and most are more distant which results in additional transmission system impacts and costs. Several alternative river basins have competing reservoir projects that impact the reliability of the water supplies. Large scale projects such as the proposed Marvin Nichols Reservoir require multiple participants to develop the project and likely cannot be implemented within the time frame needed for this project.

Transporting water over long distances from existing reservoir sites has high capital costs, significantly greater energy use and higher long-term operation and maintenance costs. Some existing sources have institutional and political concerns associated with other commitments for the developed water. Use of brackish water (groundwater or surface water) has treatability concerns, brine disposal issues and uncertain costs and regulatory requirements. Aggressive water conservation measures are already in place, and the additional measures considered are incapable of providing the amount of water savings necessary to meet near-term water needs.

Impacts of Proposed Alternative

The proposed Lower Bois d'Arc Creek Reservoir is located in a rural area northeast of the City of Bonham, Texas. The project site consists of 17,068 acres, which includes 16,641 acres for the lake and 427 acres for the construction of the dam and spillways. Much of the existing site has been altered over the past 100 years mainly due to agricultural practices and stream channelization. Currently, 38 percent of the project site is cropland and grassland, 37 percent is riparian woodland/bottomland hardwoods, and most of the remainder of the site is upland/ deciduous forests. Generally, the habitat quality is the highest for cropland, tree savanna (132 acres) and grassland. Riparian woodland/bottomland hardwood habitat is low quality, with a habitat suitability index of 0.25 (on a scale of 0 to 1).

The local streams are characterized by extensive channelization, especially along Bois d'Arc Creek. Approximately 62 percent of the length of Bois d'Arc Creek within the project site has been channelized, and portions of a number of tributaries have also been straightened. Much of the channelization was performed to address flooding along the creeks. The hydrology of the watershed is characterized by rapid rises and falls of stream flows in response to rain events. During dry times there may be little to no flow in the creeks. Fluvial geomorphologic analyses indicate that the prior channelization, lack of aquatic habitat, and lack of bank stability have resulted in reduced quality for the streams within the project area.

The proposed Lower Bois d'Arc Creek Reservoir would impact 6,180 acres of waters of the U.S., which includes 5,874 acres of wetlands, 219 acres of streams and 87 acres of open waters. Most of the wetlands are forested wetlands along Bois d'Arc Creek (4,602 acres). There are also 1,223 acres of emergent/herbaceous wetlands and 49 acres of shrub wetlands. The development of the Lower Bois Creek Reservoir will potentially create 2,150 acres of emergent wetlands along the lakeshore. The proposed project will not increase flooding either upstream or downstream of the reservoir.

No threatened or endangered species are likely to be adversely affected by the proposed project. Wildlife habitat and cultural resources studies have been initiated but not completed. These studies are being conducted in consultation with appropriate state and federal resource agencies and will be ongoing as the permitting process continues.

The primary benefit of the proposed Lower Bois d'Arc Creek Reservoir is to provide a needed water supply for future demands in the NTMWD service area. In addition, the project would stimulate economic growth in Fannin County and create substantial recreational opportunities.

Mitigation

The NTMWD proposes to mitigate project impacts by developing and implementing a multi-faceted compensatory mitigation plan. The plan would consist of some combination of the following components:

- Mitigation bank credit purchase and/or in-lieu fee agreements
- Instream flow releases
- Stream restoration and riparian habitat enhancement
- Purchase of lands and management for wildlife habitat enhancement
- Land purchases to expand the Caddo National Grasslands within the congressional proclamation boundary
- Water quality protection measures and shoreline management planning
- Creation of waterfowl management areas

Ultimately, the components of the mitigation plan will be determined by the USACE based upon consultation with other resource agencies and the NTMWD. This process will establish the appropriate mitigation measures. All proposed mitigation that would require land acquisition would be accomplished as a willing seller/willing buyer transaction.

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1.0 INTRODUCTION

Lower Bois d'Arc Creek Reservoir is a proposed reservoir on Bois d'Arc Creek, a tributary of the Red River. Figure 1-1 shows the location of the project, which is in Fannin County in North-Central Texas. The project will develop a reliable water supply for the rapidly growing demands of the North Texas Municipal Water District and its customers. The water will be used in the North Texas Municipal Water District service area in Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rockwall and Rains Counties, Texas.

PURPOSE AND NEED

NTMWD's current water sources cannot meet the projected demands.

Conservation and reuse alone will not meet the shortages.

Lower Bois d'Arc Creek Reservoir will help meet NTMWD's water shortages.

Projected use from Lower Bois d'Arc Creek Reservoir:

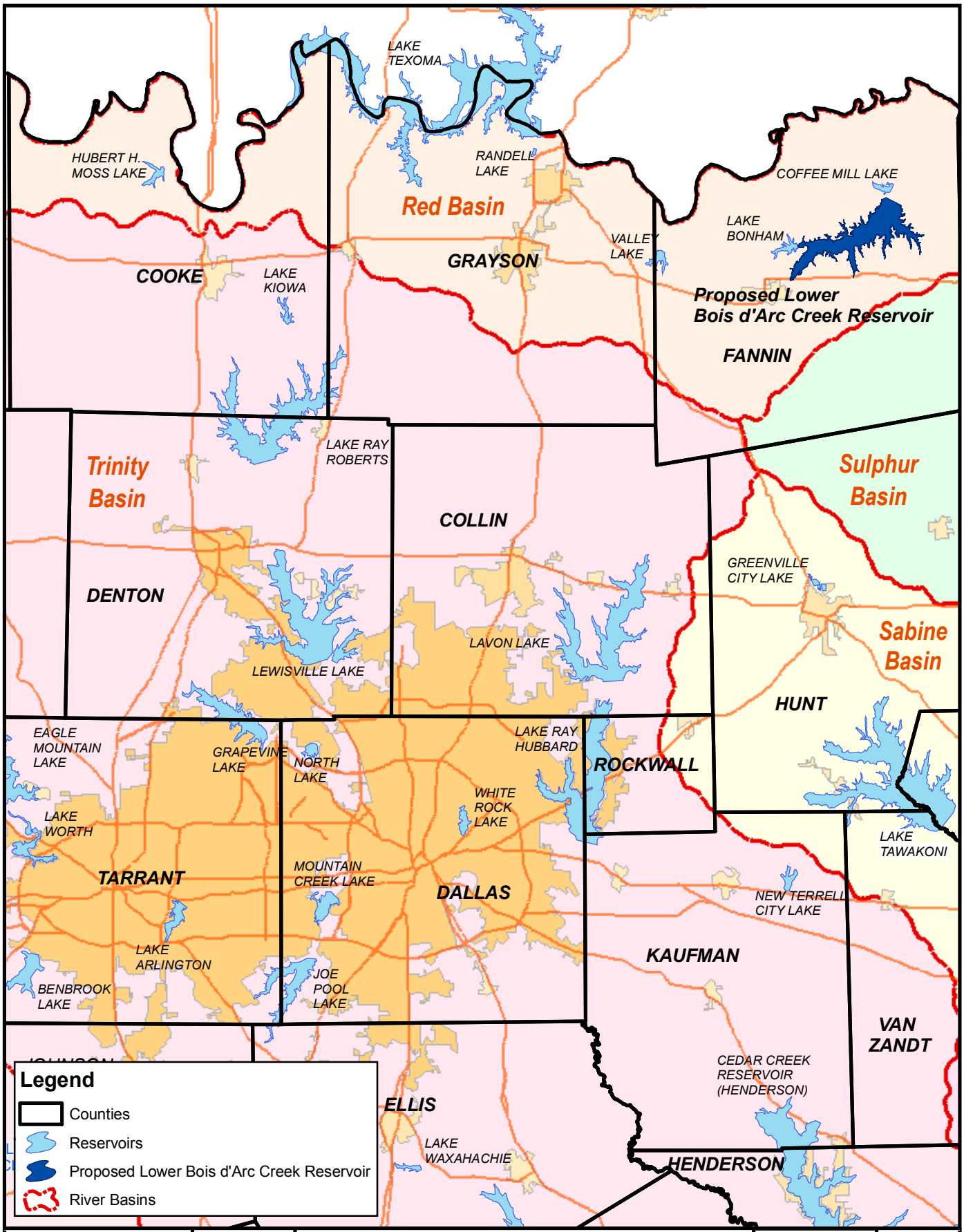
- **12,000 af/y in 2020**
- **121,000 af/y in 2030**

1.1 Background

The proposed Lower Bois d'Arc Creek Reservoir Dam is located in Fannin County in the Red River Basin, approximately 15 miles northeast of the City of Bonham. A reservoir at this site (then called the Bonham Reservoir) was included in the Red River Compact (Red River Compact Commission, 1979). The project was studied previously for the Red River Authority and the North Texas Municipal Water District (Freese and Nichols, 1984, 1996 and 2006(b)) and was recommended as a water supply for the North Texas Municipal Water District in numerous state water plans, including the most recent *2007 Texas State Water Plan* (TWDB, 2006).

1.2 Purpose and Need for the Project

The North Texas Municipal Water District (NTMWD) provides wholesale treated water, wastewater treatment, and regional solid waste services to member cities and customers in a service area covering parts of Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall Counties in North Central Texas. The NTMWD service area, shown on Figure 1-2, is one of the fastest growing areas in the state of Texas. A list of the NTMWD's water supply customers is shown on Table 1-1. State population projections show the NTMWD's service population to increase from 1.5 million to 3.3 million by 2060 (Freese and Nichols, 2006(b), TWDB, 2006). This growing population and the location of this growth is the driving force for



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North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

Project Location

FN JOB NO	NTD06128
FILE	GeneralLocationMap.mxd
DATE	August 28, 2006
SCALE	1:830,000
DESIGNED	BME
DRAFTED	BME

1-1
FIGURE

Table 1-1
Current Direct and Potential Customers of NTMWD

Member City	Customer	Potential Future Customers
Allen	Bonham	Anna
Farmersville	Caddo Basin SUD	Blue Ridge
Forney	Cash WSC	Caddo Mills
Frisco	College Mound WSC	Celina
Garland	Copeville WSC	Ector
Mesquite	East Fork SUD	Honey Grove
McKinney	Fairview	Howe
Plano	Fate	Leonard
Princeton	Forney Lake WSC	South Grayson County WSC
Richardson	Gastonia-Scurry WSC	Savoy
Royse City	Josephine	Southwest Fannin County SUD
Rockwall	Kaufman	Trenton
Wylie	Kaufman Four-One	Van Alstyne
	Lavon WSC	
	Little Elm	
	Lucas	
	Melissa	
	Milligan WSC	
	Mt. Zion WSC	
	Murphy	
	Nevada WSC	
	North Collin WSC	
	Parker	
	Prosper	
	Rose Hill WSC	
	Rowlett	
	Sachse	
	Saint Paul	
	Seis Lagos MUD	
	Sunnyvale	
	Terrell	
	Wylie NE WSC	

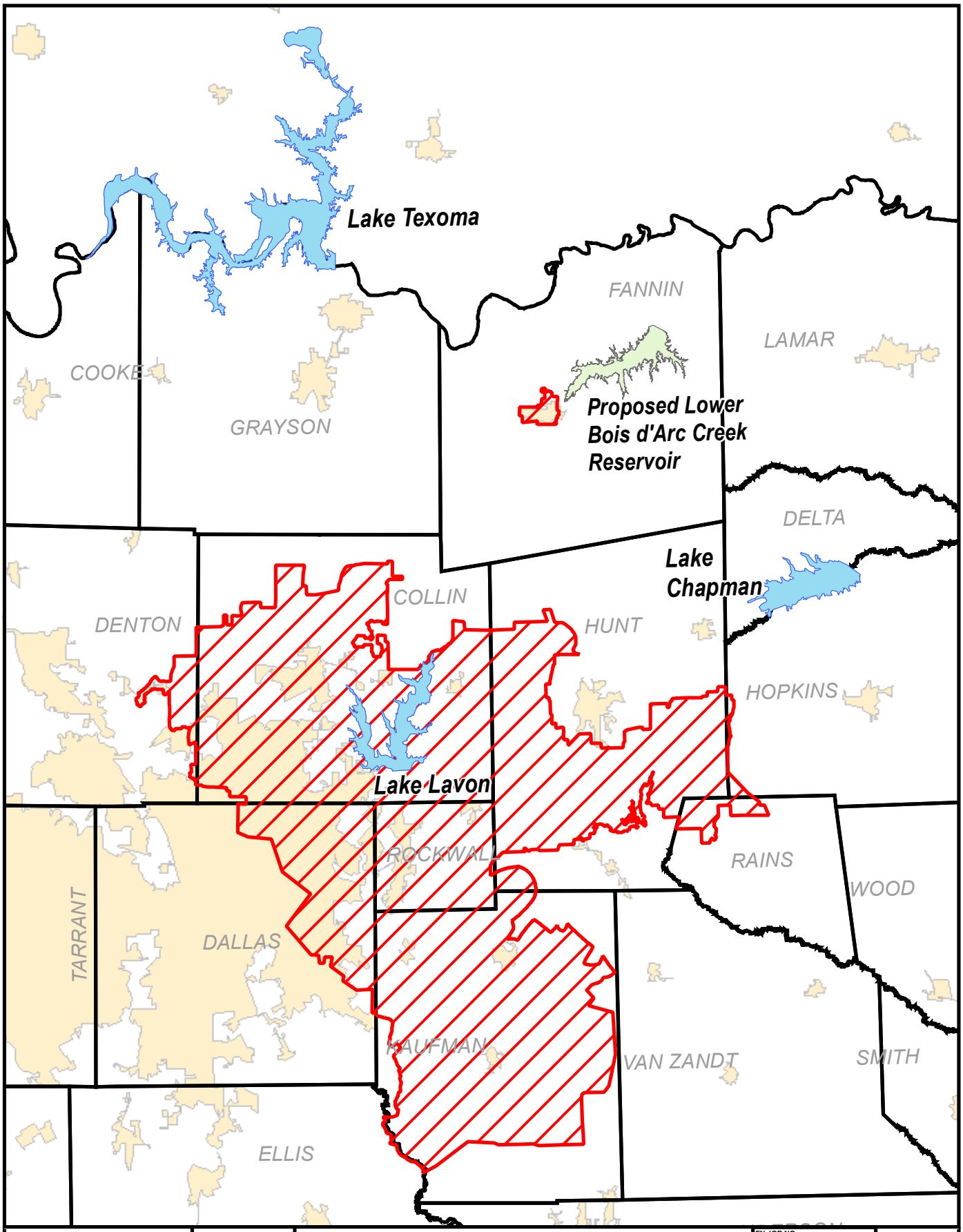
Note: This list does not include the indirect customers of the NTMWD's member cities or direct customers.

increased demands for water and the need to develop new sources of water supply. To address these needs, the NTMWD will need to construct a new northern water treatment plant by 2017 to serve the fast growing northern sectors of its service area. The Lower Bois d'Arc Creek Reservoir will provide new supply to the northern plant to help meet this increasing demand.

The primary water supply currently available to the NTMWD includes raw water from three reservoirs (Lakes Lavon, Texoma, and Chapman), wastewater reuse from the NTMWD's Wilson Creek Wastewater Treatment Plant, and the East Fork Raw Water Supply Project (2008). The supplies expected to be available from these sources in 2010 and 2060 are shown in Table 1-2. To meet immediate needs, the NTMWD has also contracted with the Sabine River Authority and Greater Texoma Utility Authority (GTUA) for interim water supplies until new sources can be developed. Including the interim supplies, the total amount of water currently available to NTMWD is 381,000 acre-feet per year in 2010 and 416,000 acre-feet per year in 2060.

With populations expected to more than double over the next fifty years, the projected demands for water are shown to increase from 371,000 acre-feet per year in 2010 to 799,000 acre-feet per year in 2060 (see Table 1-3). To help meet these needs, the NTMWD is actively promoting conservation measures with its member and customer cities, and NTMWD is currently implementing the largest wastewater reuse program in the State. Even with advanced conservation measures and increases in wastewater reuse, the NTMWD's current water supplies fall short of meeting the long-term projected demands. By 2020 the NTMWD will have a projected shortage of 90,000 acre-feet per year, increasing to 318,000 acre-feet per year by 2060 (see Table 1-4).

To address these shortages and provide a reasonable reserve for future growth and unforeseen conditions, the *2007 Texas State Water Plan* recommends multiple water management strategies for NTMWD, including additional conservation and reuse, the connection of existing sources, and the development of new water supplies. The development of the Lower Bois d'Arc Creek Reservoir is one of the strategies recommended in the *2007 Texas State Water Plan* for NTMWD. As shown on Figure 1-3, the Lower Bois d'Arc Creek Reservoir will provide additional water supply to help meet the NTMWD's water shortages beginning in 2017. After 2030, the NTMWD will need to implement additional water management strategies to continue to meet its growing water demands.



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North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

NTMWD Service Area

FN JOB NO	NTD06130
FILE	Figure1-2.mxd
DATE	May 30, 2008
SCALE	1:900,000
DESIGNED	SFK
DRAFTED	BME

1-2
FIGURE

Table 1-2
Supply Available to NTMWD from Existing Sources

Source	Supply Available (Acre-Feet per Year) [a]	
	2010	2060
Lake Lavon	104,000	104,000
Lake Texoma (NTMWD Right)	77,000	77,000
Lake Chapman	50,000	46,000
Wilson Creek Reuse	49,000[b.]	72,000[b.]
Lake Bonham	5,000 [c]	5,000 [c]
East Fork Raw Water Project	30,000[d.]	102,000 [d]
Upper Sabine Supplies (Lake Tawakoni)	50,000	10,000
Lake Texoma (Interim Purchase from GTUA)	16,000[e.]	0
Total	381,000	416,000

a. Supply is from the *2007 Texas State Water Plan* (TWDB, 2006) rounded to the nearest thousand acre-feet, unless otherwise noted.
b. Includes supplies developed since the publication of the *2007 Texas State Water Plan*.
c. Available supply is increased from the *2007 Texas State Water Plan* due to new water treatment plant.
d. 2010 supply is based on available return flows with current infrastructure. Additional infrastructure is needed for 2060 supply (Trinity River Main Stem Pump Station).
e. Supply as of 2010 from Interim Purchases from GTUA is based on 14 mgd.

Table 1-3
Projected Water Demands through 2060

Entity	Projected Demands for Water from NTMWD through 2060 (Acre-feet per Year)					
	2010	2020	2030	2040	2050	2060
McKinney	24,715	40,242	58,554	79,216	94,472	108,430
Frisco	45,615	66,088	80,628	88,889	95,829	99,133
Plano	72,439	75,080	77,318	79,810	82,281	85,069
Garland	42,911	45,702	48,139	50,151	52,087	52,087
Mesquite	28,676	34,294	38,814	41,475	42,396	42,670
Allen	23,657	28,806	33,773	35,318	36,029	36,330
Richardson	32,383	36,123	35,993	35,602	35,343	35,343
Rockwall	8,423	14,971	19,167	21,507	22,075	22,075
Wylie	6,862	10,754	13,353	18,506	19,483	21,283
Rowlett	12,283	15,318	17,154	18,668	19,860	20,905
Other Member Cities and Current Customers	67,437	102,673	124,914	150,809	181,496	221,401
Total Member Cities and Current Customers	365,401	470,051	547,807	619,951	681,351	744,726
Potential Customers	5,842	12,887	20,074	30,016	40,749	54,450
Total Current and Potential Customers	371,243	482,938	567,881	649,967	722,100	799,176

a. Listed in order of projected 2060 demands for water from NTMWD, with 2060 demands of 20,000 acre-feet per year or more listed individually.
b. Projected 2060 demands are 210 acre-feet per year less than those in the *2007 Texas State Water Plan* (TWDB, 2006) due to slight differences in projected demands for water from NTMWD in Fannin County.

Figure 1-3
NTMWD Projected Water Needs

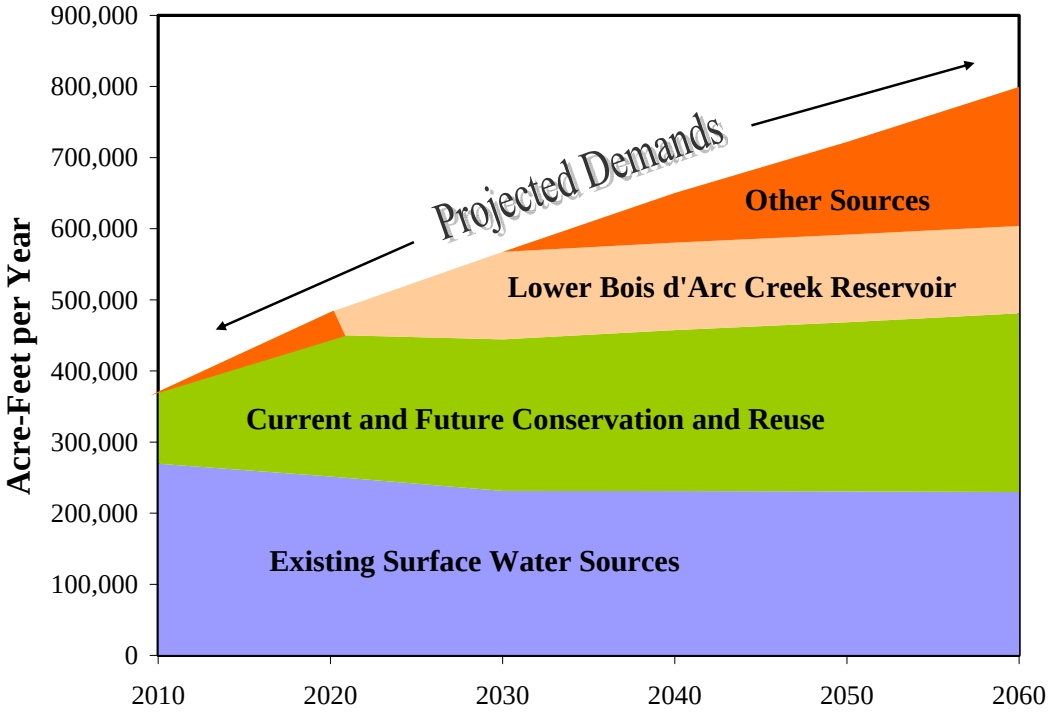


Table 1-4
Comparison of Current Supply and Projected Demands for NTMWD

Source	Supply Available (Acre-Feet per Year)					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Existing Sources [a.]	381,400	378,400	371,400	389,400	414,400	416,400
Treatment and Distribution losses [b.]	(19,000)	(19,000)	(19,000)	(19,000)	(21,000)	(21,000)
Available Treated Water Supply	362,400	359,400	352,400	370,400	393,400	395,400
Projected Demand [c.]	371,243	482,938	567,881	649,967	722,100	799,176
Additional Conservation [c]	13,000	34,000	48,000	61,000	73,000	86,000
Shortage (rounded to nearest thousand)	**0**	**90,000**	**167,000**	**219,000**	**256,000**	**318,000**

a. Existing supply is from *2007 Texas State Water Plan* with changes noted in Table 1-2.
b. Based on historical records, treatment and distribution losses in the NTMWD system are assumed to be 5 percent of raw water diversions.
c. Projected demands are from Table 1-3. Additional conservation is from the *2007 Texas State Water Plan*.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Description of Proposed Action

The development of Lower Bois d'Arc Creek Reservoir is a recommended water supply project for the NTMWD in the *2007 Texas State Water Plan*. The dam and reservoir would be located in Fannin County in the Bois d'Arc Creek watershed, approximately 15 miles northeast of the City of Bonham. At its conservation pool, the reservoir will store 367,609 acre-feet of water. The firm yield estimate for this project is 126,200 acre-feet per year. The project is intended to be completed and operational by 2017.

ALTERNATIVES

Lower Bois d'Arc Creek Reservoir is the preferred alternative based on economic and environmental factors and the ability to satisfy the purpose and need for the project.

Practicable alternatives are limited:

- **Distant projects have high capital costs, greater energy use and higher long-term O&M costs.**
- **Brackish water has treatability concerns, brine disposal issues and uncertain costs and regulatory requirements.**
- **Existing sources have institutional and political concerns associated with "willing seller" and other commitments.**

The project will be used as water supply for customers of NTMWD in nine counties in North-Central Texas, including Fannin County. Most of the water used by NTMWD is expected to be transported via pipeline to a new treatment plant located near the City of Leonard in Fannin County. In the near term, while water availability from Lower Bois d'Arc Creek Reservoir exceeds the capacity of the new water treatment plant, water may also be delivered through the bed and banks of Pilot Grove Creek and Lake Lavon to other NTMWD facilities.

2.1.1 Dam and Reservoir

Lower Bois d'Arc Creek Reservoir Dam will be constructed as a zoned earthen embankment. The dam will be about 10,400 feet in length and will have a maximum height of about 90 feet. Based on the preliminary design developed for the water rights application, the top elevation of the embankment was 553.0' msl. Subsequent to the submittal of the water rights application, the Probable Maximum Flood (PMF) analysis was updated to reflect updated elevation contours upstream of the reservoir site. The updated PMF analysis is included in Appendix A, and also includes an assessment of the potential impacts to flooding upstream of the reservoir site. Based on the updated study, the PMF water surface elevation slightly increased

from 549.8' msl to 550.5' msl. This increase resulted in the need to raise the top of dam elevation to 553.5' msl to provide adequate freeboard during a PMF event. At this elevation, the embankment will provide 19.5 feet of freeboard above the conservation pool of Lower Bois d'Arc Creek Reservoir, at elevation 534.0' msl. The dam configuration will be finalized during final design as additional data are developed.

The upstream and downstream side slopes of the proposed embankment are expected to be 3.5 horizontal to one vertical. All fill for the embankment is expected to come from required excavations of the spillways and from the reservoir area. Soil cement will be placed on the upstream slope and a grass cover will be placed on the downstream slope. Copies of the plan, profile and cross-section drawings for the proposed dam were included with the 404 permit application.

2.1.2 Service Spillway and Outlet Works

The service spillway will be located near the right (east) abutment of the dam. The spillway will consist of an approach channel; a 150-foot uncontrolled concrete weir, chute, hydraulic jump stilling basin and outlet channel. The weir will consist of a concrete gravity, ogee-type section with a crest length of 150 feet. The crest of the weir will be at elevation 534.0' msl. The spillway structure will extend 958 feet downstream from the centerline of the dam to the downstream edge of the end sill. A hydraulic jump stilling basin, with baffle blocks and an end sill, will be provided. The stilling basin will be at elevation 456.0' msl and it will be 128 feet long. Spillway discharges will be conveyed to Honey Grove Creek by a discharge channel approximately 2,300 feet long with a 150-foot bottom width and then flow approximately 1,500 feet to Bois d'Arc Creek.

Low-flow releases will be made through a 36-inch diameter low-flow outlet located on the right (east) side of the floodplain near the toe of the right abutment. The conduit will extend through the dam and will have an impact basin to dissipate energy. The low flow exit channel will extend to the service spillway exit channel, which will then direct flow to Bois d'Arc Creek. The outlet will include a multiple-level intake tower in the reservoir to allow for required downstream releases.

An emergency spillway will be located in the right abutment of the dam. The spillway is

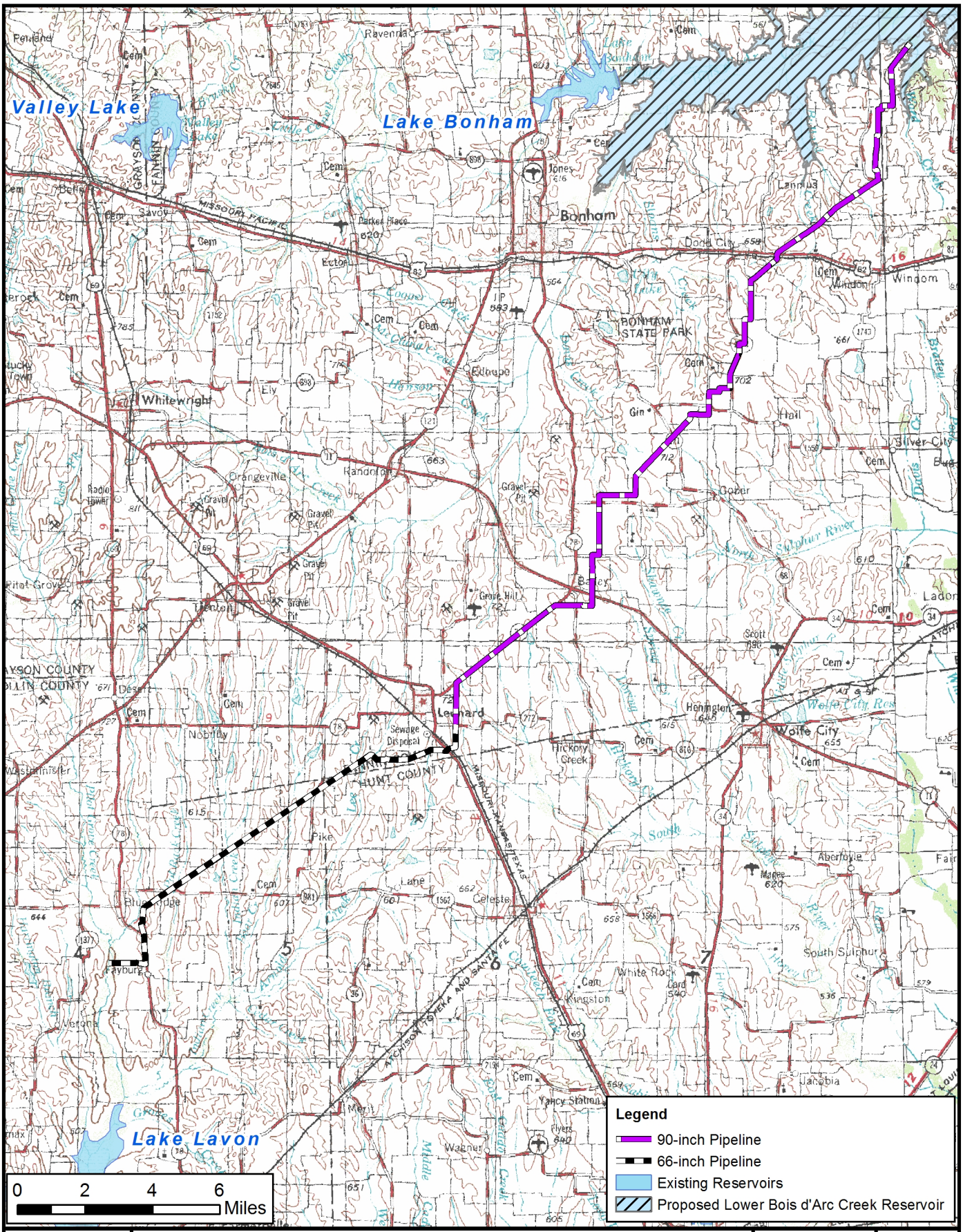
designed as a 1,400-foot wide uncontrolled broad crested structure with the crest elevation at 541' msl. This elevation was selected to contain the 100-year storm such that no flow passes through the emergency spillway during this event.

2.1.3 Raw Water Transmission Facilities

Raw water from the reservoir will be transported by a pipeline to a proposed water treatment plant near the City of Leonard in Fannin County as shown on Figure 2-1. To allow the NTMWD the ability to treat water from Lower Bois d'Arc Creek Reservoir at its existing facilities in Wylie, Texas, the transmission system will include a pipeline and discharge outlet to Pilot Grove Creek, a tributary of the East Fork Trinity River, to deliver raw water to Lake Lavon. The outlet structure is expected to be located approximately 5.4 miles north of Lake Lavon in the reach of Pilot Grove Creek between F.M. 545 and F.M. 2756. The raw water would be transported via the bed and banks of Pilot Grove Creek and Lake Lavon to the NTMWD's intake structures on Lake Lavon.

The transmission system to the proposed water treatment plant near Leonard consists of approximately 29 miles of 90-inch pipe, a pump station and intake structure at the reservoir, and a 460 million gallon terminal storage reservoir located near the new water treatment plant. This transmission system will have an initial capacity of 135 million gallons per day (mgd), with an ultimate capacity of 170 mgd. The transmission system to Pilot Grove Creek will include approximately 14.4 miles of 66-inch pipeline, an outlet structure at Pilot Grove Creek and appropriate controls. The maximum daily discharge to Pilot Grove Creek through the 66-inch pipeline will be 113 mgd.

The NTMWD proposes to follow the terms and conditions of the current (2007) Nationwide Permit 12 (NWP 12), *Utility Line Activities*, as the design criteria for the raw water pipeline in order to avoid and minimize impacts to waters of the U.S. Thus, construction of the pipeline would include such measures as restoring preconstruction contours in waters of the U.S.; limiting total impacts at a single crossing to less than 0.5 acre with a goal of less than 0.1 acre; and backfilling the top 6 to 12 inches of the pipeline trench in wetlands with topsoil from the trench. A copy of the 2007 NWP 12 is included in Appendix E. Prior to final design and construction, a detailed jurisdictional determination would be conducted for the pipeline route to



North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

Proposed Reservoir and Transmission System Location
USGS 250K Topographic Map

FN JOB NO	NTD07405
FILE	Figure2-1.mxd
DATE	February 11, 2008
SCALE	1:250,000
DESIGNED	BME
DRAFTED	BME

2-1
FIGURE

allow identification, avoidance, and minimization of impacts to waters of the U.S. Because activities that meet the terms and conditions of NWP 12 by definition would result in no more than minor impacts, no further discussion of the environmental effects of the raw water transmission line is included in this report.

In addition to the primary NTMWD transmission system, some portion of the water is projected to be used locally in Fannin County, including additional supply for the City of Bonham. The *2007 Texas State Water Plan* estimates that by 2060 as much as 8,600 acre-feet per year of water could be provided from the proposed reservoir to Fannin County. The proposed Fannin County Water Supply Project would require construction of additional transmission, treatment and distribution facilities in Fannin County. The amount of water from the proposed Lower Bois d'Arc Creek Reservoir for the Fannin County Project is dependent on local entities entering contracts (direct or indirect) with NTMWD. The Fannin County Water Supply Project is not part of this 404 permit application, and any additional authorizations needed to develop the Fannin County Water Supply Project will be obtained separately.

2.1.4 Proposed Project Operation

NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni (Upper Sabine supply), reuse and interim supplies (see Table 1-2). In the future, NTMWD plans to add other sources of water in addition to the Lower Bois d'Arc Creek Reservoir, several of which are located farther away from the NTMWD service area. NTMWD proposes to optimize its water supplies by operating the Lower Bois d'Arc Creek Reservoir as part of its overall system, relying primarily on water supply sources close to its service area during relatively wet times and increasing water use from sources farther away from its service area during drier times.

The proposed transmission system will permit NTMWD to supply raw water directly to a new northern water treatment facility via the primary transmission line. A secondary pipeline and discharge structure at Pilot Grove Creek will allow water from Lower Bois d'Arc Creek Reservoir to be transported through Lake Lavon and used at the existing NTMWD water treatment plant in Wylie or other facilities. Water from Lower Bois d'Arc Creek Reservoir that is transported through Lake Lavon will decrease as demands for water from the new northern water

treatment plant grow over time.

2.1.5 Estimated Project Costs

Table 2-1 shows the estimated capital costs for the Lower Bois d'Arc Creek Reservoir Project, including construction costs, engineering, permitting and mitigation. The total estimated capital cost of the project is $529 million (December 2006 prices). Assuming a yield of 126,200 acre-feet per year, raw water from the project will cost approximately $406 per acre-foot ($1.25 per 1,000 gallons) during repayment of debt. After a 30-year amortization period, the cost of raw water from the project drops to $65 per acre-foot ($0.20 per 1,000 gallons).

Table 2-1
Estimate of Probable Costs for the Lower Bois d'Arc Creek Reservoir Project
Costs Based on December 2006 Prices

Item	Estimated Cost
Land Cost	$86,893,700
Dam & Reservoir	$70,113,800
Conflicts	$23,924,600
Pipelines & Outlet Structure	$198,288,800
Pump Stations	$34,467,000
Terminal Storage Reservoir	$19,416,600
Permitting and Mitigation	$95,689,700
Total Cost	***$528,794,200***

Construction costs include cost of clearing and grubbing of the reservoir site, construction of the dam and outlet structures, resolution of conflicts (roads, structures, etc.), lake intake, pipelines and pump stations, right-of-way for transmission facilities, a terminal storage reservoir, and an outlet structure on Pilot Grove Creek. Engineering and contingencies are estimated at 30 percent of construction cost for the reservoir and 35 percent for pump stations and conflict resolution. Costs for the pipeline are based on a preliminary routing study and include 20 percent for contingencies and 12 percent for engineering and surveying. For purposes of the preliminary cost estimate, permitting and mitigation costs are estimated at nearly $96 million. Costs for mitigation will be refined as the mitigation plan is developed.

Annual costs for the project assume repayment of the debt service at 6 percent interest over 30 years, and electric costs at $0.08 per kWh. Operation and maintenance costs are

assumed to be 1.5 percent of construction costs for the dam, 2.5 percent of construction costs for pump stations, and 1 percent of construction costs for pipelines.

2.2 Screening of Alternatives to Proposed Action

Alternatives to the proposed action include the "no action" alternative and other water supply strategies that are available and can be implemented to meet the project objectives. For the purposes of this report, the alternatives are grouped as follows: 1) alternatives that do not involve a discharge of dredged or fill material into the waters of the United States; and 2) alternatives that discharge dredged or fill material at other locations in waters of the United States.

The USACE Regulatory Guidance Letter 02-2 relating to compensatory mitigation indicates that the USACE must consider state planning during the 404 permit processing. In 1997 the state of Texas initiated a regional water planning process to assess the future water needs of the state and develop a long-range state water plan to meet these needs. The most recent State Water Plan was published in December 2006 (*2007 Texas State Water Plan*) and includes recommended water management strategies for the NTMWD.

As part of the state water planning process, many potential water management strategies are identified and evaluated. The state water plan considered 23 different water management strategies to meet the projected water supply shortages for NTMWD through 2060. Of these considered strategies, twelve strategies were recommended for implementation by the NTMWD, including the Lower Bois d'Arc Creek Reservoir. Since the *2007 Texas State Water Plan* was developed, the NTMWD has implemented five of the recommended strategies and plans to implement two additional strategies prior to development of the Lower Bois d'Arc Creek Reservoir. The parts of the recommended plan yet to be implemented include developing new water supplies and utilizing interim water sources while long-term strategies are developed.

Water supply strategies that are currently being implemented or recommended to be implemented prior to the proposed action are not considered alternatives to the project. These include:

- Water Conservation (implemented)

- Additional Wilson Creek Reuse Project (implemented)
- Interim Purchase from GTUA (implemented)
- East Fork Raw Water Supply Project (implemented)
- Upper Sabine Basin Supply (implemented)
- Interim Treated Water Purchase from Dallas Water Utilities (to be implemented prior to proposed action)
- Additional Lake Lavon Yield (to be implemented prior to proposed action)

The other four strategies recommended in the *2007 Texas State Water Plan* for implementation after the Lower Bois d'Arc Creek Reservoir include:

- Additional Lake Texoma water with blending with new fresh water supply
- Marvin Nichols Reservoir
- Toledo Bend Reservoir
- Oklahoma water supply

The supplies that are currently available from conservation and additional reuse projects, GTUA interim supply and Upper Sabine Basin Supply are included in the needs analyses discussed in Section 1 and are not alternatives to the Lower Bois d'Arc Creek Reservoir Project. The water management strategies planned to be implemented prior to Lower Bois d'Arc Creek Reservoir include the purchase of treated water from Dallas Water Utilities and permitting additional yield from Lake Lavon. Both of these strategies will help meet the NTMWD's water needs until the Lower Bois d'Arc Creek Reservoir is completed, but collectively will only supply approximately 20 mgd of treated water and will not be able to meet the NTMWD's needs beyond 2020. As such, these strategies do not meet the project's purpose and need to provide sufficient supplies to meet the NTMWD's needs over the next 20 years.

Potential alternatives to the Lower Bois d'Arc Creek Reservoir project include the development of new reservoirs, transporting water from existing reservoirs, development of new groundwater supplies and desalination of brackish water.

All of the identified potential alternatives to the proposed project will involve discharges of dredged or fill material into waters of the United States with the exception of the No Action Alternative and Other Water Conservation Alternative. At a minimum, the other alternatives

will require the construction of infrastructure to store and transport water supplies to the NTMWD service area that will include the discharge of dredged or fill material to other locations in waters of the United States. Descriptions of the potential project alternatives are presented in the following sections. A synopsis of the applicability of these potential strategies as a practicable alternative to the proposed project is discussed in Section 2.2.1 and summarized in Table 2-2. Descriptions of the alternatives, including the "no action" alternative are included in Sections 2.2.2 through 2.2.20.

2.2.1 Comparison of Alternatives

The review of the potential alternatives considered many factors, including cost of the water, quantity, reliability, the potential impacts of developing the project on the environment, natural resources and other water users, timing to develop the strategy and potential implementation issues. Table 2-2 presents a list of the strategies considered and the reason(s) a strategy was considered not a practicable alternative to the Lower Bois d'Arc Creek Reservoir project. A comparison of the unit costs for the alternative strategies is shown on Table 2-3 and on Figure 2-2.

The construction of Lower Bois d'Arc Creek Reservoir is the recommended approach for NTMWD to provide additional near-term water supplies. The NTMWD is projected to have water shortages of 90,000 acre-feet per year by 2020. Some of this shortage will be met through the additional wastewater reuse and additional supply from Lake Lavon. Lower Bois d'Arc Creek Reservoir would provide the remainder of the supply to meet the deficit in 2020. By 2030 the reservoir would be fully utilized to help meet the NTMWD's growing water needs. This source is the preferred alternative because it is located relatively close to the area with need, can provide sufficient water, and have a relatively low unit cost of water. The Lower Bois d'Arc Creek Reservoir could also serve as a fresh water supply to potentially blend with water from Lake Texoma, thereby further extending the available resources while conserving energy and costs.

Strategies that are not practicable alternatives to the proposed project typically have higher unit costs, greater uncertainty of reliable yield than Lower Bois d'Arc Creek Reservoir, or may be committed to other users.

Table 2-2
List of Potential Water Supply Alternatives for NTMWD

Strategy	Practicable Alternative (Yes/No)	Comment
No Action		Retained for comparison
New Lake Texoma (Blend)	No	Requires additional new source of fresh water to blend to meet water quality standards.
Marvin Nichols Reservoir	No	Greater impacts to waters of U.S. Requires other participates to make project cost effective.
Toledo Bend Reservoir	No	High costs and energy use.
Oklahoma Water	No	Current political and legal impediments.
New Lake Texoma (Desalinate)	No	High costs and energy use. Potential environmental impacts and uncertainty associated with brine disposal. Reduced quantity.
Lake O' the Pines	No	Water rights holders have not committed to selling water. Competing local interests.
Wright Patman - Texarkana	No	Texarkana has not committed to selling water.
Wright Patman - Raise Pool	No	Impacts to White Oak Creek mitigation area. Conflicts with Dallas long-range water supply plan.
Wright Patman - System	No	Water rights holders not committed to sell water. Environmental impacts to mitigation area and conflicts with Dallas' long-range plan. High costs and energy use.
Ogallala Groundwater	No	High cost and uncertainty with long-term reliability.
Carrizo-Wilcox Groundwater	No	High cost and competing local interests for water.
George Parkhouse North	No	Impacts to waters of U.S. Yield is impacted by potential upstream reservoirs.
George Parkhouse South	No	Impacts to waters of U.S. Yield is impacted by potential upstream reservoirs.
Livingston	No	Competing interests for water.
Sam Rayburn / Steinhagen	No	High costs and energy use. Competing interests for water.
Gulf of Mexico	No	Very high costs and high energy usage
Other Conservation	No	Limited participation, high costs, and does not meet identified purpose and need.
Upper Bois d'Arc Creek Reservoir	No	Does not meet purpose and need.

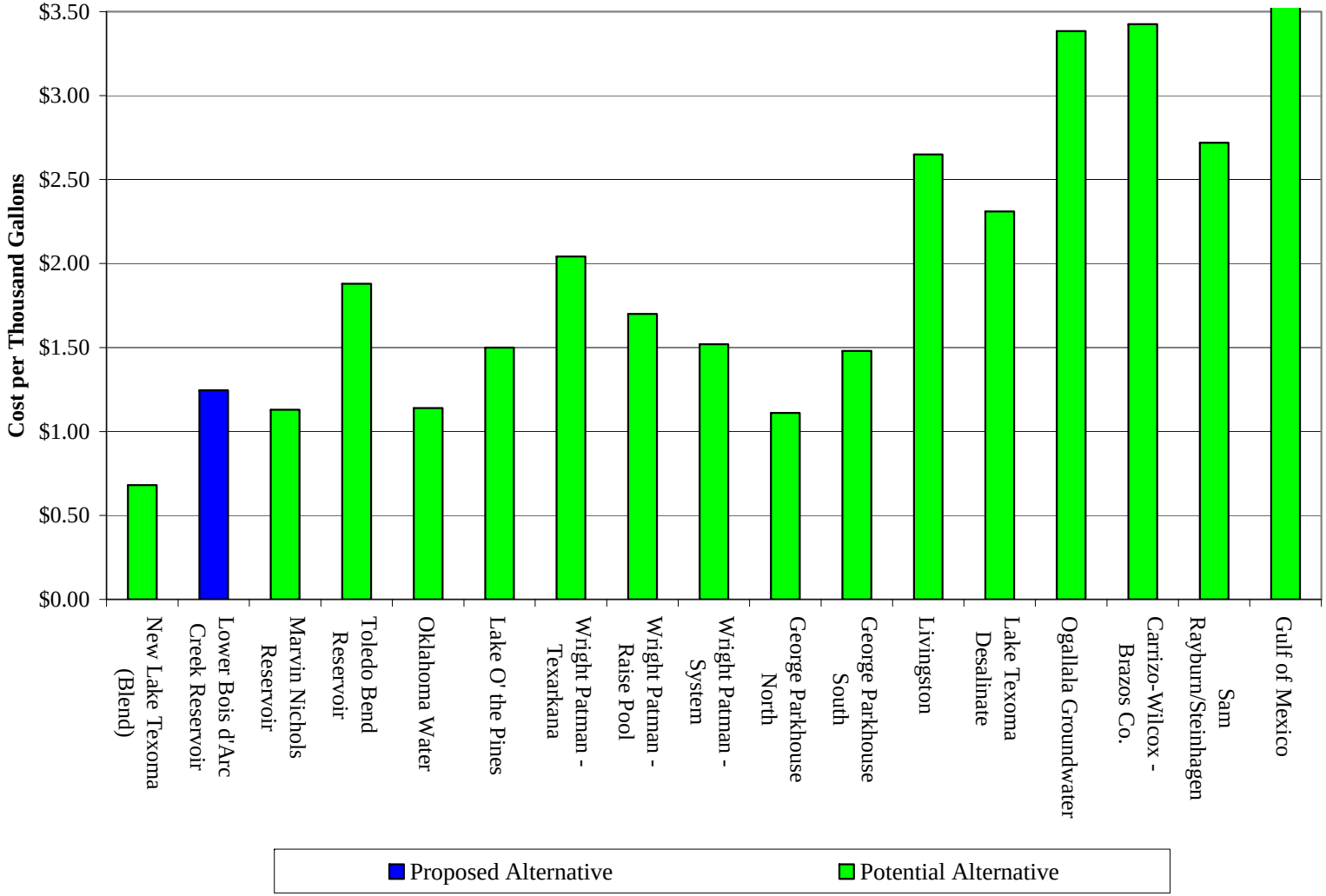
Table 2-3
Costs for Potential Supply Alternatives

Strategy	Texas State Water Plan Costs[1]			Updated 2006 Costs		
	NTMWD Share of Capital Cost	Unit Cost for NTMWD ($/kGal.)		NTMWD Share of Capital Cost	Unit Cost for NTMWD ($/kGal.)	
		Pre-Amort.	Post-Amort.		Pre-Amort.	Post-Amort.
Implemented at same time as Lower Bois d'Arc Creek Reservoir						
New Lake Texoma (Blend)	$201,829,000	$0.58	$0.18	$236,683,000	$0.68	$0.21
Lower Bois d'Arc Creek Reservoir	***$399,190,000***	***$0.87***	***$0.14***	***$593,505,204[2]***	***$1.25***	***$0.20***
Potential Alternatives						
Marvin Nichols Reservoir	$534,125,000	$0.94	$0.26	$626,362,140	$1.13	$0.33
Toledo Bend Reservoir	$886,002,000	$1.56	$0.57	$1,039,004,000	$1.88	$0.73
Oklahoma Water	$128,898,000	$0.95	$0.37	$151,157,000	$1.14	$0.46
Lake O' the Pines	$257,192,000	$1.25	$0.60	$301,606,000	$1.50	$0.73
Wright Patman - Texarkana	$429,176,000	$1.70	$0.74	$503,290,000	$2.04	$0.92
Wright Patman - Raise Pool	$825,088,000	$1.42	$0.39	$967,571,000	$1.70	$0.51
Wright Patman - System	$418,251,000	$1.26	$0.45	$555,191,000	$1.52	$0.57
George Parkhouse North	$362,322,000	$0.91	$0.23	$424,891,000	$1.11	$0.31
George Parkhouse South	$480,099,000	$1.24	$0.25	$563,006,000	$1.48	$0.33
Livingston	$1,299,183,000	$2.21	$0.77	$1,523,537,000	$2.65	$0.95
Lake Texoma Desalinate	$538,635,300	$1.96	$0.82	$631,651,000	$2.31	$0.97
Ogallala Groundwater	$1,994,699,000	$2.83	$0.61	$2,339,160,000	$3.38	$0.78
Carrizo-Wilcox - Brazos Co.	$577,413,000	$2.89	$1.28	$677,125,000	$3.43	$1.54
Sam Rayburn /Steinhagen	$1,252,392,000	$2.27	$0.69	$1,660,739,000	$2.72	$0.87
Gulf of Mexico	$2,836,207,000	$5.57	$2.41	$3,325,987,000	$6.63	$2.92

a. Costs for the *2007 Texas State Water Plan* are reported in 2002 dollars. Costs for the alternative strategies were updated to 2006 dollars using ENR indexing.

b. Capital cost includes interest during construction, which is required for SB1 cost estimates. Cost without interest during construction is $528,794,200.

Figure 2-2
Cost Comparison of Potential Alternatives to Lower Bois d'Arc Creek Reservoir



2.2.2 Description of No Action Alternative

Under the No Action Alternative the proposed dam would not be constructed and the project area would generally continue in its present state. The No Action Alternative does not meet the purpose and need to provide sufficient water supply to meet the projected water demands of the NTMWD. After implementing advanced water conservation, additional reuse, and other strategies recommended for implementation prior to the Lower Bois d'Arc Creek Reservoir, there still is a projected water shortage in 2020, increasing to a 312,000 acre-foot deficit by 2060. Without additional water supplies, the socio-economic impacts to the NTMWD service area would be great. A socio-economic study conducted as part of the *2007 Texas State Water Plan* showed that the failure to provide sufficient water to support growth in the North Texas area would result in lost income and tax revenues of nearly $161 billion through 2060 (TWDB, 2006). The "no action" alternative is not a practicable alternative.

Supply from New (undeveloped) Reservoirs

2.2.3 Marvin Nichols Reservoir Alternative

The Marvin Nichols Reservoir is a proposed reservoir in the Sulphur River Basin, and is a recommended strategy in the *2007 Texas State Water Plan* for the NTMWD, the Tarrant Regional Water District (TRWD), and the Upper Trinity Regional Water District (UTRWD). The total yield of Marvin Nichols Reservoir is 612,300 acre-feet per year, assuming that Lake Ralph Hall is constructed and that Marvin Nichols Reservoir is operated as a system with Wright Patman Lake.

The proposed reservoir, if constructed, would be the largest lake contained completely within the State of Texas. At the recommended conservation pool elevation of 328 feet msl, the reservoir would inundate approximately 67,400 acres. The U.S. Fish and Wildlife Service has classified some of this acreage as Priority 1 bottomland hardwoods, which is the highest quality classified by USFWS (USFWS, 1984). Previous studies indicate that approximately 39 percent of the reservoir site is classified as bottomland hardwood forest, 20 percent upland deciduous forest and 19 percent grasslands (HDR, Inc. *et al*, 2007). Additional studies are needed to confirm the quality and extent of these resources.

The Marvin Nichols Reservoir site is located approximately 29 miles upstream of an ecologically significant stream segment as identified by the Texas Parks and Wildlife Department, but is not directly located on a classified stream segment. The site will impact three known cemeteries, approximately 22 miles of oil and gas pipelines and 4 miles of state and federal highways (HDR, Inc. *et al*, 2007).

The Marvin Nichols Reservoir would provide considerable amounts of new water supply to the North Texas area at a relatively low cost. However, the development of this strategy will have greater environmental impacts than the proposed Lower Bois d'Arc Creek Reservoir. The inundation area of Marvin Nichols Reservoir is more than four times the inundation area of the Lower Bois d'Arc Creek Reservoir. Preliminary estimates of impacted wetlands and bottomland hardwoods for this alternative are considerably greater than the acreage determined for the proposed project. Development of the Marvin Nichols Reservoir also requires multiple participants to effectively achieve the cost benefits and full utilization of the available supply. As a result, the timing for this strategy is dependent upon the needs of the other participants. In the *2007 Texas State Water Plan*, this strategy is planned in phases, with Phase I being completed in 2030 and Phase II by 2050. Due to the permitting requirements and current opposition to this project, it is highly unlikely that this reservoir site could be permitted and developed by 2020 as an alternative to the Lower Bois d'Arc Creek Reservoir. This strategy also requires participation with other water providers. With these considerations, the Marvin Nichols Reservoir could not meet the NTMWD's projected water shortages over the next 10 to 20 years.

The Marvin Nichols reservoir is not a practicable alternative to the Lower Bois d'Arc Creek Reservoir project because it has greater environmental impacts and cannot be implemented within the time frame required to satisfy the purpose and need of this project.

2.2.4 George Parkhouse South Lake Alternative.

George Parkhouse Lake (South) is a potential reservoir located on the South Sulphur River in Hopkins and Delta Counties. It is located immediately downstream from Jim Chapman Lake and would yield 122,000 acre-feet per year (with 80 percent available for North Texas). At conservation elevation 401 ft. msl, George Parkhouse Lake (South) would inundate approximately 29,000 acres and store 652,000 acre-feet. As with the George Parkhouse North

Lake site, the yield of George Parkhouse Lake (South) would be reduced substantially by the development of Marvin Nichols Reservoir. The yield studies conducted as part of the Reservoir Site Protection Studies indicate the yield of this lake would be reduced by 60 percent to 48,400 acre-feet per year if constructed after Marvin Nichols (HDR *et al*, 2007).

The lake, as currently configured, would abut the dam for Jim Chapman Lake and over fifty percent of the land impacted would be bottomland hardwood forest or marsh (HDR *et al*, 2007). The proposed George Parkhouse Lake (South) is not a practicable alternative due to the uncertainty of the reliable supply with the development of other reservoirs in the river basin and the environmental impacts. Since the Marvin Nichols Reservoir is part of the NTMWD's long-range water supply plan, it is highly unlikely that George Parkhouse (South) Lake or George Parkhouse (North) Lake will also be developed.

2.2.5 George Parkhouse North Lake Alternative

George Parkhouse Lake (North) is a potential reservoir located on the North Sulphur River in Lamar and Delta Counties, about 15 miles east of the City of Paris. At a proposed conservation elevation of 410.0 ft msl, the reservoir would store 330,871 acre-feet of water and inundate 14,387 acres. The firm yield would be 144,300 acre-feet per year (with 80 percent of the yield available for NTMWD), but its yield would be reduced substantially by the development of Lake Ralph Hall and/or Marvin Nichols Reservoir. A sensitivity study of the reservoir yield found that the yield of George Parkhouse North could range from 32,100 acre-feet per year (assuming both reservoirs are constructed prior to George Parkhouse North) to 117,400 acre-feet per year assuming only Lake Ralph Hall is constructed prior to George Parkhouse North (HDR *et al*., 2007).

The reservoir site is located upstream of a designated Priority 1 bottomland hardwood preservation site known as Sulphur River Bottoms West. Most of the land impacted by this alternative is grassland or agricultural lands. Only about 200 acres are classified as bottomland hardwood forest (HDR *et al*., 2007). However, the amount of affected wetlands would require field surveys and verification.

The proposed reservoir is not a practicable alternative to Lower Bois d'Arc Creek Reservoir due to the uncertainty of the reliable supply with the development of other reservoirs

in the river basin.

2.2.6 Upper Bois d'Arc Creek Reservoir

Other potential dam site locations on Bois d'Arc Creek have been considered in previous studies. Most of these sites were studied as potential flood measures to reduce flooding along Bois d'Arc Creek and in the City of Bonham. An Upper Bois d'Arc Creek reservoir site was studied by the USACE in 1968, and subsequently reviewed again by the USACE in 2000 (USACE, 1968 and USACE, 2000). The proposed Upper Bois d'Arc Creek Reservoir would be located about 3.5 miles south of the City of Bonham. It would have a controlled drainage area of 108 square miles, which is about one third of the drainage area of the proposed project. The proposed reservoir would have a total storage of 137,500 acre-feet, with 82,040 acre-feet dedicated to water supply. Based on the USACE analyses, the Upper Bois d'Arc Creek reservoir would provide flood protection for the 50-year storm event and 24 mgd of water supply. Due to the smaller drainage area and smaller storage in the reservoir, this alternative cannot provide the amount of water supply needed for the project. A reservoir site upstream of the City of Bonham is not a practicable alternative to the proposed project.

2.2.7 Other New Reservoirs

Several other proposed reservoirs were recommended or considered in the *2007 Texas State Water Plan*, but were not considered for NTMWD because of commitments to other users. The proposed reservoirs include Lake Fastrill, Lake Columbia, Lake Tehuacana, and Lake Ralph Hall. Water from Lake Fastrill is committed to Dallas; most of the water from Lake Columbia is committed to users in the Neches River Basin; Lake Tehuacana is located adjacent to Richland-Chambers Reservoir, and would be operated by the TRWD; and Lake Ralph Hall would be developed and used by the UTRWD.

Transporting Water From Existing Reservoirs

2.2.8 Lake Texoma Alternatives

Lake Texoma is an existing USACE reservoir on the Red River on the border between Texas and Oklahoma. NTMWD has a water right to divert 84,000 acre-feet per year of water from Lake Texoma, and use 77,300 of this amount from Lake Lavon (after an allowance of

6,700 acre-feet per year in channel losses). Water from Lake Texoma is relatively high in dissolved salts. Currently NTMWD blends Lake Texoma water with its other sources to make it suitable for municipal use.

The U.S. Congress has authorized the reallocation of 150,000 acre-feet of storage in Lake Texoma from hydroelectric power generation to municipal use in Texas, with 50,000 acre-feet reserved for the Greater Texoma Utility Authority (GTUA). The NTMWD is currently negotiating a contract with the Tulsa District for the remaining 100,000 acre-feet of storage in Lake Texoma authorized for Texas. NTMWD has been granted a Texas water right to impound and divert this water. Due to the elevated levels of dissolved salts in Lake Texoma, the use of this supply will require either:

- The development of new fresh water supplies to blend at a treatment facility or
- The construction of a new desalination water treatment facility.

These implementation methods are very different and should be considered two different alternatives to Lower Bois d'Arc Creek Reservoir. Desalination of Lake Texoma water is discussed in Section 2.2.17.

Lake Texoma Development with New Fresh Water Supplies

The elevated dissolved salts in Lake Texoma would have some environmental impacts whether the water is used by blending or desalination. Due to environmental concerns and additional costs associated with large desalination projects, the NTMWD's preferred use of this water source is to blend the Texoma water with a new fresh water supply. It is anticipated that Texoma water would be blended in a constructed balancing reservoir near a treatment facility and not in an existing lake or stream. This would reduce potential impacts of added dissolved solids to local lakes or streams.

At this time, there are no readily available fresh water supplies in the amount needed to blend with the new water supply from Lake Texoma, and existing supplies are not sufficient to provide a blended water of acceptable quality for municipal use. Therefore, the blended alternative cannot be implemented without also implementing another water supply alternative to provide new fresh water to NTMWD. NTMWD does plan to make use of water supplies from this source, but only after development of other significant fresh water sources (such as Lower

Bois d'Arc Reservoir). Blending cannot be considered an alternative to Lower Bois d'Arc Reservoir in the next 20 years without implementation of another water supply source.

2.2.9 Toledo Bend Reservoir Alternative

Toledo Bend Reservoir is an 181,600 acre lake located in East Texas on the Texas-Louisiana state line. The total permitted supply from this source for Texas is 750,000 acre-feet per year. The Sabine River Authority of Texas operates the Texas portion of this lake. In the *2007 Texas State Water Plan* the transport of water from Toledo Bend Reservoir to the North Texas area is a recommended joint strategy for the NTMWD, TRWD, and the Sabine River Authority (SRA). This project, as presented in the *2007 Texas State Water Plan*, could deliver a total of 500,000 acre-feet per year, with 200,000 acre-feet per year for NTMWD.

This alternative will require multiple transmission pipelines to transport the water approximately 200 miles to North Texas. The current concept for this project includes the use and storage of existing reservoirs as part of the transmission system. This transfer of water is anticipated to have a low to medium low impact to the receiving reservoirs.

While this strategy will likely have fewer environmental impacts than the construction of a new reservoir, it will have greater capital costs and energy usage associated with the long transmission pipelines. NTMWD's share of the estimated pumping costs for this alternative is nearly $30 million per year for 200,000 acre-feet per year. For a comparable quantity of supply to Lower Bois d'Arc Creek Reservoir (126,000 acre-feet per year), the estimated pumping costs for water from Toledo Bend Reservoir would be approximately $18.6 million as compared to $4.5 million for water from Lower Bois d'Arc Creek Reservoir. (These costs assume electricity at $0.08 per kilowatt-hour.) As energy costs continue increase, the operating costs for water from Toledo Bend Reservoir will increase by a larger amount than estimated for the Lower Bois d'Arc Creek Reservoir. The higher energy usage also places additional burdens on existing and future electrical generating facilities, which creates additional environmental impacts to those directly associated with this project.

The Toledo Bend project is not a practicable alternative to the Lower Bois d'Arc Creek Reservoir project because it has significantly higher capital costs, greater energy usage, and the greater long-term operating costs than the costs for the Lower Bois d'Arc Creek Reservoir

project.

2.2.10 Water from Oklahoma Alternative

Another potential alternative is the use of water from Oklahoma. At the present time, the Oklahoma Legislature has established a moratorium on the export of water from the state. Assuming the moratorium is lifted in the future, the *2007 Texas State Water Plan* recommends that the NTMWD, the TRWD, and the UTRWD jointly develop a project to use water from Oklahoma. The recommended project is planned for 2060 and includes 50,000 acre-feet per year each for TRWD and NTMWD and 15,000 acre-feet per year for UTRWD.

Since the *2007 Texas State Water Plan* was published, the TRWD, UTRWD and NTMWD have each submitted water rights applications for water in Oklahoma. The NTMWD has applied for water from the Kiamichi River, Muddy Boggy Creek and stored water in Lake Hugo. At this time, the state cannot act upon these permits without further direction from the Oklahoma Legislature or the judicial system.

If the Oklahoma Water Resources Board grants an Oklahoma water rights permit, the NTMWD will also need to obtain a Texas interbasin water rights permit, 404 permit for the diversion structure and Texas State 401 water quality certification if Oklahoma water is discharged to a Texas stream or lake. Depending upon the source of water and its diversion location, a transmission system will be needed to the NTMWD's service area.

Due to the uncertainty of the Oklahoma moratorium on export of water to Texas and the status of the Oklahoma water rights permit, this strategy may not be able to be implemented in a timely manner to meet NTMWD's near-term water needs.

2.2.11 Lake O' the Pines Alternative

Lake O' the Pines is an existing USACE reservoir in the Cypress River Basin with Texas water rights held by the Northeast Texas Municipal Water District (NETMWD). The NTMWD has explored the possibility of purchasing supplies in excess of local needs from the Cypress Basin. According to the *2007 Texas State Water Plan* there could be as much as 89,600 acre-feet per year available for export from the basin. There are competing interests for this supply, including increased demands for steam electric power in the vicinity of this lake (northeast

Texas). The *2007 Texas State Water Plan* shows this source fully allocated to existing users.

Development of this source would require contracts with the NETMWD and other Cypress River Basin suppliers with excess supplies. At this time, NETMWD and other suppliers have not committed to selling this amount of water. Lake O' the Pines is about 120 miles from the Metroplex, and the distance, limited supply and uncertainty to reach agreements with existing water rights holders make this supply uncertain as an alternative to Lower Bois d'Arc Creek Reservoir.

2.2.12 Lake Wright Patman Alternatives

Lake Wright Patman is an existing reservoir in the Sulphur River Basin, about 150 miles from NTMWD. It is owned and operated by the USACE. The City of Texarkana has contracted with the USACE for storage in the lake and a supply of 13 MGD (14,568 acre-feet per year). Texarkana holds a Texas water right to use up to 180,000 acre-feet per year from the lake. However, to obtain a reliable supply of 180,000 acre-feet per year from Lake Wright Patman, Texarkana would have to activate a contract with the USACE to increase the conservation storage in the lake. Implementation of this contract requires an environmental evaluation of the change in operation of the reservoir as required by the National Environmental Policy Act. The USACE contract specifies that the maximum supply from this operational change is 84 MGD, or about 94,132 acre-feet per year, resulting in a total supply of 108,800 acre-feet per year. Accessing the full 180,000 acre-feet per year in the Texas water right would require additional modifications to the USACE contract.

There are three different strategies by which water could be made available to the NTMWD from Wright Patman Lake:

- Water could be purchased from the City of Texarkana under its existing water right.
- Flood storage in Wright Patman Lake could be converted to conservation storage, and the NTMWD could use the increased yield.
- Wright Patman Lake could be operated as a system with Jim Chapman Lake (formerly Cooper Lake) upstream to further increase yield.

The cost for each of these options is greater than the estimated costs for the Lower Bois d'Arc Creek Reservoir project. There are also other implementation issues that affect the

viability of the strategies. Each strategy is discussed in more detail below.

Purchase from Texarkana. Of the 180,000 acre-feet per year for which Texarkana currently has a water right, Texarkana could sell 100,000 acre-feet per year and still have sufficient supplies to meet its projected needs. Development of this supply would require activating the contract between Texarkana and the USACE for additional conservation storage (which would require some environmental studies and mitigation) and improvements to Texarkana's pump station on the lake. This strategy would require Texarkana to be willing to sell water to NTMWD. To date, Texarkana has not committed to selling water.

Raise Flood Pool. According to a recent study conducted for the USACE, increasing the top of conservation storage in Wright Patman Lake to elevation 228.64 feet msl and allowing diversions as low as elevation 215.25 feet msl would increase the yield of the project to about 364,000 acre-feet per year (Freese and Nichols, 2003). It was assumed that 180,000 acre-feet per year of the additional supply developed could be made available to water suppliers in North Texas. The remainder of the supply would be reserved for local use. The studies found that increasing the elevation above 228.64 feet msl would inundate portions of the White Oak Creek Mitigation Area, located upstream from Wright Patman Lake. (Approximately 500 acres of the mitigation area are below elevation 230 feet msl, and about 3,800 acres are below elevation 240 feet msl.) This strategy would require changes to the USACE operation of Wright Patman. Also, this strategy is recommended for Dallas in the City's long-range water supply plan and the *2007 Texas State Water Plan*. Due to the available quantity of water from this source, it is unlikely that both NTMWD and Dallas would pursue this strategy.

Purchase from Texarkana, Raise Flood Pool, and System Operation. The recent study conducted for the USACE indicated that system operation of Wright Patman Lake and Jim Chapman Lake could increase the yield from the two projects by about 108,000 acre-feet per year. It was assumed that the combination of purchasing water from Texarkana, converting flood storage to conservation storage, and system operation with Jim Chapman Lake could make 390,000 acre-feet per year available from Wright Patman Lake. The state water plan assumed that this strategy would be developed jointly with multiple water providers in North Texas. The amount of supply for the NTMWD would be 130,000 acre-feet per year. Other suppliers have

not committed to participating with this strategy. In addition to the uncertainty of multiple participants, this strategy would have the same implementation and environmental concerns noted for the other Wright Patman alternatives: contractual changes between the USACE and Texarkana, willing sellers, impacts to the White Oak Mitigation Area, changes to USACE operations of the lake, and conflicts with other potential users.

Due to the uncertainty of reaching contractual agreements with existing water rights holders, environmental impacts to the White Oak Mitigation Area and surrounding area, conflicts with other water suppliers, and the higher operational costs, water supply from Wright Patman Lake is not considered a practicable alternative to the Lower Bois d'Arc Creek Reservoir.

2.2.13 Lake Livingston Alternative

Lake Livingston is an existing reservoir on the Trinity River. The larger portion of the lake is located in Polk and San Jacinto Counties. The Trinity River Authority (TRA) and the City of Houston hold the water rights for Lake Livingston. The TRA has indicated that as much as 200,000 acre-feet per year might be available to water suppliers in North Texas from the lake. However, according to the *2007 Texas State Water Plan*, much of this available supply is expected to be used to meet projected needs in the greater Houston area and would not be available for NTMWD. Lake Livingston is about 180 miles from the Metroplex. Due to the distance to NTMWD, this is a relatively expensive strategy. The higher costs of this strategy and the competition with other users for supply make this strategy less desirable than the proposed project.

2.2.14 Sam Rayburn Reservoir/Lake B.A. Steinhagen Alternative

Sam Rayburn Reservoir is an existing USACE reservoir on the Angelina River in the Neches River Basin. Lake B.A. Steinhagen is located on the Neches River downstream from Sam Rayburn Reservoir. During the development of the *2007 Texas State Water Plan*, the Lower Neches Valley Authority, which holds Texas water rights in the reservoirs, indicated that as much as 200,000 acre-feet per year might be available to water suppliers in North Texas. In order to preserve hydropower generation from Sam Rayburn Reservoir, the Lower Neches Valley Authority wants the water to be diverted from Lake B.A. Steinhagen, which is about 200 miles from the Metroplex. Because of the distance, this is a relatively expensive source of supply

for NTMWD. There also has been recent interest in supplies from Sam Rayburn Reservoir/ Lake B.A. Steinhagen from other users. At this time, it does not look like any supply from Sam Rayburn Reservoir/ Lake B.A. Steinhagen will be available to NTMWD.

2.2.15 Other Existing Lakes

Other existing lakes in the vicinity of NTMWD service area include Lake Ray Hubbard, Ray Roberts Lake, Lewisville Lake, Lake Grapevine, Lake Fork, Cedar Creek Reservoir, Richland-Chambers Reservoir and Lake Palestine. Each of these sources is fully committed to existing customers. Lakes Ray Hubbard, Ray Roberts, Lewisville, Grapevine, Fork and Palestine are water supply sources for the City of Dallas, and these sources are needed to meet the demands of the City, its customers and other holders of water rights in the lakes. Cedar Creek and Richland-Chambers reservoirs are owned and operated by the TRWD. These water sources are fully committed to meet the water demands of the TRWD.

New Groundwater Supplies

2.2.16 Ogallala Aquifer Groundwater Alternative

Mesa Water, Incorporated, is interested in selling groundwater from the Ogallala aquifer in Roberts County to water suppliers in North Texas. (Roberts County is in the Panhandle of Texas.) Mesa Water controls rights to groundwater in Roberts County with options for additional supply and has permits from the local groundwater conservation district to export groundwater. Mesa Water has indicated that they can develop a reliable supply of 200,000 acre-feet per year for water suppliers in North Texas through 2060 and beyond. The groundwater in Roberts County is about 250 miles from the Dallas-Fort Worth area and is not a renewable source. Previous studies have shown the long-term reliability of this water supply to be less than 50 years to over 100 years, depending on assumptions. Current restrictions to pumping in the Panhandle area limit annual withdrawals to 1.25 percent of the saturated thickness of the aquifer. Because of the distance and project operation, this is a relatively expensive source of supply for the NTMWD. Also, due to the uncertainty regarding the long-term reliability of this source, this is not a practicable alternative to Lower Bois d'Arc Creek Reservoir.

2.2.17 Carrizo-Wilcox Aquifer Groundwater Alternative.

The Carrizo-Wilcox aquifer covers a large area of east, central, and south Texas. Organizations and individuals have been studying the development of water supplies in Brazos County and surrounding counties for export. Brazos County is about 150 miles from the NTMWD service area. This is a relatively expensive source of supply for the NTMWD. Due to cost considerations and competition for this water source, the Carrizo-Wilcox groundwater alternative is not a practicable alternative to the proposed action.

Desalination of Brackish Water

2.2.18 Desalination of Lake Texoma Water

As discussed in Section 2.2.7, water from Lake Texoma is relatively high in dissolved salts. One option to use this water for municipal purposes is to desalinate the water using reverse osmosis water treatment or another similar treatment method. Desalination can result in losing up to one third of the raw supply to the treatment process and require disposal of over 30 million gallons per day (mgd) of highly salty water. Disposal options include deep injection wells, discharge to a stream or evaporation ponds. Each of these disposal options requires additional environmental studies and consideration of potential impacts.

Desalination is also a more expensive strategy than blending, and there are considerable uncertainties in the operation and long-term costs of a large-scale desalination facility. The estimated costs for desalination of water from Lake Texoma are based on current cost information for large desalination facilities. However, they are more uncertain than other cost estimates developed for the potential alternatives for the following reasons:

- There is not an established track record of success in the development of large brackish water desalination facilities.
- Most of the large desalination facilities built to date are located on or near the coast. If a 100-million-gallon-per-day or larger plant were to be developed for Lake Texoma water, it would be the largest inland desalination facility in the world. To date large scale inland desalination facilities (greater than 50 MGD) have not been permitted or constructed in Texas. The Fort Bliss/ El Paso Water Utilities desalination facility, which is the largest inland desalination plant in Texas, produces 27.5 mgd.

- The method, cost and regulatory requirements of brine disposal for such a facility are uncertain. Brine disposal has the potential to significantly increase the estimated cost for desalination. Deep well injection will likely require multiple sites to accommodate the quantity of discharge required, and large volume discharges of brine to surface water will be difficult to permit. Detailed studies to solidify the cost estimates and feasibilities will be required if a large scale desalination strategy is pursued.

The desalination alternative will only provide the equivalent of about 60 percent of reliable treated water supply from the Lower Bois d'Arc Creek Reservoir. There are also environmental, cost and permitting issues associated with the brine disposal for a large-scale inland desalination facility. Estimated costs for desalination of Lake Texoma water is about 1.5 times that of treated water from Lower Bois d'Arc Creek Reservoir during debt repayment and nearly twice the costs after debt is repaid. Desalination is a much more energy intensive process than conventional water treatment. As energy costs continue to increase, these differences are expected to increase. Desalination of Lake Texoma water is not a practicable alternative to the proposed project due to the cost uncertainty, smaller water supply and the potential environmental impacts associated with large-scale brine disposal.

While large scale desalination of Texoma water is currently not practicable, there are some potential options to use a small portion of the Texoma water either through desalination or blending, but the quantity would be much smaller than the amount of water developed from Lower Bois d'Arc Creek Reservoir. As such, a smaller scale project would not be an alternative to the Lower Bois d'Arc Creek Reservoir.

2.2.19 Gulf of Mexico With Desalination Alternative

The State of Texas has sponsored initial studies of potential seawater desalination projects, and this is seen as a potential future supply source for the state. Because of the distance to the Gulf of Mexico, seawater desalination is not a particularly promising source of supply for NTMWD. The supply from seawater desalination is essentially unlimited, but this is a high energy use strategy and the cost is much higher than the cost of other water management strategies for NTMWD. This is not a practicable alternative to the proposed project.

Other Potential Alternatives

2.2.20 Other Water Conservation Measures Alternative

As part of the state water planning process, an initial screening of 23 municipal conservation strategies was conducted, including each of the measures identified in the Water Conservation Best Management Practices Guide, which was prepared under the direction of the Water Conservation Implementation Task Force (Water Conservation Implementation Task Force, 2004). Of these measures, seven were determined as not feasible for North Texas water users and five measures were determined to be less cost effective and were not included in the recommended packages. Eleven conservation strategies were recommended in the *2007 Texas State Water Plan*[1]:

- Public and school education,
- Price elasticity (reduction in use due to increase in rates),
- Water system audit, leak detection and repair, and pressure control,
- Federal residential clothes washer standards,
- Conservation pricing,
- Water waste prohibition,
- Coin-operated clothes washer rebate,
- Residential water audit,
- Industrial, commercial, and institutional (ICI) general rebate,
- ICI water audit, water waste reduction, and site-specific conservation program,
- Reuse of treated wastewater

NTMWD has included each of the recommended conservation strategies in its water conservation plan and/or the model conservation plans for its member cities and customers (Freese and Nichols, 2008(a)).

[1] Water savings associated with the low-flow plumbing fixture rules were incorporated into the demand projection and therefore, low flow plumbing fixtures are not included in the list of recommended strategies.

In addition, the NTMWD has included four strategies that were not recommended in the *2007 Texas State Water Plan*. These include:

- Metering of all new connections and retrofitting existing connections,
- Wholesale water assistance programs,
- Conservation coordinator, and
- Landscape water management regulations.

The estimated water savings associated with the recommended conservation measures are included in the NTMWD's needs analysis in Section 1 of this report (Table 1-4). These strategies are currently being implemented and are not considered alternatives to the proposed project.

The NTMWD has identified several conservation measures that may be appropriate for some of its customers but due to variability of costs and applicability, these measures are included as "optional" strategies in the model plan. For several of the measures listed below, the long-term water savings are already accounted for in the projected demands for NTMWD (e.g., rebates for low flow fixtures and toilet replacement program).

- Athletic Field Conservation
- Rainwater Harvesting
- Showerhead and faucet retrofit program
- Toilet replacement program
- Single-family efficient washer rebate program
- Rebates for low flow fixtures
- Rebates for rain/freeze sensor and ET Controllers
- Pressure reducing valve installation programs or rebates
- On-demand hot water heater rebates

The conservation strategies that were determined not feasible or cost prohibitive include:

- New Construction Graywater
- Park Conservation
- Landscape irrigation system rebate
- Landscape design and conversion program

Park conservation strategies were eliminated from the recommended plan because of insufficient data to estimate the water savings. This strategy requires site specific considerations. New construction graywater strategies have limited participation and relatively high costs. Both the landscape irrigation system rebate program and landscape design and conservation program were determined to be very costly. Estimates of cost are greater than $10 per 1,000 gallons of water saved (Freese and Nichols, 2006).

While NTMWD did not include the above strategies in its water conservation plans, the NTMWD encourages any of its member cities or customers to implement any and all conservation strategies that are appropriate for its use. However, even if implemented, the amount of water savings associated with these strategies would not provide the amount of water savings necessary to meet near-term water needs.

3.0 AFFECTED / EXISTING ENVIRONMENT

3.1 Project Setting

The proposed Lower Bois d'Arc Creek Reservoir is located in Fannin County in North-Central Texas. The proposed dam is located on Bois d'Arc Creek and Honey Grove Creek in the Red River Basin. From the dam site Bois d'Arc Creek flows approximately 20.1 miles northeast into the Red River. Lake Bonham, which serves as the water supply for the City of Bonham, would be located immediately upstream of Lower Bois d'Arc Creek Reservoir on Timber Creek. The proposed dam site would be upstream of the Bois d'Arc Unit of the Caddo National Grasslands.

EXISTING ENVIRONMENT

Existing site has been altered over past 100 years mainly due to agricultural practices and stream channelization.

- 62% of Bois d'Arc Creek has been channelized.

Area is predominantly agricultural or undeveloped.

- 38% of site is cropland and grassland.

Hydrology characterized by rapid rise and fall of stream flows from rain with little to no flow during dry times.

Fluvial geomorphologic analyses indicate that prior channelization, lack of aquatic habitat, and lack of bank stability result in reduced quality of streams within the project area.

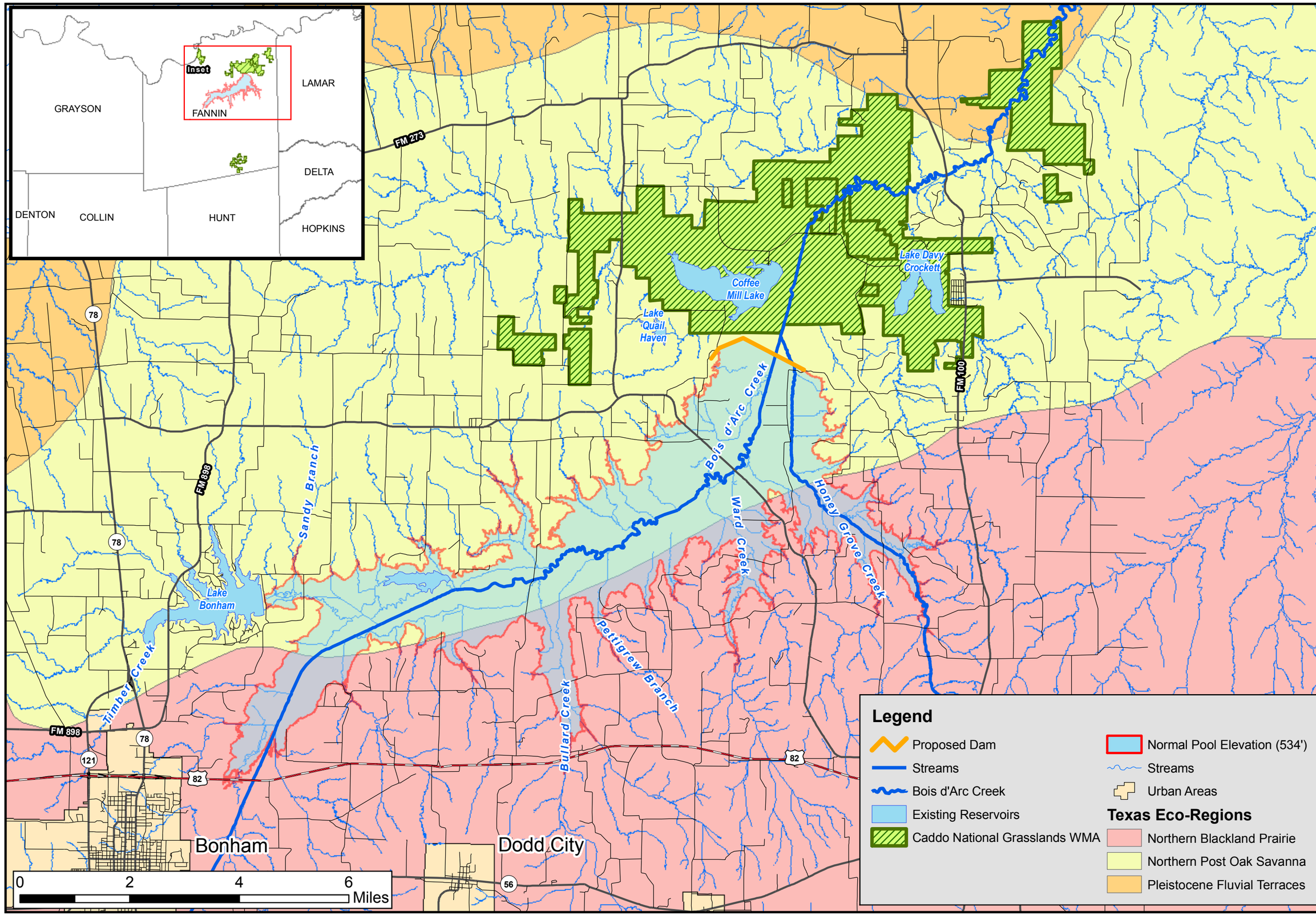
Riparian woodland/bottomland hardwood cover type is low quality.

5,874 acres of wetlands:

- 4,602 acres – forested wetlands
- 1,223 acres – emergent/ herbaceous
- 49 acres – shrub wetlands

3 potential threatened and endangered species in Fannin County

Ecologically, the proposed project straddles the Post Oak Savannah and Blackland Prairie Ecological Regions of Texas (Gould et. al., 1960) (Figure 3-1). The Blackland Prairie is a true prairie grassland community that is dominated by a diverse assortment of perennial and annual grasses and forbs. Included within this area are forested or wooded areas that are restricted to bottomlands along major rivers and streams, ravines, protected areas, or to specific soils. The original plant community associated with the Post Oak Savannah Ecological Region was savannah dominated by native bunch grasses and forbs with scattered clumps of trees, primarily post oaks. Forested areas were mostly limited to hardwood bottomlands along major rivers and creeks, or in areas protected from fire. (Texas Parks and Wildlife Department, February 9, 2007)



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DATE: March 2008
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North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

Project Setting
General Location Map

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Fort Worth, Texas 76109-4895
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3-1
FIGURE

3.2 Past and Present Land Use

The impacted area of the proposed Lower Bois d'Arc Creek Reservoir project (includes reservoir conservation pool, dam site and construction area) will cover 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in Fannin County, Texas. This land is predominantly undeveloped and used for agricultural purposes. Approximately 1,757 acres (10.3%) is in agricultural land use (cropland) with an additional 4,761 (27.9%) acres in grassland or old field succession. The majority of the remainder is in undeveloped land use consisting of various natural or previously disturbed vegetative cover types. A very small component is in transportation (local or state roads), utility corridors (electrical transmission lines) and scattered single family residential land use. Land use of the adjoining properties does not differ substantially from that found within the boundaries of the proposed reservoir, with most of the area being agricultural or undeveloped land, but the percentages of land use types differ. Since the adjoining areas are not within the floodplains of Bois d'Arc Creek and contain a smaller component of wetlands, a higher proportion of the adjoining areas is in agricultural land use as opposed to undeveloped land and a greater proportion of the undeveloped lands have been cleared.

The total land area of Fannin County is approximately 570,597 acres (892 square miles). Most of this area is agricultural or undeveloped land (Goerdel, A.R., 2001). Due to the slow pace of development in the past in Fannin County, land use has not changed substantially over the past several years. In 1989, the amount of land in crops and pasture totaled 392,480 acres and 10,550 acres was urban or built-up land. The 2002 Agricultural Census for Fannin County indicates that the amount of land in farms has remained fairly consistent with acreages varying between 392,000 and 483,000 over the past two decades (USDA, 2008(b)).

The Caddo National Grasslands is a federally-designated area within Fannin County. The jurisdictional boundaries of the Grasslands cover 17,785 acres and contain three lakes. The Caddo National Grassland is comprised of two units, the Bois d'Arc Unit and the Ladonia Unit. The Bois d'Arc Unit is located just to the north of the proposed Lower Bois d'Arc Creek Reservoir site.

3.3 Water Resources

3.3.1 Hydrology and Hydraulics

The watershed is in the Red River Basin. Figure 3-2 shows the location of the reservoir, along with the location of selected USGS stream gauges and selected watershed boundaries. The reservoir will have a drainage area of 327 square miles. Other reservoirs in the Bois d'Arc Creek watershed include Lake Bonham, which serves as the water supply for the City of Bonham, and Lake Crockett and Coffee Mill Lake, which are recreation lakes.

Until recently, the Bois d'Arc Creek near Randolph gauge was the only source of historical data within the watershed. This gauge measured flows from about 22 percent of the proposed reservoir's watershed from December 1962 to September 1985. A new USGS gauging station (station 07332620 Bois d'Arc Creek at FM 1396 near Honey Grove, Texas) is located just above the dam site and began collecting data on June 23, 2006. At the time of this report, the USGS has only published gauge height information for this station and has not yet published flow records.

Hydrologic characteristics of the stream at the dam site can be estimated by examining the historical flows at the Randolph gauge and at the North Sulphur River near Cooper gauge (7343000) in an adjacent watershed (the North Sulphur gauge has a continuous record back to October 1949). Bois d'Arc Creek at the dam site has a highly dynamic flow regime, characterized by a rapid response to rainfall and a quick decline to base flow conditions. Both the Randolph and North Sulphur gauges show extended periods of little or no flow under dry conditions. Flows of 0.1 cfs or less occur about 15 percent of the time at the Randolph gauge, and 24 percent of the time at the North Sulphur gauge. Field observations show that Bois d'Arc Creek near the dam site may have more sustained base flows than the upper sections of the creek near the Randoph gauge. However, it is likely that under dry conditions Bois d'Arc Creek contains little or no flow throughout the reservoir site.

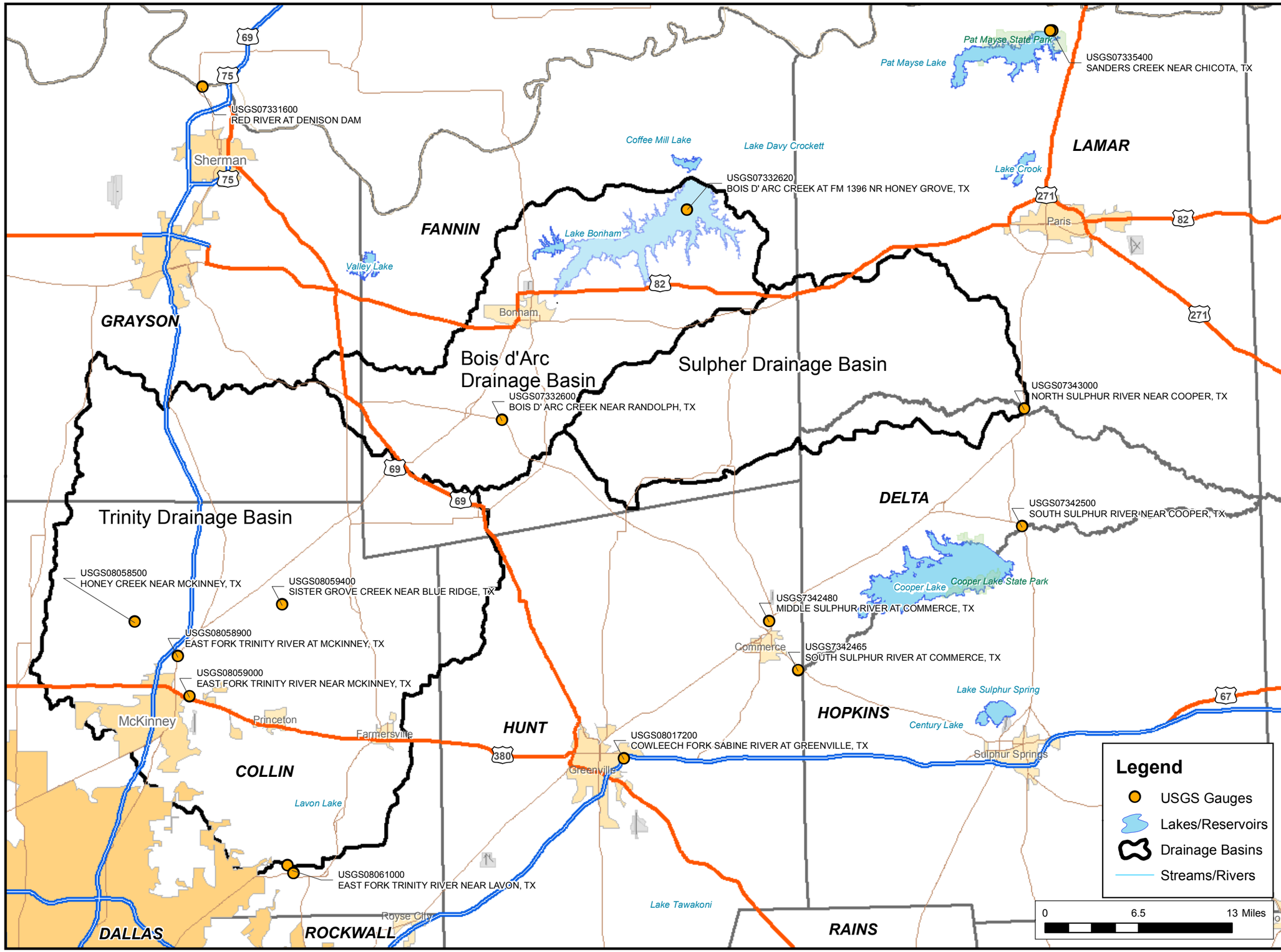

Figure 3-2

North Texas Municipal Water District

Stream Gauge Locations and Key Drainage Areas

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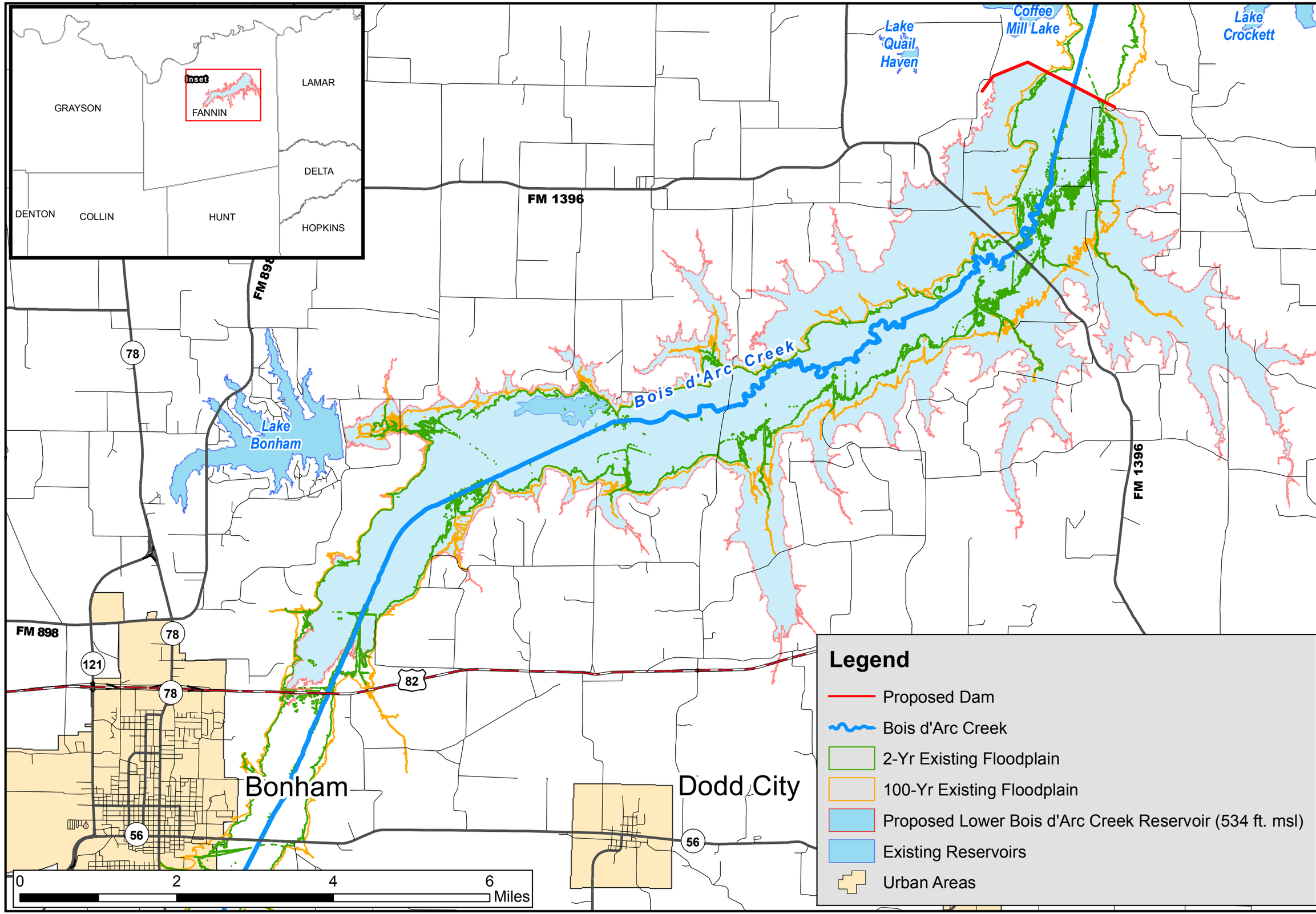
Floodplains and Flood Storage

Bois d'Arc Creek has historically experienced periodic flooding along its banks and in the City of Bonham. Over time, the creek has been channelized in attempts to reduce flooding. Presently, about two-thirds of the Bois d'Arc Creek within the project site is channelized, as well as considerable portions of the creek immediately upstream and downstream of the site. Despite these changes, there has been frequent flooding along Bois d'Arc Creek, particularly adjacent to the Highway 56 Bridge that is located about 19 stream miles upstream of the proposed dam site.

Currently, the effective FEMA floodplain along Bois d'Arc Creek is Zone A, which is an estimated 100-year floodplain. As part of the studies for this project, Freese and Nichols developed a more accurate delineation of the actual 100-year floodplain (see Appendix A). The USACE river channel floodwave routing model, HEC-RAS, and site-specific data were used to estimate the water surface along Bois d'Arc Creek under different rainfall conditions. Elevation contour data from aerial photography and LiDAR mapping were used to develop 137 cross sections of 22 miles of Bois d'Arc Creek for the HEC-RAS model. Analyses of the 2-, 10-, 50-, 100-, and 500-year flood events were conducted. The 2-year and 100-year floodplains at the project site are shown on Figure 3-3. Within the project site, the 2-year flood plain covers approximately 43 percent of the site, and the 100-year flood plain extends over 55 percent of the site.



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DATE: March 2008
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North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

Existing Floodplain Map

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3-3

FIGURE

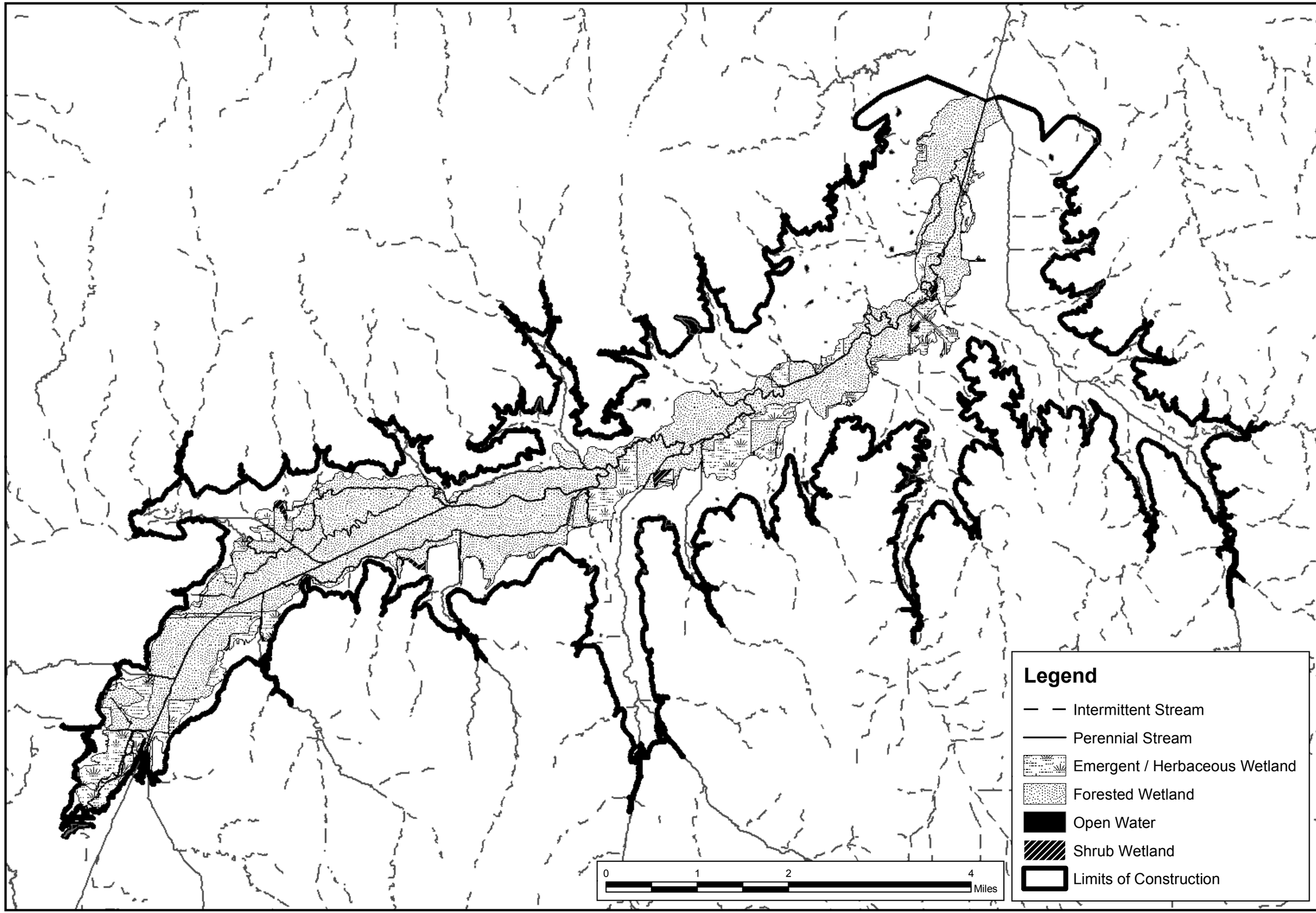
3.3.2 Aquatic Resources

Aquatic resources on and adjacent to the proposed Lower Bois d'Arc Creek Reservoir site consist of numerous streams (riverine habitats), with the predominant stream being Bois d'Arc Creek, and various open water (lacustrine or lake) habitats. Bois d'Arc Creek includes portions of its original channel in addition to channelized stretches of the creek. There are numerous named and unnamed perennial and intermittent streams on the project site. These streams are all tributaries of Bois d'Arc Creek, and there is a total of 219 acres of riverine habitat within the project site. In addition to these streams, there are several ponds or open water, lacustrine habitats present within the boundaries of the proposed Lower Bois d'Arc Creek Reservoir (See Figure 3-4). Open water lacustrine habitats comprise approximately 87 acres of the proposed Lower Bois d'Arc Creek Reservoir site. Aquatic resources also include 1,223 acres of emergent wetland (including the emergent wetlands associated with a small lake located on Thomas Branch), 49 acres of shrub wetland and 4,602 acres of forested wetlands.

Major aquatic resources near the proposed Lower Bois d'Arc Creek Reservoir site include Lake Bonham, Coffee Mill Lake, and Lake Crockett. Lake Bonham is located just upstream from the upstream end of the proposed reservoir on Timber Creek. Coffee Mill Lake is located on Coffee Mill Creek approximately 1,000 feet upstream of Bois d'Arc Creek. Coffee Mill Creek enters Bois d'Arc Creek approximately 1.5 miles downstream of the proposed Lower Bois d'Arc Creek Reservoir dam. Lake Crockett is located on Sandy Creek approximately one mile upstream of its confluence with Bois d'Arc Creek. The confluence is approximately 4.5 miles downstream of the proposed Lower Bois d'Arc Creek Reservoir dam. Both Coffee Mill Lake and Lake Crockett are within the Caddo National Grasslands Bois d'Arc Unit.

Fluvial Geomorphology

A fluvial geomorphology study was performed to characterize stream stability, riparian vegetation, and potential for biodiversity and aquatic habitat. This study consisted of data collection, literature reviews, field measurements and analyses. The study focused on the project site to provide an initial assessment of existing stream conditions, which will be used to assist with the development of the proposed mitigation plan. The following presents synopses of the ecoregion setting, local soils and the rapid geomorphic assessment of project site streams.



North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

Waters of the United States

F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure4(Overview).mxd

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Fort Worth, Texas 76109-4895
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3-4

FIGURE

Ecoregions:

The proposed Lower Bois d'Arc Creek Reservoir is located in two Level IV ecoregions as mapped and described by Griffith et. al.(2004). The southern portion of the reservoir and the associated streams are in the Northern Blackland Prairie Ecoregion (Level IV) of the Texas Blackland Prairies (Level III), while the northern portion is in the Northern Post Oak Savannah (Level IV) Ecoregion within the East Central Texas Plains region (Level III) (Figure 3-1). Beginning approximately six miles downstream of the proposed dam site, Bois d'Arc Creek Creek flows through the Pleistocene Fluvial Terraces (Level IV) of the South Central Plains Ecoregion (Level III) and eventually converges with the Red River in the Red River Bottomlands (Level IV) of the South Central Plains Ecoregion.

This diverse ecological, including topographical, soil, and geological characteristics influences the vegetation, wildlife, and hydrological characteristics of the area. An understanding of these features can help put the results of the geomorphic assessment of stream condition into regional context.

The Northern Blackland Prairie Ecoregion encompasses most of Honey Grove Creek, Ward Creek, Pettigrew Branch, Bullard Creek, and Bois d'Arc Creek upstream of the confluence with Sandy Branch. The soils of this ecoregion are characterized by mostly fine-textured, dark, calcareous, and productive Vertisols. (The central concept of Vertisols is that soils that have a high content of expending clay will have at some time of the year deep wide cracks. They shrink when drying and swell when they become wetter (USDA, 2008)). These soils are underlain by interbedded chalks, marls, limestones, and shales of Cretaceous age.

The northern part of Lower Bois d'Arc Creek Reservoir, Sandy Creek and the other tributaries entering Bois d'Arc Creek to about six miles downstream of the proposed dam are within the Northern Post Oak Savannah Ecoregion. This region is characterized by fine textured loam soils with a udic moisture regime, underlain mostly by Eocene and Paleocene-age formations.

Farther downstream Bois d'Arc Creek flows predominately through the Pleistocene Fluvial Terraces Ecoregion. This ecoregion typically has broad flats and gently sloping stream

terraces, with soils typically Alfisols. (Alfisols soils have an argillic, a kandic, or a natric horizon and a base saturation of 35% or greater. They typically have an ochric epipedon, but may have an umbric epipedon. They may also have a petrocalcic horizon, a fragipan or a duripan.)

Soils

The mainstem of Bois d'Arc Creek from upstream of Bonham and downstream to about three miles above the confluence with the Red River traverses the Tinn soil series. This series consists of moderately well drained, very slowly permeable, clayey soils on floodplains. The series has a very high shrink swell potential and an erosion factor K value of 0.32.

Tributaries flowing into the proposed Bois d'Arc Creek Reservoir on the north side upstream of Sandy Creek flow through the Normangee-Wilson-Bonham series group consisting of loamy and clayey, moderately acid to neutral soils. Normangee and Bonham series have moderate to high shrink swell potential and an erosion factor K ranging from 0.31-0.37, while the Wilson series has low to high shrink swell and an erosion factor K ranging from 0.37-0.43.

From approximately the mouth of Sandy Creek to near FM 100 downstream of the proposed dam soils adjacent to the floodplain Tinn series are in the Whakana-Porum-Freestone series that are loamy, very strongly acid to neutral soils on terraces. Freestone series has low to high shrink swell potential and an erosion factor K ranging from 0.32-0.37; the Porum series has low to high shrink swell and an erosion factor K ranging from 0.32-0.43; and the Whakana series has low to moderate shrink swell and an erosion factor K of 0.32.

On the south side of the proposed reservoir Honey Grove, Bullard, and Sloans creeks are in the Frioton series that is clayey and loamy, moderately alkaline soils on floodplains. This series has a high shrink swell potential and an erosion factor K of 0.32.

The majority of the remaining drainages on the south side of the reservoir consist of the Ellis-Crockett series of loamy and clayey, moderately acid to neutral soils on uplands. The Crockett series has low to high shrink swell potential and an erosion factor K ranging from 0.32-0.43 and the Ellis series has high shrink swell potential and an erosion factor K ranging from 0.32.

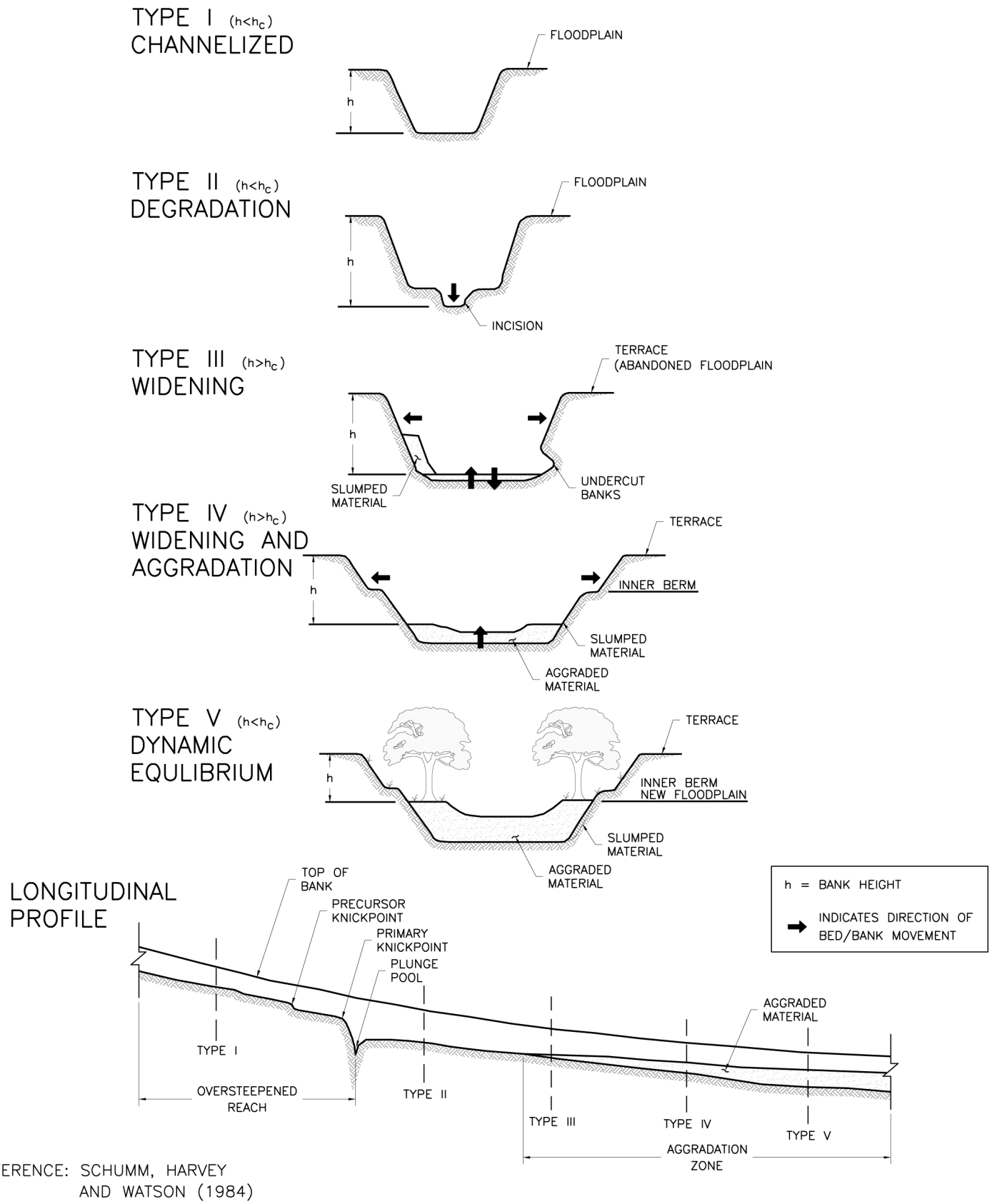
Rapid Geomorphic Approach

A study of the fluvial geomorphology of Bois d'Arc Creek and four major tributaries (Honey Grove Creek, Sandy Creek, Ward Creek, and Bullard Creek) within the inundation pool of the proposed reservoir was performed to characterize current stream conditions and to produce a preliminary geomorphic classification of the stream segments (Freese and Nichols, 2008(b)).

A rapid geomorphic assessment (RGA) approach was used to integrate data from various sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features. A number of aquatic habitat components are created or influenced by stream geomorphology characteristics. Instream fish cover (woody debris, pools, overhanging vegetation, undercut banks, backwaters, etc.) and invertebrate habitat elements (fine wood debris, submerged logs, leaf pack, undercut banks, etc.) can be created, maintained or destroyed by stream stability conditions and channel equilibrium. The RGA is the first-tier, or "reconnaissance level" approach to determine the nature and scale of instability in the system (localized vs. system-wide). The results of reconnaissance level study determine the aims and methods employed in the second-tier, or "analytic level" of investigation. This procedural framework is consistent with that of the Texas Instream Flow Program's "Step 1: Reconnaissance and Information Evaluation." RGAs involve the calculation of an objective stability index that is used in combination with a channel evolution model (CEM) to map the extent of conditions and processes, thus determining the scale of instability (Simon et al., 2007),.

Two stability indices were calculated: the Bank Erodibility Hazard Index (BEHI), developed by Rosgen (1996) as a quick way to estimate the potential for bank erosion along a stream reach, and the Pfankuch index, designed by Pfankuch (1975) and included with modifications in Rosgen (1996).

The incised channel evolution model describes the morphological adjustments of a creek following channelization (Figure 3-5). A number of studies of incised channels in alluvial materials in the United States have shown that following channelization, the altered channel geometry changes through a predictable sequence of channel evolution (Ireland et al., 1939; Schumm et al., 1984; Harvey and Watson, 1986; Simon and Hupp, 1986; Simon, 1989). The model of this process identifies the stages of channel form beginning with the channelized



REFERENCE: SCHUMM, HARVEY
AND WATSON (1984)

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NORTH TEXAS MUNICIPAL WCID

LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

INCISED CHANNEL EVOLUTION PROCESS

F&N JOB NO.	NTD06128
DATE	JAN. 2008
SCALE	N.T.S.
DESIGNED	JWS
DRAFTED	GAL
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3-5

FIGURE

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[NTD06128][AUSTIN1]N:\WR\REPORT\FIGURE 3.DWG LAYOUT: Layout1
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section (Type I), in which dynamic equilibrium is disrupted, through major stages of disequilibrium and channel evolution back to a state of dynamic equilibrium. The channel incises (Type II) then widens (Type III) as a result of bank failure and mass wasting. As the channel becomes over-widened it will begin to aggrade because the stream power will be insufficient to carry the existing sediment load (Type IV). Eventually a new channel will form within the over-widened section with sufficient stream power to carry the total sediment supply and a new dynamic equilibrium will be reached (Type V).

Data sources included field measurements and observations, current one-foot LiDAR generated topography, current two-foot aerial topography, and both current and historic aerial photography and maps. Based on these data, stream reaches in the study area were classified as having good, fair, or poor stability.

The results of this initial evaluation will be incorporated with hydrology/hydraulics, biology, and water quality evaluations to develop a multidisciplinary conceptual model of the study area. This conceptual model will be used to formulate a preliminary mitigation plan proposal.

Freese and Nichols personnel collected field data for 82 sites; data included channel and bank geometry, identification of substrate material, identification of debris jams or blockages, identification of potential in-stream cover, riparian zone characteristics, and the condition of the upper slopes, lower slopes, and channel bed. A Bank Erosion Hazard Index form (Rosgen, 1996) was used to record bank geometry, information regarding riparian vegetation and rooting depths, and general bank armoring; and a Pfankuch Channel Stability form (Pfankuch, 1975) was used to collect a variety of information related to the condition of the upper slopes, lower slopes, and channel bed.

In addition, longitudinal profiles of each stream were generated from LiDAR-generated topography data to characterize the channel slopes along each stream. Comparisons of current with historical maps and aerial photography were used to characterize both the nature and approximate timing of changes in the streams' paths.

The collected data were consolidated into a Rapid Assessment Classification Sheet for each data point and used to formulate a general characterization of each portion of the study

streams. These characterizations were then interpreted in the context of the incised channel evolution model (Schumm et al., 1984) and used as the basis of a stream stability rating.

A Rapid Assessment Classification Sheet was used to assign a stream stability rating (good, fair, or poor) to each portion of the study streams. A rating of "Good" indicates that the channel is in, or near, dynamic equilibrium. Good reaches provide stable channel sections and the sediment transport capacity is balanced with sediment supply. The riparian vegetation consists of a variety of species that provide good stream bank coverage (armoring) and a dense root system. A rating of "Good" also means the reach provides good, permanent, in-stream habitat.

A rating of "Fair" indicates that the channel is approaching dynamic equilibrium but is not completely stable. Fair reaches provide moderately stable channel sections but are still subject to some bank erosion and sediment transport capacity has not yet balanced with sediment supply; however, inner berms and emergent vegetation are present and the reach is recovering, and both the riparian and in-stream habitat is still somewhat transitional.

"Poor" rated reaches are still in a state of disequilibrium. These reaches are continuing to erode and are subject to mass wasting. As a result of the disequilibrium these sections do not contain stable channel sections, riparian vegetation, or in-stream habitat.

The present day Bois d'Arc Creek system is characterized by the previous channel straightening, changing vegetated buffer, current incision, and the incision induced widening of the main stem of Bois d'Arc Creek and its' major tributaries. Approximately sixty-two percent (62%) of the main stem of Bois d'Arc Creek within the proposed reservoir was channelized. By comparing the historical map circa 1915 to the aerial imagery of 1950, we concluded that most of the channelization to the creek occurred between 1915 and 1950. Since 1950, several road crossings have been constructed where approximately 3,000 additional feet has been straightened. Due to the manmade alterations to the creek, the flowline has downcut causing a headcut effect propagating up the creek. The dominant channel material for Bois d'Arc Creek is clay with accumulations of shale, gravel, sand, and silt in the depositional features throughout the reaches.

A “poor” rated reach of Bois d’Arc Creek

A “fair” rated reach of Bois d’Arc Creek.

Honey Grove Creek is a large tributary of Bois d’Arc Creek; however, the confluence of the two streams is located approximately 2,000 feet downstream of the proposed dam. Approximately 35,700 feet (6.8 miles) of Honey Grove Creek is in the proposed inundation pool of Lower Bois d’Arc Creek Reservoir.

Approximately 9,500 linear of Honey Grove Creek (nearly 30%), within the reservoir, was channelized prior to 1915. Portions of the original channel remain discernable through the

2007 aerial photographs although portions appear to have been filled in and converted to farm land. Comparing the 1915 maps to the 1950 aerial shows that the lower 3,000 feet of the present day Honey Grove Creek (downstream of the reservoir) is a manmade channel and the natural channel has been removed for agricultural reasons. We conclude that most of the channelization to the creek occurred between 1915 and 1950. Due to the manmade alterations to the creek, the flowline has downcut causing a headcut to propagate up the creek.

The dominant channel material is sand with minor components of shale gravel in some bars in the lower reach. There is a distinct break in the slopes of the upper half of the stream and the lower half of the stream. With the exception of the lower reach of this creek, there is little variation in terms of physical characteristics, vegetation, and overall stability along Honey Grove Creek.

The riparian vegetation along the banks is moderate, with a mix of grasses along the middle slope and trees and grasses on the upper slope. The lower banks have little to no vegetation in most locations providing little bank protection. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. Depositional side bar features are common due to high sediment load from the banks. These depositions are loosely packed and are transitory. There is no evidence that the channel is forming inner berms or a new floodplain at this time. Streambank erosion rates in some areas, particularly the downstream 2,300 feet of the channel, appear to be high due to undercut banks and mass wasting. There is little habitat potential for this reach, with very little shade over the creek and incised channel banks.

In terms of the rapid assessment classification, the lower reach of Honey Grove Creek appears to be a Type III within the channel evolution process. Although this reach of the channel does not exhibit characteristics of equilibrium, the classification for 88 percent of the reach is a “fair” rating while only the downstream 2,300 feet (12%) is rated “poor.”

Poor rated section of Honey Grove Creek along lower reach.

Fair rated section of Honey Grove Creek along lower reach.

Ward Creek is a large tributary of Bois d'Arc Creek with the stream confluence at approximate Station 174+00 on Bois d'Arc Creek. Approximately 27,900 feet (5.4 miles) of Ward Creek are within the proposed inundation pool of Lower Bois d'Arc Reservoir.

Comparing the 1950 aerial photograph to the 1915 map of Ward Creek shows that approximately 3,500 to 4,000 feet (approximately 10%) of this stream was channelized. Although this section was channelized, it should be noted that the changes in the pattern of this stream were much less aggressive than the alterations to segments of Bois d'Arc Creek and Honey Grove Creek discussed above, as this section of Ward Creek had low sinuosity prior to

the channelization.

Depositional side bars are common and, where the stream has downcut, there are signs that a new floodplain is beginning to develop with the channel). Streambank erosion rates in some reaches appear to be very high due to mass wasting; however, there are long reaches that appear to be recovering with the formation of inner berms and emergent vegetation.

The dominant channel material is sand with some shale and gravel accumulations in the bar depositions. The riparian vegetation along the banks is dense, with a mix of small vines, brush, and trees along the lower and mid slopes and trees and grasses on the upper slope. Depositional side bars and point bars are common due to high sediment load but most of the reach is recovering and mass wasting is intermittent. There is good habitat potential along segments of this reach with 70 to 80 percent shade over the creek, in-stream vegetation and formation of a new floodplain within the channel. The remaining segments of the creek have little habitat potential due to the lack of stream cover or shade.

In terms of the rapid assessment classification of Ward Creek, the majority of the reaches of this creek appear to be in Type III or Type IV of the channel evolution process with inner berms forming within the channel. The downstream segment of this creek appears to be in Type III and continues to react to the changes in Bois d'Arc Creek. A major impact on this segment of the creek was the apparent meander cutoff at the confluence. The overhead electric easement and section downstream of the knickpoint are in Type III and Type II, respectively of the evolution process. The classification of this reach is predominantly fair, with approximately 80 percent of the reach given a "fair" rating and the remaining 20 percent a "poor" rating

Bullard Creek is a large tributary of Bois d'Arc Creek with the stream confluence at approximate Station 345+00 on Bois d'Arc Creek. There are approximately 25,900 feet (4.9 miles) of Bullard Creek in the proposed inundation pool of Lower Bois d'Arc Reservoir. Nearly 4,500 linear feet (20%) of Bullard Creek was channelized prior to 1950). This channelization project actually redirected the lower reach of Bullard Creek through a minor tributary resulting in the abandonment of approximately 4,000 linear feet of the original Bullard Creek. The net effect was to channelize and enlarge approximately 8,000 linear feet (30%) of the existing Bullard Creek.

The dominant channel material is clayey silt with some sand and gravel in the bars along the entire reach. Side bars and point bars are common with some mid-channels bars due to the moderate to high sediment load from the stream banks. Streambank erosion rates in some reaches appear to be very high due to mass wasting from the near vertical side slopes; however, there are some reaches that appear to be recovering with the formation of inner berms and emergent vegetation.

Bullard Creek is predominantly in fair stability conditions, with approximately 62 percent of the reach given a “fair” rating and the other 38 percent given a “poor” rating.

A “poor” rated segment on Bullard Creek.

A “fair” rated segment on Bullard Creek

Sandy Creek is the only one of the four tributaries studied that is on the north side of Bois d’Arc Creek. Nearly 14,200 feet (2.7 miles) of Sandy Creek will be inundated by the proposed Lower Bois d’Arc Creek Reservoir.

From the 1950 aerial photographs, we estimated that approximately 2,200 linear feet (15%) of Sandy Creek, was channelized between 1915 and 1950.

The dominant channel material is sand with some minor deposits of shale. There is a minor component of gravel material present on bars in the lower reach of the channel; however, it was unclear if this material was wash material from the channel or if it was gravel from the roads within the basin. Although there is some clay in the material along Sandy Creek, it appears to be a smaller component than the other tributaries and Bois d’Arc Creek. As observed in the aerial photographs, the channelization of Bois d’Arc Creek and alterations of Sandy Creek have resulted in down cutting from the confluence with Bois d’Arc Creek to well beyond the upstream end of the inundated reach of Sandy Creek. Aerial photographs show the head cut has extended to upstream of F.M. 1396, nearly 1.5 miles upstream of the proposed inundation pool.

The riparian vegetation along the majority of the reach includes heavily wooded upper banks and terraces with almost no bank vegetation. There are occasional trees growing on the banks of the stream but the lack of any other vegetation is resulting in continued bank erosion, undercutting, and occasional mass wasting. Even where trees are present on the slopes, the bank

material is being mined from beneath and between the roots. Due to the high sediment load from bank erosion and incision the depositional patterns within Sandy Creek include frequent side bars, point bars, and occasional transverse or mid-channel bars. The wooded terrace provides dense shade along most of Sandy Creek, but due to the sediment load and near vertical banks there is little to no habitat potential within the channel.

In terms of the rapid assessment classification, most of Sandy Creek appears to be Type III in the evolution process with two reaches that are Type IV. The continued widening of this creek indicates it is not in equilibrium. The classification for the majority of this stream is poor, with approximately 79 percent of the reach given a" poor" rating and the remainder rating "fair."

Based on the rapid assessment of Bois d'Arc Creek and the four studied tributaries, none of the reaches inundated by the proposed reservoir have reached a new state of dynamic equilibrium; however, there are reaches in which new channels are beginning to form within the over-widened channels and the creek is beginning to approach the end point in the channel evolution model.

The following table summarizes the results of the rapid assessment for reaches analyzed for the Phase I Geomorphic Assessment.

Table 3-1
Summary of Rapid Assessment Classification for Studied Streams.

Stream (Total Length Studied, ft)	Rapid Assessment Classification (% Total)
Bois d'Arc Creek (89,300)	Poor (56%)
	Fair (44%)
Honey Grove Creek (35,700)	Poor (4%)
	Fair (96%)
Ward Creek (27,900)	Poor (20%)
	Fair (80%)
Bullard Creek (25,900)	Poor (38%)
	Fair (62%)
Sandy Creek (14,150)	Poor (79%)
	Fair (21%)

Streams

The primary stream within the proposed Lower Bois d'Arc Creek Reservoir site is Bois d'Arc Creek. All other streams on the site are either direct tributaries of Bois d'Arc Creek or are tributaries of a tributary to Bois d'Arc Creek. As discussed in the previous section, Bois d'Arc Creek includes portions of its original channel in addition to channelized stretches of the creek. In some areas, the natural channel and the channelized channel are located parallel to one another. In addition to Bois d'Arc Creek, streams in the area include Pig Branch, Powder Creek, Onstott Creek, Timber Creek, Thomas Branch, Burns Branch, Sandy Creek, Bullard Creek, Pettigrew Creek, Yoakum Creek, and Honey Grove Creek. With the exception of Yoakum Creek, all of the named streams within the proposed project site are perennial streams. Yoakum Creek is an intermittent creek. These named streams are fed by many unnamed tributaries, most of which are intermittent. There is a sewage treatment plant approximately 0.5 miles upstream of Bois d'Arc Creek on Pig Branch. Together, the streams on site comprise approximately 219 acres of riverine habitat.

Bois d'Arc Creek rises in the eastern portion of Grayson County near Whitewright, Texas, and flows in a northeasterly direction across Fannin County to enter the south bank of the Red River. TPWD (1974) described the creek as generally running clear over a predominantly

sandy substrate and supporting a diverse assemblage of fish species. However, a reconnaissance report prepared by the USACE (2000) noted extensive channelization and losses to the riparian corridor and associated stream bank vegetation from agricultural practices that have resulted in siltation of the stream, bank caving, and elevated stream temperatures. The dynamic conditions of the streams and banks were confirmed during recent field studies associated with the geomorphology study discussed in the previous section. Based on data from the USGS, historical maps, aerial photography and field visits, approximately 24 percent of the total stream lengths within the project site have been channelized. The breakdown of these lengths by stream type is:

- Unchannelized Perennial Streams, 24.8 miles
- Unchannelized Intermittent Streams, 68.5 miles
- Channelized Perennial Streams, 25 miles
- Channelized Intermittent Streams, 5 miles

A review of available fisheries data and other literature from Bois d'Arc Creek, portions of the Red River, Sulphur River, and nearby reservoirs was performed to determine fish species expected to occur within Bois d'Arc Creek. A survey conducted in 1982 found over 20 species of fish in Bois d'Arc Creek, including spotted gar (*Lepisosteus oculatus)*, common carp *(Cyprinus carpio)*, river carpsucker *(Carpiodes carpio)*, channel catfish *(Ictalurus punctatus)*, golden shiner *(Notemigonus crysoleucas)*, smallmouth buffalo *(Ictiobus bubalus)*, red shiner *(Cyprinella lutrensis)*, largemouth bass *(Micropterus salmoides)*, white crappie *(Pomoxis annularis)*, freshwater drum *(Aplodinotus grunniens)*, western mosquitofish *(Gambusia affinis)* , and several sunfish *(Lepomis* spp.*)* species (TPWD, 2000).

A more recent survey, *An Assessment of the Biological Integrity of the Eastern Red River Basin in Texas*, was completed in 1998 by the Red River Authority. In this study, Rapid Bioassessment methodologies were used for the quantification of a biological integrity score using Rapid Bioassessment Protocols. Each sampling site was classified as being in Limited (<35), Intermediate (35-40), High (41-48), or Exceptional (>48) condition. The calculated Index of Biological Integrity (IBI) scores for both locations in Bois d'Arc Creek were 35, resulting in an Intermediate classification. Fish species collected include the bullhead minnow (*Pimephales vigilax)*, Texas shiner *(Notropis amabilis)*, red shiner, western mosquitofish, bluegill *(Lepomis macrochirus)*, longear sunfish *(L. megalotis)*, warmouth *(L. gulosus)*, largemouth bass, common

carp, blackstripe topminnow *(Fundulus notatus)*, and yellow bullhead *(Ameiurus natalis).*

After completing the review of available fisheries data and identifying fish species known to occur in Bois d'Arc Creek, a more thorough review at the species level was performed to determine preferences for habitat types and to determine if the species could survive in riverine and lacustrine environments. As part of this review, personnel from TPWD were contacted to provide survey reports prepared as part of their Statewide Freshwater Fisheries Monitoring and Management Program. Survey reports from Lake Coffee Mill, Lake Davy Crockett, Lake Texoma, and Bonham City Lake were reviewed to determine if species from Bois d'Arc Creek have also been documented from these local impoundments. Eleven of the 15 identified species or groups (73%) have been documented in these reservoirs according to the TPWD survey reports. (It is important to note that these survey reports completed by TPWD deal primarily with sport fish and important prey species. As such, not all species of fish collected or observed during the surveys are reported or discussed in the reports.) All species or groups (100%) have been documented from other lacustrine habitats, or their ability to survive in a lacustrine environment has been determined. A summary of this information is provided in Table 3-2.

Based on the species identified in Table 3-2, it is apparent that a majority of the fish assemblage in Bois d'Arc Creek is comprised of generalist species, able to survive in both riverine and lacustrine habitats. One reason is that species that inhabit streams with large environmental variability (such as the species found in Bois d'Arc Creek) have evolved to cope with disturbance in areas where environmental conditions can be extreme and somewhat unpredictable (Poff and Ward, 1990). In addition, Poff and Allan (1995) noted that although habitats in warm water prairie streams can be spatially homogenous, highly dynamic flow regimes (frequent spates and seasonal drying) cause strong temporal variation in habitat characteristics. In such streams, generalist species that can use a variety of habitats are common and may comprise a large component of the assemblage. Similar results have been found in other studies performed in the same geographical area. Gelwick and Morgan (2000) and Morgan (2002) examined fish habitat utilization on the basis of visually classified mesohabitats (pool, riffle, run, and backwater) identified within the mainstem of the Sulphur River. Both studies reported the fish species within the riverine communities to be habitat generalists. Based on the

Table 3-2
Selected Bois d'Arc Creek Fish Species, Their Preferred Habitat, and Documented Occurrence in Lacustrine Environments

Fish Species	Preferred Habitat	Species Accounts from Local Reservoirs	Reliable Observation or Documentation of Species Occurrence / Survival from Lacustrine Environment
Spotted Gar	The spotted gar requires clear, quiet water with abundant aquatic vegetation. It occurs in backwater areas of rivers, lakes and wetlands. Like other gar species, it is tolerant of warm water with low dissolved oxygen levels. They spawn in shallow, warm water. The spotted gar is also known to enter brackish water (Pflieger 1975, Trautman 1981, Page and Burr, 1991).	Lake Coffee Mill.	Yes
Common Carp	Common carp exploit large and small manmade and natural reservoirs, and pools in slow or fast moving streams. They prefer larger, slower-moving bodies of water with soft sediments but they are tolerant and hardy fish that thrive in a wide variety of aquatic habitats (Page and Burr, 1991; Froese and Pauly, 2002).	Bonham City Lake, Lake Texoma, Lake Coffee Mill, Lake Davy Crockett.	Yes
River Carpsucker	The river carpsucker is highly ubiquitous, occurring in streams and rivers of every size and physical-chemical constitution. It also seems to do well in many reservoirs (Miller and Robison, 1973). Abundant in quiet, silt-bottomed pools and backwaters of rivers and larger creeks having low to moderate gradient. Frequently in impoundments. In Oklahoma, prefers relatively shallow water with little organic matter and large biomass of tubificids (Sublette et al. 1990).	Lake Texoma.	Yes
Channel Catfish	Channel catfish seem to do equally well in streams, rivers, lakes, and ponds. In streams and rivers, they often spend the days in deep pools, under logs and other cover, or in holes in stream banks, venturing out to feed in shallower water at night (Miller and Robison, 1973).	Bonham City Lake, Lake Texoma, Lake Coffee Mill, Lake Davy Crockett.	Yes
Golden Shiner	The golden shiner is basically an inhabitant of quiet waters, being common in larger impoundments, large natural lakes, and in the quieter pools of sluggish streams. It prefers clear waters with much vegetation but can withstand moderate siltation (Miller and Robison, 1973). Common to abundant in ponds and lakes, often in sluggish sections of streams and rivers (NatureServe, 2006).		Yes

Fish Species	Preferred Habitat	Species Accounts from Local Reservoirs	Reliable Observation or Documentation of Species Occurrence / Survival from Lacustrine Environment
Smallmouth Buffalo	Smallmouth buffalo typically inhabit large rivers, preferring deep, clear, warm waters with a current. They frequent low velocity areas, such as pools, creek mouths, and backwaters of large rivers. Smallmouth buffalo can also do well in large reservoirs or lakes and their standing crop increases as the storage ratio decreases (Edwards and Twomey, 1982).	Lake Texoma.	Yes
Red Shiner	The red shiner is very common and widespread and can survive in a wide variety of habitats (Miller and Robison, 1973). The red shiner inhabits perennial rivers, streams, canals, lakes, and ponds as well as ephemeral habitats with high turbidity and few competing species (Sublette et al., 1990).		Yes
Largemouth Bass	Largemouth bass seek protective cover such as logs, rock ledges, vegetation, and man-made structures. They prefer clear quiet water, but will survive quite well in a variety of habitats. It is a highly successful lake and pond fish in Oklahoma but can also do well in the deeper, quiet pools of large streams (Miller and Robison, 1973).	Bonham City Lake, Lake Texoma, Lake Coffee Mill, Lake Davy Crockett.	Yes
White Crappie	White crappie prefer larger ponds, reservoirs, and rivers. They are tolerant of a wide variety of conditions, including areas of silt and turbidity. This species is usually found near structure such as fallen trees, stumps, docks, rocks, and aquatic vegetation (Ohio Department of Natural Resources, Division of Wildlife, 2005). Because of their tolerance levels, the white crappie has proven to be one of the most successful and prolific centrarchids. It can be found in almost all kinds of waters (Miller and Robison, 1973).	Bonham City Lake, Lake Texoma, Lake Coffee Mill, Lake Davy Crockett.	Yes
Freshwater Drum	The freshwater drum is most common in the deeper pools of rivers and in many lakes. While they can tolerate turbid waters, they seem to do best in clear waters, especially lakes, and grow fastest in smaller impoundments (Miller and Robison, 1973).	Bonham City Lake, Lake Texoma, Lake Coffee Mill.	Yes

Fish Species	Preferred Habitat	Species Accounts from Local Reservoirs	Reliable Observation or Documentation of Species Occurrence / Survival from Lacustrine Environment
Western Mosquitofish	Western mosquitofish can be found in river channels, margins, backwaters, springs, marshes, and artificial habitats of all kinds (Minckley et al., 1991). Often in shallow, often stagnant, ponds and the shallow edges of lakes and streams where predatory fishes are largely absent and temperatures are high. Most abundant in shallow water with thick vegetation (NatureServe, 2006). Inhabits standing to slow-flowing water; common in vegetated ponds and lakes, backwaters and quiet pools of streams. Frequents brackish water (Page and Burr, 1991).		Yes
Bullhead Minnow	The bullhead minnow prefers pools, backwaters, and quiet runs of small to large rivers having continuous flow and low to moderate gradient, over sand, silt, or gravel; most common in medium-sized rivers; also in some reservoirs; tolerant of turbidity; avoids rapid currents (NatureServe, 2006).		Yes
Texas Shiner	The Texas shiner typically prefers runs and pools of clear springs and headwater tributaries, where it may be very common, sometimes in limited numbers in larger streams. Water usually clear and substrate typically of sand, gravel, and rubble (NatureServe, 2006).		Yes
Blackstripe Topminnow	The blackstripe topminnow prefers small to large, lowland, low-gradient streams and sloughs with water of moderate to high turbidity; quiet water of creeks, rivers, lakes, swamps, drainage ditches, highwater pools of rivers, and ponds (NatureServe, 2006).		Yes
Yellow Bullhead	The yellow bullhead prefers shallow weedy parts of clear warm lakes, ponds, or slow-moving streams or canals. More tolerant of pollution than are most other ictalurids (NatureServe, 2006).	Bonham City Lake, Lake Davy Crockett.	Yes
Sunfish spp.	Most sunfish species inhabit quiet waters, such as sluggish stream reaches, pools, wetlands and lakes. Many favor the cover of macrophytes and woody debris (EPA, 2006).	Bonham City Lake, Lake Texoma, Lake Coffee Mill, Lake Davy Crockett.	Yes

presence of mainly generalist species within Bois d'Arc Creek and their documented capability of survival in lacustrine habitats, it is doubtful that negative impacts to the fisheries population will result from the proposed project.

Instream Uses

The Texas Commission on Environmental Quality (30 TAC 297.1) defines instream use as "the beneficial use of instream flows for such purposes including, but not limited to, navigation, recreation, hydropower, fisheries, game preserves, stock raising, park purposes, aesthetics, water quality protection, aquatic and riparian wildlife habitat, freshwater inflows for bays and estuaries, and any other instream use recognized by law." A review of available resources was performed in order to determine the instream uses associated with Bois d'Arc Creek.

According to the Texas Natural Resources Code §21.001(3), a "navigable stream" means a stream which retains an average width of 30 feet from the mouth up. While a field determination of this criterion has not been performed, a review of the Tulsa District's list of navigable waters subject to regulation under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) reveals that Bois d'Arc Creek is not listed as a navigable water of the U. S.

According to the 1979 Texas Parks and Wildlife Department (TPWD) publication, *An Analysis of Texas Waterways*, there is a two-mile stretch of Bois d'Arc Creek immediately above the confluence with the Red River that maintains an average width of 75 feet and normally has enough water to support recreational use. The report notes that the fishing is good and that there are good camping areas where Bois d'Arc Creek passes through the Caddo National Grasslands.

The Texas Commission on Environmental Quality (TCEQ), charged with the responsibility of maintaining and enhancing the waters in the state, has divided surface waters in the state of Texas into numbered segments for the purpose of organizing water quality data and designated water uses and classifications. This information is used to describe the status and trends of the state's waters.

The main water quality segment (as classified by TCEQ) contained within the project area is Segment 0202A – Bois d'Arc Creek (unclassified water body) (TCEQ, 2008). The

State's Water Quality Inventory maintains data for every stream segment on chemical and physical parameters, contaminants such as metals, organics, pathogens, and nutrients. Segment fact sheets also provide descriptions, concerns, and information on designated water uses. A description of the various uses that TCEQ rates for designated segments within the state follows:

- Aquatic Life Use - focuses on the ability of waters to support aquatic life. The aquatic life use category has ratings of limited, intermediate, high or exceptional based on physical, chemical and biological characteristics as well as the prevalence and magnitude of toxic chemicals in the water and sediment. The Texas Surface Water Quality Standards include numerical criteria (as maximum instream concentrations) for 39 toxic pollutants in order to protect aquatic life;
- Contact Recreation Use - includes recreational activities involving a significant risk of ingestion, including wading by children, swimming, water skiing, diving and surfing. This use is assigned to all water bodies except special cases but it is not a guarantee that the water is completely free of disease-causing organisms. A coliform density of 400 colonies/100ml is used as a screening level;
- Noncontact Recreation Use – includes recreational pursuits not involving a significant risk of water ingestion, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity. The noncontact recreation use for these water bodies is protected by the same coliform screening levels assigned to contact recreational waters;
- Fish Consumption Use - human health criteria found in the Texas Surface Water Quality Standards are used to protect the fish consumption use. The standards identify levels at which certain toxic substances dissolved in water pose a significant risk that these toxics may accumulate in the tissues of aquatic species.
- Public Water Supply - this use is assigned for those segments that are to be used as a source for public water systems. The indicators used to measure the safety or usability for drinking water includes the presence or absence of substances such as metals or pesticides. The concentration of dissolved solids is also measured since treatment to remove them from drinking water is expensive.

These uses are rated as fully supporting, partially supporting, or not supporting of the use depending upon the percentage of samples that exceed the screening criteria levels. TCEQ conducts use attainability analyses to determine whether the designated uses listed above are appropriately set and whether those uses are impaired. The analysis identifies the causes of use impairments and the results typically bring about changes in use assignments that are reflected in revisions to the Texas Surface Water Quality Standards.

The designated water uses assigned by the TCEQ for Segment 0202A – Bois d'Arc Creek (unclassified water body) are aquatic life (Intermediate Aquatic Life Use), contact recreation,

and fish consumption use. The aquatic life and contact recreation uses for this segment are classified as "fully supporting," while the fish consumption use was not assessed. In addition, this segment is classified as "fully supporting" for overall use (TCEQ, 2008).

No evidence could be found supporting instream uses associated with hydropower or game preserves for Bois d'Arc Creek. Uses associated with park purposes, aesthetics, water quality, aquatic and riparian wildlife habitat, and freshwater inflows for bays and estuaries are discussed in other sections of the report.

Wetlands

Wetlands identified within the proposed Lower Bois d'Arc Creek Reservoir site include 4,602 acres of forested wetland, 1,223 acres of herbaceous wetland, and 49 acres of shrub wetland. All wetlands identified were found to directly abut Bois d'Arc Creek. Forested wetlands were found to be primarily dominated by green ash (*Fraxinus pennsylvanica*) with smaller amounts of sugarberry (*Celtis laevigata*), cedar elm (*Ulmus crassifolia*), bois d'arc (*Maclura pomifera*), honeylocust (*Gleditsia triacanthos*), bur oak (*Quercus macrocarpa*), and box elder (*Acer negundo*). Vegetation common in herbaceous or emergent wetlands included various sedges (*Carex* spp.), docks (*Rumex* spp.), buttercups (*Ranunculus* spp.), goldenrods (*Solidago* spp.), ironweeds (*Vernonia* spp.), spike rushes (*Eleocharis* spp.), and Virginia rye (*Elymus virginicus*). Dominant woody vegetation in the shrub wetland habitat type included green ash, honey locust, sugarberry, and bois d'arc.

In order to estimate the overall quality of the wetlands located within the project area, specific functions were evaluated based on site visit observations, including: groundwater recharge, groundwater discharge, floodflow alteration, sediment stabilization, sediment / toxicants retention, nutrient removal / transformation, production export, wildlife diversity and abundance, aquatic diversity and abundance, recreation, and uniqueness / heritage.

Groundwater recharge, groundwater discharge, aquatic diversity and abundance, and uniqueness / heritage functions were given a low value; floodflow alteration and sediment stabilization were given a high value; sediment / toxicants retention, nutrient removal / transformation, production export, wildlife diversity and abundance, and recreational functions

were given a medium value. Overall, the wetland areas within the project site were determined to have a medium value. More detailed information concerning wetlands is located within the Jurisdictional Report submitted as part of the 404 application for the Lower Bois d'Arc Creek Reservoir.

Water Quality

The TCEQ included Bois d'Arc Creek watershed in its 2004 Texas Water Quality Inventory for the Red River Basin (TCEQ, 2008). In that report, TCEQ identified Bois d'Arc Creek as an unclassified segment (ID 0202A) with the following uses: aquatic life, contact recreation, and fish consumption. The length of Bois d'Arc Creek assessed included 62 miles extending from the confluence of the Red River to the upstream perennial portion of the stream southwest of Bonham in Fannin County. TCEQ concluded that the aquatic life and contact recreation uses were fully supported. Aquatic life use attainment was based on dissolved oxygen sampling in the lower 25 miles of the stream. Contact recreation use attainment was based on sampling for E. coli and fecal coliform bacteria. The fish consumption use was not assessed.

Water quality data in Bois d'Arc Creek are collected by the TCEQ and USGS. Most of the stream data is from 1997 to the present. There are three water quality sampling stations in Bois d'Arc Creek: 1) at FM 100, downstream of the proposed project, 2) at State Highway 78, just upstream of the project site, and 3) at FM 1396 within the project site. The two sites at FM 100 and State Highway 78 are sampled by the TCEQ as part of the Clean Rivers Program. Data from the TCEQ sampling sites extend from October 1997 to July 2007, and include a variety of parameters. Based on these analyses, the water quality is good and there is no impairment of stream use due to water quality concerns.

In June 2006, the USGS installed a streamflow gauging station at FM 1396 and began collecting limited water quality data (temperature, conductivity and dissolved oxygen). Data collected to date from this site, including the recent provisional data, are consistent with the data collected by the TCEQ.

Historical data for dissolved minerals in Bois d'Arc Creek at FM 100 are summarized in Table 3-3. The water quality data at State Highway 78 is similar indicating that there is no

apparent measurable contribution of dissolved minerals to the creek in the vicinity of the project.

Table 3-3
Water Quality in Bois d'Arc Creek at FM 100

	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Mean	26	50	295
Median	12	41	273

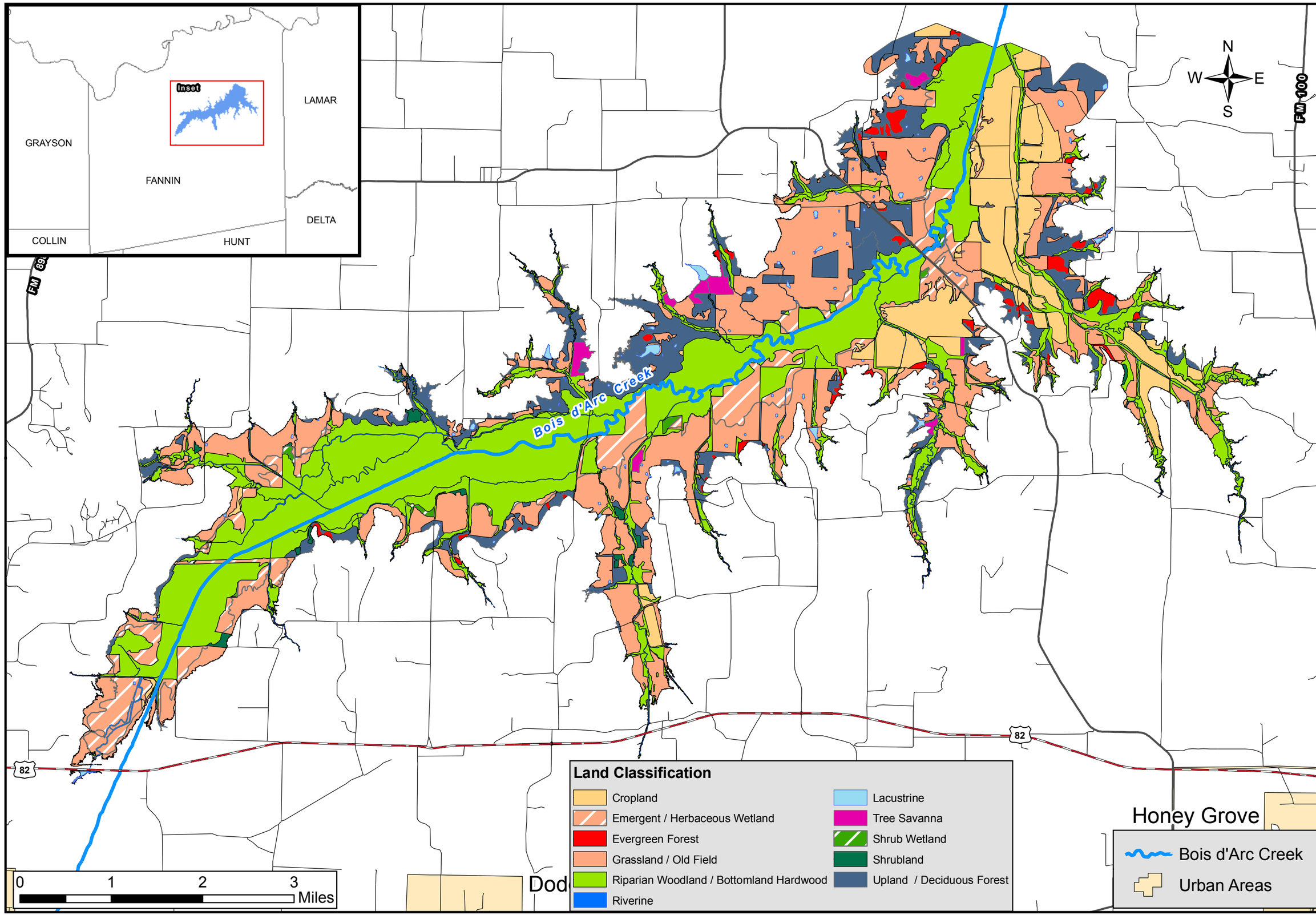
Source: TCEQ water quality database, downloaded April 29, 2008

3.4 Terrestrial Resources

3.4.1 Vegetation

The proposed Lower Bois d'Arc Creek Reservoir project will impact 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in north central Fannin County, Texas. The types and quantities of habitat within the proposed project site were identified as part of the Habitat Evaluation Procedure (HEP) Study, which was conducted during the summer of 2007 (see Appendix D).

Nine cover types were identified for HEP analysis within the Lower Bois d'Arc Creek Reservoir project area. The upland cover types included *Upland Deciduous Forest*, *Evergreen Forest*, *Tree Savanna*, *Shrubland*, *Cropland*, and *Grassland / Old Field*. The wetland cover types included *Riparian Woodland / Bottomland Hardwood* (including forested wetland habitat), *Shrub Wetland*, and *Emergent / Herbaceous Wetland*. In addition, the project area included *Shrub Savanna*, *Riverine* and *Lacustrine* cover types that were not used in HEP analysis. Habitat types within the normal pool area (534' msl) of the proposed Lower Bois d'Arc Creek Reservoir are shown in Figure 3-6. The acreages of each of these habitats are shown in Table 3-4.



F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
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DRAFTED: BME
FILE: Figure3-6.mxd

North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

HEP Cover Type Mapping

N
W E
S

Freese and Nichols
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

3-6
FIGURE

Table 3-4
Habitat Types and Acreage Found on Lower Bois d'Arc Reservoir Site

Habitat Type	Acreage
Evergreen Forest	228
Upland / Deciduous Forest	2,216
Riparian Woodland / Bottomland Hardwood / Forested Wetland (Total for HEP Purposes)	6,330
Riparian Woodland / Bottomland Hardwood	*1,728*
Forested Wetland	*4,602*
Shrubland	63
Shrub Wetland	49
Grassland / Old Field	4,761
Emergent / Herbaceous Wetland	1,223
Cropland	1,757
Riverine	219
Lacustrine	87
Tree Savanna	132
Shrub Savanna	4
Grand Total	**17,068**

Bottomland Hardwoods (Deciduous Forest)

The riparian woodland / bottomland hardwood cover type in the project area includes the predominantly deciduous forests of riparian zones and wetlands, and is associated with the floodplains of Bois d'Arc Creek and Honey Grove Creek. The condition of the forest floors in these areas varied from standing water to dry, cracking mud. Average tree canopy cover equals approximately 68 percent, while the shrub cover equals approximately 19 percent. There are approximately 6,330 acres of riparian woodland / bottomland hardwood forest in the proposed Lower Bois d'Arc Creek Reservoir pool area.

Dominant trees include black willow (*Salix nigra*), boxelder, green ash, sugarberry, and cedar elm. Average diameter at breast height (dbh) of overstory trees equals approximately 9 inches and basal area in the forest averages 97 square feet per acre. Dominant shrubs are often small trees of the species listed above, as well as honey locust, poison ivy, coralberry (*Symphoricarpos orbiculatus*), buttonbush *(Cephalanthus occidentalis)*, and Virginia creeper (*Parthenocissus quinquefolia*). Common herbaceous plants in the bottomland hardwood forest

include baccharis (*Baccharis* spp.), Cherokee sedge (*Carex cherokeensis*), ragweeds (*Ambrosia* spp.), and Virginia wildrye.

Upland Woods (Deciduous Forest)

Upland deciduous forests in the project area are composed of 90 percent deciduous trees on average and with an average height of overstory trees of 43 feet. The upland forest cover type makes up approximately 2,216 acres of the proposed Lower Bois d'Arc Creek Reservoir.

Dominant tree species include post oak (*Quercus stellata*), water oak (*Q. nigra)*, southern red oak (*Quercus falcata*), Shumard red oak (*Quercus shumardii*), cedar elm, sugarberry, bois d'arc, green ash, and eastern red cedar (*Juniperus virginiana*). Average tree canopy closure and overstory tree height equal approximately 68 percent and 43 feet, respectively. Deciduous trees comprised 92 percent of the tree canopy on average.

Common shrub and vine species include coralberry, greenbrier (*Smilax* spp.), honey locust, poison ivy (*Toxicodendron radicans*), Virginia creeper, and dogwood (*Cornus drummondii*). Shrub canopy closure in the typical upland forest averages about 33 percent.

Dominant herbs include sedges, flatsedge (*Cyperus* spp.), panicgrass (*Dichanthelium* spp.), corn salad (*Valerianella* sp.), Virginia wildrye, ironweed, Venus' looking-glass (*Triodanis* sp.), and wild onion (*Allium ascalonicum*). Average herbaceous canopy cover equals approximately 38 percent.

Upland Juniper Woods (Evergreen Forest)

Evergreen forests in the project area have a tree canopy with very few deciduous trees and with little understory. The evergreen forest cover type makes up approximately 228 acres of the proposed Lower Bois d'Arc Creek Reservoir.

These forests are dominated by the evergreen eastern red cedar mixed with deciduous tree species including southern red oak, post oak, and blackjack oak (*Quercus marilandica*). Average tree canopy closure equals approximately 70 percent, with evergreens comprising 98 percent of the tree canopy on average.

Shrub and herbaceous cover is sparse in these areas, averaging about 5 and 8 percent,

respectively. Shrub and vine species occurring in these forests include coralberry, greenbrier, gum bumelia (*Sideroxylon* (syn. *Bumelia*) *lanuginosum*), and possumhaw holly (*Ilex decidua*). Herbaceous species include Cherokee sedge, panicgrass, johnsongrass (*Sorghum halepense*), and KR bluestem (*Bothriochloa ischaemum* var. *songarica*).

Emergent / Herbaceous Wetland

There are approximately 1,223 acres of herbaceous wetland within the proposed Lower Bois d'Arc Creek Reservoir site. Emergent wetlands in the project area are dominated by an herbaceous layer made up of wetland obligates such as rushes, sedges, smartweed, and redstem (*Ammannia* sp.). The shrub layer is primarily made up of black willow, green ash, baccharis, swampprivet (*Forestiera* sp.), buttonbush, honeylocust, cocklebur (*Xanthium strumarium*), and desert false indigo (*Amorpha fruticosa*). The herbaceous canopy includes numerous grass species, such as barnyardgrass (*Echinochloa crus-galli*), crowngrass (*Paspalum* sp.), and eastern gammagrass (*Tripsacum dactyloides*). Other plants found in the herbaceous wetlands include rushes (*Juncus* spp.), blue sedge (*Carex glaucodea*), spikerush, flatsedge, smartweed (*Polygonum* spp.), sumpweed (*Iva annua*), frog fruit (*Phyla* spp.), water primrose (*Ludwigia* sp.), balloon vine (*Cardiospermum halicacabum*), docks, and buttercups.

Grassland/Oldfield

The grassland/old fields in the project area are generally upland improved pastures and are typically the result of forest clearing. These areas may be currently or recently grazed or thickly grown over by grasses and forbs. Grassland in the proposed Lower Bois d'Arc Creek Reservoir covers an area of approximately 4,761 acres.

Dominant grass species include tall fescue (*Lolium arundinaceum)*, perennial rye (*Lolium perenne*), bahiagrass (*Paspalum notatum*), bermudagrass (*Cynodon dactylon*), Texas wintergrass (*Nassella leucotricha*), and dallisgrass (*Paspalum dilatatum*). Common forbs include western ragweed (*Ambrosia psilostachya*), ironweed, dock, vetch (*Vicia* spp.), and wild pea (*Lathyrus* spp.). Herbaceous canopy cover averages approximately 87 percent, while the herbaceous canopy height in spring averages about 13 inches.

Shrub Wetland

Shrub wetlands in the study area can be considered wetlands in successional transition between herbaceous wetlands and bottomland hardwood forests. Approximately 49 acres of the proposed Lower Bois d'Arc Creek Reservoir consist of the shrub wetland cover type.

The shrub layer is dominated by small trees such as green ash, sugarberry, and cedar elm, and shrub species such as honey locust, and baccharis. Shrub canopy cover averages approximately 48 percent. Dominant herbaceous plants include sedges, ragweeds, ironweed, goldenrods, evening primrose (*Oenothera speciosa*), cut-leaf groundsel (*Packera tampicana*), trumpet vine (*Campsis radicans*), and wild pea. Herbaceous canopy cover averages about 66 percent.

Shrubland

There are approximately 63 acres of shrubland within the proposed Lower Bois d'Arc Creek Reservoir. Shrublands in the project area represent a midpoint in the successional transition from upland old fields to forests, with a shrub layer dominated by tree species such as green ash, bois d'arc and eastern red cedar. Shrub species within this layer also include honey locust, persimmon (*Diospyros* sp.), and coralberry. Shrub canopy cover averages approximately 44 percent, while tree canopy cover averages about 3 percent. The diverse herbaceous layer was dominated by cherokee sedge, goldenrods, johnsongrass, silver bluestem (*Bothriochloa laguroides*), wild pea, and snow-on-the-prairie (*Euphorbia bicolor*). The herbaceous cover is abundant, averaging approximately 89 percent.

Cropland

The croplands in the project area are primarily planted with oats (*Avena sativa*), soybeans, and hay crops, often alternated with winter wheat (*Triticum aestivum*) cover. Trees and shrubs are excluded from these areas, but are often present in adjacent fencerows. This cover type makes up about 1,757 acres of the proposed Lower Bois d'Arc Creek Reservoir.

Fallow fields are dominated by johnsongrass, but also often include panicgrass, knotroot bristlegrass (*Setaria parviflora*), tall fescue, and bermudagrass. Forbs are also common in the herbaceous layer, including docks, pigweed (*Amaranthus* spp.), spurges (*Euphorbia* spp.),

morning glory (*Ipomoea* sp.), and black-eyed susan (*Rudbeckia hirta*). This herbaceous cover stands at an average of 22 inches in the spring, with an average canopy cover of approximately 47 percent.

Tree Savanna

Tree savannas in the project site have sparse tree and shrub canopies and abundant herbaceous cover. This cover type makes up about 132 acres of the proposed Lower Bois d'Arc Creek Reservoir.

Tree canopy cover within this cover type averages 12 percent and primarily consists of large lone trees. These trees are most often cedar elms, bois d'arc, or eastern red cedars. Shrub canopy cover is also low in these areas, averaging about 9 percent. The shrub and vine species commonly seen in these areas include gum bumelia, coralberry, greenbrier, poison ivy, and southern dewberry (*Rubus trivialis*).

Herbaceous cover in tree savannas within the project area is both diverse and abundant, averaging 89 percent cover. Species frequently occurring in the herbaceous layer include ironweed, western ragweed, sedges, flatsedge, bermudagrass, panicgrass, KR bluestem, indian plantain (*Arnoglossum* spp.), prairie plantain (*Plantago* sp.), croton (*Croton* spp.), and docks.

3.4.2 Wildlife (HEP)

The wildlife habitat value of the approximately 17,068-acre area that will be inundated by the Lower Bois d'Arc Creek Reservoir was estimated using the Habitat Evaluation Procedures (HEP), developed by the U.S. Fish and Wildlife Service (USFWS). The process was conducted by a team that included personnel from USFWS, the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Forest Service (USFS), Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TWDB), Texas Commission on Environmental Quality (TCEQ), North Texas Municipal Water District (NTMWD), and Freese and Nichols, Inc.

HEP methods were used to quantify the habitat value of the study area to a set of wildlife Evaluation Species selected by the HEP team; this valuation was made for baseline conditions. The study area was subdivided into cover types (i.e., discrete areas with similar ecological

characteristics that are adequately homogeneous); each cover type was evaluated separately. Habitat value was calculated as the product of habitat quantity and habitat quality, expressed in Habitat Units (HU). Habitat quantity was expressed in acres of total area of each cover type in the study area. Habitat quality was expressed in terms of a Habitat Suitability Index (HSI). HSI values were determined by comparing the habitat characteristics that are optimum for the selected wildlife evaluation species to the habitat variables measured in field studies. HSI values range from 0.0 to 1.0, with a ranking of 0.0 being unsuitable and 1.0 being optimum conditions.

The Lower Bois d'Arc study area was subdivided into the following nine cover types: Upland Deciduous Forest, Evergreen Forest, Tree Savanna, Shrubland, Cropland, Grassland / Old Field, Riparian Woodland / Bottomland Hardwood, Shrub Wetland, and Emergent / Herbaceous Wetland. The habitat quality within each delineated cover type was evaluated in relation to the habitat requirements of one or more of the sixteen evaluation species selected by the HEP team: the American kestrel, barred owl, brown thrasher, Carolina chickadee, downy woodpecker, eastern cottontail, eastern meadowlark, eastern turkey, field sparrow, fox squirrel, green heron, raccoon, racer, scissortailed flycatcher, swamp rabbit, and the wood duck.

The habitat quality, expressed in HSI, of each cover type for each evaluation species in each cover type is presented in Table 3-5. The overall HSI value for each cover type was calculated as the arithmetic mean of the HSI values for all the evaluation species for that cover type. Baseline Habitat Units (HUs) were calculated for each cover type within the Lower Bois d'Arc Creek Reservoir project area by multiplying the average cover type HSI values by the acres in each cover type, as presented in Table 3-6. Complete results of the field studies, including maps of cover types and sampling locations, species descriptions, and measurements at each sampling point, are presented in Appendix D.

Table 3-5
Habitat Suitability Indices by Cover Type

	Cover Types								
Evaluation Species	**Upland Deciduous Forest**	**Evergreen Forest**	**Tree Savanna**	**Shrubland**	**Cropland**	**Grassland / Old Field**	**Riparian Woodland / Bottomland Hardwood**	**Shrub Wetland**	**Emergent / Herbaceous Wetland**
American kestrel	--	--	1.00	--	1.00	1.00	--	--	--
Barred owl	0.20	--	--	--	--	--	0.14	--	--
Brown thrasher	--	0.02	--	--	--	--	--	--	--
Carolina chickadee	0.75	0.40	--	--	--	--	--	--	--
Downy wood-pecker	0.29	--	--	--	--	--	0.34	--	--
Eastern cottontail	--	0.31	0.31	0.31	0.31	0.31	--	--	--
Eastern meadowlark	--	--	0.59	--	--	0.53	--	--	--
Eastern turkey	0.68	0.68	--	--	--	--	--	--	--
Field sparrow	--	--	--	0.43	--	--	--	--	--
Fox squirrel	0.42	--	--	--	--	--	0.03	--	--
Green heron	--	--	--	--	--	--	--	0.81	0.87
Raccoon	--	--	--	--	--	--	0.52	0.28	0.17
Racer	--	--	--	0.98	--	0.18	--	--	--
Scissor-tailed flycatcher	--	--	1.00	--	0.83	0.98	--	--	--
Swamp rabbit	--	--	--	--	--	--	--	0.52	--
Wood duck	--	--	--	--	--	--	0.22	0.22	0.22
Average HSI Values	**0.47**	**0.35**	**0.73**	**0.57**	**0.72**	**0.60**	**0.25**	**0.46**	**0.42**

Table 3-6
Baseline Habitat Units by Cover Type.

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Upland Deciduous Forest	0.47	2,216	**1,042**
Evergreen Forest	0.35	228	**80**
Tree Savanna	0.73	132	**96**
Shrubland	0.57	63	**36**
Cropland	0.72	1,757	**1,265**
Grassland / Old Field	0.60	4,761	**2,857**
Riparian Woodland / Bottomland Hardwood	0.25	6,330	**1,583**
Shrub Wetland	0.46	49	**23**
Emergent / Herbaceous Wetland	0.42	1,223	**514**
		TOTAL HABITAT UNITS	**7,494**

3.4.3 Threatened and Endangered Species

Section 7 of the federal Endangered Species Act (ESA) requires federal agencies to consult with the U. S. Fish and Wildlife Service (USFWS) to ensure that actions they authorize, fund, or carry out will not "jeopardize" listed species. The USFWS lists two birds and one mammal as federally endangered, threatened or recently delisted whose present or historic ranges may include the proposed project area. Information regarding listed species is included in Table 3-7. These species include the recently delisted bald eagle (*Haliaeetus leucocephalus*), the endangered interior least tern (*Sterna antillarum athalassos*), and the threatened Louisiana black bear (*Ursus americanus luteolus*).

The bald eagle is found primarily near rivers and large lakes. In Texas, it nests primarily along rivers or within one to two miles of a large body of water. Nest sites are in tall trees, usually the tallest or one of the taller trees in the vicinity to provide unobstructed path to nest. The bald eagle will roost communally, especially in winter. It hunts live prey, generally fish, but will also take other live prey such as waterfowl, turtles, and small mammals. It also scavenges and pirates food from other birds.

Interior least terns breed in the Mississippi and Rio Grande River Basins. Interior least

terns begin nesting activities in late April to early June and by early September nesting is usually complete. During the nesting season, the terns occur primarily on barren to sparsely vegetated sand, shell, and gravel beaches, sandbars, islands, and 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 at the higher elevations away from the water's edge, since nesting usually starts when river levels are high and relatively small amounts of sand are exposed. (Texas Parks and Wildlife Department, 2008).

The black bear once ranged throughout Texas. Fannin County is included in the historic range of the American black bear (*Ursus americanus*). Black bears inhabit both upland and bottomland forests and woodlands, including swamps. The best bear habitat consists of mature hardwood stands with numerous mast producing trees and shrubs. Bears tend to omnivorous but prefer soft and hard mast such as acorns, pecans, blackberries, and wild grapes. There has been at least one documented black bear sighting in Fannin County since Texas Parks and Wildlife Department began tracking sightings in 1977 (Texas Parks and Wildlife Department, 2005).

3.5 Cultural Resources

Previous archeological investigation in Fannin County and a recent assessment of the archeological potential at the proposed project site indicate that both prehistoric and historic sites are highly likely to be present within the reservoir site. At present there is only one recorded historic site, Wilks Cemetery, within the lake area. No prehistoric or other historic sites have been recorded.

Based on historical knowledge, land types and findings at similar sites, it is likely that prehistoric sites will be found in the Bois d'Arc Creek floodplain, along the tributaries and alluvial terraces. Due to the steep slopes on the south side of the creek, the archeological potential in this area is expected to be low. Prehistoric sites, if present, would likely be deeply buried.

Table 3-7
Federally Listed Threatened and Endangered Species of Fannin County, TX

Common Name	Scientific Name	Habitat requirements	Federal Status	Comments
BIRDS				
Bald Eagle	*Haliaeetus leucocephalus*	Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds	DM	No nesting habitat present. *Not likely to adversely affect*.
Interior Least Tern	*Sterna antillarum athalassos*	Nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony	E	No suitable habitat present due to lack of braided streams of sufficient size for nesting. *Not likely to adversely affect*.
MAMMALS				
Black bear	*Ursus americanus*	Bottomland hardwoods and large tracts of inaccessible forested areas; due to field characteristics similar to Louisiana Black Bear (LT, T), treat all east Texas black bears as federal and state listed Threatened	T	Potential habitat present in project area. *Not likely to adversely affect*.
DM – Delisted Taxon, Recovered, Being Monitored First Five Years E – Endangered T – Threatened				

Historic sites are expected to be low because most of the project site lies within the floodplain and would be sparsely populated. It is possible that unmarked family cemeteries may be found along the perimeter of the proposed lake, outside of the floodplain. Paleo-Indian archeological sites are expected to be the most common type of site present in the area.

Further discussion of the archeological potential at the Lower Bois d'Arc Creek Reservoir site is included in Appendix C.

3.6 Recreational Resources

Recreation within and near the proposed Lower Bois d'Arc Creek Reservoir is mostly non-commercial. There are some waterfowl and upland bird shooting resorts in the county. Except for the Caddo National Grasslands and city and state parks, none of which would be within the reservoir pool, the land within the project site is privately accessed. Recreational opportunities on private land are limited to the landowner's wishes, and based on limited discussions and observations with residents, generally include hunting (deer, feral hogs, waterfowl, and dove), fishing in ponds, occasional bird watching, and "enjoyment of nature".

Within the county, Lake Bonham, Caddo National Grasslands and Bonham State Park provide facilities for activities such as photography, bird-watching, picnicking, camping, boating, hunting, fishing, hiking, and biking.

3.7 Other Social Effects

Fannin County is generally a rural county with an estimated population of just over 34,000. The population of Fannin County is projected to grow slowly over the next several decades, with projected annual growth rates of 1.6 percent to less than 1 percent over any 5 year period (Texas State Data Center). This slow growth will mean that development pressure on agricultural and undeveloped lands within the County will be low. In contrast, the population for the State of Texas is projected to increase from 20,851,820 persons in 2000 to 43,582,000 persons in 2040, an average annual increase of 1.86 percent, nearly twice the average rate projected for Fannin County. (Texas State Data Center and Office of the State Demographer, 2006).

Projected population growth is expected to occur in the county's urban centers. Agricultural practices are expected to continue at a relatively steady level as experienced in recent decades. As discussed in Section 3.2, most of the area within the project site is undeveloped or agricultural lands. Many of the properties have agricultural exemptions, and as such the tax base for land within the project site is relatively low as compared to more urban areas.

Table 3-8
Past and Projected Populations for Fannin County
(Texas State Data Center and Office of the State Demographer, 2006)

Year	Population	Annual Percent Increase
2000	31,242	-
2005	33,878	1.63%
2010	36,493	1.50%
2015	39,129	1.40%
2020	41,617	1.24%
2025	43,716	0.99%
2030	45,333	0.73%
2035	46,537	0.53%
2040	47,465	0.40%
Total Change in Population, 2000 to 2040	16,223	1.05%

Note: Growth rate scenario is based on recent net migration into the county from 2000 to 2004.

4.0 ENVIRONMENTAL CONSEQUENCES OF NO ACTION ALTERNATIVE

4.1 Project Setting

The No Action Alternative would allow the project and study areas to continue in their present conditions except where acted upon by other agents of change. These agents would include population growth as nearby towns and cities grow due to increased birth rates and immigration from areas outside Fannin County. The project area would be expected to remain predominantly rural and undeveloped for the foreseeable future.

NO ACTION ALTERNATIVE

Minimal changes to project site conditions and use.

Significant adverse impacts to economic viability and growth in the NTMWD service area would result from not developing new water supplies.

4.2 Past and Present Land Use

The No Action Alternative would consist of not constructing Lower Bois d'Arc Reservoir on the project site. Under the No Action Alternative, the present trends in land use change would continue. Some increased urbanization in nearby cities and towns would be expected as the population of Fannin County increases. Although as previously stated, this would be at a slower pace than what would occur in the remainder of the State as a whole due to slower population growth projected for Fannin County. Changes in land use would likely occur within and in proximity to the City of Bonham, located approximately one mile to the west southwest of the project site. Land use change in the proximity of the proposed project site is expected to be minimal. There may be some additional development in the project area as the result of urbanization moving outward from the City of Bonham and would be dependent on general development trends in north Texas. Some agricultural lands may convert to grasslands or undeveloped lands as family farms are passed down to future generations or sold. Conversely, increased demands for agricultural products and/or increases in commodity prices may result in some conversion of undeveloped lands into farms and/or pastures. The No Action Alternative would not impact the Caddo National Grasslands.

4.3 Water Resources

4.3.1 Hydrology and Hydraulics

The No Action Alternative would have minimal to no changes in the hydrology and hydraulics of the watershed. The potential increases in urbanization in the City of Bonham may increase upstream runoff to Bois d'Arc Creek. However, these increases are expected to be small. Low flows are not expected to change. These changes are not expected to affect the current flood plain boundaries or frequency of flooding currently experienced along the creek. The greatest potential impact to flooding within the project site is the development of additional roads and bridges. Currently, the most serious flooding occurs adjacent to bridge crossings that cause constrictions in flood flows. Additional constrictions along the creek could increase the potential for flooding.

4.3.2 Aquatic Resources

Aquatic resources under the No Action Alternative are expected to remain similar to the current resources. As stated earlier, population growth and development within Fannin County are projected to be slow. Changes that occur as a result of no action would likely be gradual changes resulting over time from increased population and resulting nearby or upstream land use changes.

Streams

The No Action Alternative would not cause any sudden or substantial changes to the current condition of project area streams. Local streams would be largely free from direct impacts but may experience slight changes in water quality, such as changes in turbidity and increased flows if undeveloped lands are developed into suburban land use types or could be subject to localized flood control measures such as channelization. However, extensive conversion of existing lands to suburban developments is not expected under the No Action Alternative. The trends of stream degradation, such as siltation of the stream, bank caving, and elevated stream temperatures, due to losses to the riparian corridor and associated stream bank vegetation from agricultural practices would also continue. The cutting and instability documented on the tributary streams during the geomorphology study will likely continue until the streams reach their equilibrium.

Instream Uses

Instream uses under the No Action Alternative are expected to remain the same.

Wetlands

As with streams, the No Action Alternative would not cause any sudden or substantial changes to the current conditions and/or functions of project area wetlands. As stated earlier, population growth and development within Fannin County are projected to be slow. Changes that occur as a result of no action would likely be gradual changes resulting over time from increased population and resulting nearby or upstream land use changes. It is expected that some of the forested wetland areas would continue to be cleared for timber and allowed to revegetate naturally over time. Some conversion of wetland areas to agricultural lands may occur with increases in demands for food and biofuels; however, to this point the growth of agriculture in Fannin County has been static or slow. Some wetlands may experience changes in water quality, such as changes in turbidity and flooding frequency as undeveloped lands are slowly developed into with population growth. These changes are expected to be minimal. Under the No Action Alternative, wetland functions would primarily stay intact and unchanged.

Water Quality

Under the No Action Alternative the water quality is expected to remain similar to the existing conditions and continue to support all current instream uses of Bois d'Arc Creek.

4.4 Terrestrial Resources

With the exception of roads and utility rights-of-way, the project area is comprised primarily of agricultural or undisturbed areas. Of the 17,068 acres comprising the project site, 16,763 acres are terrestrial habitat, including wetlands. Due to the slow growth in population expected in Fannin County over the next 30 years, the No Action Alternative is expected to have little impact on terrestrial resources from urbanization. Some conversion of undeveloped areas to agricultural lands may occur as well as conversion of agricultural lands to undeveloped lands. Based on the historical growth of agriculture in Fannin County, these changes are expected to be static or slow.

4.4.1 Vegetation

Due to the slow growth occurring and expected to continue to occur in Fannin County, the No Action Alternative would be expected to have little impact on vegetation and habitat types in the project area. Some natural succession within the project area plant communities would be expected to occur in areas no longer used for agriculture or that have otherwise been disturbed in the last few decades and some small changes associated with the slight increase in the project area population could be expected between now and 2040 as previously undisturbed areas are cleared for sparse additional residential development associated with this population growth. Agricultural clearing may result in the loss of natural vegetation communities; however, as stated earlier, agricultural development has been static or has grown slowly. Some agricultural lands may be allowed to remain fallow, providing new vegetative habitats.

4.4.2 Wildlife (HEP)

The impacts to wildlife under the No Action Alternative will be determined during the remaining stages of HEP analyses. It is anticipated that there will be minimal changes to wildlife habitats under the No Action Alternative. Changes that may occur will be the result of potential changes in land uses within the project area. These may include some additional rural houses, potential for increases in agriculture due to favorable economic conditions, and/or conversion of agricultural lands to old fields or grass fields as properties are sold or passed to future generations.

4.4.3 Threatened and Endangered Species

The No Action Alternative would not cause any direct impacts to endangered species or their habitats. Any impacts that occur as a result of no action would be gradual changes resulting over time from increased population and resulting nearby development, most likely in the City of Bonham. These impacts are likely to be minimal due to small number of potential threatened or endangered species in Fannin County and the lack of suitable habitat in and near the project area for these species.

4.5 Cultural Resources

Extensive development within the project site is not anticipated under the No Action Alternative. Therefore deeply buried prehistoric sites would most likely remain buried and be undisturbed. Continued cutting and erosion in the creek channels may expose near-surface sites, including potential Paleo-Indian archeological sites along the river bottoms. Also conversion of floodplains to agricultural lands may impact near-surface sites within this area.

The only recorded historic site is a cemetery and no changes to this site are expected. However, as lands within the project site change ownership, potential unrecorded historic sites may be moved or destroyed.

4.6 Recreational Resources

Without the Lower Bois d'Arc Creek Reservoir, there would be few anticipated changes in the recreation opportunities within Fannin County. Most of the land is privately owned and expected to continue.

4.7 Other Social Effects

Under the No Action Alternative, the area is expected to remain rural with some agricultural practices. Population changes will be slow and are not expected to be significant within the project area. Reductions in agricultural practices may occur as lands are passed down to future generations or sold. Hunting is expected to continue at its current level or slightly increase as agricultural lands are allowed to convert back to undeveloped acreage. Historically, the economic development of Fannin County has lagged behind other areas in the state. Under the No Action Alternative, these trends are expected to continue.

The No Action Alternative does not provide the needed water supply for the NTMWD. Instead, the No Action Alternative results in adverse economic and social impacts to the NTMWD service area. Water shortages will curb growth and economic viability. A socio-economic study conducted as part of the *2007 Texas State Water Plan* demonstrated that the failure to provide sufficient water to support growth in the North Texas area would result in lost income and tax revenues of nearly $161 billion through 2060 (TWDB, 2006).

5.0 ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION ALTERNATIVE

5.1 Project Setting

The construction of the proposed Lower Bois d'Arc Creek Reservoir ("Proposed Alternative") would add a significant recreational, land use and economic feature to Fannin County. The reservoir would likely be one of the key components of the socio-economic and natural environments of Fannin County. It is expected to stimulate development and is likely to create numerous job opportunities in the vicinity of the reservoir. The greatest impact would likely be to the City of Bonham and the immediately surrounding areas. Undeveloped and agricultural lands would likely convert to developed lands around the proposed project in support of the economic growth and recreational opportunities.

PROPOSED ALTERNATIVE

Lower Bois d'Arc Creek Reservoir will directly impact or inundate 17,068 acres:

- **16,641 acres - lake**
- **427 acres – dam and construction**

Impact 6,180 acres of waters of U.S.

- **Create 2,150 acres of wetlands along shoreline**
- **Net gain of 16,554 acres of lacustrine environment**

No T&E species likely to be adversely impacted.

Stimulate economic growth in Fannin County and create recreational opportunities.

Provide water to meet NTMWD's needs through 2030.

Will not increase flooding upstream or downstream of project site.

5.2 Past and Present Land Use

The Proposed Alternative would consist of constructing Lower Bois d'Arc Creek Reservoir on the project site. Under this alternative 17,068 acres of wetlands, bottomland, and adjacent upland habitat along Bois d'Arc Creek in Fannin County, Texas would be converted from its current land use to reservoir land use. This land is predominantly in undeveloped land uses. Approximately 1,757 acres (10.3%) is in agricultural land use and 4,761 acres (27.9%) is grassland/old field. Some areas in residential, transportation, and utility right-of-way land uses would be lost as well; however, these are only a minor component of the proposed reservoir site. Most of these areas would likely be relocated to adjacent or nearby undeveloped areas upon construction of the reservoir, converting these areas to residential, transportation or utility right-of-way uses.

Indirect impacts can be divided into two basic types, those related to land development

activities resulting from the construction of a new reservoir in the area and those related to the implementation of mitigation actions required by regulatory agencies to offset impacts to regulated or environmentally sensitive habitats resulting from development of the reservoir.

Indirect impacts from the construction of a large reservoir in Fannin County would likely include the conversion of adjacent and nearby undeveloped areas to developed areas. Upon construction of the reservoir, land values in areas of Fannin County in proximity to the reservoirs would increase as a result of development pressure on undeveloped tracts of land, which, in turn would likely cause some agricultural and undeveloped properties to be converted to higher value land use types. Development of these areas would likely include large, single family residential areas, commercial uses such as retail centers to support the single family residential areas and water based land use types such as marinas. In addition, recreational land uses such as parks and golf courses would likely result from the construction of the lake and the resulting scenic and recreational opportunities created. This development, in turn, would create a demand for increased infrastructure, such as additional and improved roads and utilities, schools, churches and other amenities. The Proposed Alternative may indirectly impact lands within the jurisdictional boundaries of Bois d'Arc Unit of the Caddo National Grasslands by potentially increasing land values in the area surrounding the proposed reservoir, making future land acquisitions for the Caddo National Grasslands more expensive.

Mitigation of environmental impacts to wetlands, bottomland hardwoods and other environmentally sensitive areas as a result of construction of the proposed reservoir would require the conversion of land from their current uses, most likely agricultural and undeveloped land use types. Undeveloped land use types would likely be areas that were once in agricultural production and are now fallow or previously disturbed areas that could be enhanced or restored to their original, natural condition to provide mitigation credits. The amount of mitigation required is unknown, but will depend on the quality of the habitats impacted and the present conditions of any prospective mitigation sites. The Proposed Alternative could benefit the Caddo National Grassland if mitigation actions include enhancement or restoration activities within the Grasslands.

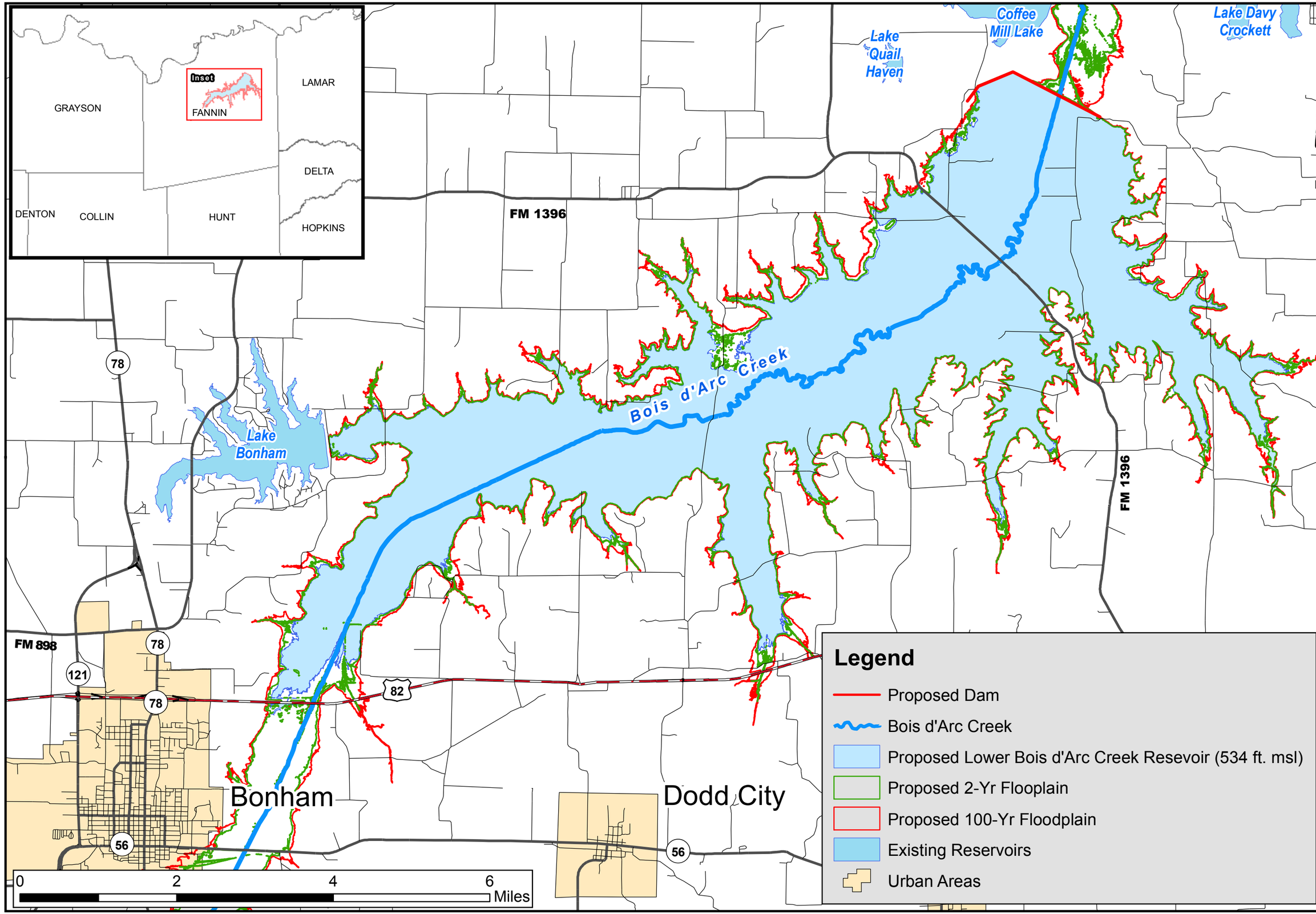
5.3 Water Resources

5.3.1 Hydrology and Hydraulics

Areas within the Lower Bois d'Arc Creek Reservoir project site will be inundated to elevation 534' msl under normal operating conditions. Analyses of the 100-year rainfall event show water levels within the project increasing to 539.7' msl. The 500-year event will increase water levels within the lake to 541.6' msl. These impacted areas will be acquired by the NTMWD as part of the project. Property within the 541 elevation contour will be purchased by the NTMWD for the project, and flowage easements will be attained for property that lies between 541' and 545' msl.

Preliminary estimates of properties impacted by the project include 52 current residences, 39 other structures and one cemetery. There are several electrical transmission lines that cross the project site that will need to be raised or re-routed, one 10-inch gas pipeline and several phone cables. Farm to Market (FM) Road 1396 will be impacted by the lake and will be re-routed. Preliminary cost estimates included re-routing this road to the east of the reservoir site. The bridge at State Highway 82 at the upper part of the proposed lake will need to be slightly modified. Several small county and private roads will likely be closed as part of the project. In addition, the impounded water under conservation pool conditions will abut the downstream face of the Lake Bonham dam, and downstream protection of the dam will be provided. The acquisition of property, flowage easements, resolutions of conflicts, and protection of the Lake Bonham dam are included in the cost estimates for this project presented in Chapter 2.

The construction of the Lower Bois d'Arc Creek Reservoir will not increase flooding upstream or downstream of the project site. A study conducted in 2005 and updated in 2007 evaluated the potential impacts of the Lower Bois d'Arc Creek Reservoir for the 10-, 50-, 100- or 500-year flood events (see Appendix A). The results found that the reservoir did not increase water levels upstream of the Highway 82 bridge for any of these flood events. The modeling shows that flood levels decrease immediately downstream of the dam, and then return to levels without the project. Figure 5-1 shows the 2-year and 100-year flood plains with the project.



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DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure5-2.mxd

North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

Proposed Floodplain Map

Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

5-1
FIGURE

5.3.2 Aquatic Resources

Impacts resulting from construction of the proposed Lower Bois d'Arc Creek Reservoir will mean the creation of 16,641[2] acres of lacustrine habitat. Existing small lacustrine habitats comprise approximately 87 acres within the proposed project area, resulting in a net gain of 16,554 acres of this habitat type. A total of 219 acres of riverine habitat will be lost. Additionally 1,223 acres of emergent wetland (including the emergent wetlands associated with a small lake located on Thomas Branch), 49 acres of shrub wetland, and 4,602 acres of forested wetland habitat will be converted to lacustrine habitat. Although a net gain of 16,554 acres of lacustrine habitat will result from the project, habitat diversity would be reduced due to the loss of these other habitat types. Approximately 2,150 acres of emergent wetlands will likely be created along the shores of the proposed reservoir (between elevations 529' and 534' msl), which is more than the 1,223 acres that currently exist within the project area.

Streams

Within the proposed site boundaries, all perennial and intermittent streams will be lost due to inundation of the proposed site by waters forming Lower Bois d'Arc Creek Reservoir. It is estimated that approximately 123.3 miles of perennial and intermittent streams will be inundated. The riverine habitat (219 acres) will be converted to open water or deep water habitat. Biotic assemblages typical of small, fluvial (flowing water) environments will be replaced by those typical of large lacustrine environments. This includes changes in phytoplankton, zooplankton, benthic macroinvertebrates, and fish populations. Stream channels in and near the upper reaches and perimeter of the reservoir will experience increased silt deposition from sediments that drop out of the water column of these streams as water velocity drops upon approaching or entering the main body of the lake. Tributary streams will become more stable as bank cutting and instability is reduced due to lower head differentials with impounded waters in the lake.

[2] The estimated conservation pool acreage is determined from the updated elevation data obtained from the LiDAR survey conducted in January 2007. This acreage is slightly greater (115 acres) than the acreage reported for the Texas water rights permit application. The difference in these values is less than 1 percent, and is within the accuracy of the methodologies. All acreages reported in the 404 application and supporting report are based on data obtained from the updated 2007 LiDAR aerial survey.

Fish populations found in Bois d'Arc Creek and surrounding water bodies are all adapted to lacustrine habitats and therefore most would be expected to continue to occur in the completed reservoir. Although these species may occur in the reservoir, relative abundance may vary due to the introduction of predator and competing species over time, which may affect the survivability and population densities of some of the present species. In addition, vast expanses of new habitat for some of the resident species will be created, which will cause these species numbers to increase dramatically. As stated earlier, over time new species, such as flathead catfish (*Pylodictis olivaris*), blue catfish (*Ictalurus furcatus*), striped bass (*Morone saxatilis*), white bass (*Morone chrysops*), or other fish suitable to large, open water bodies, even if not originally native, will likely be introduced either naturally or intentionally into the lake and will affect species abundance, diversity and distribution.

Instream Uses

Impacts to instream uses will be from the conversion of ephemeral, intermittent, and perennial stream habitats to a reservoir environment. The uses of aquatic life, contact recreation, noncontact recreation, and fish consumption will all be enhanced and expanded. The public water supply use will be greatly enhanced by the construction and operation of the Lower Bois d'Arc Creek Reservoir.

Impacts to instream uses downstream of the dam will be mitigated through environmental flow releases and proposed stream restoration of Bois d'Arc Creek below the dam. These activities are included in the design of the project to compensate for losses of stream function and wildlife habitat, and when completed may enhance instream uses below the dam. A stream flow study is planned to assess the current conditions and potential impacts from the project. As part of the water rights application, environmental flow releases were estimated using the Texas Consensus Bypass Criteria (Freese and Nichols, 2006). The Consensus method bases flow releases on reservoir storage.

Instream uses upstream of the project site are not expected to be impacted.

Wetlands

Impacts from construction of the proposed Lower Bois d'Arc Creek Reservoir will result in the initial loss of 1,223 acres of emergent wetland, 49 acres of shrub wetland, and 4,602 acres of forested wetland habitat. All wetland areas within the project site would be converted to lacustrine habitat as a result of the project. However, some emergent wetlands will likely be created over time along the shores of the proposed reservoir within the littoral zone to a depth of approximately five feet. A preliminary desktop analysis shows that an estimated 2,150 acres of potential emergent wetland habitat would be created between the 529'. msl and the 534'. msl elevation. Additionally, it is expected that intentional activities along the margins of the lake will be performed to create and/or enhance wetland areas to offset impacts resulting from the project.

Impacts to functions performed by wetlands within the proposed project area as a result of constructing the reservoir would vary. Groundwater recharge and groundwater discharge functions were both considered low under the No Action Alternative. Under the Proposed Action Alternative, these functions are likely to remain low due to the clay content of the underlying soils, resulting in no impact to these functions. Similarly, the uniqueness/heritage function of the wetlands within the proposed project area was considered low under the No Action Alternative, as this area is typical of many floodplain areas in northeast Texas. Under the Proposed Action Alternative, the uniqueness/heritage function would remain low since this area will be typical of the many reservoirs located in northeast Texas.

Flood flow alteration and sediment stabilization functions were both considered high under the No Action Alternative. Under the Proposed Action Alternative, these functions will remain high, or even slightly increase, due to increased storage capacity from the reservoir and the slowing of stream flows during and following storm events. As a result, implementation of the Proposed Action Alternative would result in no impact, or slight beneficial impacts, to these functions.

Under the No Action Alternative, sediment / toxicants retention and nutrient removal / transformation wetland functions were considered medium. Under the Proposed Action Alternative, the function of sediment retention would increase as flows are slowed and sediment

is allowed to settle out of the water column and become trapped within the reservoir. This, in turn, would increase the function of toxicant retention since most toxicants of concern in the environment adsorb to particulate matter. However, potential toxicants within the reservoir are not a major concern. Similarly, the Proposed Action Alternative is expected to increase the function of nutrient removal / transformation due to the increased retention time for water and nutrient interaction with vegetation.

Under the No Action Alternative, the function of production export was considered medium due to amount of plant biomass being produced within the wetland system and its direct connection to Bois d'Arc Creek. Under the Proposed Action Alternative, much of the plant biomass production would be lost due to inundation of the existing vegetation and this energy source being trapped within the reservoir resulting in an overall decrease in production export. Overall, the Proposed Action Alternative would have a slight negative impact on production export.

Under the No Action Alternative, wetland wildlife diversity and abundance was considered medium. Under the Proposed Action Alternative, many of the terrestrial species of wildlife would be displaced due to permanent inundation of the project site. On the other hand, construction of the reservoir would result in the creation of habitat for waterfowl, shorebirds, and wading birds that would offset losses to these forms of wildlife. Overall, a slight decrease in wildlife diversity is expected as a result of construction of the reservoir.

Under the No Action Alternative, wetland aquatic diversity and abundance was considered low due to the intermittent nature of inundation of the site. Under the Proposed Action Alternative, aquatic diversity and abundance is expected to greatly increase as a result of the reservoir providing a permanent water source and creating both shallow and deep water habitat for a variety of aquatic species. Overall, a large beneficial impact to aquatic diversity and abundance would result from construction of the reservoir.

Under the No Action Alternative, the function of recreation provided by the wetlands was considered medium due to the amount of hunting observed within these areas. However, this recreational function is severely limited due to private ownership of the entire wetland area. Under the Proposed Action Alternative, recreational uses of the site are expected to greatly

increase. This beneficial impact would be derived by providing public access to the reservoir for recreational purposes such as boating, fishing, hunting, bird watching, and sight seeing. Overall, a large beneficial impact to recreational function would result from construction of the reservoir.

Water Quality

With the proposed project the average dissolved mineral concentrations in the lake are projected to be at similar or lower levels than reported for Bois d'Arc Creek. This is because most of the inflows to reservoirs occur during high-flow events, which typically have lower mineral concentrations. Also, most stream sampling occurs during times of low to moderate flow. As a result, the mean concentrations of minerals in lakes are commonly as much as two to three times lower than the mean concentration of the inflow data.

To assess the potential water quality in the Lower Bois d'Arc Creek Reservoir a water-balance model was developed, considering diversions, evaporation and precipitation over the historical period of record (1940 to 1986). The historical water quality data from Bois d'Arc Creek and similar tributaries of the Red River in northern Texas counties were analyzed to estimate concentrations of total dissolved solids, chloride, and sulfate in the natural runoff to the proposed reservoir (Freese and Nichols, 2006).

The findings of the study show that the Lower Bois d'Arc Creek reservoir will have good water quality and relatively low mineral concentrations. The predicted water quality parameters for the proposed reservoir are shown in Table 5-1.

Table 5-1
Estimates of Water Quality in Proposed Lower Bois d'Arc Creek Reservoir

Mean Chloride (mg/L)	Mean Sulfate (mg/L)	Mean TDS (mg/L)
19	38	221

The primary impact of the construction of the reservoir on downstream mineral concentrations will be to reduce the observed variability in these parameters. Water released from the reservoir during wet weather conditions will likely have higher mineral content than that entering the stream as direct runoff. However, low-flow releases from the reservoir to meet downstream environmental needs during dry weather periods will likely have a lower mineral content than the naturally occurring low flows within the stream.

There could also be changes to temperature, dissolved oxygen, suspended sediment, and other water quality parameters. Further data collection would be needed to develop a more comprehensive assessment of future downstream water quality.

5.4 Terrestrial Resources

5.4.1 Vegetation

Direct impacts to terrestrial vegetation will be direct inundation of approximately 16,641 acres by the proposed reservoir and impacts to 427 acres from the construction of the dam and spillways. Of this total, approximately 16,762 acres are vegetated by terrestrial vegetation, which excludes 219 acres of riverine habitat and 87 acres of lacustrine habitat. An evaluation of impacts by using a multi-agency HEP study is planned. Based on preliminary desktop cover type delineations for the area within the project boundaries (~ 17,068 acres), approximately 50 percent is deciduous forest (comprised of upland deciduous forest, riparian woodland/bottomland hardwoods and forested wetlands), 28 percent is grassland/old field, 10 percent is cropland and 7 percent is emergent/herbaceous wetlands with small percentages of evergreen forests, tree savannah, shrubland, shrub wetland, and shrub savannah. Characteristic species and community characteristic will be further quantified during the HEP study performed to evaluate habitat values.

Further losses to terrestrial habitats will result from secondary or indirect impacts as residential areas are constructed adjacent to and/or in proximity to the proposed reservoir. Over time, these residential areas, along with the associated infrastructure, such as schools, roads and utilities, and attendant commercial and recreational facilities will likely result in greater habitat loss to adjacent upland habitats than those expected from the proposed reservoir.

5.4.2 Wildlife (HEP)

Under the Proposed Action Alternative terrestrial and stream habitats will convert to aquatic habitats. As such, terrestrial wildlife within the project site area will likely relocate to nearby areas and new aquatic wildlife will develop within the project area. A more detailed analysis of the potential impacts to wildlife under the Proposed Action Alternative will be determined during the remaining stages of HEP analyses.

5.4.3 Threatened and Endangered Species

The U.S. Fish and Wildlife Service lists three threatened and endangered species as occurring in Fannin County. These include the recently delisted bald eagle, the endangered interior least tern and the threatened black bear. Direct adverse impacts to the bald eagle are not expected to occur. The project area contains little or no nesting or foraging habitat for the bald eagle due to the lack of large trees associated with large rivers or other large water bodies. The bald eagle prefers nest sites in large trees adjacent to large water bodies. Nest trees are generally the tallest tree in the vicinity and have an unobstructed flight path to the nest site.

Direct adverse impacts of the proposed project on the interior least tern are not expected to occur due to the lack of nesting habitat present in the proposed reservoir site for this species. Foraging habitat during the nesting season is generally confined to within two to four miles of the nest site (U.S. Fish and Wildlife Service, 1990). For these reasons no adverse impacts to interior least tern nesting habitat are expected.

Direct adverse impacts of the proposed project on black bear are not expected to occur. While potential habitat is present in the project area, only one sighting of a black bear has occurred in Fannin County since Texas Parks and Wildlife Department began tracking sightings in 1977 (Texas Parks and Wildlife Department, 2005). Preferred habitat of the black bear

consists of large forests with escape cover including extensive areas of minimal human disturbance. According to the U.S. Fish and Wildlife Service (1995) suitable forest community types include the species such as bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), river birch (*Betula nigra*), American sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), American elm (*Ulmus americana*), green ash, Nuttal oak (*Quercus nuttallii*), overcup oak (*Quercus lyrata*), sweetgum (*Liquidambar styraciflua*), water oak, swamp chestnut oak (*Quercus michauxii*), and southern red oak.

The proposed project area currently includes extensive areas of undeveloped land interspersed by a rural road system and only small areas of urban development. This type of environment could serve as habitat for black bear; however, black bear sightings are extremely rare. As such, adverse impacts to black bear habitat are not expected.

Since the federally listed species for Fannin County are unlikely to be found on site or in adjacent areas, indirect impacts to these species are not expected. Prior to permitting of the reservoir, the USFWS will be consulted under Section 7 of the ESA to obtain the latest biological data for these species and ensure that these species are considered in the planning for this reservoir.

As with direct impacts, indirect impacts to endangered species are likely to be minimal due to the low potential of any endangered species occurring in the project area.

5.5 Cultural Resources

The proposed Lower Bois d'Arc Creek Reservoir will inundate approximately 16,641 acres. Based on the assessment of the potential for archeological sites within the project boundaries, it is highly likely that prehistoric and historic sites will be flooded with the construction of the project. Some buried sites may be impacted during construction from excavations for borrow pits and channel modifications for the intake construction. After inundation, the water will provide additional protections from future disturbances.

Historic sites within the reservoir boundaries will be impacted by the project. The Wilks Cemetery will need to be relocated outside of the project boundaries. Other sites identified during field studies will need to be recorded and possibly moved or protected. It is anticipated

that at least half of the historic archeological sites recorded would have yielded their significance and will not be eligible for inclusion on the National Register of Historic Places or State Archeological Landmarks.

Construction of the project will provide a means to identify, record and protect prehistoric and historic archeological sites that otherwise may have not been identified. The loss of archeological resources within the project area will be mitigated before the lake is completed as part of the agreed mitigation plan for the project.

5.6 Recreational Resources

With the proposed Lower Bois d'Arc Creek Reservoir there would be a substantial increase in recreational opportunities, especially water-based activities. The proposed reservoir would provide much more public access for fishing, boating, and other water-related activities. If some of the proposed mitigation is implemented, there would be increased public hunting on and around the reservoir as well as expansion of the Caddo National Grassland and its facilities.

Additional public and private parks could potentially provide more camping related activities, including attracting recreational vehicle tourism.

5.7 Other Social Effects

In 2004, Dr. Terry Clower and Bernard Weinstein conducted a study on the economic, fiscal and developmental impacts of the proposed Lower Bois d'Arc Creek Reservoir. An updated assessment was conducted in 2007. Copies of these studies are included in Appendix B of this report. Based on the findings of these studies, the development of the proposed action will have a long-term positive impact to the economies and fiscal health of Fannin County, surrounding counties and the service area of the NTMWD. The projected impacts are summarized below.

Constructing the proposed Lower Bois d'Arc Creek Reservoir will directly impact the population of Fannin County by displacing persons currently residing within the proposed reservoir site and by attracting new residents into the project area due to increased economic opportunities. Based upon a review of aerial photographs and the number of current residents in

Fannin County, the number of displaced persons is expected to be small. It is likely many of the displaced residents would relocate to within Fannin County.

During construction a temporary influx of workers will occur. The initial migration of workers will result from commencement of dam construction and will continue until all construction activity is completed. While some of these construction workers may relocate to the project area, many will commute from nearby areas.

The construction of a large reservoir will make Fannin County a more appealing area in which to live, causing a migration of permanent residents into the county. An estimated 1,100 new, permanent residences will be constructed as a result of lake development over a 30-year period. In 2006, the average household in Fannin County contained 2.51 persons. If new households are similar in size to existing households, then the project should attract approximately 2,800 new permanent residents to the area in proximity to the reservoir in addition to the projected growth that would occur without the project. This influx would be over a 30-year period.

In addition to the expected influx of new residents due to a more attractive living environment, new residents will move into the area as a result of enhanced job opportunities provided by dam and pump facilities construction and operation, recreational business opportunities, new housing construction, new industrial and commercial activities generated by increased availability of water, and from jobs created by meeting the needs of other new residents. Over 2,200 jobs are estimated to be created as a result of improved economic conditions in Fannin County alone. Many of these jobs would likely be taken by persons moving into the project area. The influx of these persons and any family members would further expand the population. Most of these jobs and therefore much of the population gain would likely stay in Fannin County; however, all of the surrounding counties would see a gain in jobs and, therefore, likely gains in population.

During construction of the proposed Lower Bois d'Arc Creek Reservoir the average number of jobs created would be approximately 400 to 500 per year. It is expected that many of the required workers will have to come from outside the immediate project area. Once construction of the dam and pipeline is completed, on-going impacts from the operation and

maintenance of these infrastructures would support about 20 fulltime-equivalent direct and indirect jobs. These impacts will also extend into surrounding counties.

Once the project is constructed, improved economic conditions resulting from new home construction, increased recreational spending, new resident spending and increased commercial and industrial activity will also create new jobs in the project area. It is estimated that ultimately up to 2,300 jobs could be created in Fannin County alone as a result of the proposed reservoir after construction is complete.

Income impacts from the proposed project would be either through gains in salaries and wage levels in the areas in proximity to the dam, pipelines or related facilities and in surrounding counties or in the form of increased revenues to local governments through increases in the tax bases. Construction of the proposed reservoir is projected to cost between $181 million and $200 million. This money will come from outside the immediate project area. Most of the direct benefits would be captured by local economies; however, most of the indirect benefits would be realized by those areas receiving the new water supply.

Construction of the dam alone would generate over $60 million in wages and salaries in Fannin County and construction of the pipeline and associated facilities would generate an additional $100 million.

The acquisition of over 17,000 acres of taxable land for the reservoir would cause a short term decrease in the tax base of Fannin County; however, as construction commences, new residents move into the area, property values increase, and new residential, commercial and industrial developments move into the area, the tax base of Fannin County would increase. Local taxing jurisdictions will enjoy not only substantial temporary gains in revenues from business activities related to construction of the dam, pipelines and related infrastructure, and new housing, they will also see new revenues based on increased property values and spending by visitors and residents. Property taxes on new housing alone will add $1.9 million to county tax revenues above any losses due to the lake impoundment and related environmental mitigation. Similarly, net gains in area school district revenues will approach $5 million per year at full development. Local taxes on retail sales will generate at least $290,000 per year with an additional $175,000 per year provided by hotel occupancy taxes.

This growth in the economy will also create a demand for new publicly-provided services. These would include electric services, roads, water services, public safety, schools, and other municipal services that the local jurisdictions would be required to provide.

Construction of a large reservoir will attract many new residents to Fannin County. Over a 30-year period an estimated 1,100 new permanent households will be established around the lake. An additional 2,100 residences will likely be built as vacation/weekend/second homes. In addition to these residences, new economic opportunities would create a demand for housing.

Due to the long-term nature of the project, many workers may wish to move into the project area rather than commute, creating a demand for housing, most likely in Bonham or the surrounding areas. The result would be a demand for increased housing in the project area to accommodate a portion of these workers. Once construction is complete, an estimated 2,200 jobs will be created by the economic demands of new residents, new home construction, permanent jobs associated with the new facilities and new jobs created by increased commercial and industrial activities resulting from the enhanced ability of Fannin County to attract and retain new business. An additional estimated 300 jobs will created in either Fannin or Collin County by operation of the dam, pipeline and ancillary facilities and by recreational users of the lake. These jobs will create an influx of workers, which will, in turn, create a demand for housing in the project area.

6.0 CONCEPTUAL MITIGATION PROPOSAL

MITIGATION

NTMWD will provide multi-faceted compensatory mitigation as required for the project.

Final mitigation package will provide net positive benefit to Fannin County and the region.

Caddo National Grasslands offers unique opportunities for mitigation for the public good:

- **Purchases to provide connectivity of Grasslands**
- **Stream restoration to improve aquatic and riparian habitats**

Compensatory mitigation is required by USACE regulations to offset losses of aquatic resource functions and services due to the impacts of a project. The impacts of the proposed project to waters of the U. S. include placement of fill material for construction of the Lower Bois d'Arc Creek Dam and inundation of intermittent and perennial streams, wetlands, and open waters (ponds and lakes). Such mitigation is also required to meet the national policy goal of no net loss of wetlands functions. In addition, compliance with the National Environmental Policy Act typically requires the USACE to seek mitigation to compensate for project impacts to terrestrial areas.

Mitigation for large projects such as reservoirs historically has resulted in the setting aside of some acreage for perpetual management as wildlife and aquatic habitat to compensate for impacts. In Texas, the mitigation area ratios for non-flood control reservoirs have ranged from none (Palo Duro and Mitchell County Reservoirs) to 1.54 acres (Lake Gilmer) per acre inundated. The larger reservoirs have typically had smaller mitigation ratios. For example, the required mitigation ratio for both Richland Chambers (41,356 acres) and Owen H. Ivie (19,200 acres) reservoirs was 0.31 acre per acre inundated. The size of the required mitigation depends on the acreage and quality of affected aquatic resources and wildlife habitat (i.e., the impacts) as compared to the quality of the proposed mitigation lands and the value of other non-land compensation (i.e., the mitigation proposal/plan). The impacts and proposed mitigation are weighed by the USACE, in consultation with other resource agencies, in order to determine the final amount of mitigation lands that will be required. All proposed mitigation that would require acquisition of property would be as a willing seller/willing buyer transaction.

It is not practical to accomplish the required mitigation for this project by purchasing a large block of land and setting it aside in perpetuity. Rather, a combination of strategies will be required. Based on the current knowledge of impacts associated with the 17,068 acre project footprint as noted in the preceding chapters, the NTMWD mitigation plan would likely consist of

the following components:

- Mitigation bank credit purchase and/or in-lieu fee agreements
- Instream flow releases
- Stream restoration and riparian habitat enhancement
- Purchase of lands and management for wildlife habitat enhancement
- Private land purchases to expand the Caddo National Grasslands within the congressional proclamation boundary
- Water quality protection measures and shoreline management planning
- Creation of waterfowl management areas

The following are brief descriptions of preliminary proposed elements of a mitigation plan to compensate for permanent, unavoidable losses to waters of the U. S., terrestrial wildlife habitat, and other natural resources and functions due to the proposed Lower Bois d'Arc Creek Reservoir.

6.1 Mitigation Bank Credits and In-lieu Fee

If available, the NTMWD would consider purchasing mitigation bank credits for compensatory mitigation. Purchase of bank credits is the preferred option under USACE and EPA rules, effective June 9, 2008. However, there is not currently a bank or in-lieu fee program available that could be used for mitigation for the proposed Lower Bois d'Arc Creek Reservoir.

6.2 Instream Flow Mitigation

NTMWD proposes mitigating the impact of the reservoir on instream flows by developing flow bypass criteria that are consistent with the Texas Instream Flow Program and employing the principles of adaptive management.

Table 6-1 shows the environmental flow criteria submitted with the State of Texas water rights application for Lower Bois d'Arc Creek Reservoir. These criteria are based on the Consensus Method for Environmental Flows, a statistical "desktop" method developed by the Texas Water Development Board, the Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and others. These criteria were developed to be used in the

Table 6-1
Consensus Bypass Criteria for Lower Bois d'Arc Creek Reservoir
(Values in cfs)

Reservoir Storage	Jan	Feb	Mar	Apr	May	Jun
Greater than 80% [a]	25.5	44.9	38.2	31.5	28.9	11.9
Between 80% and 50% [b]	7.3	15.8	13.4	11.2	8.5	1.7
Below 50% [c]	0	0	0	0	0	0
Reservoir Storage	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Greater than 80% [a]	1.7	0.2	0.5	1.7	7.8	19.5
Between 80% and 50% [b]	0.1	0.0	0.0	0.0	0.8	2.3
Below 50% [c]	0	0	0	0	0	0

a Based on median of daily naturalized flows
b Based on 25th percentile of daily naturalized flows
c Seven-day low flow with a 2-year recurrence interval (7Q2)

absence of more specific information on instream flow needs and are the default criteria used in regional water planning in Texas. These criteria require the passage of all reservoir inflows up to the applicable criteria. Inflows to the reservoir above that amount may be diverted or impounded in the reservoir, as long as flows immediately downstream do not fall below the criteria. The bypass criteria vary by month and by reservoir storage as shown on Table 6-1. In the case of Lower Bois d'Arc Creek Reservoir, the low flow release amounts (which is based on 7Q2 flow) is 0.0 cfs. The proposed instream flow mitigation concept uses the flows in Table 6-1 as the initial basis of the criteria. These criteria will be reviewed during the monitoring period and may be modified over time as part of adaptive management.

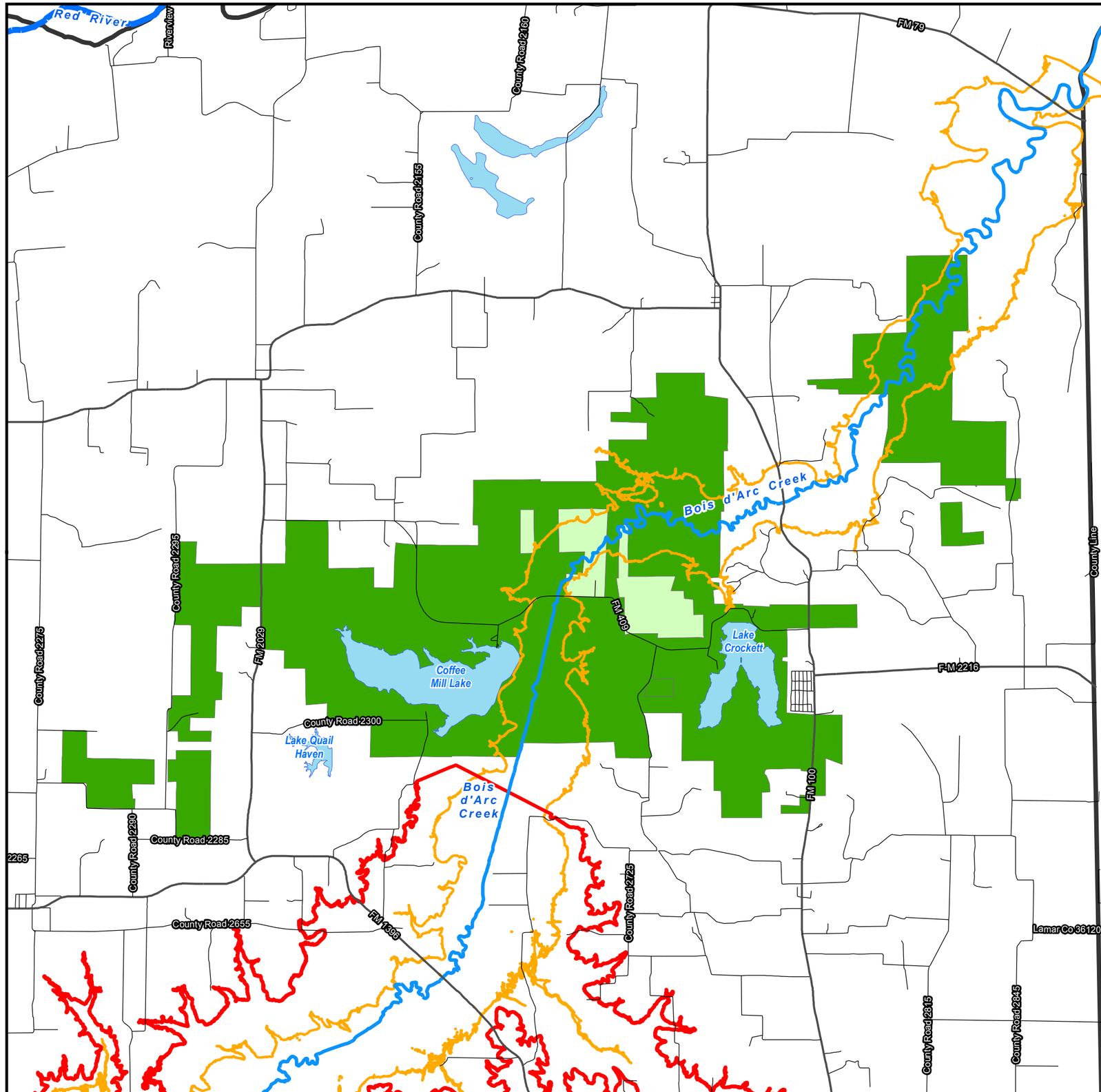
The Texas Instream Flow Program recognizes the variability of flows within a stream system. As previously discussed in Section 3.3.1, the Bois d'Arc Creek watershed is characterized by rapid rises and falls of stream flows in response to rain events, and during dry times there may little to no flow in the stream. Because the reservoir will tend to trap much of the sediment, the water that will be released from the reservoir will have a higher sediment carrying capacity than current flows of equal magnitude. This may allow lower flows to accomplish current functions. It also will require care when making deliberate releases of inflows to prevent excessive erosion downstream. Monitoring of downstream conditions will also be conducted when the reservoir is full and spilling. Such monitoring will provide information needed to refine the release policies.

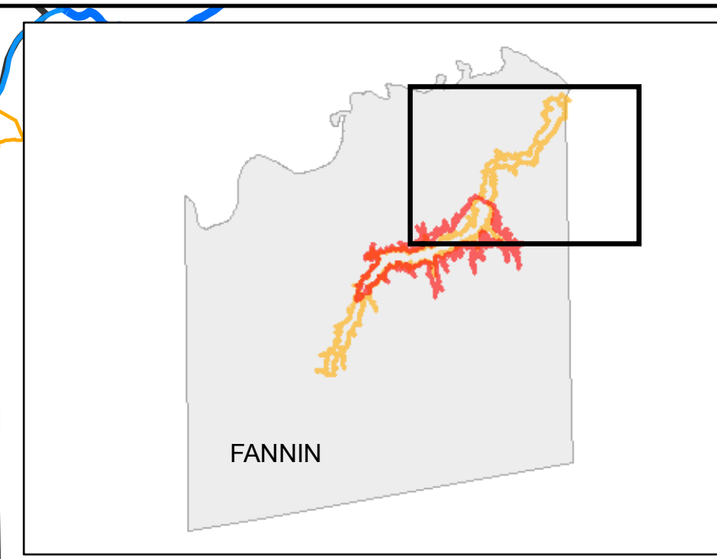
Development of the instream flow criteria will require the establishment of monitoring stations below the reservoir. These stations will be monitored at various flow levels prior to construction of the reservoir. After construction of the reservoir, the stations will be monitored for a period of five years to examine the impact of the instream flow criteria on the stream and habitats. The instream flow criteria may be adjusted during the monitoring period if the criteria have a negative impact on the stream.

6.3 Stream Restoration and Riparian Habitat Enhancement

This component would consist of restoration of pre-channelization structure and hydrology of Bois d'Arc Creek downstream of the proposed reservoir and would compensate for losses of stream functions and riparian wildlife habitat functions. A downstream (Figure 6-1) and / or upstream (Figure 6-2) corridor approximately the width of the 100-year floodplain may be purchased from willing sellers. Restoration activities could include restoring the connection of cutoff meanders, removing levees and other control structures with the goal of restoring more natural hydrology to the riparian zone and restoring pre-channelization stream functions such as flood water conveyance, aquatic habitat, etc. Design of the channel will be consistent with the instream flow criteria mentioned in the previous section so that the flow levels established by the criteria provide environmental benefits while minimizing adverse impacts such as excessive erosion.

After restoration activities are substantially completed (i.e., the area is functioning as intended), the control of the downstream corridor would be transferred to a public (USDA, USFWS, TPWD) or other (Nature Conservancy, etc.) conservation organization to manage and preserve the property in perpetuity.





0 1 2 3 Miles

Legend

- Bois d'Arc Creek
- Proposed Lower Bois d'Arc Creek Reservoir
- 100-Yr Existing Floodplain
- Existing Reservoirs

Caddo National Grasslands WMA

- Private
- Forest Service
- Red River
- Counties

N W E S

North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

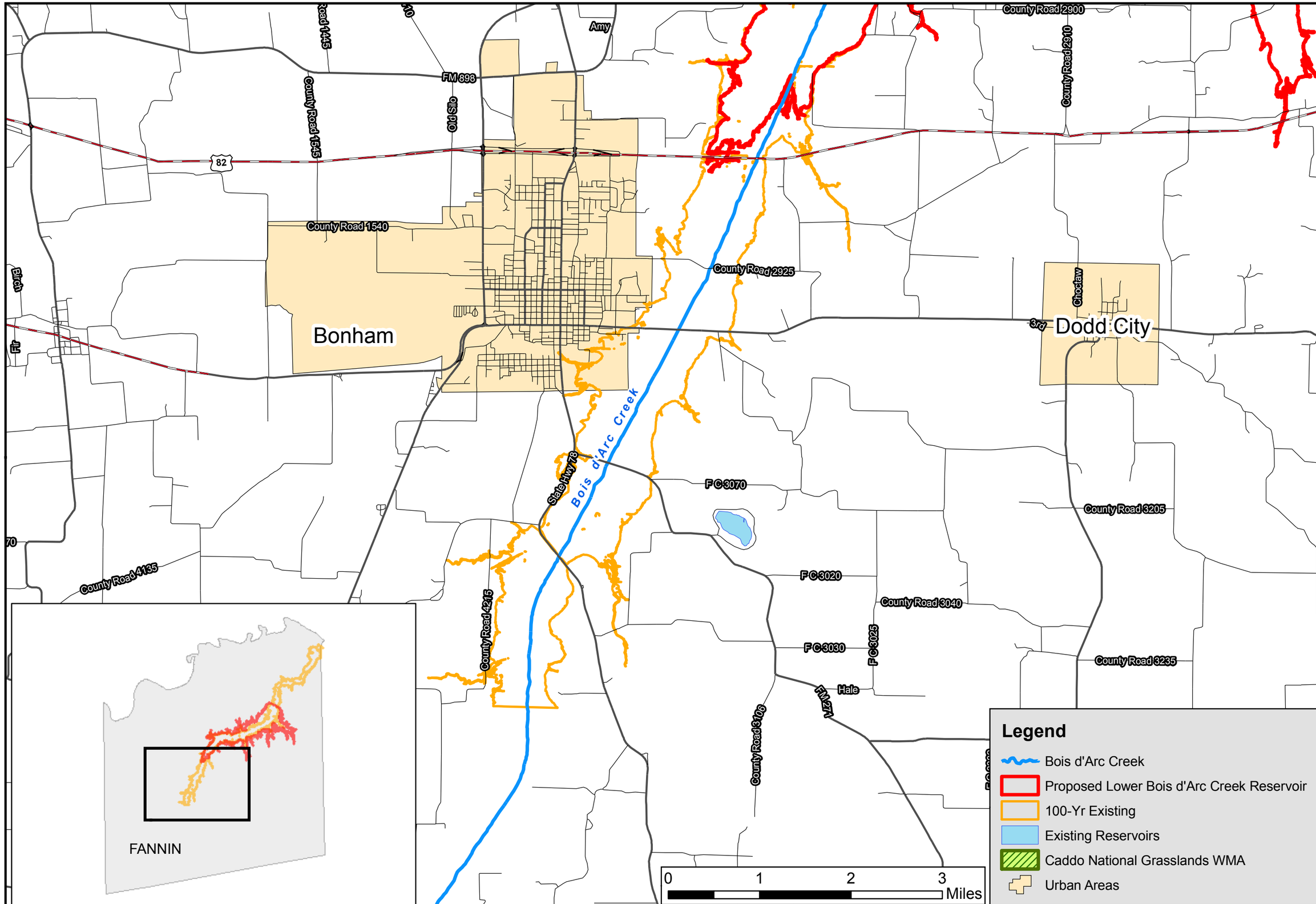
Potential Area for Mitigation in the Downstream 100 - Year Floodplain

F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure6-1.mxd

Freese and Nichols
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

6-1

FIGURE



North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

Potential Area for Mitigation in the Upstream 100 - Year Floodplain

F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure6-2.mxd

Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

6-2

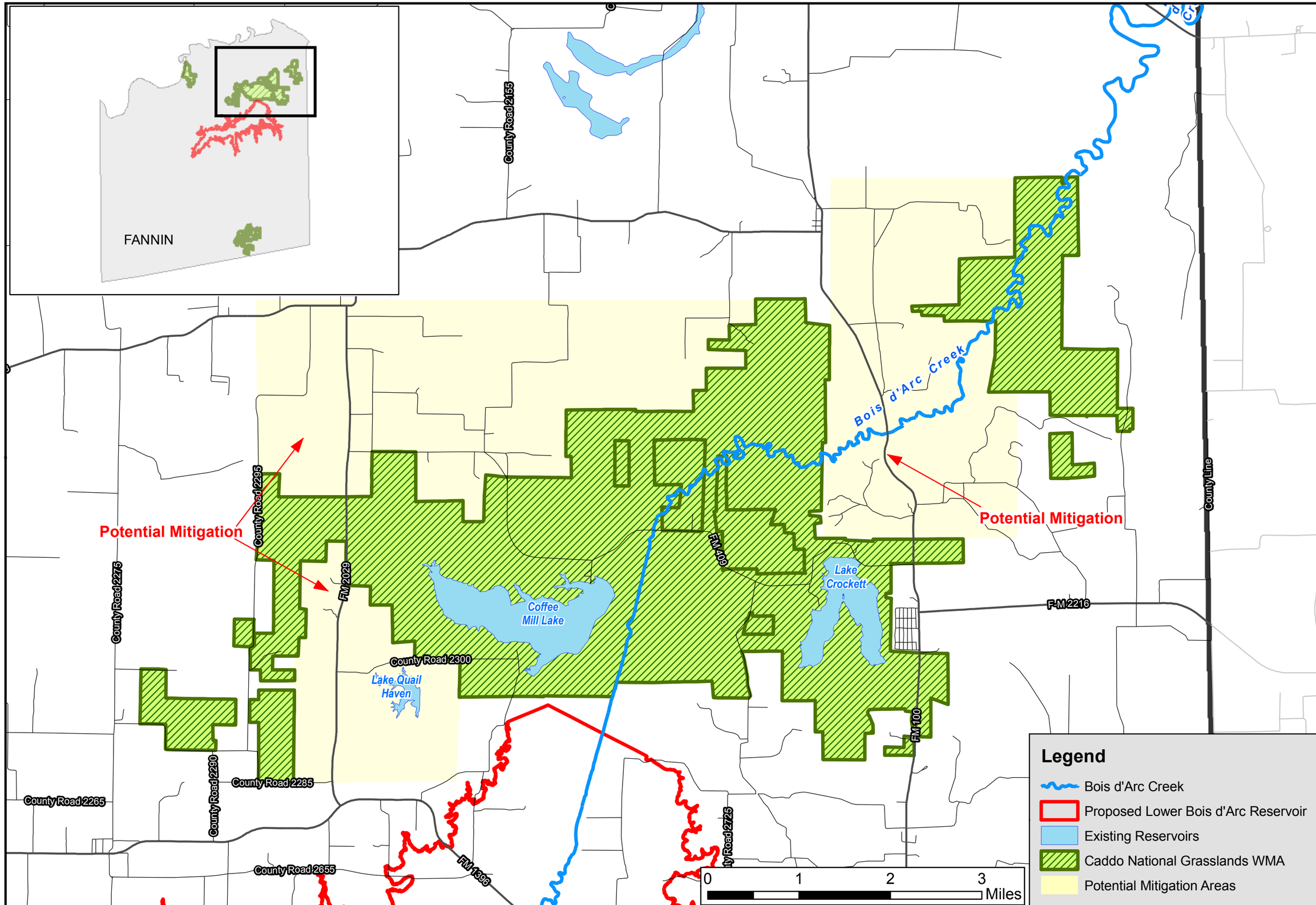
FIGURE

6.4 Wildlife Habitat Mitigation

This plan would compensate for losses of upland wildlife habitat and would consist of purchasing land for habitat mitigation. Purchased lands from willing sellers for habitat mitigation would be managed to increase the value of the land as wildlife habitat and would increase biodiversity of the region by the creation and enhancement of a variety of habitat occurring in the region – prairie, riparian forest, upland forest and shrub lands. The lands would be protected from any future development or non-wildlife habitat uses.

6.5 Caddo National Grasslands Enhancement

The Caddo National Grasslands area provides opportunity to mitigate losses of streams, wetlands, and terrestrial habitat. This mitigation component would include the purchase of key parcels of land from willing sellers (Figure 6-3) that, in addition to providing compensatory mitigation, would help enhance the mission and values of the nearby Caddo National Grasslands. Adding these key parcels would improve management and wildlife habitat by connecting fragmented land parcels. The Caddo National Grasslands is comprised of 17,785 acres and contains three lakes. The Forest Service currently does not have the funding to purchase additional property that would add value to the functions of the National Grassland. Activities supported by the Grassland are hiking, camping, fishing, hunting, horseback riding, mountain biking, wildlife viewing, and photography. Common wildlife are white-tailed deer, small mammals, coyotes, bobcats, red fox, waterfowl, bobwhite quail, turkey, and songbirds, all of which thrive in the diverse habitats provided by the Grasslands. Largemouth bass, blue and channel catfish, and various sunfish species are common catches at the lakes in the Grasslands. Procuring additional key land to add to the Grassland would be a benefit to the wildlife of the area as well as enhancing and expanding the recreation opportunities for area residents and tourists.



North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

Potential Caddo Mitigation Area

F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure6-3.mxd

Freese and Nichols
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

6-3

FIGURE

6.6 Water Quality

NTMWD will cooperate with resource agencies to regulate boating, fishing, hunting and other recreational and commercial activities on and surrounding Lower Bois d'Arc Creek Reservoir. NTMWD will cooperate with local agencies to protect water quality through measures addressing erosion, septic tank installations, fuel spills, etc. The County or other local entity will be responsible for managing development around the lake, including protection of the lake's water quality.

6.7 Shoreline Development Planning

NTMWD will obtain flowage easements that would help guide development around the reservoir. Flowage easements would be purchased for land from 541' msl up to elevation 545' msl. Approximately 1,500 acres would be included in the flowage easements. Development restrictions within the flowage easements would help avoid flood damage to habitable structures and minimize the secondary impacts of development (such as degradation of water quality by unauthorized septic systems) adjacent to the reservoir.

6.8 Waterfowl Management Area

NTMWD would set aside and manage (in cooperation with appropriate resource agencies or private conservation organizations) a portion of the reservoir area for waterfowl management. The area selected would have water depth five feet or less and should provide good habitat for waterfowl and other wildlife. Timber in this area would not be cleared for reservoir construction, but would be left standing to provide cover and some wildlife food (acorns, etc.) production. Features of this plan could include 1) creating a buffer zone around the area to minimize impacts of future development, 2) providing access points for boats and walk-ins, and 3) habitat enhancements such as nest boxes and food plots. Creation of this waterfowl management area would avoid and minimize some of the project impacts on wetland functions such as waterfowl habitat; sport hunting; wildlife observation; canoeing and other recreational boating; and breeding and egg deposition areas for fish, amphibians, and reptiles. Depending on the extent and duration of inundation, portions of shallow water areas could remain in standing timber or be converted to emergent and shrub-scrub wetlands.

7.0 PUBLIC INVOLVEMENT

7.1 Agency Coordination

The NTMWD has actively coordinated with the Tulsa District of the USACE, the Texas Commission on Environmental Quality, and other state, federal and local agencies regarding this project. The most recent coordination activities regarding the permit applications have been on-going since May 2005.

PUBLIC INVOLVEMENT

NTMWD is actively coordinating with State and Federal agencies.

NTMWD has sponsored and /or participated in several public meetings on the Lower Bois d'Arc Creek Reservoir project.

Information on the project is available on NTMWD's website.

www.ntmwd.com

Pre-application meetings with the Tulsa District were held at the District's headquarters on May 26, 2005 and November 20, 2006. Key points and an overview of the project were presented at these meetings. In March 2007, the Tulsa District participated in an inter-agency site visit to the project site. A follow-on meeting on August 23, 2007 was held to coordinate methodologies of field activities for the jurisdictional study. Over the course of the summer of 2007, Tulsa District staff participated with field activities for the HEP study, which is discussed below.

During the August 23, 2007 meeting, discussions with the Tulsa District focused on wetland delineation results and plans for completion, permitting for the raw water transmission line, and data pertinent to the 404 permit application. The Tulsa District had agreed with the Fort Worth District that Tulsa would handle the 404 permitting for the entire project, including the proposed pipeline from the proposed reservoir site to Pilot Grove Creek. The Tulsa District assumed that the pipeline could be designed to have minimal impacts on waters of the U.S. and thereby meet the terms and conditions of Nationwide Permit 12. Therefore, the NTMWD proposes to design and construct the pipeline for coverage under the 2007 version of NWP 12. A copy of this permit is presented in Appendix E.

Similar coordination activities have been on-going with the TCEQ regarding the corresponding water rights application. On December 29, 2006, the NTMWD submitted an application for a Texas water right to construct the Lower Bois d'Arc Creek Reservoir and to take, store and divert state water. A copy of the water rights application was also provided to the

Tulsa District. Specific authorization requests in the water rights application include the following:

- Impound up to 367,609 acre-feet of water in Lower Bois d'Arc Creek Reservoir and divert up to 175,000 acre-feet per year for municipal, industrial and agricultural purposes at a maximum diversion rate of 236 million gallons per day.
- Use of Lower Bois d'Arc Creek Reservoir for recreational purposes.
- Interbasin transfer of 175,000 acre-feet per year from the Red River Basin to the Trinity, Sabine, and Sulphur River Basins.
- Reuse of 100 percent of the return flows generated from the diversion and use of water from Lower Bois d'Arc Creek Reservoir.
- Bed and banks permit to transport up to 236 million gallons per day via Pilot Grove Creek and Lake Lavon for diversion from the perimeter of Lake Lavon.

Following the submittal of the water rights application, an inter-agency team with representatives from the USFWS, USACE, USEPA, USFS, TPWD, TWDB, TCEQ, NTMWD, and Freese and Nichols, Inc. was formed to conduct the HEP study. An initial site visit was held on March 27, 2007 to introduce the project to interested parties, including local, state and federal interests. A briefing of the project was held in Bonham, followed by a field visit to areas within the project site. Representatives from inter-agency HEP team, City of Bonham and Fannin County Water Supply Agency attended. Subsequent organizational and technical meetings were held regarding the HEP study. The inter-agency team participated in the field data collection for the HEP study over the summer of 2007.

Other coordination activities included meeting with representatives of the Caddo National Grasslands, City of Bonham, Fannin County, and the Fort Worth District USACE lake manager at Lake Lavon.

7.2 Public Information and Review

The proposed Lower Bois d'Arc Creek Reservoir has been a recommended new supply for the NTMWD for over 20 years and was included in the 2002 and 2007 Texas State Water Plans, which were produced using a very public involvement process. The NTMWD has actively provided information on the project to the public and the community in Fannin County. A public information forum on the proposed project was held on January 30, 2007. Approximately 400 people from Fannin County and surrounding areas attended.

In compliance with Texas state requirements for interbasin transfer permits, the TCEQ sponsored three public meetings on the proposed project. Meetings were held on September 10, 2007 in Greenville, Texas (Sabine River Basin), September 11, 2007 in Bonham, Texas (Red River Basin) and September 13, 2007 in McKinney, Texas (Trinity River Basin). Public comments were received and responses will be developed by the TCEQ as part of the water rights application.

In addition to the public meetings held to date, the NTMWD maintains a website with links to information about the Lower Bois d'Arc Creek Reservoir project. The NTMWD's website is www.ntmwd.com.

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APPENDIX A

Probable Maximum Flood Analysis

APPENDIX B

The Economic, Fiscal, and Developmental Impacts of the Proposed Lower Bois d'Arc Reservoir Project (2004)

And

The Economic, Fiscal, and Developmental Impacts of the Proposed Lower Bois d'Arc Creek Reservoir Project An Updated Assessment (2007)

APPENDIX C

The Archeological Potential of the Proposed Lower Bois d'Arc Creek Reservoir

And

The Archeological Potential of the Proposed Lower Bois d'Arc Creek Reservoir Pipeline Route

APPENDIX D

Habitat Evaluation Procedure (HEP) Report

For the

Lower Bois d'Arc Creek Reservoir

APPENDIX E

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