cropland; barren/ wasteland; orchards; improved pasture; native pasture; temporary quarantined land; timber at productivity; timberland at 1978 market value; timberland at restricted use; transition to timber; wildlife management; and other agricultural land as defined in Tax Code Section 23.51 (2) (TCPA, 2012a). As shown in Table 3.12-18, in 2012, 27.2 percent of parcels in Fannin County were appraised as agricultural land. These 9,050 parcels are equal to $947,204,160 in market value; or 35.3 percent of the county's total market value. Table 3.12-18 shows the parcel count, market value, and their percent of the overall parcel count and market value for the four agricultural and timberland property types (FCAD, 2012).

Table 3.12-18. Appraised Agricultural and Timberland in Fannin County (2012)

PTAD Classification	Property Type	Parcel Count	Market Value	Parcel Count (%)	Market Value (%)
D1	Qualified Ag Land	9,050	$947,204,160	27.2	35.3
D2	Non-Qualified Ag Land	2,173	$90,039,809	6.5	3.4
E	Farm Improvement	5,226	$351,000,548	15.7	13.1
X	Exempt Property	1,951	$346,005,650	5.9	12.9

Source: FCAD, 2012

Farmers and ranchers are not exempt entities; nor are all purchases by farmers and ranchers exempt from sales tax. Sales of some agricultural items, however, are always exempt, regardless of who is buying the item or how it will be used. Non-taxable agricultural items include seeds and annual plants such as corn, oats, soybeans, and cotton seed (the products of which are commonly recognized as food for humans or animals); animals including cattle, sheep, poultry and swine (the products of which are ordinarily food); horses and mules; water; feed for farm and ranch animals or wild game including oats, hay, chicken scratch, wild bird seed and deer corn. Other agricultural items are taxable unless purchased for exclusive use on a commercial farm or ranch in the production of agricultural products for sale. "Exclusively used" means the item must be used 100 percent of the time on a commercial farm or ranch in the production of food or other agricultural products. For example, a tractor used exclusively on a commercial farm to plow fields, mow hay and harvest crops qualifies for exemption. But, the tractor does not qualify for the exemption if it is used for any non-qualifying activity such as providing an amusement service (i.e. hayrides), or if it is used on any property other than a commercial farm or ranch for any reason. A tractor used to mow grass on a utility line right-of-way does not qualify for exemption (TCPA, 2011a).

For sales tax purposes, a farm or ranch is land used wholly or in part in the production of crops, livestock and/or other agricultural products held for sale in the regular course of business. Examples of farms and ranches include commercial greenhouses, feed lots, dairy farms, poultry farms, commercial orchards and similar commercial agricultural operations. A farm or ranch is not a home garden, timber operation, kennel, land used for wildlife management or conservation, land used as a hunting or fishing lease or similar types of operations that do not result in the sale of agricultural products in the normal course of business.

Certain items used exclusively in the production of timber for sale in the regular course of business qualify for exemption from Texas sales and use tax. Timber production includes activities to prepare the production site, and to plant, cultivate, or harvest commercial timber that will be sold in the regular course of business; and the construction, repair, and maintenance of private roads and lanes exclusively used for access to commercial timber sites (TCPA, 2012c).

Real property, including certain leasehold interests, and personal property are taxable. Real property is the rights, interests and benefits connected with real estate. Section 1.04 of the Property Tax Code defines real property to include standing timber (Texas A&M, 2011). The main natural resource in

Fannin County is timber. Consequently, wood-product manufacture has been important in the local economy (TSHA, 2016). Large swaths of clearcut bottomland timber are already visible in the proposed project area, as landowners, in anticipation of the proposed project, sell off their timber to make additional income before selling the land.

Retail Sales Taxation

The state of Texas retail sales tax stands at 6.25 percent. Local sales taxes vary by county and by city. As displayed in Table 3.12-19, most counties in the local area have a retail sales tax of 0.5 percent, but as in the case of Collin and Grayson Counties, some have none. In addition, as is common in Texas, most cities and towns in the local area impose additional tax rates of one to two percent on retail sales.

Table 3.12-19. Retail Sales Tax Rates in ROI

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
Fannin	–	0.5	6.75
	Bailey	1.0	7.75
	Bonham	1.5	8.25
	Dodd	1.0	7.75
	Ector	1.0	7.75
	Honey Grove	1.5	8.25
	Ladonia	1.0	7.75
	Leonard	1.5	8.25
	Ravenna	1.0	7.75
	Savoy	1.5	8.25
	Trenton	1.5	8.25
	Windom	1.0	7.75
Collin	–	0.0	6.25
	Allen	2.0	8.25
	Anna	2.0	8.25
	Blue Ridge	2.0	8.25
	Celina	2.0	8.25
	Dallas	1.0	7.25
	Fairview	0.0	6.25
	Farmersville	2.0	8.25
	Frisco	2.0	8.25
	Garland	0.0	6.25
	Josephine	1.0	7.25
	Lavon	1.5	7.75
	Lowry Crossing	1.0	7.25
	Lucas	1.0	7.25
	McKinney	2.0	8.25
	Melissa	2.0	8.25
	Murphy	2.0	8.25
	Nevada	1.75	8.00
	New Hope	1.0	7.25
	Parker	1.0	7.25

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
	Plano	1.0	7.25
	Princeton	2.0	8.25
	Prosper	2.0	8.25
	Richardson	1.0	7.25
	Royse	2.0	8.25
	Sachse	1.5	7.75
	St. Paul	1.0	7.25
	Van Alstyne	2.0	8.25
	Weston	1.0	7.25
	Wylie	2.0	8.25
Hunt	–	0.5	6.75
	Caddo Mills	1.5	8.25
	Campbell	1.25	8.0
	Celeste	1.25	8.0
	Commerce	1.5	8.25
	Greenville	1.5	8.25
	Hawk Cove	1.0	7.75
	Josephine	1.0	7.75
	Lone Oak	0.0	6.75
	Neylandville	1.0	7.75
	Quinlan	1.5	8.25
	Roys	2.0	8.75
	Union Valley	1.0	7.75
	West Tawakoni	1.5	8.25
	Wolfe	1.5	8.25
Lamar	–	0.5	6.75
	Blossom	1.25	8.0
	Deport	1.0	7.75
	Paris	1.5	8.25
	Reno	1.0	7.75
	Roxton	1.0	7.75
	Sun Valley	1.0	7.75
	Toco	1.0	7.75
Delta	–	0.5	6.75
	Cooper	1.0	7.75
	Pecan	1.0	7.75
Grayson	–	0.0	6.25
	Bells	2.0	8.25
	Collinsville	2.0	8.25
	Denison	2.0	8.25
	Dorchester	1.0	7.25

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
	Gunter	2.0	8.25
	Howe	2.0	8.25
	Knollwood	2.0	8.25
	Pottsboro	2.0	8.25
	Sadler	1.0	7.25
	Sherman	2.0	8.25
	Southmayd	2.0	8.25
	Tioga	2.0	8.25
	Tom Bean	2.0	8.25
	Van Alstyne	2.0	8.25
	Whitesboro	2.0	8.25
	Whitewright	2.0	8.25

Source: TCPA, 2011b

Taxable Sales and Local Sales Dollars Returned

Table 3.12-20 shows taxable sales in the local area from 2005-2010. Collin County has the most sales subject to state and local sales taxes, with $9.5 billion in 2010. The next highest amount of taxable sales is just under $1 million in Grayson County, which represents approximately 10 percent of Collin County's total.

Table 3.12-20. Taxable Sales in ROI (in $1,000s)

County	2005	2006	2007	2008	2009	2010
Fannin	100,598	105,509	110,519	113,708	109,830	109,400
Collin	8,020,256	8,870,383	9,604,264	9,534,874	9,019,346	9,549,447
Hunt	535,328	490,356	527,664	533,400	536,932	540,892
Lamar	365,690	393,485	398,412	420,033	404,866	406,938
Delta	7,690	7,058	6,330	6,162	6,230	6,657
Grayson	942,929	1,006,651	1,054,571	1,061,146	1,001,111	995,342
Total	**9,972,491**	**10,873,442**	**11,701,760**	**11,669,323**	**11,078,315**	**11,608,676**

Source: TCPA, 2010a

Table 3.12-21 shows the allocation historical summary of total dollars returned to a local sales taxing city, county, special purpose district or transit authority by the Comptroller's office for their local sales tax collection. Collin County, by far the largest in taxable sales of the five counties, does not impose a county sales tax, while most of the individual cities within do. Grayson County, like Collin County, also does not impose a county sales tax, while its individual cities do levy sales taxes.

Table 3.12-21. Local Sales Taxes Returned to the Counties in ROI by the Texas Comptroller of Public Accounts (in dollars)

County	2005	2006	2007	2008	2009	2010
Fannin	599,276	710,162	719,443	944,226	782,322	708,672
Collin	0.0	0.0	0.0	0.0	0.0	0.0
Grayson	0.0	0.0	0.0	0.0	0.0	0.0

County	2005	2006	2007	2008	2009	2010
Hunt	2,517,479	2,669,123	2,884,755	2,945,433	2,909,476	2,991,815
Lamar	2,157,350	2,293,670	2,328,929	2,830,631	3,199,651	2,517,828
Delta	51,939	77,500	44,987	49,662	56,593	56,238

Source: TCPA, 2010b

3.12.5 Summary of Socioeconomics

The socioeconomics section above identifies aspects of the social and economic environment sensitive to change and that may be affected by the proposed actions. Fannin County is the primary focus of any direct impacts that may occur. The five surrounding counties are also included in the ROI, since indirect impacts are expected, though to a lesser extent.

Population – The existing population, projected population change, as well as community cohesion and quality of life, are all described for the ROI.

- The 2010 estimated combined population of Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties is over one million, a net increase of about 40 percent since 2000.
- The six-county ROI is expected to grow by almost 150 percent by 2060, almost twice as fast as the projected statewide growth.
- Concern exists that an influx of "outsiders" – especially workers during the construction phase – could erode community cohesion. Community cohesion is the degree to which residents have a sense of belonging to their neighborhood or community. Fannin County has a medium level of community cohesion, qualifies as a "working class" community, and is considered to be an area with relative ethnic homogeneity

Labor – The size of the civilian labor force, employment, and unemployment rates from 2000-2010 describe the size and availability of workers in the ROI.

- The labor forces of Fannin, Hunt, Lamar, and Grayson counties have grown slightly since 2000. Only Collin County's labor force grew at a rate higher than the state's.
- Annual employment in Fannin, Hunt, Delta and Grayson counties decreased from 2000 to 2010, increased slightly in Lamar County, and grew by 37 percent in Collin County.
- Fannin and Lamar counties have had unemployment rates consistently at or above the statewide averages from 2000 through 2010.

Earnings – Measures such as per capita personal income, total industry income, and compensation by industry describe earnings in the ROI.

- Collin County had the highest per capita personal income in 2010. All counties except Collin had a per capita income smaller than the statewide average. All but Collin County had more than a 30 percent increase in income from 2000-2010.
- The average compensation per job for 2010 was just under $30,000 for Delta County; approximately $40,000 for Fannin, Lamar, and Grayson counties; just over $50,000 for Grayson County; and approximately $65,000 for Collin County.
- The Government and Government Enterprises, Manufacturing, and Health Care and Social Assistance sectors generated the most compensation of employees for all counties in the ROI.

Public Finance – The primary non-federal taxation in the local area is of property and retail sales. A portion of these taxes help fund schools in the local area.

- The total appraised value available for county taxation in Fannin County in 2010 was almost $1.5 billion. In 2005, 37 percent of Fannin County parcels were appraised as agricultural land and 17 percent as farm and ranch improvement.
- The Texas retail sales tax is 6.25 percent; however, local sales taxes vary. Most counties in the local area have a retail sales tax of 0.5 percent, but Collin and Grayson have no retail sales tax.
- Collin County had the most sales subject to state and local sales taxes, with $9.5 billion in 2010. The next highest amount of taxable sales is just under $1 billion in Grayson County. Neither imposes a county sales tax, while the other four counties do.

3.13 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Executive Order (EO) 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (The White House, February 11, 1994), requires that federal agencies consider as a part of their action, any disproportionately high and adverse human health or environmental effects to minority and low income populations. Agencies are required to ensure that these potential effects are identified and addressed.

EO 13045 "Protection of Children from Environmental Health Risks and Safety Risks" (The White House, April 21, 1997), places a high priority on the identification and assessment of environmental health and safety risks that may disproportionately affect children. The EO requires that each agency "shall ensure that its policies, programs, activities, and standards address disproportionate risks to children." It considers that physiological and social development of children makes them more sensitive than adults to adverse health and safety risks and recognizes that children in minority and low-income populations are more likely to be exposed to and have increased health and safety risks from environmental contamination than the general population.

3.13.1 Environmental Justice

The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low-income communities and identify steps to mitigate any adverse impacts. For purposes of assessing environmental justice under NEPA, the Council on Environmental Quality (CEQ) defines a minority population as one in which the percentage of minorities exceeds 50 percent or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis (CEQ, 1997).

Alternative 1 would include the construction of a 16,641-acre reservoir and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. As such, Fannin County represents the primary focus and region of influence (ROI) for any direct and indirect impacts related to environmental justice and protection of children that may be associated with the implementation of either action alternative. For purposes of this analysis, the five surrounding counties – Collin, Hunt, Lamar, Delta, and Grayson – are defined as the region of comparison (ROC), or appropriate units of geographic analyses and the general population. For additional context, data is also provided for the state of Texas. The blending portion of Alternative 2 would also include a 25-mile water pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. For this portion of the project, Grayson County is also considered the ROI for any direct and indirect impacts. And for purposes of comparison for this portion of the project, Fannin, Collin, Hunt, Cooke, and Denton counties are defined as the geographic units of analyses and the "general" population.

Due to the site-specific nature of the proposed project, United States Census Bureau (USCB) block group (BG) and census tract (CT) data were used to identify high concentration "pockets" of environmental justice populations near the project area, defined as the dam and reservoir (impoundment area) and water pipeline. Figures 3.13-1, 3.13-2, and 3.13-3 help describe the distribution of minorities, low-income populations, and children in the vicinity of the project area.

Minority Populations

The CEQ defines "minority" as including the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic (CEQ, 1997). Data presented in Table 3.13-1 were based on the USCB's 2010 decennial census. BG and county level census data are used where appropriate throughout the section.

The CEQ defines a minority population in one of two ways:

1. "...If the percentage of minorities exceeds 50 percent..." (CEQ, 1997). In this more straightforward scenario, if more than 50 percent of the Fannin County or Grayson County population consists of minorities (the sum of minority groups), this would qualify the county as comprising an environmental justice population.
2. "...[If the percentage of minorities] is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis" (CEQ, 1997). For purposes of the analysis, under Alternative 1 and 2, a discrepancy of 10 percent or more between minorities (the sum of all minority groups) in Fannin County as compared to the surrounding five counties (Collin, Grayson, Hunt, Lamar, Delta) or the state of Texas would be considered "substantially" higher. Any discrepancy higher than 10 percent would categorize Fannin County as an environmental justice population. For Alternative 2, a discrepancy of 10 percent or more between minorities in Grayson County as compared to the surrounding five counties (Collin, Fannin, Cooke, Denton, and Hunt) or the state of Texas would be considered "substantially" higher and would categorize Grayson County as an environmental justice population.

Table 3.13-1 summarizes minority population groups in Fannin, Collin, Delta, Hunt, Cooke, Denton, Grayson, and Lamar counties as well as the state of Texas.

Table 3.13-1. Summary of Minority and Minority Groups in the ROI and ROC [a]

County	Total Population	Minority *(%)*	American Indian and Alaska Native *(%)*	Black or African American *(%)*	Asian *(%)*	Native Hawaiian and Other Pacific Islander *(%)*	Hispanic or Latino *(%)*
Fannin[b]	33,915	6,039 *(17.8)*	369 *(1.1)*	2,312 *(6.8)*	125 *(0.4)*	7 *(0.0)*	3,226 *(9.5)*
Collin	782,341	274,389 *(35.1)*	4,448 *(0.6)*	66,387 *(8.5)*	87,752 *(11.2)*	448 *(0.1)*	115,354 *(14.7)*
Lamar	49,793	10,947 *(22.0)*	700 *(1.4)*	6,703 *(13.5)*	311 *(0.6)*	10 *(0.0)*	3,223 *(6.5)*
Delta	5,231	770 *(14.7)*	72 *(1.4)*	380 *(7.3)*	30 *(0.6)*	0 *(0.0)*	288 *(5.5)*
Hunt	86,129	20,751	804	7,133	916	147	11,751

County	Total Population	Minority (%)	American Indian and Alaska Native (%)	Black or African American (%)	Asian (%)	Native Hawaiian and Other Pacific Islander (%)	Hispanic or Latino (%)
		(24.1)	*(0.9)*	*(8.3)*	*(1.1)*	*(0.2)*	*(13.6)*
Grayson[c]	120,877	23,691 *(19.6)*	1,835 *(1.5)*	7,081 *(5.9)*	1,046 *(0.9)*	41 *(0.0)*	13,688 (11.3)
Cooke	38,437	38,437 *(20.2)*	402 *(1.0)*	1,054 *(2.7)*	290 (0.8)	19 *(0.0)*	5997 *(15.6)*
Denton	662,614	224,861 (33.9)	4,551 *(0.7)*	55,534 *(8.4)*	43,478 *(6.6)*	462 *(0.1)*	120,836 *(18.2)*
All Counties in Texas	25,145,561	13,597,743 *(54.1)*	170,972 *(0.7)*	2,979,598 *(11.8)*	964,596 *(3.8)*	21,656 *(0.1)*	9,460,921 *(37.6)*

[a] Percentage of total population in parentheses
[b] ROI for Alternative 1
[c] Also part of ROI for Alternative 2
Source: USCB, 2010a

As Table 3.13-1 indicates, Fannin County does not meet the regulatory definition of a minority population. Fannin County's population consists of approximately 18 percent minorities, compared to Collin County's 35 percent; Lamar County's 22 percent; Grayson County's 20 percent; Hunt County's 24 percent; and Delta County's 15 percent (USCB, 2010a). The percentage of minorities in Fannin County is higher than the percentage of minorities in Delta County; less than the percentage of minorities Collin, Lamar, Grayson, and Hunt counties; and less than the state's 54 percent. The discrepancy in the percentage of minorities between Fannin and Delta counties is about three percent – or less than ten percent. The minority populations in Fannin and Grayson counties also represent less than half of their total county populations, respectively. Minorities in Fannin County are neither greater than 50 percent of the total county population nor are they substantially higher than the percentage of minorities in the five surrounding counties (Collin, Lamar, Grayson, Hunt, Delta) or the state of Texas as a whole.

Grayson County does not meet the regulatory definition of a minority population, either. Grayson County's population consists of 20 percent minorities, compared to Collin County's 35 percent, Fannin County's 18 percent, Hunt County's 24 percent, Cooke County's 20 percent, and Denton County's 34 percent (USCB, 2010a). The percentage of minorities in Grayson County is higher than the percentage(s) of minorities in Fannin County, and less than the state's 54 percent. The discrepancy in the percentage of minorities between Grayson County and Fannin County is about two percent; or less than ten percent. The minorities in Grayson County are neither greater than 50 percent of the county population nor are they a substantially higher than the percentage of minorities in the five surrounding counties (Fannin, Collin, Hunt, Cooke, Denton) or the state of Texas as a whole.

Minority Populations by Block Groups

The discussion of environmental justice up until this point describes the existing minority population on the county level. Due to the site-specific nature of the proposed project, in addition to describing the proportion of minorities on the county level, BG data are used to describe the distribution of minorities in the vicinity of the project area. A BG is a statistical subdivision of a CT, generally defined to contain between 600 and 3,000 people and 240 and 1,200 housing units. It is the smallest geographic unit for which the United States Census Bureau (USCB) tabulates sample data, i.e. data which are only collected from a fraction of households. BGs are statistical areas bounded by visible features such as roads, streams, and railroad tracks, and by nonvisible boundaries such as property lines, city, township, school district, county limits and short line-of-sight extensions of roads. CTs coincide with the limits of cities, towns, or other administrative areas, and are "designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions..." (USCB, 2013). Fannin County is made up of nine CTs and 30 BGs.

Minority data for BGs in the project area were evaluated, as impacts from noise or delays from traffic would be felt most by populations in these locations. These include the towns of Bonham, Honey Grove, Windom, Dodd City, Bailey, and Leonard. Applying the CEQ definition(s) from above, BGs (and associated towns) are identified as having an environmental justice population if:

- More than 50 percent of a BG consists of minorities.
- The percentage of minorities in a BG is substantially higher than the percentage of minorities in Fannin County. For purposes of this analysis, a discrepancy of ten percent or more between minorities (the sum of all minority groups) in a BG and Fannin County would be considered "substantially" higher, and would categorize that BG as an environmental justice population.

Figure 3.13-1 shows the distribution of minority populations within Fannin County, color-coding the proportion of minorities using ranges. These ranges were developed based on commonalities or themes revealed by the BG data. Each BG is outlined black, and the percentage of minorities in each BG is indicated in the figure.

The data revealed that Alternative 1 would affect an area where minority populations represent between four to nine percent of the population (color-coded red in Figure 3.13-1), which is less than Fannin County's 17.8 percent of the total population. The southwestern portion of the project area under Alternative 1 would occur adjacent to Bonham, though technically avoiding the city itself. One of the BGs in Bonham is comprised of 58 percent minorities (color-coded purple in Figure 3.13-1), more than three times Fannin County's 17.8 percent. East of the water pipeline, minorities represent 32 and 29 percent of the BGs in Honey Grove and Ladonia (color-coded blue in Figure 3.13-1), respectively; both figures are "substantially" higher than the county's. Because the percentage of minorities in Honey Grove, Ladonia, and Bonham BGs is substantially higher than Fannin County's 17.8 percent, these are defined as environmental justice populations.

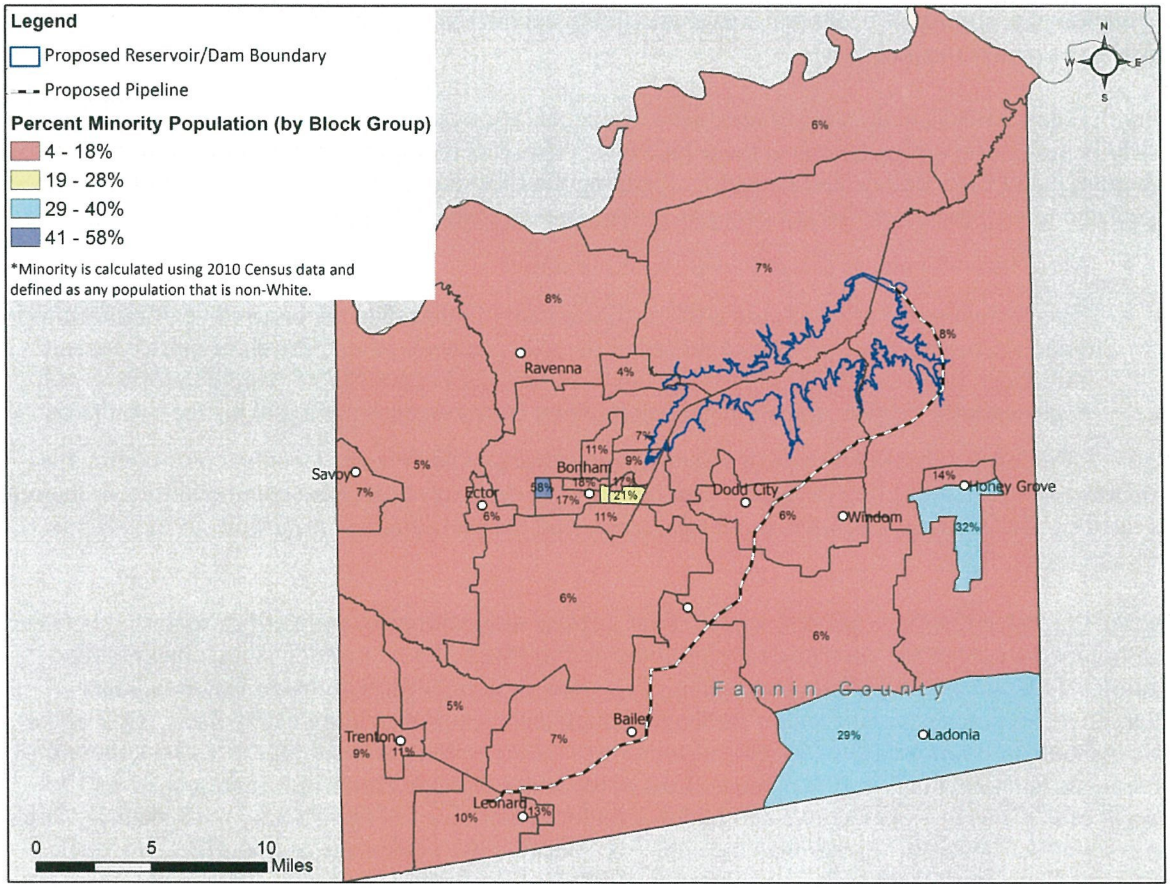


Figure 3.13-1. Distribution of Minorities Within Fannin County

Low-Income Populations

Low-income populations are defined as households with incomes below the federal poverty level. There are two slightly different versions of the federal poverty measure: poverty thresholds defined by the USCB and poverty guidelines defined by the U.S. Department of Health and Human Services (DHHS).

The poverty thresholds are the original version of the federal poverty measure, and are updated each year by the USCB. The USCB uses a set of income thresholds that vary by family size and composition (number of children and elderly) to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The same applies for a single individual. The official poverty thresholds do not vary geographically, but are updated for inflation. The official poverty definition considers pre-tax income and does not include capital gains or non-cash benefits such as public housing, Medicaid, and food stamps (CEQ, 1998). Poverty thresholds are primarily used for statistical purposes, such as calculating poverty population figures or estimating the number of Americans in poverty each year. Poverty threshold figures are reported in the annual poverty report, and provide a yardstick for progress or regress in antipoverty efforts. *Environmental Justice Guidance Under NEPA* recommends that USCB poverty thresholds be used to identify low-income populations (CEQ, 1997).

The DHHS poverty guidelines are simplifications of the USCB's detailed matrix of poverty thresholds and are used mostly for administrative purposes, such as determining financial eligibility for certain federal programs. The DHHS guidelines are also used as the basis for many state and regional guidelines, including Head Start, the Food Stamp Program, the National School Lunch Program, the Low-Income Home Energy Assistant Program, and the Children's Health Insurance Program. Similar to the USCB's poverty thresholds, the DHHS poverty guidelines are updated annually and vary based on family size (but not the number of children and elderly). The poverty guidelines do not vary geographically for the 48 contiguous states. The DHHS 2014 poverty guidelines define low-income populations as those whose median household income is at or below the maximum annual income of $19,790 for a family of three (DHHS, 2014).

The best available data for poverty and economic characteristics in the ROI and ROC under both alternatives were 2010 American Community Survey (ACS) estimates for Selected Economic Characteristics. Table 3.13-2 uses these data and provides statistics relevant to assessing the presence of low-income populations in the areas that would be affected by Alternatives 1 and 2.

Table 3.13-2. Income and Poverty Statistics in the ROI and ROC

County	Total Population	Median Household Income[a,b]	Average Family Size	Percentage of All People Below the Poverty Threshold[b]	Percentage of All Families Below the Poverty Threshold[b]
Fannin	33,915	$42,605	3.01	14.0	10.6
Collin	782,341	$77,090	3.25	8.1	5.4
Hunt	86,129	$40,218	3.12	22.8	17.5
Lamar	49,793	$37,659	2.99	17.3	13.1
Delta	5,231	$37,908	2.95	14.5	9.1
Grayson	120,877	$45,577	3.02	14.4	10.4
Cooke	38,437	$46,804	3.09	14.7	12.2
Denton	662,614	$70,464	3.24	8.2	5.1
All Counties in Texas	25,145,561	$48,615	3.31	17.9	13.8

[a] 2010 inflation-adjusted dollars.
[b] From 2010 American Community Survey estimates for Selected Economic Characteristics dataset.
Sources: USCB, 2010a and USCB, 2010d

Because CEQ guidance does not specify a threshold for identifying low-income communities, the same approach as described to identify environmental justice minority populations is applied to low-income populations. As displayed in Table 3.13-2, the percentage of all people living below the poverty threshold in Fannin County is higher than in Collin County. The discrepancy in the percentage of persons living below the poverty threshold between Fannin and Collin counties is approximately six percent – or less than ten percent. The percentage of all families living below the poverty threshold in Fannin County is higher than in Collin, Delta, and Grayson counties; however, the differences are less than 10 percent. Both the percentages of persons and families living below the poverty threshold in Fannin County is lower than in the state of Texas overall. Neither the percentage of all people living below the poverty threshold nor the percentage of families below the poverty threshold are more than 50 percent of the Fannin County population. For purposes of the analysis under both Alternative 1 and 2, Fannin County does not qualify as an environmental justice population by either CEQ definition (USCB, 2010a; USCB, 2010d).

The percentage of all people below the poverty threshold in Grayson County is higher than in Fannin, Collin, and Denton counties. The discrepancy in the percentage of persons living below the poverty threshold between Grayson County and Fannin, Collin and Denton counties is less than ten percent (between less than one percent and about five percent). The percentage of all families living below the poverty threshold in Grayson County is higher than in Collin, Delta, and Denton counties. The discrepancy in the percentage of families living below the poverty threshold between Grayson and Collin, Delta, and Denton counties is less than ten percent (between less than one percent and five percent). Both the percentages of people and families living below the poverty threshold in Grayson County is lower than in the state of Texas overall. Neither the percentage of all people living below the poverty threshold nor the percentage of families below the poverty threshold are more than 50 percent of the Grayson County population. For purposes of the analysis for the additional 35-mile pipeline included under Alternative 2, Grayson County does not qualify as an environmental justice population by either CEQ definition (USCB, 2010a; USCB, 2010d).

Low-Income Populations by Census Tracts

As with minority populations, because of the site-specific nature of the proposed project, data are used to identify high concentration "pockets" of low-income populations and describe the distribution of income across Fannin County. Unlike with minority populations, poverty and income data is not available on the BG level. CT data are used to describe the distribution of persons living below the poverty threshold in the vicinity of the project area. CTs are small, relatively permanent statistical subdivisions of a county or equivalent entity, generally with a population size between 1,200 and 8,000 people (CTs are made up of several BGs, therefore BGs are a smaller geographic unit). A CT usually covers a contiguous area; and its boundaries usually follow visible and identifiable features such as streams or roads (USCB, 2013).

Low-income CTs that would be affected by the proposed project were evaluated, as impacts from noise or delays from traffic would be felt most by populations in these locations. These include the towns of Bonham, Honey Grove, Windom, Dodd City, Bailey, and Leonard. Applying the CEQ definition(s) from above, the following CTs (and associated towns) are identified as having a low-income population or environmental justice population if:

- More than 50 percent of a CT consists of families or persons below the poverty threshold.
- The percentage of low-income families or persons in a CT is substantially higher than the percentage in Fannin County. A discrepancy of ten percent or more between an individual CT and Fannin County would be considered "substantially" higher; and would categorize that CT as constituting a low-income population.

Figure 3.13-2 shows the distribution of low-income populations in Fannin County's nine CTs, color-coding the percentage of low-income populations using ranges. These ranges were developed based on commonalities or themes revealed by the CT data. The results displayed in Figure 3.13-2 indicate that low-income populations represent between 21 and 25 percent of the population in one the CTs associated with Bonham, compared to 14 percent of the county's population overall. For purposes of the analysis under both Alternatives 1 and 2, Bonham constitutes a low-income population, or an environmental justice population, on this basis.

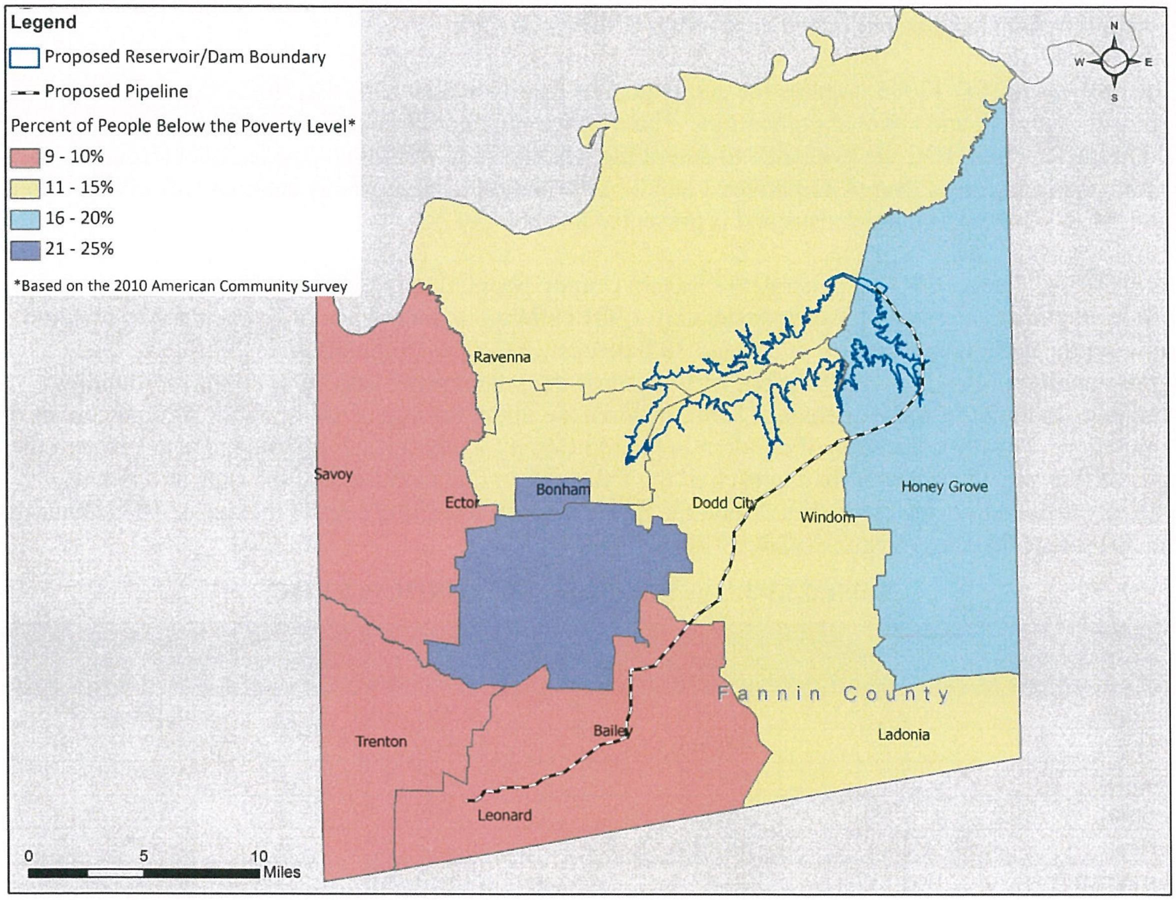


Figure 3.13-2. Distribution of Low-Income Populations in Fannin County

3.13.2 Protection of Children

EO 13045 *Protection of Children from Environmental Health Risks and Safety Risks* was prompted by the recognition that children are more sensitive than adults to adverse environmental health and safety risks because they are still undergoing physiological growth and development. EO 13045 defines "environmental health risks and safety risks [to] mean risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to)." Children may have a higher exposure level to contaminants because they generally have higher inhalation rates relative to their size. Children also exhibit behaviors such as spending extensive amounts of time in contact with the ground and frequently putting their hands and objects in their mouths that can lead to much higher exposure levels to environmental contaminants. It is well documented that children are more susceptible to exposure to mobile source air pollution, such as particulate matter from construction or diesel emissions (USEPA, 2012b).

The Memorandum Addressing Children's Health through Reviews Conducted Pursuant to the National Environmental Policy Act and Section 309 of the Clean Air Act recommends that a Draft EIS "describe the relevant demographics of affected neighborhoods, populations, and/or communities and focus exposure assessments on children who are likely to be present at schools, recreation areas, childcare centers, parks, and residential areas in close proximity to the proposed project area, and other areas of apparent frequent and/or prolonged exposure" (USEPA, 2012b).

The analysis for EO 13045 requires the assessment of readily available demographic data and information on local, regional, and national populations. The number and distribution of children less than 18 years old in the ROI and ROC are evaluated to determine whether they would be exposed to environmental health and safety risks from Alternatives 1 and 2. Information to support this analysis was derived from the USCB's 2010 decennial census and is presented in Table 3.13-3.

As shown in Table 3.13-3, in general, the Fannin County population is older than that of the state as a whole. Fannin County contains approximately 1,981 children under the age of five and 6,380 children between the ages of five and 18; or 5.8 and 18.8 percent of the total population, respectively. The representation of children under the age of five is less than the representations in all the surrounding counties. In Fannin County, a total of 8,361 children are under the age of 18, or about 24.6 percent of the population. The representation of children in Fannin County under the age of five and also between the ages of five and 18 are lower than in each of the five surrounding counties and the state as a whole. Whether broken into age categories or not, the representation of children under the age of 18 is lower than the 30.3 percent state average (USCB, 2010a).

Table 3.13-3. Age Distribution in the ROI and ROC

County	Total Population	Children Under 5 *(Percent)*	Children 5 to 18 years *(Percent)*
Fannin	33,915	1,981 *(5.8)*	6,380 *(18.8)*
Collin	782,341	58,849 *(7.5)*	183,697 *(23.5)*
Lamar	49,793	3,187 *(6.4)*	10,394 *(20.9)*
Delta	5,231	309 *(5.9)*	996 *(19.0)*
Hunt	86,129	5,713 *(6.6)*	18,335*(21.3)*
Grayson	120,877	7,833 *(6.5)*	24,976 *(20.7)*
Cooke	38,437	2,687 *(7.0)*	38,437 *(21.4)*
Denton	662,614	49,790 *(7.5)*	151,788 *(22.9)*
All Counties in Texas	25,145,561	1,928,473 *(7.7)*	5,693,241 *(22.6)*

Source: USCB, 2010a

Youth Populations by Census Tracts

As with minority and low-income populations, because of the site-specific nature of the proposed project, data are used to identify high concentration "pockets" of youth populations and describe the distribution of children across Fannin County.

Pursuant to the EPA's 2012 Memorandum Addressing Children's Health, CTs were examined to identify the age distribution in Fannin County, specifically children under the age of five in the vicinity of the project area. Figure 3.13-3 shows that Alternative 1 is almost entirely located in an area where children represent six to seven percent of the total county population.

This CT data is compared with previously defined "pockets" of minority or low-income populations; as EO 13045 recognizes that children of environmental justice populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population. Under Alternatives 1 and 2, children in areas defined as minority or low-income environmental justice populations (i.e., Bonham and Honey Grove) will be evaluated for disproportionate impacts as it relates to a child's health and safety.

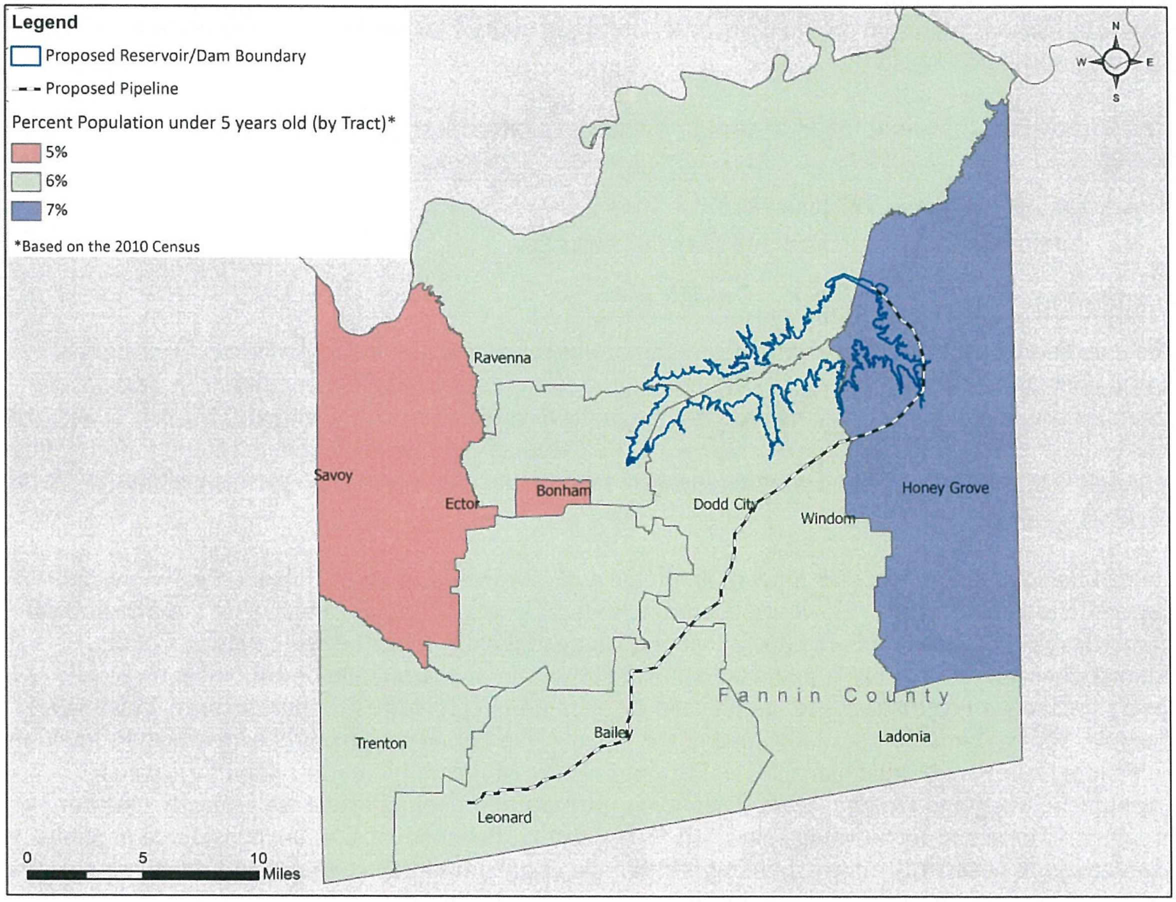


Figure 3.13-3. Age Distribution in Fannin County

3.14 CULTURAL RESOURCES

3.14.1 Cultural Chronology

This cultural chronology summarizes approximately 14,000 years of history in Fannin County and within North Central Texas generally. Because of the limited amount of previous research that has been conducted within Fannin County per se, much of the archaeological background draws from regional information gathered in adjacent counties.

The prehistoric era (12,000 B.C. to A.D. 1700) is almost exclusively composed of Native American occupations and encompasses the bulk of human occupation in the New World. It is subdivided into seven distinct sub-periods:

- Paleoindian (12,000 to 6,000 B.C.)
- Archaic (6,000 B.P. to 200 B.C.)
- Woodland/Fourche Maline (200 B.C. to A.D. 800)
- Formative Caddo (A.D. 800 to 1000)
- Early Caddo (A.D. 1000 to 1200)
- Middle Caddo (A.D. 1200 to 1400)

- Late Caddo (A.D. 1400 to 1700)

These sub-periods represent pre- to early post- European contact and reflect over 13,000 years of cultural continuity (Perttula, 2004).

The Historic Era, following initial contact by European explorers, is typically divided into two distinct phases:

- Historic European (1700 to 1815)
- Anglo-American settlement (1815 to the present)

Paleoindian Period 12,000 B.C. to 6,000 B.C.

The Paleoindian period represents the beginning of human occupation in the Americas. During this period populations arrived and spread throughout the New World. Climatic conditions in Texas were generally cooler and moister than at present though the terminal Pleistocene climate (Nickels et al., 2010; McKenzie et al., 2001). Based on the absence of Paleoindian occupations in Fannin County during this period, it is assumed that Native populations were largely nomadic and had no permanent sites in the area (Mahoney, 2001).

Isolated Paleoindian artifacts are known within the area and include Clovis, Folsom, Plainview, and other diagnostic projectile points. However, according to the Texas Historical Commission's Archeological Sites Atlas (TASA), there are no known Paleoindian-aged archaeological sites in Fannin County, although their presence is likely and would most likely be an open campsite or kill/butchering site. Several important Paleoindian sites are located in the region (e.g., North Sulphur, Aubrey, Lewisville) (Perttula, 2004). Artifact types indicative of the Paleoindian Period which could be reasonably found in the Fannin County region include Clovis, Dalton, Folsom, Midland, Plainview, San Patrice, and Angostura (Turner and Hester, 1999). Diagnostic artifacts of Paleoindian age are typically uniform throughout Texas and surrounding states. By their scarcity, Paleoindian sites are considered precious resources from which any information derived may be of great importance to the collective knowledge of the earliest Native American occupations.

Archaic Period 6,000 B.C. to 200 B.C.

The Archaic Period represents the bulk of human occupation in the New World, spanning almost 6,000 years, during which climate became drier and warmer than the cooler transitional Pleistocene conditions of the Paleoindian Period (Collins, 1995; Nickels et al., 2010). The Archaic Period is typically divided into three distinct phases: Early, Middle, and Late. During the Archaic Period, populations increased and became more specialized to the regions in which they lived. Within the region, few sites diagnostic of Archaic age are presently known (Perttula, 2004). Trends elsewhere in the state and within adjacent counties suggest that populations were semi-nomadic, following available food resources throughout a region on a seasonal basis. Sites documented by AR Consultants (ARC) in southern Fannin County show a Middle Archaic habit of harvesting mussels from streams, a theme also documented within the Bois d'Arc Creek drainage (Davis et al., 2014).

Artifact types indicative of the Archaic Period which could be reasonably found in the Fannin County region include Big Sandy, Andice, Bulverde, Wells, Morrill, Carrolton, Dallas, Trinity, Ellis, Yarbrough, and Edgewood (Turner and Hester, 1999). Diagnostic artifacts of Archaic age are typologically diverse yet spatially uniform throughout North Central Texas. Sites in the area would be expected to be seasonal open campsites with lithic scatters, small burned rock, and mussel shell concentrations. During the Late Archaic Period, evidence suggests that group mobility declined as populations increased. The result was a more localized toolkit and the beginning of sedentism in North Texas (Perttula, 1998).

Woodland Period (Fourche Maline) 200 B.C. to A.D. 800

During the Woodland Period, populations continued to regionalize into sedentary units, increasingly centered around rectangular or round structures (Perttula, 2004). Skinner et al. (2007) documented a structure 20 by 80 feet (6 to 24 meters) in size dating to this period in Lamar County. Regionally, the Woodland Period also marks the introduction of bow and arrow technology, which is reflected in the archeological record by a decrease in projectile point size from larger atlatl or hand-propelled points, to those small enough to be launched at high speeds and fly more accurately at great distances (Turner and Hester, 1999). Pottery also makes its first large-scale appearance in the region in the form of grog-tempered William Plain ware and later shell-tempered and decorated Coles Creek ceramics.

During this period, territories became established and small hunter/forager villages appear in the form of possibly communal housing at locations where occupations were apparently constant over many years, as at the Ray Site in Lamar County (Davis et al., 2014; Bruseth et al., 2001). Likewise, projectile point technology further subdivided into a more localized toolkit. Gary projectile points are typical to this period in the region and may have decreased in size in later years. Scallorn-type points make an introduction as the first arrow-type points in the regional archeological record and by the end of the period had completely replaced dart-type points (Turner and Hester, 1999).

Formative/Early Caddo Period A.D. 800 to 1000 and 1000 to 1200

During the Formative Caddo Period, horticulture makes its first appearance in the archeological record though only supplemental to hunting and foraging (Mahoney, 2001). Single-family structures and mounds were present during this period as well (Davis et al., 2014). The Early Caddo Period marks the initiation of large-scale maize production in North Central Texas, which would become the hallmark of later Caddo culture. Hunting and foraging were still practiced, but only as supplement to the fledgling agriculture (Perttula, 2004). Formative and Early Caddo sites in the middle Red River Valley are typically located on elevated, arable land along major creek and river drainages. Sites include single structures and small villages, some with burial mounds (Jones, 2008).

Middle Caddo Period A.D. 1200 to 1400

Middle Caddo settlements along the middle Red River area include such site types as farmsteads, artifact assemblages, hamlets, and large communities with one or mounds (e.g., flat-topped mound, substructure mound, burial mound) (Perttula, 2001). Agricultural domesticates such as maize are apparently being intensively cultivated during this time period. In burials, this correlates to an overall increase in the frequency of individuals afflicted with dental caries and cavities (Loveland, 1987; 1994). The recovery of Gulf Coast shell artifacts and Kay County flint, which were very common in burial features at the Sanders site at the mouth of Bois d'Arc Creek, suggest extensive trade occurred during this time period with groups located along the Gulf Coast and Great Plains (Perttula, 2001). The lithic assemblage commonly seen in Middle Caddo sites includes Bonham, Scallorn, and Morris arrow points, celts, and ground stone. Ceramics include: long-stemmed clay pipes, Canton Incised, Maxey Noded Redware/Blackware, Sanders Engraved, Paris and Sanders Plain (Perttula, 2004; Davis, 1995).

Late Caddo Period A.D. 1400 to 1700

The population increase, social complexity, and agricultural dependence that occurred within the Middle Caddo subperiod continued to evolve and expand during the Late Caddo subperiod. According to Perttula (2001), due to European diseases and an invasion from the Osage, Caddo groups had abandoned the Red River valley in northeast Texas by the late 1700s and moved to the Caddo Lake area along the Texas/Louisiana border. Historic Caddo sites commonly contain historic European beads and metal trade goods such as points, knives, lead shot, and gun parts. These areas often also contain plain and decorated shell-tempered ceramics, triangular arrow points, and many stone scrapers. Such occurrences in the immediate area include Sanders, Harling, and Goss Farm (41FN12) at the mouth of Bois d'Arc Creek, as well as in the Riverby Ranch mitigation area.

Contact Period

In 1539, Spanish conquistador Hernando de Soto and 600 soldiers landed on the western coast of Florida in order to explore the southeastern portion of the United States and acquire gold from the indigenous populations of North America (Moscoso Expedition, 2004). The proposed route used by the expedition traveled through portions of present-day Florida, Georgia, South Carolina, North Carolina, Tennessee, Alabama, Mississippi, Arkansas, and northeast Texas (Hudson et al., 1989; Bruseth and Kenmotsu, 1991; Bruseth, 1992). When the expedition (led by Louis de Moscoso) entered Texas in 1542, it supposedly traveled along the Red River to Nacogdoches. From Nacogdoches, the expedition traveled along a route known today as the Old San Antonio Road to the Guadalupe River in proximity to present-day New Braunfels (Bruseth and Kenmotsu, 1991).

Historic Period (1700 to 1815) to Present

From approximately 1760-1779, Frenchman Athanase de Mezieres led major expeditions throughout northeast Texas in order to establish trade relations with the Caddoes, Delaware, Cherokees, and Wichitas. As a result, numerous trade goods such as metal tools, gun parts, and glass beads are sometimes observed within the archaeological record of sites dating to this period (Chipman, 2012). Background and historical information discussed in this section relies heavily on ARC's report (Davis et al., 2014) and others referenced within their report.

Camp Benjamin

When the Civil War broke out in April 1861, Fannin County's citizens supported the Confederacy and secession from the Union. Several companies of Fannin County men joined the Trans-Mississippi Confederate army. Bonham was the site of three important Confederate facilities during the war, including a hospital for the soldiers, a commissary which supported seven brigades, and the military headquarters of the Northern Sub-District of Texas, Confederate States of America (C.S.A.). In addition, Camp Benjamin was established in the Bois d'Arc Creek floodplain, northeast of Bonham, and was occupied by the 9th Regiment Volunteer Texas Infantry from December 13, 1861 until January 1, 1862. At that time, the 10 company regiments left for Memphis, Tennessee (Brothers, 2010). Over 1,200 enlisted men and officers lived at the camp. A concrete cross was erected in 1980 at the reputed location of a cemetery, where at least seven 9th Regiment soldiers were buried after dying from measles or pneumonia (Honey Grove Signal-Citizen, 1980; Davis et al., 2014).

Fannin County

Anglo European settlement within the region intensified after Spain ceded control of Texas in 1828. Fannin County was carved from Red River County in 1837 and named after another Texas Revolution hero, James W. Fannin, a Colonel in the Texas Army who was killed in the Goliad Massacre (Alvarez, 2006). Prior to the Civil War, cattle ranching was the primary source of income in Fannin County. Most of the early Anglo settlers were from the Old South and many brought slaves with them; black slaves comprised nearly 20 percent of the population. Following the Civil War, agriculture continued to dominate the local economy, shifting to corn and cotton production, with corn production peaking in 1900. Following 1900, businesses and population both began dwindling within the county as cotton production grew, peaking in 1920. Efforts were made throughout the Great Depression and into World War II to increase dairy production within the county, but never with the desired outcome. Beef cattle fared better, and their numbers continued to grow (Pigott, 2012) (Davis et al., 2014).

Bonham

The largest city and county seat of Fannin County is Bonham, located at the southern end of the proposed Lower Bois d'Arc Creek Reservoir. The first settlement within present Fannin County, it was founded in

1836 when Bailey Inglish traveled from Kentucky and established a blockhouse and stockade (called Fort Inglish) along Bois d'Arc Creek in order to protect local settlers. The settlement that arose surrounding the fort was initially named Bois d'Arc, but in 1844 the town changed its name to Bonham, in honor of the Alamo defender James B. Bonham (City-Data.com, 2012a; Kleiner, 2012). Growth within the City of Bonham was fast following the Civil War, particularly after the arrival of the Texas and Pacific Railroad (T&P RR) in 1873. By the turn of the Century, Bonham boasted electric and telephone service, eight churches, three colleges, three newspapers, and several mills and manufacturing businesses (Kleiner, 2012). While population decreased in Fannin County as a whole, the population in Bonham continued to grow for a time and then stabilized during the Great Depression at 6,349 in 1940. Population remained steady until the turn of the present century rising in 2009 to 10,527 from 6,686 in 1990 (Kleiner, 2012; City-Data.com, 2012a). During World War II, Bonham, like many other Texas cities, housed German prisoners of war in a local internment camp from which prisoners were sent to work on local farms and ranches (Leonard, 2003).

Carson (Gum Springs)

The unincorporated community of Carson, formerly Gum Springs, is located directly west of the proposed LBCR and its alternatives on FM 1396. During the late 1800s, Carson was a cotton-centered community, boasting its own gin, school, and church (Minor, 2012a). The Gum Springs Cemetery is located about one kilometer (0.6 mile) south of FM 1396. Today, Carson is a small, loosely-grouped collection of homes noticeable only by a central water tower (Davis et al., 2014).

Dodd City

Dodd City is located east of Bonham on State Highway (SH) 56 approximately 2.2 miles (3.5 km) southwest of the Bullard Creek arm of the proposed reservoir. Dodd City was founded in 1839 by Kentuckian Major Edmund Hall Dodd. Previously named Licke, Quincy, and Dodd Station (following the arrival of the T&P Railroad [RR]), the name 'Dodd City' was officially adopted in 1873. Farming and railroad service boosted the city's economy until the 1930s when the local businesses and then population began to decline. By 1979 the population had dwindled to 302, less than the mid-1880s population. Today, Dodd City is a quaint, small town with a population of approximately 419 (Davis et. al, 2014; Minor, 2012b).

Honey Grove

Honey Grove is a town located on SH 56 approximately 3.1 miles (5 km) south of the Fox Grove Creek arm of the proposed LBCR and its alternatives. Honey Grove began as a small community named after a local apiary. During the Civil War, Honey Grove produced swords and Bowie knives for the Confederacy and housed an ordinance shop; it also served as a training site for soldiers (Conrad, 1988). As a sharecropping support community, Honey Grove prospered until the practice died out after World War II. Honey Grove currently maintains a population of approximately 1,828, well below its peak population of 3,000 in 1890 (Minor, 2012c; City-Data.com, 2012b).

Lamasco

Lamasco is located about a 0.5 mile (0.8 km) north of the main Sandy Creek arm of the proposed Lower Bois d'Arc Creek Reservoir and its alternatives on FM 1396. The name of this community was derived from three founders (Law, Mason, and Scott). While the town was never outstandingly large, it did support a steam gristmill, sawmill, two hotels, a general store, and a drugstore, as well as a post office until 1920. The community never recovered from the Great Depression and currently centers on a loose cluster of houses with a population of 33 (Hart, 2012a). The Lamasco Cemetery is located on the south side of FM 1396 on the west edge of the community.

Windom

The City of Windom is located approximately 5.5 miles (8.8 km) southeast of the Bullard Creek arm of the proposed reservoir, approximately half way between Dodd City and Honey Grove on SH 56.

Windom was founded in 1870 and shortly thereafter had the good fortune to have the T&P RR constructed through town. As a local center for shipping and receiving goods, Windom thrived until the Great Depression, when its already small population (317 in 1929) began to decline (Hart, 2012b). Today, Windom's population hovers around 252 (City-Data.com, 2012c).

Greens Chapel and Bois d'Arc Springs

Located approximately 2 miles (3.2 km) northeast of the proposed dam area, Greens Chapel is a small rural town located approximately one mile (1.6 km) east of Bois d'Arc Springs. The springs seep from the base of the Bonham sandstone cliffs resting on Eagle Ford shale at the confluence of Bois d'Arc and Coffee Mill creeks (Brune, 1981; Dobbs, 2012). Early settlers and people came from all over the country to enjoy the area and the pure water found there. Greens Chapel was named after Parris Green, who moved to the area before the Civil War to start a tannery which employed thirty to forty men (Dobbs, 2012). Although Parris Green reportedly moved to Arkansas in the late 1860s, the community continued to grow due to its close proximity to numerous springs, as it was the closest town to the springs themselves (Davis et al., 2014). By the 1930s, there were dozens of families living in the area, like the Martins, Roses, Newhouses, Rowtons, and Higginbothams, and the area boasted a grist mill, saw mill, cotton gin, a tannery, and a syrup mill (Dobbs, 2012). However, the area's population began to decline in the 1930s as a result of the passing of the Bankhead-Jones Farm Tenant Act (Long, 2011).

Selfs

The Selfs area was once populated by a handful of small, rural communities all located near the proposed reservoir dam: Selfs, Jones Mill, Spoonamore/Oliver-Hill, Greens Chapel, and Shilo, with only the community of Selfs still in existence today. In the 1880s, brothers, G. W. and G. T. Self built a gristmill and cotton gin at the location of the present-day Selfs (Hart, 2013; Jones, 1977). Area settlers, drawn to the gin and mill, soon formed a small community of 800 by 1900. The community at that point boasted two mills, four stores, two blacksmith shops, two barbershops, three doctors, a school, a broom factory, a post officer, a confectionery, a furniture store, Woodman Hall, and the North Texas Business College. The early 1900s represented the peak in prominence and population for the community of Selfs. The population declined to 25 during the mid-1930s and fluctuated between 25 and 50 for the next 30 years. In the mid-1960s, the population had again reached 50 persons (Davis et al., 2014).

Telephone

The community of Telephone is located approximately 12 miles northeast of Bonham at the intersection of FM 273 and FM 2029. Poke Hindman opened and owned a general store in 1886 which was the first place of business in Telephone. Typical of the many small rural communities during that time period between 1860 and 1870, Telephone consisted of a school and a church (Davis et al., 2014). The first cemetery was dedicated in 1884, and a post office followed in 1886 (Jones, 1997). From 1890 through the 1930s, the population grew from 30 to 100, reaching a peak of 280 residents and 10 businesses by the mid-1940s. One additional business existed by the late 1960s but the population remained the same (Hart, 2011a).

Caddo National Grasslands

The Caddo National Grasslands was purchased and developed under the Bankhead-Jones Farm Tenant Act of the 1930s. Located in the northeastern portion of the project area, bordering Coffee Mill Lake, the 17,785 acres were purchased to provide various recreational opportunities while improving land-use management (Long, 2011), although many owners and tenants of ranches were displaced as a result of purchases or seizures by the federal government. The grasslands served as an important gathering place for farmers because travel was limited and difficult at best. The growth patterns of small rural communities were predicated on these types of gathering locations because they provided critical access to necessities otherwise not available. As rapid technological advances and more efficient/effective travel became available, the general population, especially those of small rural communities, moved away from the agricultural lifestyle (Davis et al., 2014).

3.14.2 Known National Register Properties and Historical Markers at Reservoir and Vicinity

National Register Properties

Within the APE

There are no properties listed on the National Register of Historic Places (NRHP) within the basin of the proposed Lower Bois d'Arc Creek Reservoir.

Outside of the APE

No NRHP properties are located within one mile (1.6 km) of the proposed undertaking. The nearest NRHP property is the Clendenen-Carleton House, built around 1888 and located in Bonham about 1.6 miles (2.6 km) west of the APE. The closest National Register District is the Lake Fannin Organizational Camp located about 10 miles (16 km) northwest of the proposed reservoir.

Historical Markers

Within the APE

There are no State of Texas Historical Markers within the proposed Lower Bois d'Arc Creek Reservoir footprint.

Outside of the APE

Within a one mile (1.6 km) radius mile of the proposed LBCR site, there are four State of Texas Historical Markers:

- The Shiloh Cemetery (Marker Number 13221), which dates to the 1860s, is located 1.5 miles (2.4 km) southeast of the proposed dam site for Lower Bois d'Arc Creek Reservoir on CR 2730.
- The Allen's Chapel Methodist Church and Cemetery (Marker Number 12911), dating to 1847, is located 260 yards (240 meters) west of the southernmost extent of the Allens Creek arm of the project area on CR 2750.
- The Vineyard Grove Baptist Church (Marker Number 8943), constructed in 1853, is located 0.7 mile (1.1 km) east of the Yoakum Creek arm of the project area on FM 1396 north of the community of Allens Chapel.
- The Vicinity of Fort Inglish (Marker Number 8886) marker denotes the approximate 1,250-acre location of the original town site of Bonham, dating to 1837. The marker is located 0.8 mile (1.3 km) southwest of the project area on the edge of the City of Bonham on East 9th Street (SH 205).

In addition, more than 20 historical markers occur within the confines of the City of Bonham. These markers commemorate a variety of buildings and historical locations such as Carlton College, the Booker T. Washington School, the First United Methodist Church of Bonham, and the Steger Opera House.

3.14.3 Cultural Resource Investigations

Pre-Reservoir Investigations

Other cultural resources investigations have been conducted in the area prior to those initiated because of the undertaking (the Proposed Action) currently under study. A group from the University of Texas excavated several skeletons and recovered several artifacts from a prehistoric Caddo site (41FN12) at the Goss Farm near the mouth of Bois d'Arc Creek in 1930. In 1946, Rex Housewright of the Dallas Archeological Society subsequently uncovered a child burial at the site. The site was on a ridge in the

Red River floodplain at the west end of the Goss Plantation. The burial is assumed to be prehistoric in age and included a necklace that contained more than 260 turquoise beads and two turquoise pendants. Because workable turquoise occurs naturally in Arkansas, although the turquoise was assumed to be from New Mexico, the source of this turquoise has not been determined. In addition to the turquoise, R.K. Harris collected a cache of four mussel shell hoes from the site in 1953 (Davis et al., 2014).

The University of Texas investigated the Harling Mound, formerly the Morgan Mound (which measured approximately 230 feet long, 170 feet wide, and 7 feet high), at Riverby, Texas in 1962 (Davis, 1962a, 1962b). No burials were found during mound excavation, but the ceramics recovered dated to the Sanders phase (ca. A.D. 1000-1200). Excavation was conducted because the landowner wanted to level the mound to use the land for agriculture; however, a final report on this investigation has not been written (Davis et al., 2014). A "heavy" boatstone made of red-black hematite was collected on an earlier visit to the site (Harris, 1951).

The first recorded survey in Fannin County was conducted in 1960 for the proposed Brushy Creek Reservoir, now called Valley Lake, located near Bells, TX in west central Fannin County (TASA, 2011). Several prehistoric lithic scatters were recorded during the survey, and they range in age from the Archaic to Caddo (Davis et al., 2014). Furthermore, ground stone fragments were also found at one site.

The Texas State Building Commission (now the Texas Historical Commission [THC]) and the Texas State Water Development Board performed an archaeological survey of the proposed Timber Creek Reservoir (now Lake Bonham) and Bois d'Arc Reservoirs in 1968 (Hsu, 1968). The archaeological survey of the Timber Creek Reservoir identified two sites (41FN15 and 41FN16). Site 41FN15 consisted of a lithic scatter, a Scallorn point, two Gary points, and a potsherd. Site 41FN16 consisted of a Gary point and lithic scatter. Both sites were found on the edge of the first terrace of Timber Creek (Davis et al., 2014).

The proposed dam location that was the subject of the 1968 survey was upstream from the LBCR site currently proposed. Thirteen sites (41FN17 through 41FN29) were found approximately seven miles southwest of Bonham adjacent to Bois d'Arc Creek on knolls within the floodplain and on terraces adjacent to Bois d'Arc Creek. The sites contained mussel shells, animal bones, pottery, flakes, arrow and dart points, celts, axes, fire-cracked rock (FCR), and evidence of human burials (Davis et al., 2014). The sites were found to be either eroding out of creek banks or on the surface of plowed fields; a comprehensive survey was not conducted. One site of particular interest (41FN19) is located on a knoll adjacent to the old Bois d'Arc Creek channel (Hsu, 1968). The knoll is 300 m long by 50 m wide (330 yard by 55 yards), and the site (Hsu's collection) included two projectile points, two sherds, and lithic debris. These sites ranged in age from the Middle Archaic to the Caddo, and the landowner had collected a small ground hematite axe, a polished full groove axe, the proximal half of a polished cylindrical celt, and two incised sherds from the site surface. No functional information about the potential of finding buried cultural resources in the Bois d'Arc Creek floodplain is available because subsurface testing was not part of this survey. Nevertheless, numerous avocational archaeologists have reported finding dart points in the eroding channel bed in this area (Davis et al., 2014).

Southern Methodist University (Jurney et al., 1989) conducted an archaeological evaluation of three units of the Caddo Grasslands in Fannin County in 1989. According to their report, the Bois d'Arc Creek floodplain has high potential for prehistoric archaeological sites while the valley slope has a medium potential (Jurney et al., 1989). Figure 34 in the Jurney et al. report showed that the uplands also represent a high probability for identifying historic sites. The report states that the areas of low probability for historic sites are locations that are too far removed from historic transportation routes such as roads and railroads, and the bottomlands most likely represent a medium potential for historic sites (e.g., crossings or mills) since flooding prevented domestic occupation (Jurney et al., 1989; Davis et al., 2014).

In 2005, ARC investigated approximately 1,700 acres at the proposed location of Lake Ralph Hall, which would be constructed in Fannin County north of Ladonia, in the North Sulphur River floodplain, and seventeen historic and prehistoric sites (41FN60-76) were recorded as a result of the survey (Skinner et al., 2005). Further testing for a Middle to Late Archaic campsite (41FN68), a deeply buried Middle Archaic campsite (41FN66), and a site near the cobble core/chopper tool site (41FN73) was recommended by ARC. Further surveys, studies, or testing in the area would likely lead to the discovery of more deeply buried archaeological sites (Bousman and Skinner, 2007).

Most of these various small-scale surveys and studies that have been conducted throughout Fannin County have found little or no evidence of prehistoric or historic occupation (Davis et al., 2014). ARC surveyed for the South Wastewater Interceptor in Bonham, which tested in the Bois d'Arc Creek floodplain, as well as on the upland toe slope and the overlooking upland ridge, but did not find sites in those settings (Skinner and Davis, 2009).

Other major investigations, including surveys, testing, and site excavation, conducted in surrounding counties include the South Sulphur River valley at Cooper Lake in Delta and Hopkins counties, along Sanders Creek just to the east of Bois d'Arc Creek at Pat Mayse Reservoir, and at Camp Maxey. To the east, studies have been conducted in Pine Creek, at Crook Lake, B&B Landfill, and at the Gene Stallings Ranch near Powderly. A historic Native American site (the Womack site), is located adjacent to the Red River channel in northwest Lamar County. In Red River County further east of the surrounding counties, a survey was conducted at Big Pine Reservoir, and test excavations were conducted at the Mackin Mound site. Summer field schools of the Texas Archeological Society (TAS) conducted studies at the Sam Kaufman site in the early 1990s subsequent to site discovery and major excavation at the site in 1968, and additionally excavated the Ray site in Lamar County. Relevant site information is available from excavations and studies at Hugo Reservoir, McGee Creek Reservoir, and Pine Creek Reservoir in adjacent parts of Oklahoma (Davis et al., 2014).

Programmatic Agreement

In 2010, four parties signed a Programmatic Agreement (PA) regarding compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended) concerning construction of the proposed Lower Bois d'Arc Creek Reservoir (NTMWD et al., 2010). The four parties were the NTMWD; USACE, Tulsa District; THC, the Executive Director of which serves as the State Historic Preservation Officer (SHPO); and the Caddo Nation of Oklahoma. This PA is still in effect and has governed all cultural resources investigations and analysis associated with this undertaking (i.e., the proposed reservoir). The purpose of the PA is to serve as a guidance document that will be relied upon by all parties identified above to ensure that Section 106 requirements are met throughout the life of the project. The PA will serve to guide the work and ensure compliance with Section 106 on a timeline separate from that of the EIS. The PA will be in place for a period of ten years from signing, and may be renewed as needed. An additional agreement document will be drafted and signed by the PA signatories that will outline mitigation or avoidance measures for all identified adverse effects.

The PA notes that Section 106 and its implementing regulation 36 CFR Part 800 require the Tulsa District to ensure both that historic properties are identified and documented, and that any adverse effects to those historic properties are evaluated and resolved prior to any issuance of a Section 404 permit. Because the effects of the Proposed Action on historic properties will not be fully determined prior to approval of the Proposed Action and issuance of the permit, the PA will serve to fulfill the legal requirements of Section 106 of the NHPA by ensuring that adverse effects are identified and resolved prior to any ground disturbance or construction. The development and execution of the PA solidifies the agreement between the Tulsa District, the Caddo Nation, and the SHPO to accomplish the Section 106 process by implementing the PA in accordance with 36 CFR 800.6 and 36 CFR 800.14(b)(3).

The PA also specifies that the Area of Potential Effects (APE) of this undertaking consists of the reservoir proposed footprint itself, up to the elevation of the planned top of flood pool (elevation 541 feet MSL at the crest of the emergency spillway), as well as, "the planned location of the dam and all associated construction and staging areas, the planned new water treatment facility at Leonard, Texas, the pipeline from the new water treatment facility to the discharge point into Pilot Grove Creek, all raw water pipelines between the reservoir and associated existing water treatment facilities, lands manipulated for impact mitigation, plus the full horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project component boundaries and associated impact areas" (NTMWD et al., 2010). This also would include the area of the downsized reservoir alternative, which is located within the Proposed Action's footprint. The discharge point into Pilot Grove Creek cited in the PA is no longer part of the project.

The PA further notes that, prior to contact with Europeans, the Bois d'Arc Creek and Red River drainages in northeastern Texas were occupied by ancestors of the Caddo Nation and thus may retain historic properties of importance to this Nation. The PA states that the four signatories agree that the proposed undertaking (i.e., dam, reservoir, pipeline, treatment plant, and all appurtenant facilities) shall be implemented and administered in accordance with a number of stipulations that would ensure the Tulsa District takes into account the effects of issuing a Section 404 permit on historic properties as required by Section 106 of the NHPA. The Tulsa District is tasked with ensuring that all stipulations and measures are implemented.

The initial and principal stipulation consisted of tasks to "accomplish identification, evaluation, effect determination, and resolution." The first task instructed NTMWD to prepare a research design (described below) to guide cultural resource investigations within the APE. This research design "will synthesize current knowledge about the prehistory and history of the project area using existing records on historic resources, including but not limited to archaeological sites and historic standing structures in the APE." The design proposed a survey methodology appropriate for the particular landscape encompassed by the APE and also developed research questions relevant to the APE that guided testing and data recovery efforts.

In keeping with the PA stipulations, a draft research design was prepared in 2010 by ARC and submitted on behalf of NTMWD to the SHPO, the Caddo Nation Tribal Historic Preservation Officer (THPO), and Tulsa District for review. The reviewing parties returned comments back to ARC, and a second revised draft was submitted and reviewed in the same manner.

The next steps specified in the PA were initial cultural resources investigations and eligibility determinations for the NRHP. Whenever historic or cultural resources were identified within the APE, their eligibility for inclusion in the NRHP was to be assessed using the criteria outlined in 36 CFR 60. Should USACE, SHPO, and Caddo Nation agree that a property is or is not eligible, this consensus would be deemed conclusive. However, if USACE, or SHPO, or Caddo Nation disagreed regarding the eligibility of a given property, the Tulsa District then would obtain a determination of eligibility from the Keeper of the NRHP pursuant to 36 CFR 63.

The term "Cultural Resources" is a broad category which includes historic and prehistoric archaeological sites, deposits and features; historic and prehistoric districts; and built environment resources, including, but not necessarily limited to, buildings, structures (e.g. bridges), and objects. Traditional cultural properties and sacred sites, including cemeteries, human remains, and features or sites associated with significant events or practices in the traditional culture of an ethnic group are also deemed cultural resources.

Consistent with terminology defined in 36 CFR 800.16, the term "historic property" is used to denote all cultural resources identified as eligible for listing in the NRHP. Cultural resources determined to be ineligible for inclusion in the NRHP would require no further protection or evaluation.

Subsequent steps in the first stipulation of the PA outline procedures for Findings of No Adverse Effect, Findings of Adverse Effect, and Resolution for Adverse Effects. Additional stipulations pertain to curation and disposition of recovered materials, treatment of human remains, inadvertent discoveries of historic properties, and dispute resolution.

Reservoir-Related Investigations – Archeological and Historical Architectural Investigations

ARC conducted extensive archeological and historical architectural field investigations during 2011 and 2013 to identify cultural resources within approximately 5,000 acres of the entire 16,641-acre proposed LBCR site. The 2011 and 2013 surveys focused on the dam and reservoir footprint APE for the project, which is all land upstream from the dam location and below an elevation of 541 feet MSL (Davis et al., 2014). The majority of the reservoir study area is in the floodplain or on the first and second terraces of Bois d'Arc Creek. However, the historical architectural fieldwork and survey were conducted on the valley slope, which is part of the prairie upland south of the creek. All fieldwork was conducted in accordance and consistent with the stipulations outlined in the PA above. Methodology information discussed in this section relies heavily on ARC's report (Davis et al., 2014).

Research Design

The ARC reservoir APE surveys conducted in 2011 and 2013 as described above were designed to address a series of 11 hypotheses developed to implement and direct a better understanding of the archeological record in the region as well as to guide interpretations from field survey findings.

1. Hypothesis 1 states that the valley contains stratified alluvial soils designated by the Natural Resource Conservation Service (NRCS) Soil Surveys as "frequently flooded." This would imply that stabilized depositional sequences have laid down well-stratified deposits in the area, providing an intact archeological record.
2. Hypothesis 2 says that the duration of habitation within the valley (seasonal versus permanent) directly reflects the types of resources being used and/or available to Native populations. Well stratified sediments from the floodplain would also reflect these changes in the local ecotone over time.
3. Hypothesis 3 addresses Paleoindian use-patterns in the area, and states that the region's earliest visitors used seasonal resources, using locally available resources to overwinter.
4. Hypothesis 4 states that, following climatic shifts associated with the end-Pleistocene, Archaic peoples settled into the region and established informal territories to support increasing populations based marginally on hunting bison.
5. Hypothesis 5 indicates that Middle and Late Archaic population increase in the region will be reflected in toolkit contents, artifact density, and site activity areas and settings.
6. Hypothesis 6 states that during the Woodland, or Fourche Maline period, populations continued increasing and permanent housing and ceramic technology make an appearance in the region associated with the arrival of agriculture.

7. Hypothesis 7 indicates that during the Formative-Middle Caddo period villages will be found on the terraces north of Bois d'Arc Creek where arable soil and year-round water are available. Fully sedentary culture should be apparent by the appearance of permanent buildings, mounds, and ceramic traditions.
8. Hypothesis 8 says that Late Caddo sites will be located in the same areas as before, but population will dwindle with a climatic shift toward drier conditions. Specialized toolkit items such as refined bow and arrow technology will also identify this period.
9. Hypothesis 9 addresses Historic Caddo occupations in the region. These sites will be in the same areas of arable land along the northern side of Bois d'Arc Creek and will be identifiable by the presence of European-manufactured trade goods and iron tools.
10. Hypothesis 10 states that Historic European settlers in the region prior to the Civil War would have occupied similar areas as Caddo populations but will be identifiable by collapsed rock chimneys on arable, tillable land above normal flooding zones.
11. Hypothesis 11 covers local populations from the Civil War to the present and is based largely on the presence of standing structures, many of which are expected to be located near the site of previous or older structures.

Sample Design Methodology

To develop the approach for the survey methods, it was assumed that certain areas are intrinsically more likely to have intact cultural resources and deposits. Subsequently, a stratified hierarchical approach was used. The assumption that certain areas may contain more resources is based on the knowledge that archeological site locations are usually associated with certain landforms, elevations, soil types, and proximity to existing resources. Sample design methods also involved the use and examination of historical maps and imagery to identify potential historical sites (Davis et al., 2014). In addition, Light Detection and Ranging (LiDAR) was used to identify elevations within the project area. Based on the evaluation of historical maps and imagery researched, combined with the use of the stratified hierarchical approach, ARC designated terraces and their associated slopes as the higher probability areas. The trends for prehistoric resources were anticipated to correspond to historic archeological resources, with the exceptions being infrastructural or non-occupational sites such as roads, bridges, trash piles, etc. (Davis et al., 2014).

Field Survey Methodology

The pedestrian survey began with two tasks, the first of which was a reconnaissance survey of the accessible parts of the present creek channels and the original channel sections that were bypassed by channelization. The second involved a geomorphological study of the terrace sediments (and floodplain) to preliminarily evaluate and assess the archaeological potential of the reservoir area. The geomorphological study focused on the recognition and correlation of buried soils and documentation of flood deposition and erosion episodes (Davis et al., 2014). The channel sections in the floodplain were considered lateral transects and were projected to locate areas that could be studied geomorphologically as a result of "representative profiles" created by erosion over time. In addition, these profiles would provide the opportunity to recover organic materials for radiocarbon dating and environmental reconstruction. Furthermore, these profiles provided the depth to the base of the exposed Late Pleistocene subsoil or the bedrock under it. Inspections completed when the creek level was at a seasonal low provided evidence of site deposits, levees, point-bars, and filled in channel profiles in the channel walls (Davis et al., 2014).

The initial reservoir sample area was recommended to be approximately 3,800 acres, which represented approximately a 20 percent sample of the reservoir area (Skinner et al., 2010). The initial survey and draft report were completed in 2011 and summarized the findings of the survey. After several meetings with the USACE and the THC, it was decided in 2011 that an additional 1,200 acres needed to be surveyed to more effectively and completely evaluate the potential impacts to resources. The additional 1,200 acres represented an additional 10 percent sample project area, bringing the total to 30 percent. The survey areas are shown on Figure 3.14-1 and summarized in Table 3.14-1 (Davis et al., 2014). Twenty-four survey areas were established, and field crew members walked within each individual transect to evenly cover all visible ground surfaces. Survey areas A through I, N through R, T, and U were ¼ mi wide (0.4 km); the survey area at the proposed dam location was ½ mi wide (0.8 km); and survey areas J, L, M, V, and W were ⅛ mi wide (0.2 km). Survey areas K and S were both 100 feet (30 m) wide. The most extensive impacts from construction activities are associated with the floodplains and the terraces which would be eroded by fluctuations in reservoir levels. Subsequently, the survey areas were selected so that they crossed a variety of settings, with a focus on the floodplains and terraces. The survey areas also incorporated parts of microenvironments within the proposed reservoir area with a focus on attaining a representative sample from both high and low potential areas (Davis et al., 2014).

Table 3.14-1 Quantitative Survey Descriptions

Transect/ Survey Area	Total Acres	Floodplain Acres	Terrace Acres	Upland Acres	Percent Floodplain	Percent Terrace	Percent Upland
Dam	645.40	427.30	160.80	57.30	66.21%	24.91%	8.88%
A	438.39	141.30	251.80	45.29	32.23%	57.44%	10.33%
B	657.00	209.00	448.00	0.00	31.81%	68.19%	0.00%
C	156.62	125.00	31.62	0.00	79.81%	20.19%	0.00%
D	175.00	163.00	11.00	1.00	93.14%	6.29%	0.57%
E	102.70	102.70	0.00	0.00	100.00%	0.00%	0.00%
F	100.07	19.35	40.94	39.78	19.34%	40.91%	39.75%
G	303.39	139.50	36.69	127.20	45.98%	12.09%	41.93%
H	309.10	244.60	0.00	64.50	79.13%	0.00%	20.87%
I	58.20	33.70	18.70	5.80	57.90%	32.13%	9.97%
J	110.73	6.33	101.40	3.00	5.72%	91.57%	2.71%
K	508.80	508.80	0.00	0.00	100.00%	0.00%	0.00%
L	105.79	38.69	67.10	0.00	36.57%	63.43%	0.00%
N	57.57	43.61	0.00	13.96	75.75%	0.00%	24.25%
O	29.31	0.00	24.61	4.70	0.00%	83.96%	16.04%
P	224.90	38.50	186.40	0.00	17.12%	82.88%	0.00%
Q	232.76	34.70	168.80	29.26	14.91%	72.52%	12.57%
R	28.75	6.80	0.00	21.95	23.65%	0.00%	76.35%
S	163.30	1.60	0.00	161.70	0.98%	0.00%	99.02%
T	164.80	129.46	0.00	35.34	78.56%	0.00%	21.44%
U	249.70	226.60	0.00	23.10	90.75%	0.00%	9.25%
V	11.86	1.19	9.66	1.01	10.03%	81.45%	8.52%
W	33.88	14.89	18.99	0.00	43.95%	56.05%	0.00%
Totals	**5004.32**	**2665.12**	**1704.31**	**634.89**	**53.26%**	**34.06%**	**12.69%**

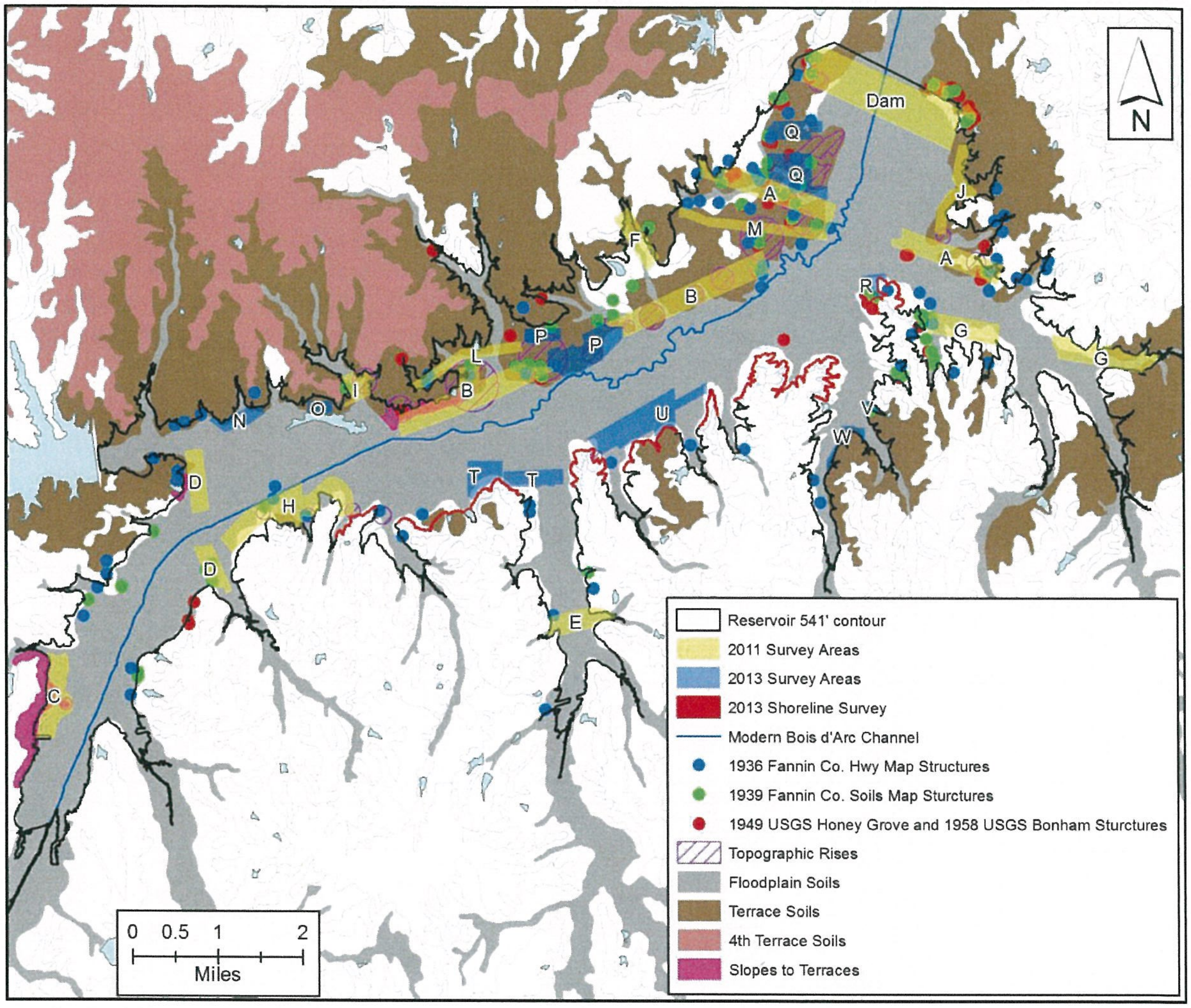


Figure 3.14-1. ARC Survey Transect Areas

Source: Davis et al., 2014

Field methods were designed to gather baseline information and data related to the location and recording of cultural resources within the survey areas for the purpose of making a preliminary assessment of NRHP eligibility. The inventory of recorded sites in the survey areas provides information related to site distribution and density, size and deposit depth, artifact groupings, ecofact conservancy, and dating potential (Davis et al., 2014). The information gathered as part of the field methods were used by ARC to develop recommendations for sites and areas that require or would benefit from additional or more extensive cultural resource investigations. This includes testing and mitigation of sites that are eligible for listing on the NRHP. Pedestrian survey data collection methods include conducting shovel testing, performing geomorphological assessments using trenches, and completing archival and oral history research (Davis et al., 2014).

As part of the terrace settings, the field crew walked parallel and individually numbered transects, spaced 20-30 m apart. The field crew excavated shovel tests along the transects in each survey area at approximately every 75 to 100 meters (69 to 91 yards) and took detailed notes on ground exposure, soil types, and topographic settings encountered. The excavation of shovel tests were concentrated where artifacts were present on the surface or on topographic rises, ridge tops, knolls, and on terrace edges, with an average of two to three shovel tests per acre excavated in the high potential terrace sediments. The dimensions of all shovel tests were approximately 30 cm (12 in.) in diameter, extended to 80 cm (31 in.) below surface (cmbs) or to the bottom of the Holocene deposit (THC, no date-a), and were performed at 10 cm levels (Davis et al., 2014).

The focus of the floodplain survey was centered at the floodplain edge, where it meets the first terrace, and the channel edge, where overbank levees might have been. The field crew made extensive notes on ground exposure and soil types for each survey area. Parallel transects were used to examine creek banks in the Bois d'Arc Creek channel. An average of one shovel test per acre was excavated in the floodplain, and the shovel tests were only performed in those settings where buried deposits were expected to be encountered within the top 60 to 80 cm (24 to 32 inches) of sediment below the present ground surface. The soils in the face of the bank were profiled at regular intervals using picks to examine the stratigraphy. Handheld GPS units were used to record profile locations, and *in situ* recordings of artifacts exposed in the bank were made. Shovel testing was also conducted on elevated rises within the floodplain and in areas where mussel shells, animal bones, and other artifacts were noted on the surface during the survey. In areas where buried cultural deposits were located beneath a meter or more of alluvium, trenching and shovel tests were conducted as described above (Davis et al., 2014).

To determine if cultural materials were present in the diversity of soil profiles, clay soils were broken apart, hand sorted, and visually inspected, while sandy soils were screened using a ¼ inch hardware cloth. The Munsell Soil Color Chart was used to compare the texture and color of soils gathered from the shovel test matrices to already categorized soils. A shovel test form was completed for each location, recording the number of artifacts and soil type. As noted above, handheld GPS units were used to record the locations of artifacts and soil types. All subsurface artifacts were collected in 10-cm (4-inch) levels for analysis and curation. Temporally and functionally diagnostic artifacts located on the surface were mapped and collected for analysis and curation, and all artifacts identified were photographed using digital cameras (Davis et al., 2014).

All sites were documented during the survey using a standard Texas State Site Form. Field sketch maps were drawn incorporating local landmarks, shovel tests locations, features, and site boundaries. Prehistoric sites were delineated using six or more shovel tests to determine the subsurface extent of cultural deposits, surface artifact scatters, and in the case of terrace and floodplain deposits, backhoe trenches. The standard methodology for determining the site edge/boundary was that shovel tests were excavated outward from the point of discovery until no evidence of a site deposit was present, as indicated by an absence of artifacts or cultural deposits. Data collected included the criteria necessary for making initial recommendations for a site's inclusion to the NRHP including: site integrity, features, cultural context, potential for intact buried deposits, and artifactual materials present.

Historic site horizontal and vertical site boundaries were defined using shovel tests, as well as surface scatters of artifacts, parcel and aerial maps, layout of structures, and structural remains. Vertical site boundaries (i.e., deposit depths) were specifically defined using shovel tests, supplemented by bucket augering and backhoe trenching in the terrace and floodplain sediments. Horizontal site boundaries were specifically defined using surface scatter and six or more shovel tests where ground visibility was less than 30 percent. Similar to the discussion of prehistoric sites above, shovel tests were excavated outward from the point of discovery until no evidence of a site deposit was present, as indicated by an absence of artifacts or cultural deposits. Historic site types were tentatively identified based on cultural context and cultural material present. An architectural historian evaluated and documented all standing structures to make NRHP eligibility evaluations. All structures built before 1970 were evaluated by the architectural historian. The NRHP potential of historic sites was evaluated on integrity of site deposits and structural remains, features and archaeological materials present, cultural context, and associated persons of significance to the area.

In the event cemeteries (prehistoric and historic burials of any type) were found, the cemeteries were to be carefully evaluated using typically non-invasive initial means to determine horizontal extent (e.g., scraping the surface to obtain a better initial evaluation on the perimeter of the cemetery and unmarked graves) prior to full-scale mechanical excavation. These activities were to be conducted in accordance with consultations and coordination with the THC and the Caddo Nation (depending on whether the site was determined to be historic or prehistoric) prior to excavation, and applicable notifications would be issued. The evaluation and determination of horizontal extent was to be conducted in accordance with Section 711 of the Texas Health and Safety Code (which requires mitigation and re-interment of human remains to be inundated or otherwise negatively impacted). Prehistoric burials and cemeteries were specifically addressed in accordance with and following the Treatment Plan and were excavated in consultation and coordination with the Caddo Nation. Historic cemeteries evaluation and identification utilized some minor mechanical equipment (to scrape the surface to identify individual unmarked graves as noted above) to identify the perimeter of the cemetery (e.g., the Wilks Cemetery).

Additionally, because the land is owned by NTMWD, a political entity of the State of Texas, it is subject to state burial laws, and all work was conducted as per the stipulations outlined in the "Treatment Plan for Caddo Culturally Affiliated Human Remains" and "Treatment Plan for Native American Human Remains or Unmarked Burials", which was performed in a manner consistent with the PA and with Title 13, Part II, Chapter 22, Cemeteries, and any other requirements under Chapter 711 Of The Texas Health And Safety Code, and The Antiquities Code of Texas (Title 9, Chapter 191 of The Texas Natural Resources Code). The Treatment Plans outline the steps to be taken in the event that human remains are encountered during archaeological survey, shovel testing, unit excavating, land clearing, construction activity and/or shoreline erosion, or any other unanticipated effects of the project for the duration specified in the individual plans.

An extensive geomorphology survey was conducted using a backhoe to provide cross sections of terraces throughout the project area and to provide a baseline for paleoenvironmental reconstruction. Trenches were used to define the vertical limits of deeply buried deposits within the sites, and geomorphologist, Ms. Stephanie Coffman, conducted four streambank profiles and nine backhoe trench profiles in the project area. All of the profiles were located along the creek, within the floodplain, or on the slope of the terraces adjacent to the floodplain. These data were used to establish floodplain and terrace development, which assists in creating a natural history of the region and enables archeologists to identify site creation processes and likely depositional sequences within sites in a variety of settings. Profile drawings were made, samples were screened, and carbon and soil samples were taken to establish age ranges.

Historic archive research was performed by ARC, who consulted numerous state and local resources including the THC online Atlas, Fannin County land abstracts and tax records, and Fannin County Clerk's Office deeds and titles. In addition, historical aerial photos and historic maps were also consulted. Personal interviews were carried out using a standardized questionnaire directed toward the project area to establish a local historical narrative, document private artifact collections, and to locate cultural resources.

All prehistoric artifacts were analyzed using a variety of methods to gain the maximum amount of information from the sampling. Lithic artifacts were defined by typology, stage of manufacture, function, and probable material source. Lithic tools were analyzed in an attempt to identify any discernable hunting and foraging patterns through time, in particular from Paleoindian through Archaic compared to Late Prehistoric/Caddo. Basic ceramic identification was conducted based on known typologies, with thickness, paste, slip, and visible decorations recorded. Other artifacts were used in a variety of manners: snails were used for paleoclimatic reconstruction, mussel shell for occupation patterns, and charcoal for direct dating of buried cultural deposits.

Historic artifacts, largely being of known source and age, were sorted into typologies and described by their diagnostic attributes. These attributes contribute to an understanding of historic-era cultural settlement and land-use patterns in the project area.

Concurrent to archeological investigations, ARC also conducted a historical architecture investigation for the proposed reservoir. The following discussion of this investigation relies entirely on ARC's report (Davis et al., 2014).

Historical Architectural Design Methodology

The historical architecture survey was carried out to identify any potential NRHP properties that could be negatively impacted by the construction of the Lower Bois d'Arc Creek Reservoir. One hundred percent of the proposed reservoir was examined in this effort. Structures dating to 1970 and prior were considered historic in age during this survey.

Four factors were used to determine NRHP eligibility during the investigations. These criteria, presented in 36 C.F.R § 60.4[a-d], are (Davis et al., 2014):

(a) association with events that have made a significant contribution to the broad patterns of our history; or

(b) association with the lives of persons significant in our past; or

(c) embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) yielding, or may be likely to yield, information important in prehistory or history (primarily archaeological).

In addition to these criteria, a structure must possess some level of the seven characteristic aspects of integrity, as defined by the NRHP: location, design, setting, materials, workmanship, feeling, and association.

Birthplaces and graves of historic persons, cemeteries, religious institution-owned properties, moved structures, reconstructed buildings, commemorative properties, and properties which have gained historical significance in the last 50 years are not considered eligible for the NRHP unless they are a (Davis et al., 2014):

(a) religious property deriving primary significance from architectural or artistic distinction or historical importance; or

(b) building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

(c) birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his or her productive life; or

(d) cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

(e) reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

(f) property primarily commemorative in intent of design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

(g) property achieving significance within the past 50 years if it is of exceptional importance.

Background information for the project area was derived from the THC's Texas Historic Sites Atlas (THSA), Texas State Historical Association's "Handbook of Texas Online", Fannin County Chamber of Commerce, Fannin County Library, Fannin County Historical Society, Fannin County Historical Museum, the Portal to Texas History, and other available books and resources. Oral histories were gathered by ARC and previous interviews conducted by the Fannin County Historical Society were used as well. Historic aerial photographs and maps were also used in locating potential structures to visit during fieldwork.

Summary of Archaeological, Historical and Architectural Field Survey Results

Field Survey Results – Archaeological Sites

The sediments of the LBCR project area contain a variety of archaeological resources dating from the Middle Archaic to Historic periods. Most of the prehistoric sites seem to be temporary and seasonal occupations. As part of the initial 2011 survey, approximately 40 linear miles (500 acres) of creek channels were walked, along with the roughly 4,500 acres that were surveyed to identify the presence of historic properties. Roughly 30 percent (including the additional 10 percent of the proposed reservoir footprint agreed to be surveyed in 2013 to fulfill the obligation of the Texas Antiquities Permit) of the proposed reservoir was surface inspected, and areas that were not within the designated archeological survey areas (i.e., Bois d'Arc Creek and tributary stream channel areas) were also included in this number (Davis et al., 2014). A total of 61 archaeological sites and 26 Isolated Objects (IOs) (31 prehistoric, 26 historic, and four prehistoric/historic multi-component) were recorded (41FN95-142 and 41FN147-159). This represents an average of one archaeological site per 86 acres. Three of the archaeological sites (41FN139, 140, and 142) that were previously reported by local informants to ARC during the 2011 survey were tested in 2013 as part of the additional 30 percent identified above and were identified not to exist. Subsequently, these three sites have been removed/eliminated from the number of identified sites, resulting in a total of 58 sites. The site 41FN141 consisted of a prehistoric lithic scatter found and reported 1.1 km (0.7 mile) east of CR 2610. Due to its location outside the proposed reservoir on private property, it was not recorded, but its location was documented with a trinomial. The site needs to be delineated before a recommendation on its eligibility for listing in the NRHP can be made; however, it will not be impacted by this project. A tabular summary and individual descriptions of these archaeological sites are provided below and in Appendix S.

Most of the identified archaeological sites from the 2011 and 2013 surveys date to the 20th century, except for Wilks Cemetery (41FN96) and sites 129, 137, 138, 148, 154, 157, 158, and 159. The eight sites appear to represent the sparse remains of late 19th to early 20th century homesteads and farmsteads. Three of these sites could be linked to the same rural communities, and oral histories confirm that most 19th century residences were eliminated to increase the amount of farm and pasture land or were replaced by more modern structures that utilized space more efficiently. Based on the results of the archaeological and architectural investigations, ARC recommends that most of the prehistoric and historic site identified during the surveys in 2011 and 2013 were not eligible for listing on the NRHP or as State Antiquities Landmarks (SALs) (Davis et al., 2014). Although most of the identified sites are not eligible for listing on the NRHP or as SALs, 17 archaeological sites (both historic and prehistoric) are recommended for further testing and research to determine their eligibility for the NRHP: 41FN108, 109, 110, 113, 114, 118, 119, 120, 122, 136, 137, 138, 148, 151, 154, 156, and 159. These sites require further testing and research at a scale larger than the survey level to determine the full vertical and horizontal extent of the sites and to assist in recommending whether or not the site should be recommended as eligible for listing on the NRHP. The Wilks Cemetery has an undetermined eligibility for listing on the NRHP but will be relocated prior to the construction of the reservoir and will be evaluated for eligibility during that phase of the project (Davis et al., 2014).

Field Survey Results – Historic Structures/Buildings

Historic aerial photographs document a decrease in the number of buildings and structures within the project area through time, dropping from 81 structures in 1936, to 44 structures in 1976. At the time of ARC's survey, which included extensive archeological and historical architectural field investigations conducted during 2011 and 2013 to identify cultural resources within the entire 16,641-acre Lower Bois d'Arc Creek Reservoir survey, many more structures had disappeared and two had burned in wildfires. A total of three structures were not accessible due to right-of-entry issues. These structures were subsequently not evaluated by historians. ARC's historical architecture survey encompassed the entire proposed lake area (541 feet MSL and below) and identified a total of 38 architectural resources within the proposed Lower Bois d'Arc Creek Reservoir boundaries (Davis et al., 2014). Of these 38, ARC made a preliminary investigation of nine of the sites identified during the archeological survey to evaluate if it was appropriate to assign (archeological) site trinomials (assigned by the Texas Archeological Research Laboratory). Some of these architectural resources were associated with recorded archaeological sites, and most structures were conglomerations of styles and were not readily identified with any particular style of construction.

Agricultural outbuildings were the most numerous constituting 63 percent of the 38 historic architectural resources documented. Domestic structures (primary and secondary) composed 32 percent, while single commercial structures represented 2.5 percent of total as did the one religious structure documented. More than one-half of the structures recorded were built between 1939 and 1955, while most of the rest were built/constructed during the gaps in aerial photography from 1950 to 1976 with the exception of the New Jerusalem Baptist Church (41FN98) in Carson. Based on the appearance of 41FN98 on a Fannin County map in 1936, it is presumed the structure was built prior to 1936 and was moved to its present location, from two miles (3.2 km) north, in 1940 after its African-American congregation was displaced by formation of the Caddo National Grasslands (Davis et al., 2014). Of the 38 documented structures/buildings, none were found to have significant associations with events that made a contribution to the broad patterns of history (NRHP Criterion A) or persons important to the past (NRHP Criterion B). In addition, none of the resources evaluated were found to be an outstanding example of a type, period, or method of construction, nor were any found to be the work of a master (NRHP Criterion C), nor likely to yield information important to history or prehistory (NRHP Criterion D). Furthermore, no architectural resource was determined to meet any of the special requirements under Criteria Considerations A-G. For these reasons, ARC recommended that all 38 historic-age architectural resources evaluated are ineligible for listing in the NRHP (Davis et al., 2014). No further surveys will be conducted because the historical architecture survey encompassed the entire project area, and additional surveys are not required. A tabular summary and individual descriptions of these structures are provided in Table 3.14-2 in the following section.

Identified Historic Buildings and Structures at or Near the Reservoir

Within the Reservoir APE

Table 3.14-2 summarizes the site subtype and style for each of the known historic buildings and/or structures identified within the reservoir APE.

Table 3.14-2. Historic Buildings and Structures Within the Reservoir Basin

Resource ID	Subtype	Style	Constr. Date (ca.)
1a	Domestic, single-family dwelling	One-story, wood-frame house; L-shaped footprint; hipped roof with side gable; low-pitched roof clad with composite shingles	1950
1b	Agricultural, outbuilding	Front-gabled, rectangular shed clad with vertically placed sheets of corrugated metal	1950
2a	Domestic, single-family dwelling	Cross-gabled, wood-frame house; rectangular footprint with irregular projections	1940
2b	Agricultural, outbuilding	Rectangular outbuilding clad with corrugated metal; roof clad with corrugated metal with exposed rafters; double corrugated metal doors	pre-1976
3a	Domestic, single-family dwelling	One-story, rectangular, wood-frame house with full-width, extended roof porches on the facade and rear elevation	1970
3b	Agricultural, outbuilding	Wood-frame shed with corrugated metal cladding; roof no longer intact, but appears to have been a shed roof	1970
3c	Agricultural, outbuilding	Rectangular, side-gabled, wood-frame structure clad with sheets of metal	1970
4a	Domestic, single-family dwelling	Originally a rectangular, front-gabled dwelling, four rooms deep, with incised porch supported by square posts and containing two entry doors	1948
4b	Agricultural, outbuilding	Pole barn with rectangular footprint; barn and roof clad with sheets of corrugated metal	pre-1976
5a	Domestic, single-family dwelling	Rectangular, wood-frame dwelling resting on wood piers; 2 bays wide and 1.5 rooms deep	1939
5b	Agricultural, outbuilding	Two bay, rectangular, wood-frame structure clad with horizontal boards; front-gabled roof clad with corrugated metal; no doors intact	1939
5c	Agricultural, outbuilding	Rectangular, wood-frame structure; cladding consists of both horizontal and vertical boards	1939
5d	Agricultural, outbuilding	Rectangular, wood-frame structure clad with corrugated metal; shed roof clad with corrugated metal.	1939
5e	Agricultural, outbuilding	No style; wood-frame structure clad with corrugated metal	1939
6a	Domestic, single-family dwelling	Wood-frame dwelling clad with horizontal wood boards; side-gabled with ell and carport and storage room inserted in L	1950
6b	Domestic, secondary structure	Freestanding metal roof supported by metal poles on one side and wood poles on the other	pre-1976
6c	Agricultural, outbuilding	Rectangular pole barn clad with corrugated metal; side-gabled roof clad with corrugated metal; three bays in width	pre-1976
7a	Domestic, secondary structure	Long, rectangular pole shed 5-6 bays in width measuring 15'9" by 86'2	pre-1976
7b	Agricultural, outbuilding	Long, rectangular pole shed clad with composite shingles resembling yellow brick over horizontal boards	pre-1976
8a	Domestic, single-family dwelling	Minimal Traditional; wood-framed, cross-gabled dwelling clad with composite shingles resembling yellow brick over rabbeted horizontal boards	1950

Resource ID	Subtype	Style	Constr. Date (ca.)
8b	Agricultural, outbuilding	Rectangular, wood-frame shed; clad with salvaged materials including wood planks and corrugated metal	pre-1976
8c	Agricultural, outbuilding	Three-bay shed; front-gabled center section with a shed addition on east and west elevations	pre-1976
8d	Agricultural, outbuilding	Rectangular, pole shed; clad with variety of sheet metal including corrugated, crimped and V-channel; shed roof clad with crimped metal	pre-1976
9	Agricultural, outbuilding	Side-gabled pole barn with shed attachments on both sides forming a broken-roof; structure and roof clad with corrugated metal	pre-1976
10	Religious	New Jerusalem Baptist Church; T-shaped footprint with intersecting gable roof; wood frame building clad with horizontal composite siding with limited corrugated metal skirting remaining; front-gabled facade with drop-roofed entry porch supported by square cut-lumber supports with side balustrades	Prior to 1940; additions: 1984.
11	Commerce, community store	Wood framed, rectangular building with board and batten cladding; side-gabled roof with crimped-metal cladding and exposed rafters	1940
12a	Domestic, single family dwelling	1 ½ story, wood frame house clad with composite siding and with later lean-to addition on the east elevation	1955
12b	Agricultural, outbuilding	Rectangular, wood-frame shed clad with corrugated metal; roof clad with corrugated metal	pre-1976
13	Agricultural, outbuilding	Rectangular pole barn with side-gabled roof	1946
14a	Domestic, single-family dwelling	Rectangular, wood frame house with side-gabled roof; horizontal wood planks clad with Insulbrick siding; roof clad with metal over framing	1950
14b	Agricultural, outbuilding	Small, wood-frame shed clad with horizontal wood planks; side-gabled roof clad with corrugated metal roof and exposed rafters	pre-1976
15a	Domestic, single-family dwelling	Craftsman; wood-frame dwelling clad with metal siding; front-gabled roof with exposed rafters and braces; roof clad with crimped metal	1942
15b	Agricultural, outbuilding	Front-gabled pole barn; clad with wood planks; roof covered with various types of metal	1950, addition 1960
16	Agricultural, outbuilding	Front gabled storage shed with lean-to garage with shed roof; shed clad with vertical board-and-batten wood planks	1940
17a	Agricultural, outbuilding	Large, front-gabled, hay barn with mangers on both sides; approximately 75 feet wide x 110 feet long; framing consists of both Bois d'Arc and metal poles; walls and roof clad with sheets of corrugated metal; exposed rafters	1950
17b	Agricultural, outbuilding	Front-gabled, rectangular pole barn with lean-to shed on west elevation; cladding is wide wood planks covered with metal sheets	1950
18	Agricultural, outbuilding	Small open-front pole shed; approximately 20 feet wide by 17 feet long; board-and-batten cladding on three sides; open facade; roof clad with corrugated metal sheets	1950
19	Agricultural, outbuilding	Barn with rectangular footprint; gabled roof clad with sheet metal	pre-1976

Outside of the APE

No survey data are available of historical architecture outside the physical APE for the project.

Identified Historic Cemeteries at or Near the Reservoir

Within the Reservoir APE

The cemetery located within the area that would be inundated as a result of the Proposed Action is the Wilks Cemetery (FN-C020 and 41FN96) (TASA). This cemetery was used until 1932 and contains burials dating back to 1852, which is considered early for the region (Davis et al., 2014). The Wilks Cemetery (Site 41FN96) is located at an elevation of 533 feet MSL. approximately one mile (1.6 km) south of Coffee Mill Lake and 0.8 mile (1.3 km) west of Bois d'Arc Creek on the north shore of the proposed reservoir basin. It encompasses about 0.3 acres (80 by 180 feet) but extends an additional 595 feet west to an outlying grave marker belonging to Charity Bonham (died 1865) and Louisa A. Bonham (died 1866). The cemetery was used from 1852 (M.G. Gagle) to 1927 (Milton Wilks) and includes 39 marked graves within its physical boundaries as summarized in Table 3.14-3 below. To test for additional graves, exploratory shovel tests were conducted outside of the cemetery; all shovel tests were negative and did not identify any additional graves. Because the site would be impacted by the project and subsequently relocated, it has an undetermined status for the NRHP until it can be fully evaluated during the relocation phase (Davis et al., 2014).

Table 3.14-3. Known Interments in the Wilks Cemetery, Fannin County, Texas

Number	Name	Birth Year	Death Year	Notes
1	-	-	-	Wood Head Marker
2	-	-	-	Wood Head Marker
3	Wilks, Newton	1855	1901	-
4	Wilks, Charles Jefferson	1888	1896	Son of Newton & Mary
5	Wilks, Eliza N.	1886	1888	Son of N.& M.H.
6	Wilks, Frederick B.	1884	1885	Son of Newton & Mary
7	Wilks, Margaret J.	1814	1869	wife of Thomas A.
8	Wilks, Thomas A.	1800	1871	-
9	Wilks, Infant	1881	1881	child of Milton & Betty
10	Wilks, Noah	1882	1883	son of Milton and Betty
11	Wilks, Emsy E.	1884	1885	Son of M.& B.
12	Wilks, Betty	1853	1887	Wife of Milton
13	Wilks, Milton	1857	1927	-
14	Wilks, Florence E.	1872	1901	2nd wife of Milton Wilks
15	Wilks, Cora	1889	1889	Daughter. of Milton & F.E.
16	N.W.	-	-	Footstone
17	C.J.	-	-	Footstone
18	E.N.W.	-	-	Footstone
19	F.B.W.	-	-	Footstone
20	M.A.W.	-	-	Footstone
21	T.A.W.	-	-	Footstone
22	None	-	-	Footstone
23	N.W.	-	-	Footstone
24	E.E.W.	-	-	Footstone
25	B.W.	-	-	Footstone
26	M.W.	-	-	Footstone

Number	Name	Birth Year	Death Year	Notes
27	F.E.W.	-	-	Footstone
28	C.W.	-	-	Footstone
29	Cagle, M.G./S.C. Cagle	1809/1814	1852/1861	
30	M.V.C.	-	-	Footstone
31	E.C.C.	-	-	Footstone
32	S.H.H.	-	-	Footstone
33	M.S.C	-	-	Footstone
34	M.G.C	-	-	Footstone
35	S.C.C	-	-	Footstone
36	J.H.C	-	-	Footstone
37	-/Louisa A. Bonham	1812/1864	1865/1866	Charity Wife of David Bonham/Daughter of J. and P.E. Bonham
38	C.B.	-	-	Footstone
39	L.A.B	-	-	Footstone

Source: Davis et al., 2014

Outside of the APE

Outside the flood pool of the proposed reservoir, 19 other historic cemeteries are located within the general vicinity. These cemeteries have not been formally recorded as archaeological sites.

1. Historic Russell Cemetery (Site 41FN58) is located on the outskirts of Bonham and north of Pig Branch. The site is at an elevation of 580 feet MSL and covers an area of 30 x 30 m (33 x 33 yds.). The cemetery contains an estimated 22 interments dating from 1853 to 1967.
2. The Gum Springs Cemetery (FN-C068) is located about 1.6 miles (2.6 km) northwest of Bois d'Arc Creek at an elevation of about 550 feet MSL elevation. The cemetery is occasionally referred to as the Carson Cemetery because of its proximity to the town of Carson. The cemetery has an estimated 250 burials ranging from 1880 through the present.
3. The White Family Cemetery #2 (FN-C085 is one of two White Family Cemeteries in Fannin County) is about 1.1 miles (1.8 km) northwest of Bois d'Arc Creek at an elevation of about 545 feet MSL elevation. Records suggest this cemetery contains an estimated 15 interments ranging from 1870 to 1940.
4. The Center Grove Cemetery (FN-C067) is located about 2.2 miles (3.5 km) northwest of Bois d'Arc Creek at an elevation of about 580 feet MSL. The cemetery contains an estimated 95 interments ranging from 1877 to 1963.
5. The Owens Chapel Cemetery (FN-C086) is located about 2.2 miles (3.5 km) northwest of Bois d'Arc Creek at an elevation of about 590 feet MSL. The cemetery is sometimes called the Old Danner Cemetery. It contains more than 250 interments ranging from the 1880s to the present.
6. The Stancel Cemetery (FN-C066) is located about 1.1 miles (1.8 km) north of Bois d'Arc Creek and about 2.5 km east of Lake Bonham at an elevation of about 550 feet MSL. It contains four interments dating to the 1870s.
7. The Shiloh Cemetery is located about 1.4 miles (2.2 km) east of Honey Grove Creek at an elevation of about 590 feet MSL. More than 250 interments are present, ranging from 1860 to the present.
8. The Vineyard Grove Cemetery is located about 2.9 miles (4.6 km) southeast of Bois d'Arc Creek at an elevation of about 590 feet MSL. It contains an estimated 155 interments ranging from the 1840s to the present.

9. The Humble Family Cemetery (FN-C064) (marked as "Umble" on the USGS topographic map) is located about 1.7 miles (2.8 km) southeast of Bois d'Arc Creek at an elevation of about 600 feet MSL. It contains an estimated four interments dating from 1871 through 1893.
10. The Smith Family Cemetery (FN 084) is located about 1.9 miles (3.1 km) southeast of Bois d'Arc Creek at an elevation of about 612 feet MSL. It contains nine recorded interments dating from 1854 to 1908.
11. The Onstott-Stewart Cemetery (FN-C046) is located about 2.4 miles (3.9 km) southeast of Bois d'Arc Creek and about 0.6 miles (0.9 km) east of Bullard Creek at an elevation of about 560 feet MSL. Records indicate it contains seven interments dating from 1846 to 1993.
12. The Smyrna Cemetery (FN-C045) is located about 3.2 miles (5.1 km) southeast of Bois d'Arc Creek on the high ground between Cottonwood and Bullard Creeks at an elevation of about 570 feet MSL. The cemetery contains an estimated 500 interments dating from 1866 to the present.
13. The Cross Family Cemetery (FN-C065) is located approximately 1.1 miles (1.8 km) southeast of Bois d'Arc Creek at an elevation of about 590 feet MSL. It contains four known interments dating 1855 to 1911.
14. The Wolfe and Carlisle Family Cemetery (FN-C044) is located about 2.9 miles (4.6 km) southeast of Bois d'Arc Creek and about 820 feet (250 m) east of Burns Branch at an elevation of about 610 feet MSL. It contains 15 recorded interments dating from 1855 to 1925.
15. An unnamed cemetery is located about 3.4 miles (5.5 km) northwest of Bois d'Arc Creek and immediately west of the community of Hudsonville at an elevation of about 590 feet MSL.
16. An unnamed cemetery is located about 2.9 miles (4.6 km) northwest of Bois d'Arc Creek and immediately south of the community of Lamasco at an elevation of about 580 feet MSL.
17. An unnamed cemetery is located about 3.5 miles (5.6 km) southeast of Bois d'Arc Creek and west of the community of Allen's Chapel at an elevation of about 590 feet MSL.
18. An unnamed cemetery is located about 1.4 miles (2.2 km) southeast of Bois d'Arc Creek between Ward Creek and Pettigrew Branch at an elevation of about 600 feet MSL.
19. An unnamed cemetery is located about 1.7 miles (2.8 km) southeast of Bois d'Arc Creek and immediately north of Onstott Branch at an elevation of about 565 feet MSL.

Identified Archaeological Sites at or Near the Reservoir

Within the Reservoir APE

Table 3.14-4 summarizes the age and site type for each of the known archaeological sites identified within the APE, as well as whether or not it is recommended as eligible to be listed on the NRHP. Site descriptions discussed in this section rely heavily on ARC's report (Davis et al., 2014) and others referenced within their report.

Table 3.14-4. Archaeological Sites Identified During Current Investigations

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN95	Historic	Undefined	Barn	No
41FN96	Historic	1852 - 1927	Cemetery	Unknown – will be relocated during construction phase and would be evaluated during the mitigation phase.

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN97	Historic	Undefined	Shed	No
41FN98	Historic	Undefined	Church	No
41FN99	Historic	Undefined	House & Shed	No
41FN100	Historic	Mid-20th Century	House & Outbuildings	No
41FN101	Historic	Undefined	House & Shed	No
41FN102	Historic	1930s-1940s	House	No
41FN103	Historic	Undefined	Structure Foundation	No
41FN104	Historic	Undefined	Store	No
41FN105	Historic	Undefined	House, Barn, & Sheds	No
41FN106	Historic	Mid-20th Century	Trash Scatter	No
41FN107	Historic	Mid-20th Century	Trash Scatter	No
41FN108	Historic	Early 20th Century	Well or Cistern	Further testing is needed to determine NRHP eligibility
41FN109	Historic	Mid-20th Century	Well or Cistern & Trash Scatter	Further testing is needed to determine NRHP eligibility
41FN110	Prehistoric	Unknown	Buried Artifact Scatter (historic camp site)	Further testing is needed to determine NRHP eligibility
41FN111	Prehistoric	Late Prehistoric	Artifact Scatter	No
41FN112	Prehistoric	Unknown	Surface Artifact Scatter	No
41FN113	Prehistoric	Archaic	Buried Stratified Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN114	Prehistoric	Late Prehistoric	Buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN115	Prehistoric	Unknown	Thin Artifact Scatter	No
41FN116	Prehistoric	Unknown	Thin Artifact Scatter	No
41FN117	Prehistoric	Archaic	Surface Artifact Scatter	No
41FN118	Prehistoric	Late Prehistoric	Unstratified Buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN119	Prehistoric	Late Prehistoric	Buried Unstratified artifact scatter	Further testing is needed to determine NRHP eligibility
41FN120	Prehistoric	Archaic - Late Caddo	Stratified Alluvial Terrace Site	Further testing is needed to determine NRHP eligibility
41FN121	Prehistoric	Unknown	Buried Unstratified artifact scatter	No
41FN122	Prehistoric	Archaic - Late Prehistoric	Unstratified Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN123	Prehistoric	Late Prehistoric	Thin Artifact Scatter	No
41FN124	Prehistoric	Archaic	Artifact Scatter	No
41FN125	Prehistoric	Unknown	Possible Hearth Features	No
41FN126	Prehistoric	Unknown	FCR Concentration	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN127	Prehistoric	Archaic	Shell Lens and Dart points	No
41FN128	Historic	Undefined 20th Century	Well	No
41FN129	Multi-component	Unknown PH & Late 19th Century	Trash, Lithic Scatter and Well	No
41FN130	Prehistoric	Unknown	Campsite - Shell Lens in Creek Bank	No
41FN131	Multi-component	Archaic & Undefined Historic	Historic Ash Lens and PH Lithic Scatter	No
41FN132	Historic	Undefined 20th Century	Bridge Remains	No
41FN133	Historic	Undefined 20th Century	Bridge Remains	No
41FN134	Prehistoric	Late Prehistoric	Campsite in Creek bank	No
41FN135	Prehistoric	Unknown	Campsite in Creek bank	No
41FN136	Prehistoric	Late Prehistoric	Campsite	Further testing is needed to determine NRHP eligibility
41FN137	Multi-component	Undefined 20th Century	Site with a Well	Further testing is needed to determine NRHP eligibility
41FN138	Multi-component	Undefined 20th Century	Site with a Cistern	Further testing is needed to determine NRHP eligibility
41FN139*	Prehistoric	Late Prehistoric	Artifact Scatter	No longer considered a site
41FN140*	Prehistoric	Archaic - Late Prehistoric	Artifact Scatter	No longer considered a site
41FN141	Prehistoric	Unknown	Artifact Scatter	Further testing is needed to determine NRHP eligibility – site located on private property and is outside of APE; no impacts
41FN142 *	Prehistoric	Unknown	Lithic Quarry	No longer considered a site
41FN147	Prehistoric	Unknown	Artifact Scatter	No
41FN148	Historic	Undefined Late 19th to Early 20th century	Buried Artifact Scatter and Cistern	Further testing is needed to determine NRHP eligibility
41FN149	Prehistoric	Unknown	Campsite	No
41FN150	Prehistoric	Unknown	Campsite	No
41FN151	Prehistoric	Unknown	Occupation Site	Further testing is needed to determine NRHP eligibility
41FN152	Prehistoric	Unknown	Buried Lithic Deposit	No
41FN153	Historic	Undefined 20th Century	Homestead Artifact Scatter	No
41FN154	Historic	Undefined Late 19th to Early 20th century	Shallowly-buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN155	Historic	Undefined 20th Century	Dumping Ground	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN156	Historic	Undefined 20th Century	Homestead Ephemeral Remains	Further testing is needed to determine NRHP eligibility
41FN157	Historic	Undefined Late 19th to Early 20th century	Cistern	No
41FN158	Historic	Undefined Late 19th to Early 20th century	Cistern, foundation piers, trash and burn piles	No
41FN159	Historic	Undefined Late 19th to Early 20th century	Cluster of Buildings including a Capped Well/Cistern	Further testing is needed to determine NRHP eligibility

* Sites tested in 2013, found not to exist, and have been removed from the sites atlas.

Individual site descriptions for each of the archeological sites listed in Table 3.14-4 are located in Appendix S.

Outside of the APE

Within one mile (1.6 km) of the proposed Lower Bois d'Arc Creek Reservoir, four previously recorded archeological sites were known prior to ARC's 2011 and 2013 surveys, none of which were recommended for listing as eligible for the NRHP.

- **Site 41FN16** was discovered as a result of 1968 Texas Building Commission and Texas State Water Development Board surveys in advance of Timber Creek Lake (later named Lake Bonham). The site is located on the first terrace above Timber Creek and dates to Woodland/Early Caddoan, containing a lithic scatter and a single Scallorn point.
- **Site 41FN30** is a lithic scatter of undetermined age, documented in 1973. The site was badly eroded at the time of recording and has most likely further deteriorated since.
- **Site 41FN57** is a lithic surface scatter of undetermined age documented in 2001 by Horizon Environmental Services, Inc.
- **Site 41FN58**, the historic Russell Cemetery, is located west of the southern extent of the proposed reservoir on the west side of Pig Branch. This cemetery contains the remains of 22 people, including early settlers to the region and Revolutionary War veterans. Most marker dates were noted to be from the 1880s.

3.14.4 Raw Water Pipeline Route and Associated Facilities

ARC conducted a pedestrian survey and intensive investigation of approximately 1,033 acres of the proposed LBCR pipeline route and associated facilities in 2013 (Figure 3.14-2). ARC also surveyed the proposed Leonard Water Treatment Plant (WTP), the proposed terminal storage reservoir (TSR) adjacent to the WTP, and a proposed rail spur that would transport materials to the new WTP both during construction and operation. All of the surveys conducted for these areas were negative for cultural resources. Seven historic archaeological sites were documented during the LBCR pipeline survey, and only one prehistoric artifact was found during the survey. An interior chert flake was discovered in the terrace sediments near the proposed dam site. A summary of the archaeological sites documented during the LBCR pipeline survey are summarized in Table 3.14-5 below. Individual site descriptions are provided following the table (Davis et al., 2013).

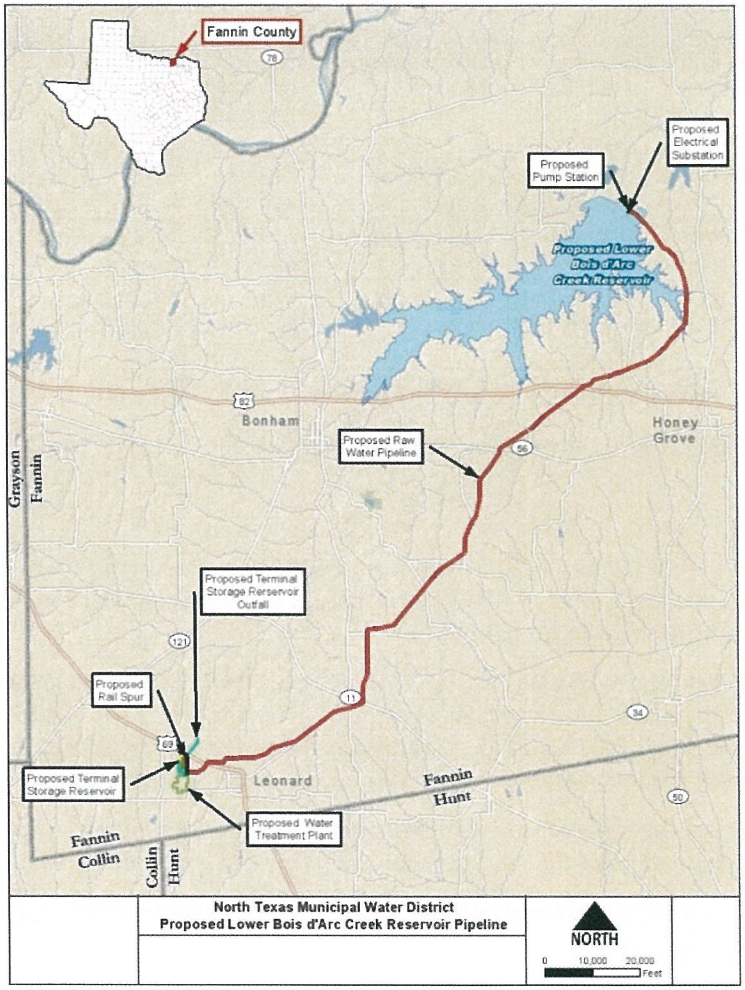


Figure 3.14-2. Raw Water Pipeline, North WTP, and Related Facilities Surveyed for Cultural Resources in 2013

Table 3.14-5. Known Archeological Sites within the Pipeline Route and Associated Facilities

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN169	Historic	Late 19th to Early 20th Century	Cistern or Well with Associated Artifacts	No
41FN170	Historic	20th Century	Cistern and Pump House with Associated Artifacts	No
41FN171	Historic	Late 19th to Early 20th Century	Artifact Scatter	No
41FN172	Historic	Early 20th Century	Farmstead	No
41FN173	Historic	Late 19th to Early 20th Century	Cistern	No
41FN174	Historic	Late 19th to Early 20th Century	Cistern	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN175	Historic	Early to Mid-20th Century	Farmstead	Unknown – further archival research is required to establish NRHP eligibility.

Individual Site Descriptions for each of the archeological sites listed in Table 3.14-5 are located in Appendix S.

Sites 41FN137 and 41FN159 were identified during the Reservoir APE investigations and are discussed in this section because the proposed pipeline route is located very close them. Further testing at these sites within the Reservoir APE is warranted to determine NRHP eligibility. Because these sites are in close proximity to the pipeline route, the site boundaries must be fenced with construction fencing at the direction of a project archaeologist to avoid impacts. The construction of this portion of the pipeline should be monitored by a professional archaeologist to ensure that sites 41FN137 and 41FN159 are not impacted (Davis et al., 2013). The monitor would possess the knowledge and expertise necessary to identify any materials exposed during the trenching and would be responsible for recording any identified materials (Davis et al., 2013). Open trench inspection and monitoring by archaeologists should be conducted from the pump station to CR 2715.

The portion of the pipeline route north of US 82 was initially thought to have potential for buried prehistoric site deposits in the floodplain sediments, and sites might have been found on elevations in the narrow floodplains. The survey found no prehistoric archaeological sites, and subsequently, no sites were recorded. Previous investigations of uplands in the surrounding region corroborated the findings of the survey (Davis et al., 2013).

Another type of prehistoric site initially thought to be located on the drainage divides where Ogallala Gravels were deposited in Late Pliocene times were lithic procurement sites. The survey found no evidence of major gravel fields containing quartzite and chert cobbles or other knappable material (Davis et al., 2013). Knapping is the shaping of flint, chert, obsidian or other appropriate rocks to manufacture stone tools. The knappable material that could have potentially been found at these locations would have provided a primary potential source of resources that could have been used during the process of cooking plant or animal foods.

All of the seven historic sites (41FN169-41FN175 as noted in Table 3.15-5 above) recorded during the pipeline and associated features study represents the remains of either late 19th or 20th century farmsteads or homesteads found on upland divides. Only one site contained historic-age structures. The historic aged structures at this one site have been modified and updated over the years, diminishing their integrity. In addition, the areas surrounding the structures consisted of maintained degrading upland surface and subsequently contained no artifacts (Davis et al., 2013). Only one of the six remaining sites did not have any associated features. This one site was associated with a farmstead which was demolished prior to 1995, according to Google Earth aerials, and consists of historic artifacts found on the surface and worked into the plow zone. The remaining five sites likely represent the remains of homesteads and farmsteads but are only represented by historic artifacts and water related features. These five sites showcase a diverse collection of late 19th or early 20th century cisterns, wells, or well-cisterns (Davis et al., 2013).

The results of the 2013 LBCR pipeline route survey correspond with others conducted in Fannin County. Prehistoric sites appear to be very ephemeral on the south side of Bois d'Arc Creek, while historic sites are common on the upland divide. Nearly all traces of mid-19th century sites have been eliminated by farming and urban growth, and only sparse remains of late 19th and early 20th century sites remain. In most cases, these sites contain no structures and are only represented by cistern or well features and associated artifacts. Because the historic sites identified in this study have been heavily impacted by farming, they provide little to no information about the early history of Fannin County (Davis et al., 2013).

3.14.5 FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

NTMWD has proposed a new bridge to be built over the planned Lower Bois d'Arc Creek Reservoir as well as extend FM 897 from U.S. Highway 82 to FM 1396. A cultural resource survey was conducted by AmaTerra Environmental in March, April, and June of 2016 under Antiquities Permit No. 7570 to determine the impact of this proposed bridge to cultural resources in the area. The survey encompassed a 6.4 mile (10.2 km) stretch of a new and existing Right-of-Way (ROW) for the Farm-to-Market Road (FM) 897 in Fannin County, Texas. The APE was measured by systematic shovel tests and pedestrian cultural resources surveys. A total of 151 shovel tests were conducted along two survey transects within a 120 foot (36.5 meter) wide ROW for a rate of one test per 328 feet (100 meters) along each transect. The archeologists discovered two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites described are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge is eligible for listing on the NRHP or as a SAL. Subsequently, no additional archeological work for the proposed FM 897 road and bridge project is recommended (Sitters and Feit, 2016).

Other areas that were explored during this investigation included the APE South, APE North, APE Central, and a Historic Debris Scatter on the side of the road. APE South measures 2.84 miles (4.5 km) and contains two family cemeteries, the two sites described below (41FN251 and 41FN252), and the Historic Debris Scatter. The Carlisle-Wolf Family Cemetery is a 50 feet by 50 feet plot of land marked by a chain-link fence that contains mostly junipers and dates back to the mid-19th century. This cemetery contains 23 aboveground features including headstones, footstones, and remnants of boxed graves, though it is not expected to be affected by the proposed project. The Cross Family Cemetery contains two fenced-in areas, 11 feet by 25 feet, and one fenced in tree, which contains no grave sites. Only eight graves marked by headstones, footstones, and an outline of cut limestone are located within the cemetery. The Historic Debris Scatter is located in a roadside drainage ditch next to a pipe culvert on the west side of CR 2945 and measures 13 feet in length. The site contains mid-late 20th century Acme Ferris bricks, mortar, clear vessels, glass, metal fragments and whiteware ceramic sherds and does not warrant a NRHP or SAL designation. APE Central contains 1.1 miles of the Bois d'Arc floodplain along with thick vegetation and standing water; the site may potentially hold two historic age bridges within the floodplain. APE North is located on the north edge of the floodplain, measures 2.5 miles, and consists of forested areas and open pastures. Sixty-eight shovel tests were performed at the site, none of which were positive for cultural materials (Sitters and Feit, 2016). A summary of the archaeological sites documented during the survey are summarized in Table 3.14-6 below.

Table 3.14-6. Known Archeological Sites within the FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN251	Historic	19th to 20th Century	Associated Artifacts	No
41FN252	Historic	19th to 20th Century	Dairy Farm, Cistern and Associated Artifacts	No

Individual site descriptions for each of the archeological sites listed in Table 3.14-6 are located in Appendix S.

3.14.6 Fannin County Bridges Survey

A Phase I intensive pedestrian survey of twelve bridge locations within Fannin County is taking place for the construction of the Lower Bois d'Arc Creek Reservoir project. At each bridge, shovel tests will be excavated on either side of the existing road or drainage area, and notes describing the surface visibility, land disturbances, drainage channels and vegetation will be taken at each site. Pictures of all the bridges or culverts will be taken and researched thoroughly, along with any artifacts found, to determine if they contain historic elements. The PA will guide the process of site identification, eligibility determination, and mitigation measures should those be necessary, and a draft report will be prepared on the findings and recommendations on the historical eligibility. No construction will take place until any impacts to historic properties are identified and any adverse impacts are mitigated.

3.14.7 Ongoing Investigations at the Riverby Ranch Mitigation Site

As a whole, the Riverby Ranch and its surrounding properties have primarily been used for agricultural purposes for approximately 170 years. Two prominent families owned most of the land from the late-19th to mid-20th century – Goss and Morgan. The two farms, sometimes referred to as plantations, were located in the small towns of Newt and Riverby (now inside the Riverby Ranch property). The town of Newt existed during the early 1900s and was the home of the Goss Farm. Newt had a post office from 1902 to 1907 and reported a population of 25 during the 1930s and 1940s until it faded from the landscape. The main businesses located in Riverby were the Morgan Farm, a local store, and the Riverby School. In the 1930s, Riverby had a population of 20, but by the mid 1940's the two villages had dissolved.

Joseph Ray Goss began his farm in 1885 on 50 acres, though over the course of his life this grew to approximately 16,000 acres. The farm employed hundreds of people who assisted with the production of corn, cotton, and peanuts. The Goss Farm contained a store, cotton gin, blacksmith, church, and school. When Gross died in 1947, the farm was split amongst the heirs and transformed into a cattle operation. George William Morgan inherited 200 acres in the late 1800s and grew his farm to 12,000 acres. His farm employed hundreds of people for the production of corn, cotton, and peanuts. The farm also contained a large store, a cotton gin, and a church. The Morgan Farm was sold in 1954 to Lloyd Smith and H. W. Frances, Jr. and was renamed the Riverby Ranch. The two prominent families competed for land regularly but set differences aside to create the Riverby School in 1913 to combine the smaller schools of Newt, Riverby, and the small town school of Ragsdale. The school enrolled up to 200 children at its peak but closed in the 1960s due to low enrollment (Davis et al., 2016).

Protocols set forth in the PA will be implemented during the continuing Investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. The PA guides the work and ensures compliance with Section 106 on a timeline separate from that of the EIS. A brief summary of the workplan and a description of the work that has been completed to date are outlined below.

As discussed in section 3.14.3.3 above, the overall LBCR Research Design outlined three major research contexts and eleven testable hypotheses dealing with the geomorphology, prehistoric natural environment, and human settlement over time in Fannin County (Skinner et al., 2010). The floodplains were classified as having a generally low archaeological potential while the upland and Pleistocene terrace edges have a high potential for both historic and prehistoric archaeological sites. In order to define and refine the proposed land modifying mitigation activities, a two part archaeological survey was needed for the development of the Mitigation Plan. The 14,959-acre mitigation property extends south from the Red River, down the Fannin and Lamar county line. The first step in the process consisted of acquiring a Texas Antiquities Permit, which was necessary since NTMWD is a political entity of the State of Texas. Investigation of the ranch was done in two phases. Phase 1 included extensive archival research on the history of Riverby Ranch as well as the collection of oral history interviews. In addition to this research, all previously recorded archaeological sites on the property were researched and revisited when possible.

Based on the results of the Phase 1 investigation, the archaeological potential of Riverby Ranch was identified (Davis et al., 2016). The initial geomorphologic definition of the property was used as the foundation but was refined with historic maps and aerial photos, soil data, and LiDAR. There were seven described alluvial geomorphic surfaces on the ranch. Only five of these geomorphic surfaces had been previously described as having potential for containing archaeological sites. These five areas were identified for survey and defined as High Potential Areas (HPAs) as depicted Figure 3.14-3 below. The areas shown as Prehistoric HPAs represent the mapped NRCS terrace soils that corresponded to the locations and settings of significant sites like 41FN1, 41FN9, 41FN12, 41FN86, and 41LR2 (Davis et al., 2016). It was expected that any locations on the leading edge of T2 and T3 could contain Paleoindian and Archaic artifacts, but they would likely be mixed with later Woodland and Caddo occupations. These HPAs have potential to contain buried site deposits, as well as human remains, especially below the plow zone. Temporary or seasonal prehistoric campsites might be found on the T3 and T4 deposits along Bois d'Arc Creek. The areas highlighted as Historic HPAs were selected because they contained the largest concentrations of structures on historic maps as well as overlapping the three rural communities of Ragsdale, Riverby, and Newt. Areas where the Historic HPA and wooded areas on the T2, T3, and T4 overlap were surveyed for intact features such as collapsed structures, foundations, and other features.

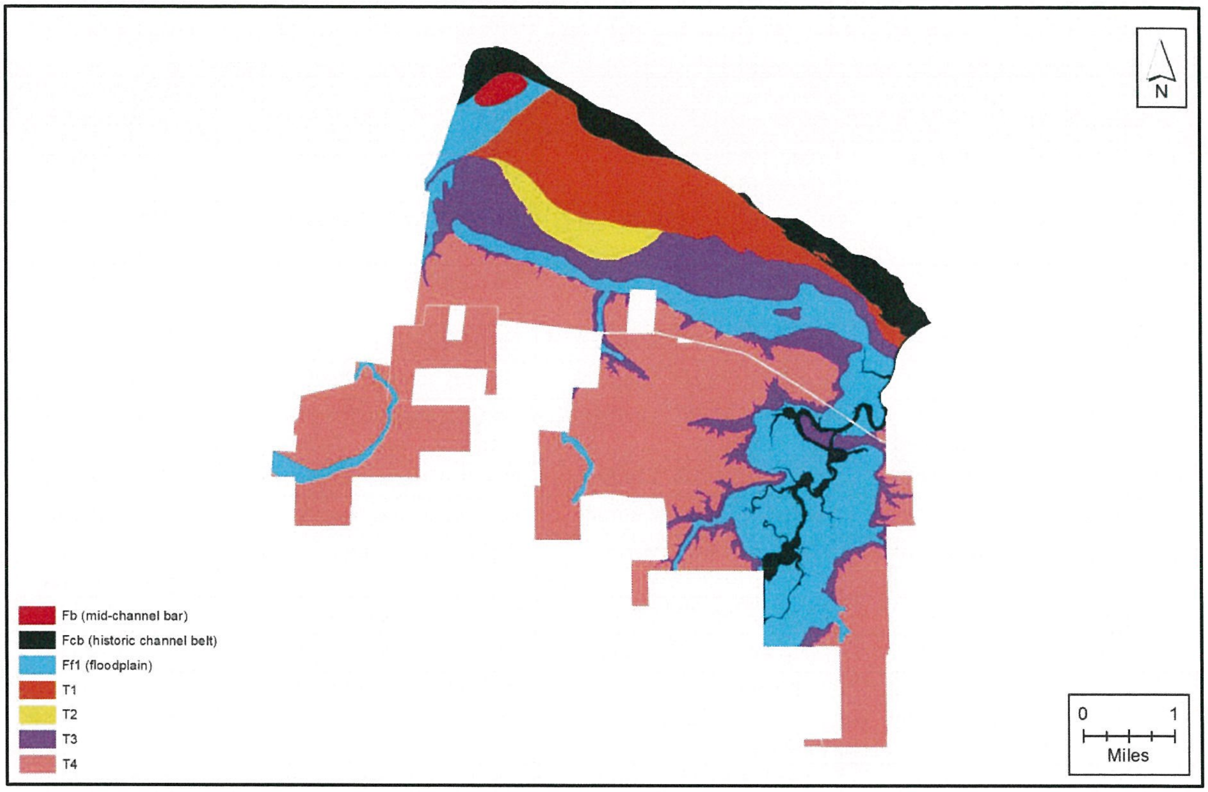


Figure 3.14-3. Estimated Geomorphology of the Red River

Note: Adapted from Hajic and Mandel (2009) and derived from NRCS Soil Data and LiDAR
Source: Davis et al., 2016

Following the completion of the Phase I investigation which helped define the HPAs, the Phase 2 study was conducted between March and August of 2015 and consisted of an intensive pedestrian survey of 3,670 acres of HPAs for prehistoric and historic archaeological sites. The survey included collecting, washing, labeling, and analyzing artifacts, as well as preparing a written report. Overall, a total of 86 sites (20 prehistoric, 52 historic, and 14 multicomponent) are recorded on the property as a result of the Phase I and II surveys (Davis et al., 2016). In addition, a total of 28 architectural resources were found to meet the historic-age guideline as established for this project and therefore were evaluated for their integrity and potential eligibility in the NRHP. Twenty five of these structures did not fulfill Criterion A, B, or C. In addition, none of these 25 structures maintained the level of integrity required to be considered for listing in the NRHP. Furthermore, none of the 28 structures were found to meet any of the special requirements under Criteria Considerations A-G. Three structures (structures 11, 21, and 25) met the historic age requirement and exhibited a potential for historical significance under Criteria A, B, and/or C. However, after careful evaluation and consideration, none of these structures were found to maintain the significant association and/or integrity required by the NRHP. As a result, Structures 11, 21, and 25 are recommended not eligible for listing in the NRHP. A summary of the 86 archaeological sites (both new and previously discovered) identified during the survey of the Riverby Ranch mitigation area is provided in Tables 3.14-7 and 3.14-8 below and individual site descriptions are included in Appendix S. A summary of the known interments for the Whitten (41FN228), Liberty (41FN229), Greenlee (41FN230), and Friendship (41FN239) cemeteries are provided in Tables 3.14-8 through 3.14-11.

Table 3.14-7. Newly Recorded Archaeological Sites Within the Riverby Ranch Mitigation Site

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN180	Historic	Late 19th to Mid-20th Century	Historic artifact scatter	Not eligible
41FN181	Historic	Late 19th to Mid-20th Century	Historic artifact scatter	Not eligible
41FN182	Historic	Late 19th to 20th Century	Harling house and artifact Scatter	Not eligible
41FN183	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN184	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN185	Multi-component	Late 19th to 20th Century	Multi-component artifact scatter	Not eligible
41FN186	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN187	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN188	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible, outside of WRP
41FN189	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN190	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN191	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible, outside of WRP
41FN192	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN193	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN194	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN195	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN196	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN197	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN198	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN199	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN200	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN201	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN202	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN203	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN204	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN205	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN206	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN207	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN208	Prehistoric	Unknown Prehistoric/Late-19th to 20th century	Prehistoric artifact scatter	Not eligible
41FN209	Multi-component	Late 19th to 20th Century	Multi-component artifact scatter	Not eligible

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN210	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN211	Multi-component	Woodland to Middle Caddo	Multi-component artifact scatter	Further testing is needed to determine NRHP eligibility or avoid
41FN212	Prehistoric	Middle to Late Caddo	Prehistoric artifact scatter	Not eligible
41FN213	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN214	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN215	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN216	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN217	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN218	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN219	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN220	Historic	Mid-20th Century	Historic artifact scatter	Not eligible
41FN221	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN222	Historic	20th Century	Historic artifact scatter	Not eligible
41FN223	Historic	Unknown	Historic artifact scatter	Not eligible
41FN224	Historic	Early to mid-20th Century	Historic artifact scatter	Not eligible
41FN225	Historic	20th Century	Historic artifact scatter	Not eligible
41FN226	Historic	Late-19th Century to Present	Historic artifact scatter	Not eligible
41FN227	Historic	Late-19th to mid-20th Century	Historic artifact scatter	Not eligible
41FN228	Historic	1876-1917	Historic Cemetery	Undetermined-protected in place
41FN229	Historic	1872-1951	Historic Cemetery	Undetermined-protected in place
41FN230	Historic	1894-1895	Historic Cemetery	Undetermined-protected in place
41FN231	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible
41FN232	Historic	1920-1965	Historic artifact scatter	Not eligible
41FN233	Historic	Late-19th to mid-20th Century	Historic artifact scatter	Not eligible
41FN234	Historic	19th Century	Historic artifact scatter	Not eligible
41FN235	Prehistoric	Late or historic Caddo components	Prehistoric artifact scatter	Yes eligible—Needs additional testing if deeper than plow zone
41FN236	Historic	Unknown	Historic artifact scatter	Not eligible
41FN237	Historic	Unknown	Historic artifact scatter	Not eligible
41FN238	Historic	Unknown	Historic artifact scatter	Not eligible
41FN239	Historic	1899-1944	Historic Cemetery	Undetermined-protected in place
41FN240	Historic	Unknown	Historic artifact scatter	Not eligible
41FN241	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible
41FN242	Historic	Unknown	Historic artifact scatter	Not eligible

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN243	Historic	20th Century	Historic artifact scatter	Yes eligible
41FN248	Prehistoric	Late Archaic or Woodland periods	Prehistoric artifact scatter	Not eligible
41FN249	Prehistoric	Late Archaic or Woodland periods	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility
41FN250	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible

Table 3.14-8. Previously Recorded Archaeological Sites within the Riverby Ranch Mitigation Site

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN1	Multi-component	Woodland/Middle and Historic Caddo/Mid-19th century cemetery	Multi-component Cemetery	Not eligible
41LR2	Prehistoric	Late Archaic/Woodland/Middle and Historic Caddo	Prehistoric artifact scatter	Yes, eligible–Need to Avoid and Protect
41FN9	Prehistoric	Woodland/Early to Late Caddo	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs
41FN12	Multi-component	Paleoindian/Woodland/Middle and Historic Caddo	Multi-component artifact scatter	Unknown-Protected within WRP
41FN39	Prehistoric	Woodland/Middle Caddo	Prehistoric artifact scatter	Unknown-Protected within WRP
41FN40	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN41/41FN88	Multi-component	Woodland/Early to Late Caddo	Multi-component artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs
41FN42	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN51	Multi-component	Archaic/Late-19th to 20th century	Multi-component artifact scatter	Not eligible – outside of WRP
41FN82	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN83	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN84	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN85	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN86	Multi-component	Archaic/Woodland/Late-19th to 20th century	Multi-component artifact scatter	Yes, eligible–Need to Avoid and Protect

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN87, 41FN91	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN89	Prehistoric	Woodland/Caddo	Prehistoric artifact scatter	Not eligible
41FN94	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN144	Prehistoric	Woodland/Middle Caddo	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs

Table 3.14-9. Known Interments in the Whitten Cemetery, 41FN228

Number	Name	Birth Date	Death Date
1	Hawley, Doss Robert	18 Jan 1898	26 Aug 1899
2	Hawley, Gillie Belle	21 Mar 1901	15 Feb 1902
3	Hawley, John Newton	19 Jul 1890	18 Oct 1895
4	Hawley, Tommie	2 Jul 1905	12 Oct 1906
5	Robinson, Joseph A.	25 Feb 1887	2 May 1904
6	Robinson, Olivian	22 Nov 1902	3 Jul 1903
7	Titus, Isaac W.	28 Dec 1860	19 Feb 1929
8	Titus, Martha Jane Mullens	07 Mar 1859	19 Oct 1917
9	Whitten, Francis M.	28 Dec 1839	07 Jan 1876

Sources: Davis et al., 2016; TXGenWeb Project, 2014d

Table 3.14-10. Known Interments in the Liberty Cemetery, 41FN229

Number	Name	Birth Date	Death Date
1	Allen, Prof Isaac	NBD	NDD
2	Arnold, Lela	8 Aug 1905	17 Jun 1919
3	Bradley, Tinnie	Jul 1863	20 Sep 1881
4	Briggs, A. B.	31 Aug 1912	10 Feb 1914
5	Briggs, Adolphus D.	28 Oct 1877	7 May 1948
6	Briggs, Alberta	01 Apr 1896	8 Sep 1919
7	Briggs, Clara Sims	30 Aug 1878	10 Dec 1945
8	Briggs, Iola	12 Jun 1939	13 Jun 1939
9	Briggs, Joe	ca 1895	23 Jun 1928
10	Briggs, John	22 Dec 1861	18 Apr 1888
11	Briggs, Lela Harris	6 May 1906	28 Jun 1944
12	Briggs, Lucinda Brown	29 Oct 1835	10 Nov 1903
13	Briggs, M. A. B.	15 Mar 1905	15 Mar 1905
14	Briggs, Mary	22 Dec 1861	13 Aug 1872
15	Briggs, Pink	14 May 1910	15 Dec 1910
16	Briggs, Samuel Davie	09 Apr 1890	24 Jul 1939

Number	Name	Birth Date	Death Date
17	Briggs, Spencer	NBD	12 Dec 1904
18	Briggs, Stephen	12 Oct 1862	24 Oct 1948
19	Bush, Estella	18 Aug 1898	19 Jul 1899
20	Bush, Rosco	07 Oct 1896	Aug 1900
21	Bush, Walter	28 May 1889	12 Oct 1889
22	Carson, Charllote	ca 1879	20 Apr 1908
23	Carson, Lillier	16 Jun 1890	17 Jun 1927
24	Cole, Mozita Green	ca 1921	16 Aug 1936
25	Cooper, Luisa	5 Nov 1928	16 Aug 1929
26	Cozine, Buford	09 Nov 1896	28 Jan 1897
27	Cozine, Dovie Nancy	31 Dec 1897	31 Dec 1897
28	Cozine, Earnest	22 Sep 1900	13 Dec 1900
29	Cozine, Ervin	23 Jun 1899	25 Aug 1899
30	Cozine, Wade	16 Sep 1894	18 Apr 1896
31	Dotson, Sam	ca 1873	11 Jan 1938
32	Fields, Dallas	1853	4 May 1928
33	Garrett, Sallie	1843	27 Dec 1886
34	Gilbreath, Aron	13 Oct 1891	24 Mar 1942
35	Gilbreath, Daisy Gates	29 Apr 1901	15 May 1936
36	Gilbreath, George M.	15 Jun 1933	20 Jun 1936
37	Gilbreath, Gussie	20 Apr 1919	8 May 1936
38	Gilbreath, Henry	15 Aug 1855	30 Nov 1935
39	Gilbreath, Lou	NBD	NDD
40	Gilbreath, Lucille	Nov 1919	14 Nov 1929
41	Gilbreath, Riley	01 Jul 1855	03 Jul 1919
42	Gilbreath, Rodie	ca 1864	1 Dec 1900
43	Gilbreath, Tom	1869	May 1899
44	Gilbreath, William	1869	11 Dec 1939
45	Golden, Willie May	23 Dec 1889	4 Jan 1900
46	Harris, Roxie Briggs	15 Aug 1892	13 Jun 1932
47	Haywood, Hilliard	Aug 1860	16 Aug 1892
48	Jackson, Versa Mae Jones	14 Mar 1914	9 Oct 1939
49	Jewett, Hattie	1871	30 Mar 1899
50	Jones, Mattie	NBD	NDD
51	Jones, Willie	10 Aug 1887	17 Oct 1891
52	Langs, Marie Hicks	15 Sep 1886	9 Mar 1930
53	Lee, David	07 Sep 1888	14 Jan 1907
54	Lee, James	04 May 1820	29 May 1914
55	Lee, James Arthur	10 Oct 1897	8 Dec 1944
56	McDade, Anthony	28 Nov 1864	10 Apr 1899
57	McDade, Mima	ca 1836	26 Feb 1907
58	McKnight, Frank	14 Feb 1870	23 Nov 1950
59	McKnight, John	01 Nov 1878	8 Nov 1948
60	McKnight, Margret	12 Oct 1840	12 Oct 1936
61	McKnight, Perry M.	05 May 1887	25 Mar 1940
62	McKnight, Robert Louis	5 May 1947	24 May 1954
63	Merphey, James Abner	24 Mar 1912	2 Feb 1913

Number	Name	Birth Date	Death Date
64	Mills, Defecer	22 Mar 1887	24 May 1901
65	Mills, Frances	ca 1876	8 Dec 1931
66	Mills, Gethero	16 Jul 1894	4 Oct 1903
67	Mills, Martin	22 Mar 1862	8 Jan 1945
68	Moore, Eli	03 Jun 1842	28 Sep 1898
69	Moore, Franklin	Mar 1892	Mar 1892
70	Moore, Matthew Thomas	27 Jun 1884	11 Nov 1885
71	Morle, Mattie Dirks	18 Dec 1899	15 Jan 1941
72	Myres, F. B.	11 Nov 1871	24 May 1901
73	Nash, John	ca 1892	22 Aug 1937
74	Nash, Lula	20 Feb 1888	9 Dec 1954
75	Perkins, Dan	15 Jan 1899	7 Mar 1944
76	Perkins, Elijah	NBD	NDD
77	Perkins, James 'Jim'	10 Jun 1867	21 May 1930
78	Pittis, Jane	ca 1900	25 Mar 1931
79	Railback, Wiley	15 Jan 1849	2 Aug 1916
80	Rayford, Joe Earl	3 May 1947	15 Aug 1951
81	Rodgers, Jim	1874	14 Jun 1939
82	Rose, Texanna	18 Jul 1876	29 Jun 1902
83	Ruffin, Florence Burnett	15 Jul 1894	4 Jan 1944
84	S., L.	NBD	NDD
85	Thomas, Renda Garrett	22 Jan 1877	28 Jun 1949
86	Toson, Elbert	18 Mar 1883	16 Jun 1903
87	Walker, Bud	NBD	10 Nov 1918
88	Walker, J. W.	1863	19 Dec 1902
89	Williams, Nora Thomas	ca 1864	13 Nov 1931
90	Williams, Willie	03 Mar 1893	04 Mar 1893

Source: Davis et al., 2016

Table 3.14-11. Known interments in the Greenlee Cemetery, 41FN230

Number	Name	Birth Date	Death Date
1	Greenlee, Mary M.	May 1855	Aug 1895
2	Greenlee, Willis S.	14 Oct 1849	10 Aug 1894

Source: Davis et al., 2016

Table 3.14-12. Known Interments in the Friendship Cemetery, 41FN239

Number	Name	Birth Year	Death Year
1	Anderson, Barbara Cox	29 Oct 1871	2 Sep 1936
2	Baker, Jessie	25 Feb 1897	21 Sep 1932
3	Carter, Burnice	22 Oct 1932	2 Nov 1932
4	Cobb, Florence	ca 1893	22 Feb 1933
5	Glover Sr., John	10 Aug 1836	17 Jun 1919
6	Haywood, Mollie	12 Apr 1873	27 Apr 1901
7	Jackson, Annie Barron	ca 1871	22 Dec 1936

Number	Name	Birth Year	Death Year
8	Jackson, Morse 'Morris, March'	04 Mar 1869	6 Jan 1947
9	Jackson, O P	12 Aug 1904	1 Dec 1944
10	Mills, Tenie	NBD	25 Dec 1915
11	Stone, Elizabeth	08 Dec 1842	17 Aug 1905
12	Whidbey, Eliza	08 Mar 1868	15 Mar 1899

Source: Davis et al., 2016

Individual Site Descriptions for each of the archeological sites listed in Table 3.14-7 and 3.14-8 are located in Appendix S.

Based on the results of the archaeological and architectural investigations, ARC recommends that the majority of the 86 sites are not eligible for listing on the NRHP or as a SAL. The eligibility of sites 41FN12 and 41FN39 is undetermined; however, these sites are within the Wetland Reserve Program (WRP) portion of the ranch, and they would not be impacted. The portion of 41FN51 that is outside the WRP is ineligible; however, the eastern portion inside the WRP is undetermined but would not be impacted. Additionally, the four known cemeteries on the property (41FN228-41FN230, 41FN239) are undetermined, but these would not be impacted and are protected within large buffers. Two sites (41LR2 and 41FN86) are considered eligible for listing on the NRHP and as SALs. Further testing is recommended for seven sites (41FN9, 41FN41/41FN88, 41FN144, 41FN211, 41FN235, and 41FN249) to determine eligibility for listing on the NRHP or as a SAL. The eligibility recommendations and report of investigations are currently under review by the USACE, Caddo Nation, and THC. Official determinations of eligibility would be coordinated among the USACE, Caddo Nation, and THC once reviews are completed. As per the terms of the PA, avoidance and mitigation measures would be coordinated and agreed upon by the USACE, Caddo Nation, and THC once eligibility determinations are completed.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 assesses the potential environmental consequences associated with the No Action Alternative, Alternative 1, and Alternative 2. The terms "consequences," "impacts," and "effects" are used interchangeably in this chapter.

Potential environmental consequences can be direct or indirect, on-site and/or off-site. According to the Council on Environmental Quality's (CEQ) NEPA Regulations at 40 CFR 1500-1508, **direct effects**, "...are caused by the action and occur at the same time and place" (1508.8(a)). **Indirect effects** "...are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." Indirect effects also include "induced changes" in the human and natural environments (1508.8(b)). In other words, direct impacts are those that are caused directly by the proposed action or connected actions, such as conversion of bottomland hardwood forest habitat to open water habitat in the reservoir. Indirect impacts are those follow-on effects induced by the initial impact, such as effects of this habitat conversion on wildlife species in the project area. Indirect impacts also include growth-inducing effects, that is, the potential for an action, such as development of a new water supply or a new water treatment plant, to facilitate population growth, economic growth and physical development in a region, which then may cause secondary effects on the environment. Growth-inducing effects are addressed primarily in Chapter 5 (Cumulative Impacts) of this EIS.

Potential environmental consequences are discussed under each resource topic for three possible alternatives: 1) No Action, in which the dam, reservoir, and ancillary facilities would not be built. Under the No Action Alternative, NTMWD would have to develop another water supply source which would have its own impacts, although these are not addressed to any extent in this chapter; 2) Alternative 1, or the Applicant's Proposed Action and Preferred Alternative, which is the construction and operation of the full-scale Lower Bois d'Arc Creek dam and reservoir and ancillary facilities at the proposed site on Bois d'Arc Creek in Fannin County, TX; and 3) Alternative 2, the downsized (smaller-scale) LBCR with Lake Texoma Blending Alternative, a smaller version of the LBCR project at the same location as Alternative 1 that would include blending of LBCR water with water from Lake Texoma, as described in Section 2.3.

This DEIS necessarily relies upon research, surveys, analyses and literature from a number of sources, including scientists, planners and engineers associated with the official State of Texas water planning process conducted by the TWDB and its sub-entities, and in particular with the permit applicant and project proponent, NTMWD. The USACE independently reviewed and evaluated all pertinent information and data with the help of its third-party contractor, Solv LLC and subcontractors. All qualitative and quantitative conclusions and findings in this chapter as to types and levels of impact are those of the USACE Tulsa District Regulatory Program alone.

4.2 METHODOLOGY

The interdisciplinary study team (see Chapter 7, List of Preparers) followed a structured process to analyze the potential environmental impacts, or effects, resulting from the No Action Alternative, Alternative 1, and Alternative 2. This procedure, called the cause-effects-questions (C-E-Q) process, is described in the text box below.

Using this process, both direct and indirect effects that could potentially occur as a result of implementing the alternatives were identified.

Causes-Effects-Questions:
A Structured Analytic Process

Step 1: Identify the specific activities, tasks, and subtasks involved in the proposed action(s) and alternative(s).

Step 2: For each specific activity, task and subtask, determine the full range of direct effects that each could have on any environmental resource. For example, removing vegetation could cause soil erosion.

Step 3: For each conceivable direct effect, identify which further effects could be caused by the direct effects. For example, soil erosion could cause stream sedimentation, which could harm or kill aquatic macroinvertebrates, which could diminish the food supply for fish, leading to decreased fish populations. This inquiry can identify multi-stepped chains of potential causes-and-effects.

Step 4: Starting at the beginning of each chain of causes-and-effects, work through a series of questions for each potential effect:

- Would this effect actually occur from this project?
- If not, why not?
- What would preclude it from happening?
- If the effect cannot be ruled out, characterize which types of data, other information, and analyses are needed to determine the parameters of the effect, including its extent, duration, and intensity.
- Identify the sources from which the data are to be obtained.

Step 5: Gather the data and conduct the analyses identified by the above steps, utilizing only relevant information.

Step 6: Document the results of this study process.

Figure 4.2-1 presents the several of the preliminary C-E-Q diagrams that the study team prepared at the outset of the analysis. This visual aid helped organize the investigation and focus it on relevant issues. The team also used this C-E-Q diagram in the scoping meeting in Bonham on December 8, 2009 to solicit input from the public.

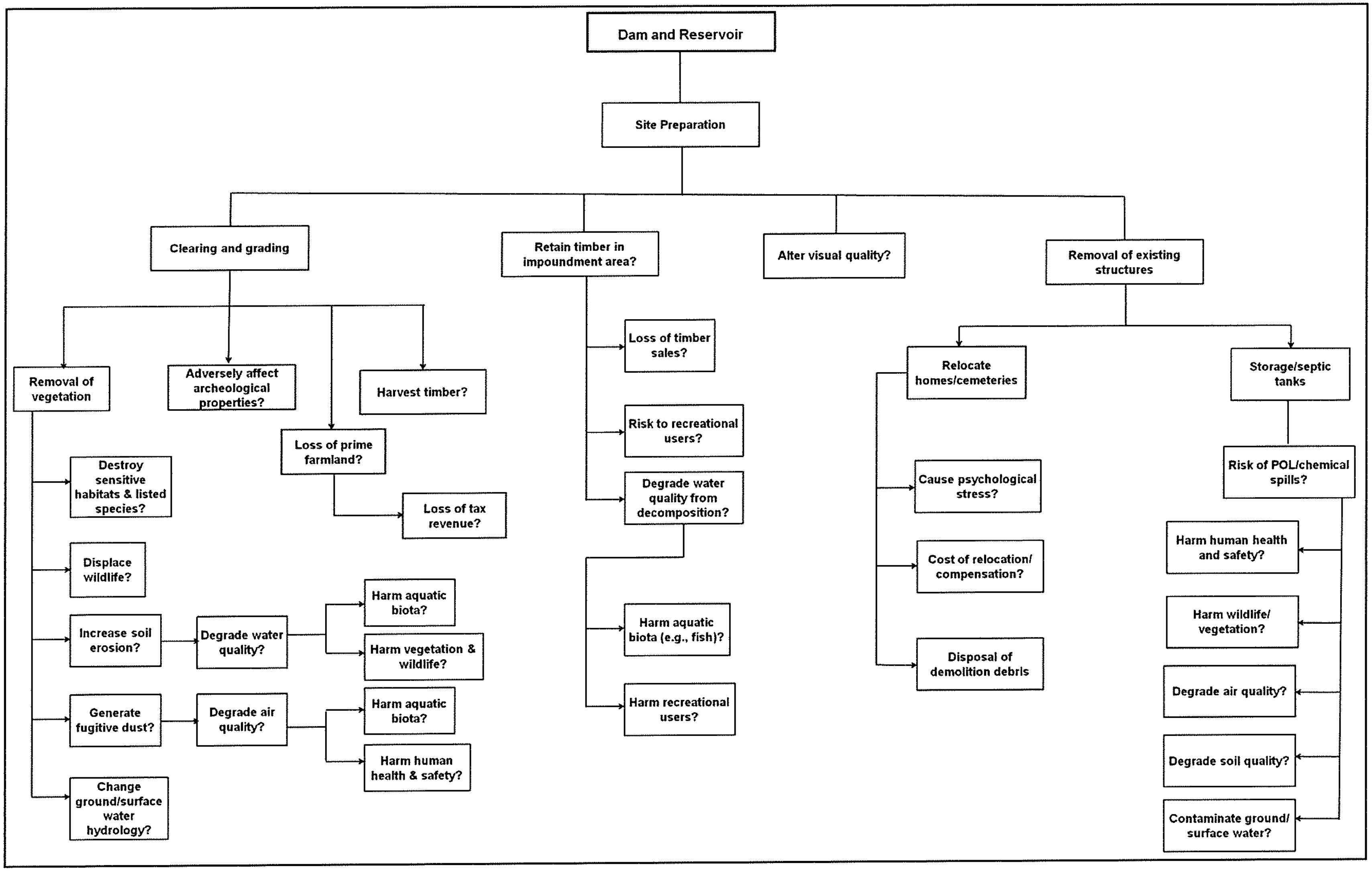


Figure 4.2-1a. Sample Preliminary Causes-Effects-Questions (C-E-Q) for LBCR

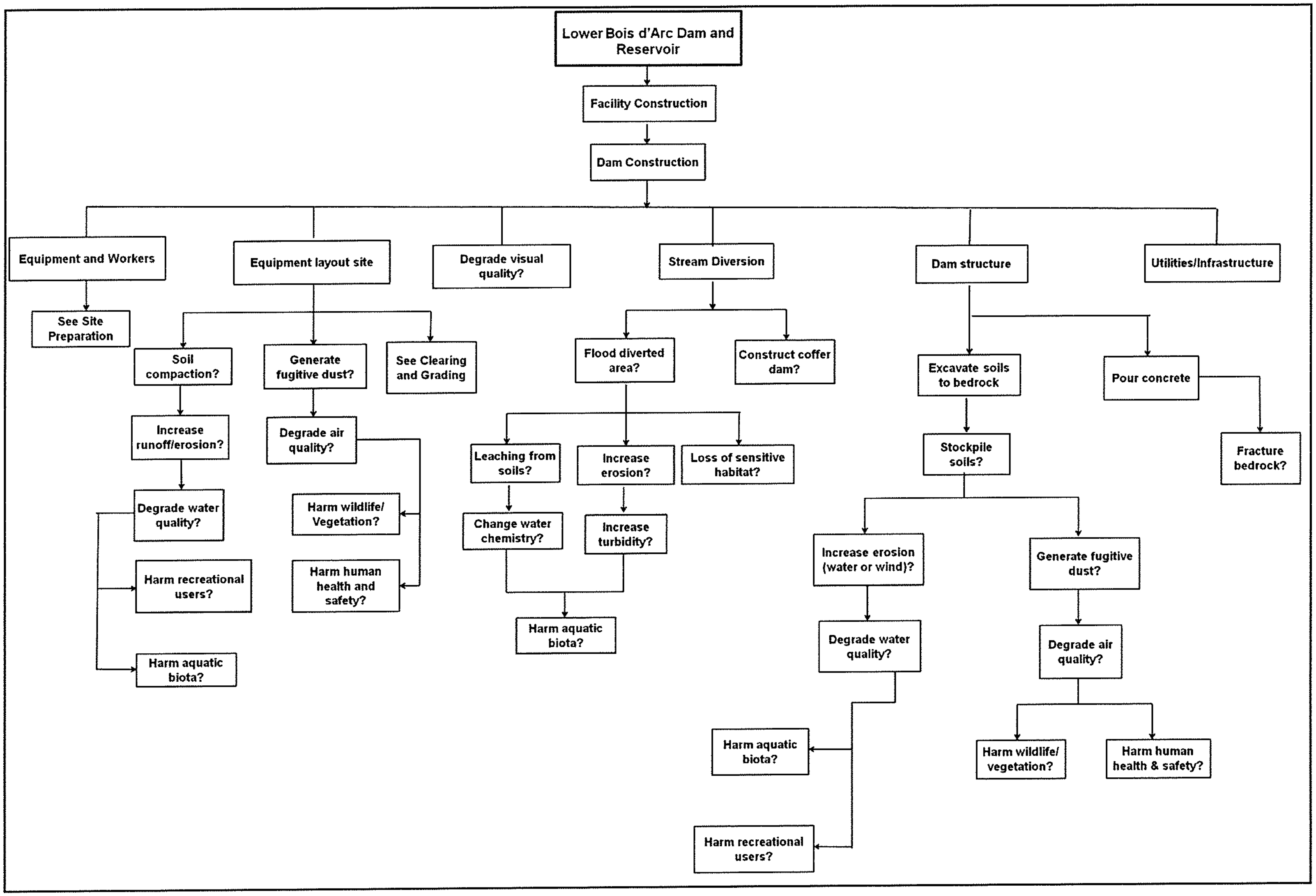


Figure 4.2-1b. Sample Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

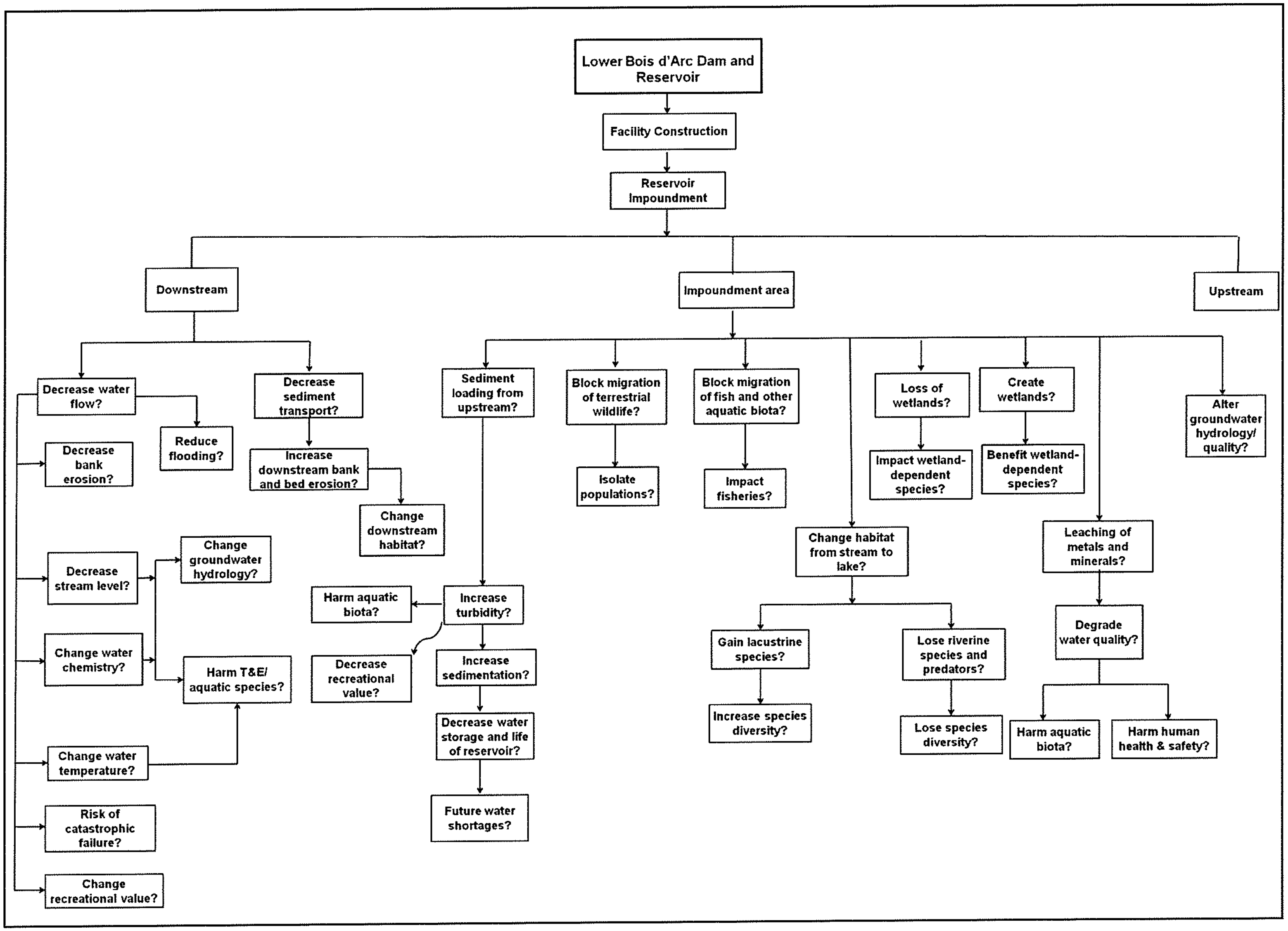


Figure 4.2-1c. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

4.2.1 Assessment Factors

A project like the proposed reservoir can have a wide variety of impacts on different components of the environment. The importance, magnitude, or "significance," of each of these diverse impacts depends on various factors. Some of these factors can be evaluated objectively. Other factors affecting significance must be evaluated subjectively, such as the importance of losing some amount of wildlife habitat. The CEQ's NEPA regulations at 40 CFR 1508.27 provide a list of factors to be considered in determining impact significance. The primary purpose of significance ratings in the NEPA process is to ascertain whether a lead agency should prepare an EIS, as opposed to a less time-consuming and less in-depth Environmental Assessment (EA) and Finding of No Significant Impact (FONSI). In the present case, the USACE determined early in the Section 404 permit application process that an EIS would be prepared for the proposed LBCR because of the high potential for significant impacts. Because the determination has already been made that the potential for overall significant impacts exists, this Revised Draft EIS does not set significance thresholds or make findings of significance for specific resources.

During the planning stage of the EIS study, the study team reviewed documentation for similar projects to ascertain activities that would be associated with the proposed action and the types of impacts they could cause. This research was supplemented by professional judgment concerning typical activities and impacts of concern for any large construction project. A preliminary environmental evaluation diagram (i.e., the C-E-Q diagram, Figure 4.2-1), was developed for each activity associated with the proposed action, listing the potential impacts for that activity.

The study team then identified the following major factors by which the effects associated with the three alternatives can be predicted, characterized, and where possible, quantified:

- <u>Size</u> of the disturbance or footprint;
- <u>Duration or frequency</u> of the impact (how long or how often);
- <u>Likelihood</u> of the impact occurring (probability): high, medium, low, none; and
- <u>Severity</u> of the impact: severe, moderate, slight or none.

With this structure established, the team then conducted the EIS study. The study team obtained information used to predict the size, duration, likelihood, and severity of the impacts for each of the resources described in the Affected Environment (Chapter 3).

4.2.2 Definitions

Discussions of environmental consequences in the following sections will include the following terms and definitions:

<u>Types of Impact</u>

Beneficial – A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Adverse – A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct – An effect that is caused by an action and occurs in the same time and place.

Indirect – An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.

Size of Impact

The size or physical extent of the impact in question is quantified to the extent feasible.

Duration or Frequency of Impact:

The duration or frequency of the impact in question is quantified to the extent feasible in terms of months, years, or decades.

Likelihood of Impact:

High – The impact is more likely to occur than not, i.e., approximately 50% likelihood or higher.

Medium – The impact has some chance of occurring, but probably below 50% likelihood.

Low – The impact has a non-zero but very small likelihood of occurrence.

None – The impact has zero probability of occurring.

Severity of Impact:

Severe – Substantial impact or change in a resource that is easily defined, noticeable and measurable, or exceeds a standard.

Moderate – Noticeable change in a resource occurs, but the integrity of the resource remains intact.

Slight – Change in a resource occurs, but no substantial resource impact results.

None – The impact is below the threshold of detection and with no perceptible consequences.

For each resource analyzed, the impacts are divided into two phases: construction and operation. Some types of impacts may of course occur both during the construction and long-term operational phases of the alternative.

4.3 LAND USE

This section discusses environmental consequences, or impacts, to land use under the No Action Alternative, Alternative 1, and Alternative 2. Table 4.3-1 summarizes the impacts for both the construction and operation phases of the proposed dam project for all alternatives.

Table 4.3-1. Summary of Impacts to Land Use Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Severe	Severe	

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Operation Phase			
Size	Long-term change of land uses at and in the vicinity of the reservoir	Long-term change of land uses at and in the vicinity of the reservoir	Changes in land use may occur but none of those changes would be attributable to not building LBCR. Rather, they may occur as a result of other planned developments due to Fannin County's projected population growth.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Moderate to Severe (less than Alternative 1)	

4.3.1 No Action Alternative

Under the No Action Alternative, Lower Bois d'Arc Creek Reservoir would not be constructed. The present trends in land use at the project site would continue. The project area would be expected to remain predominantly rural and undeveloped for the foreseeable future. Some increased urbanization in nearby cities and towns would be expected as the population of the Dallas-Fort Worth Metroplex and Fannin County increases over the decades. This urbanization 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 due to increased urbanization in nearby cities and towns would likely occur within and in proximity to the City of Bonham, located approximately one mile to the west-southwest of the north end of the project site. There may be some additional development in the project area as the result of suburban sprawl which 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. This would conversely increase demand for agricultural products and/or pastures. The No Action Alternative would not impact the Caddo National Grasslands.

4.3.2 Alternative 1

This section discusses the environmental consequences on land use during both the construction and operation phases of the proposed dam, reservoir, raw water transmission facilities, water treatment plant, terminal storage reservoir, and related facilities and roadways in Alternative 1. Impacts of this alternative are expected to be moderate to severe in magnitude. Whether these long-term changes in land use of moderate to severe magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer.

Dam and Reservoir

Under Alternative 1, the proposed dam and LBCR would take an estimated 3 to 4 years to construct and would impact 17,068 acres of forest, crop, and ranch land. An additional 5,574 acres of land around the perimeter of the proposed reservoir would be obtained for the flood pool for a total impacted area of 22,640 acres. All of the 22,640 acres would be rendered unusable for current or future agricultural use. The total area of 22,640 acres of land does not include the proposed water treatment plant, terminal storage reservoir, and pipeline. The 5,574 acres of flood pool land is permanently designated as a flood easement and would be only infrequently and temporarily inundated. Thus, 5,574 acres would be suitable for their predominant land use and 17,068 acres would be unusable for their predominant land use. There are approximately 20 single family homes located within the footprint of the proposed reservoir that would be demolished prior to inundation. The majority of these homes have already been acquired by the NTMWD. All remaining units would have to be purchased before construction could begin (McCarthy, 2011a). These residential areas are only a minor portion of the proposed reservoir site. Overall, the effects of the proposed LBCR associated with Alternative 1 on land use would be severe.

Raw Water Transmission Facilities

Pipelines associated with the proposed raw water transmission facilities would parallel county and farm-to-market roads and existing electrical transmission line easements to minimize environmental and infrastructural disturbances. While future construction would be limited within the right-of-way easement, land uses such as farming could continue directly above the buried pipeline. The pipeline would have to be constructed across local streams; however, adverse impacts associated with this could be minimized through a variety of mitigation measures and BMPs that are common to pipeline construction projects, and in any case, would be short-term and localized.

Overall, the effects of the raw water transmission facilities associated with Alternative 1 on land use would be minor.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The construction and operation of the proposed WTP (including plant access and parking areas) and TSR near Leonard are unlikely to cause any further changes in land use in that area as compared to the No Action Alternative because the area has already been developed. The construction area of the WTP, TSR, and related facilities would cover approximately 351.5 acres, which would no longer be available for the current predominant land use of agricultural hay and pasture land.

FM 1396 Relocation and New Bridge Construction

Relocating FM 1396 and constructing a new bridge over the proposed reservoir would represent a minor, long-term, localized change in land use in the vicinity of the proposed LBCR.

Reservoir Operations

Impacts to land use from the operational phase of Alternative 1 are expected to be severe. Once construction of the proposed dam was completed, this alternative could possibly serve as a catalyst leading indirectly to additional development and population growth within Fannin County, where population density is presently low and agricultural land use now predominates.

This potential effect would be especially prominent in areas with relative proximity to the new lake. Surrounding land values would likely increase, encouraging local land owners to sell their properties to developers or speculators, which would possibly result in the subdivision of agricultural lands for conversion to higher value land use types such as residential and commercial. Over time, this process would change the current appearance and "feel" of the county from low-density rural to higher-density rural, exurban, or even suburban, due to leapfrog development. This is often referred to as sprawl, which is new development separated from existing development by substantial vacant land (Greenbelt Alliance, 2017). Development in these areas would likely include single family dwelling residential areas that are suburban in nature, commercial uses such as community facilities, and retail and consumer services that serve local and nonlocal residents, as well as water-related land use types such as marinas or private campgrounds.

In the Draft Comprehensive Plan, a zoning commission was formed to guide the long-term development of the area surrounding the proposed LBCR. Through a series of public and stakeholder meetings, the commission created the following recommendations regarding the lake area development:

- Desirable home, commercial, and tourist destinations;
- Primarily rural feel, with some areas of greater development;
- Large and small lot residential development should be located on the southern half of the lake;
- Nonresidential uses in designated area (Fannin County, 2016).

The Fannin County Draft Comprehensive Plan has not been finalized as additional public meetings have yet to occur.

It should be emphasized that as the Dallas Metroplex grows in population and development spreads northward – which official demographic projections indicate will occur for decades to come – pressures for growth and development within Fannin County would occur even without the implementation of Alternative 1, that is, without the new reservoir. However, the presence of the reservoir is likely to accelerate this background trend, especially if it is developed for its recreational and high-value real estate potential.

Recreational land use such as parks and golf courses could result from the construction of the proposed reservoir. This development, in turn, would create a demand for increased "hard" infrastructure, such as additional improved roads and utilities and "soft" infrastructure such as schools, churches and other amenities. The proposed reservoir could lead to leapfrog development in surrounding counties through the construction of infrastructure to support development that might occur in Fannin County. This development could change the makeup of current land use in these counties from predominantly agricultural and rural to more developed, rural residential, and suburban in nature. These changes would take place mostly along the border of these counties as development moves out along the periphery of Fannin County.

Neither the NTMWD nor the USACE have land use planning authority in the vicinity of the proposed LBCR. However, Senate Bill 525 in the 82nd Texas Legislature, passed in 2011, granted the Fannin County government land use planning jurisdiction over "the area within 5,000 feet of where the shoreline of the Lower Bois d'Arc Creek Reservoir would be if the reservoir were filled to its storage capacity" (McCarthy, 2013). This authority, under Local Government Code Section 231.133, allows the County to regulate land use features such as:

- Height, number of stories, and size of buildings and other structures;
- Percentage of a lot that may be occupied;
- Size of yards, courts, and other open spaces;
- Population density;
- Location and use of buildings, other structures, and land for business, industrial, residential, or other purposes; and
- Placement of water and sewage facilities, parks, and other public requirements.

If Alternative 1 is selected and the LBCR is constructed, the Fannin County government would possess the authority to regulate land use for almost a mile around the reservoir perimeter in the public interest. The County has recently created a Draft Comprehensive Plan addressing land use and zoning regulations for the area surrounding the project site (Fannin County, 2016). The Draft Comprehensive plan follows the process outlined in the Texas Local Government Code, Chapter 231 - Subchapter G (TLGC 231.131-231.141) (Fannin County, 2016).

Mitigation

Land at Riverby Ranch and lands in the floodplain upstream of the LBCR would be designated for mitigation for the wetland impacts caused by Alternative 1. The land use would be changed from ranching agriculture and undesignated open space to conservation and habitat restoration.

4.3.3 Alternative 2

This section discusses the environmental consequences on land use of the construction and operation of the proposed dam and reservoir in Alternative 2. Impacts of this alternative are expected to be moderate to severe in magnitude, but less than Alternative 1. As with Alternative 1, whether these long-term changes in land use of moderate to severe magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer.

Dam and Reservoir

Under Alternative 2, construction of the proposed dam and LBCR would require an estimated 3 to 4 years and would impact approximately 9,305 acres of forest, crop, and ranchland, all within the footprint of the proposed full-sized LBCR of Alternative 1. An additional 3,800 acres of land around the perimeter of the proposed reservoir would be obtained for the flood pool for a total impacted area of 13,105 acres. All of the 13,105 acres would be rendered unusable for current or future agricultural use. The total area of 13,105 acres of land does not include the proposed water treatment plant, terminal storage reservoir, raw water pipeline, and blending water pipeline. The 3,800 acres of flood pool land is permanently designated as a flood easement and would be only infrequently and temporarily inundated. Thus, 3,800 acres would be suitable for their predominant land use and 9,305 acres would be unusable for their predominant land use. There are approximately 20 single family homes located within the footprint of the proposed reservoir that would be demolished prior to inundation. The majority of these homes have already been acquired by NTMWD. All remaining units would have to be purchased before construction could begin (McCarthy, 2011a). These residential areas are only a minor portion of the proposed reservoir site. Overall, the effects of the proposed LBCR associated with Alternative 2 on land use would be severe.

Raw Water Transmission Facilities

As under Alternative 1, pipelines associated with the proposed raw water transmission facilities would generally run parallel to county and farm-to-market roads and existing electrical transmission line easements to minimize environmental and infrastructural disturbances. The necessary infrastructure and facilities construction and improvements associated with conveying water from Lake Texoma to the proposed Leonard WTP are relatively small, and include a new pipeline and improvements at the Texoma pump station.

The pipelines would have to be constructed across local streams; however, adverse impacts associated with this could be minimized through a variety of mitigation measures and BMPs common to pipeline construction projects and, in any case, would likely be short-term and localized. While future construction would be limited within the right-of-way easement, land uses such as farming could continue directly above the buried pipelines. Overall, the effects of the raw water transmission facilities associated with Alternative 2 on land use would be minor.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The construction and operation of the proposed WTP (including plant access and parking areas) and TSR near Leonard are unlikely to precipitate any further changes in land use in that area as compared to the No Action Alternative because the area has already been developed. The lands occupied by construction of the WTP, TSR, and related facilities would no longer be suitable for the current predominant land use of agricultural hay and pasture land.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As under Alternative 1, Alternative 2 would also involve relocating FM 1396 and constructing a new bridge over the proposed reservoir. Impacts would be essentially the same as under Alternative 1 and would constitute a minor, long-term, localized change in land use in the vicinity of the proposed LBCR.

Reservoir Operations

Effects on land use from the operational phase of Alternative 2 are expected to be moderate to severe, though less than from Alternative 1. Though less acreage would be impacted than under Alternative 1, once construction of the proposed dam was completed this alternative could still possibly serve as a catalyst leading indirectly to additional development and population growth within Fannin County, especially in areas with relative proximity to the new lake. Even on a reduced scale, this trend could change the current appearance and "feel" of the county from low-density rural to higher-density rural, exurban, or even suburban, due to leapfrog development and suburban or exurban sprawl.

As described under Alternative 1, the Fannin County government now possesses the authority to regulate land use in the public interest in the vicinity of the proposed LBCR for almost a mile around the reservoir perimeter. This would not change under any alternative.

Recreational land use such as parks and golf courses could result from the construction of the proposed reservoir; however, under the downsized LBCR alternative, the development of such amenities would likely occur on a smaller scale (with both less adverse and less beneficial impacts) since the reservoir would be half the size of that which is proposed under Alternative 1. Thus, the further development of both hard and soft infrastructure resulting from the development of recreational amenities would also occur on a smaller scale. However, land use changes associated with development that would potentially occur would be similar in nature to those described under Alternative 1.

Mitigation

As under Alternative 1, land at Riverby Ranch and lands in the floodplain upstream of the LBCR would be designated for mitigation for the wetland impacts caused by Alternative 2. The land use would be changed from ranching agriculture and undesignated open space to conservation and habitat restoration.

4.4 TOPOGRAPHY, GEOLOGY, AND SOILS

This section discusses the environmental impacts on topography, geology, and soils from Alternatives 1and 2 and the No Action Alternative. Table 4.4-1 provides a summary of the environmental impacts for both the construction and operation phases of the proposed dam project for all alternatives.

Table 4.4-1. Summary of Impacts to Topography, Geology, and Soils Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	Geology – No change from current condition Topography and soils – slight to moderate
Operation Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	Geology – No change from current condition Topography and soils – slight to moderate

4.4.1 No Action Alternative

Under the No Action Alternative, the proposed dam and reservoir, raw water pipeline, water treatment plant, new bridge and FM 1396 relocation, and other related facilities would not be built. Under this alternative, over the short term topographic features, geological formations, and soils in the project area would remain essentially in their present condition. Ongoing erosion and downcutting associated with channelization of Bois d'Arc Creek would continue for the foreseeable future, eroding soils along the creek's banks and transporting them downstream. This would adversely affect topography in the immediate vicinity of the creek by causing additional widening and deepening of the channel, as well as steeper, unstable banks.

Overall, there would be no short- or long-term effects from the No Action Alternative on geology. With regard to topography and soils, adverse impacts from ongoing erosion would be long-term and slight to moderate.

4.4.2 Alternative 1

Alternative 1 includes a proposed reservoir and dam that would cover a total of 22,640 acres of various soils including 13 Prime Farmland soils. It also includes water treatment and transmission facilities. Environmental impacts on topography, geology, and soils during both the construction and operation phases of Alternative 1 are discussed below.

Construction Phase

Construction of the Proposed LBCR Dam and Reservoir Clearing

The impacts of dam and reservoir construction to topography and geology would be expected to be moderate. The dam would be constructed to a length of 10,400 feet with a maximum height of 90 feet. The reservoir embankment would be built to a height of 553.5 feet MSL. The proposed LBCR would cover over 16,641 acres of forest, crop, and ranch land. An additional 5,574 acres around the perimeter would be obtained for the flood pool. Construction is expected to take 3 to 4 years.

Dam construction would involve excavating a slurry trench of variable depth in the ground surface to create an impervious barrier along the length of the dam foundation. Reservoir construction upstream of the dam site would not be expected to impact subsurface geology, as no deep excavation and minimal grading would occur. Two spillways would be constructed along the right abutment of the dam. Soils and earth removed during excavation would be used to construct the core of the dam, potentially exposing the underlying shale formations. The bedrock includes weathered shale followed by clayey shale, which is further followed by unweathered shale. Given the depth to bedrock as well as its composition, general impacts to geology would be expected to be minor. The construction of both the service spillway and the emergency spillway would be anticipated to have negligible to minor effects on geology.

The impacts of dam and reservoir construction to soils would be expected to be moderate. Use of heavy construction equipment often results in soil compaction, which can lead to decreased infiltration rates and increased runoff and erosion rates. The magnitude, extent, and duration of construction-related impacts depend on the erodibility rates of the soil; proximity of the construction activity to receiving waters; and the construction methodologies, duration, and season. Most of the soils at the site of the proposed LBCR are clayey with a low erosional potential. Soil compaction is not expected to appreciably change the character of the existing soils. Mitigation measures such as standard Best Management Practices (BMPs) could reduce these impacts to soil resources. The project would be subject to CWA construction stormwater permitting requirements, which impose a host of specific erosion and sediment control measures.

Construction activities have the potential to disturb soils within the entire footprint of the dam and certain other areas within the reservoir. Some erosion is likely to occur from vehicle use and vegetation removal. The Draft Reservoir Clearing Plan (NTMWD, no date-b), as prepared by the applicant, guides the process of vegetation removal within the footprint of the reservoir. Vegetation clearing would also be expected along the proposed shoreline, as needed for emergency access. The selective clearing of vegetation detailed in the construction drawings would address potential impacts such as shoreline instability and erosion. These impacts could be minimized by considering the specific character of the soils, slope, and underlying strata at a particular location.

Overall, the effects on topography, geology, and soils of constructing the proposed LBCR would be adverse and moderate.

FM 1396 Relocation and New Bridge Construction

As described in Section 3.10 of this DEIS, FM 1396 is an existing two-lane, TxDOT asphalt road that crosses through the proposed reservoir footprint. Construction of the proposed LBCR would directly cause the inundation and closure of a segment of the existing FM 1396 within the reservoir footprint and the existing FM 1396 bridge over Bois d'Arc Creek. NTMWD has investigated options for replacing this road and bridge with the relevant TxDOT and Fannin County authorities. The preferred option of those considered by all three parties is to replace FM 1396 by extending FM 897 North out of Lannius with a new bridge over the proposed reservoir. This option would require building approximately four miles of new roadway that would run from north to south across the proposed reservoir. While existing County

Road ROW may be utilized, this construction would still result in temporary and long-term impacts to soils within the ROW from grading and excavation by heavy road construction equipment and paving with asphalt. Up to approximately 20 acres of soils may be lost or converted permanently as a result of paving with asphalt, which would be considered a minor impact. The replacement of FM 1396 by an extension of FM 897 would have a temporary, minor effect on topography and geology due to the use of heavy road construction equipment and paving with asphalt.

Raw Water Pipeline

Under Alternative 1, 35 miles of raw water pipeline would be constructed from the proposed reservoir to the site of the proposed new water treatment plant near Leonard. As noted in Section 3.2.2.2, the main soil groups crossed by the pipeline route include the Fairlie-Dalco complex, Houston Black clay, and Howe-Whitewright complex. The Fairlie-Dalco complex and Houston Black clay are deep soils which are well-suited for use as cropland, while the Howe-Whitewright complex is more suited to be used as rangeland or pastureland.

Construction of the pipeline would temporarily impact these soils by the use of heavy machinery to excavate a trench and lay the pipeline. The raw water pipeline would not have a permanent effect on the topography, geology, or soil. Overall, impacts of pipeline construction on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The proposed Water Treatment Plant and Terminal Storage Reservoir would be located at a site near Leonard. The grading limits or footprint of the WTP are 186.2 acres, while the grading limits/footprint of the TSR to the north are 153.5 acres. These connected actions would permanently impact soils within the grading limits by covering them with facilities or removing them from agricultural production. The predominant soil type at this site is the Fairlie-Dalco complex, which consists of deep, moderately alkaline, clayey soils on low slopes of 3-5 percent.

Overall, developing the proposed water treatment plant and terminal storage reservoir would have a slight effect on soils and no permanent effect on the topography or geology.

Operation Phase

The only potential effects on topography, geology, and soils from operation of the components of Alternative 1 are from operation of the proposed reservoir. The relocated road and new bridge, raw water pipeline, WTP, and TSR would not have effects on topography, geology, or soils during the operation phase.

Lower Bois d'Arc Creek Reservoir

The dam would operate as a structure 10,400 feet in length at the terminus of the reservoir, which would have a total footprint of 17,068 acres (including the dam). Reservoir operations are not anticipated to impact topographical or geological resources unless slope stability were to become an issue along the embankment and shoreline. Fluctuating water levels have the potential to create unstable slopes, thus increasing the potential for small slides, which would impact both the topography and geology of the slopes, especially if erosion during slides were to occur. However, in most places bank slopes would be relatively low, given the relatively gentle topography of the area. Best management practices, such as using riprap to stabilize banks and monitoring shoreline conditions would be implemented to decrease the potential of these impacts. Impacts from reservoir operations on topography and geology would thus be considered slight.

Impacts to soils from the operation of the proposed dam and reservoir are expected to be moderate. The soils within the footprint of the reservoir would be permanently altered once inundated by water. These soils would become anaerobic with altered chemical and biological processes. Sediment would also be expected to gradually accumulate within the reservoir and may collect ahead of the dam discharge area.

Operating the proposed dam and reservoir would have a long-term adverse impact on Prime Farmland Soils by eliminating these soils from potential use in agriculture. There are 13 soils listed at the site of the proposed dam and reservoir that are considered potential Prime, Unique, and Important Farmland by the NRCS. These soils would no longer be available for agricultural use once the land conversion to a reservoir occurs. However, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from restrictions under the Farmland Protection Policy Act (FPPA). The NRCS office in Temple, TX reviewed information concerning the proposed project and completed a Farmland Conversion Impact Rating Form (AD-1006). Because the rating fell below 160 (the combined score for the LBCR site was 115), USACE does not need to consider other alternatives (see Appendix P).

4.4.3 Alternative 2

This section describes the effects on topography, geology, and soils from construction and operation of Alternative 2. The Alternative 2 reservoir operations area covers a total area of 13,105 acres including the area of the dam and reservoir (9,305 acres) and flood pool (3,800 acres). Alternative 2 is smaller than Alternative 1, which has a total area of 22,642 acres including the area of the dam and reservoir (17,068 acres) and flood pool (5,574 acres). Alternative 2 also includes the construction of approximately 25 miles of new underground water pipeline from Lake Texoma to the Texoma Balancing Reservoir.

Construction Phase

Construction of the LBCR Dam and Reservoir Clearing

The impacts of dam and reservoir construction to topography and geology for Alternative 2 would be expected to be similar to those for Alternative 1. However, the impacts from the downsized dam would be somewhat less in scale and proportion because of the reduction in dam height and corresponding reservoir footprint (estimated at 46 percent less than the full-scale dam) in this alternative. Under Alternative 2, approximately 9,305 acres of waters, wetlands, and uplands would be impacted by the dam and reservoir. An additional 3,800 acres around the perimeter would be obtained for the flood pool. Construction is expected to take 3 to 4 years.

The impacts of dam and reservoir construction to soils would be expected to be moderate. Again, the impacts from the downsized dam would be somewhat less in scale and proportion because of the reduction in dam height and corresponding reservoir footprint in Alternative 2. The project would be subject to CWA construction stormwater permitting requirements, which impose a host of specific erosion and sediment control measures.

Overall, the effects on topography, geology, and soils of Alternative 2 would be minor. Overall impacts of Alternative 2 would be slightly less than those of Alternative 1.

FM 1396 Relocation and New Bridge Construction

As described in Section 3.10 of this DEIS, FM 1396 is an existing two-lane, TxDOT asphalt road situated within the proposed reservoir. Construction of the proposed LBCR would directly cause the inundation and closure of a segment of the existing FM 1396 within the reservoir footprint and the existing FM 1396 bridge over Bois d'Arc Creek. NTMWD has investigated options for replacing this road and bridge with the relevant TxDOT and Fannin County authorities. The preferred option of those considered by all three parties is to replace FM 1396 by extending FM 897 North out of Lannius with a new bridge over the proposed reservoir. This option would require building approximately four miles of new roadway that would run from north to south over the new reservoir. While existing County Road ROW may be utilized, this construction would still result in temporary and long-term impacts to soils within the ROW from grading and excavation by heavy road construction equipment and paving with asphalt. Up to approximately 20 acres of soils may be lost or converted permanently as a result of paving with asphalt, which would be considered a minor impact. The replacement of FM 1396 by an extension of FM 897 would have a temporary, minor effect on the topography and geology due to the heavy road construction equipment and paving with asphalt.

Raw Water Pipeline

Under Alternative 2, 35 miles of raw water pipeline would be constructed from the proposed reservoir to the site of the proposed new water treatment plant near Leonard, as would be done for Alternative 1. As noted in Section 3.2.2.2, the main soil groups crossed by the pipeline route include the Fairlie-Dalco complex, Houston Black clay, and Howe-Whitewright complex. The Fairlie-Dalco complex and Houston Black clay are deep soils which are well-suited for use as cropland, while the Howe-Whitewright complex is more suited to be used as rangeland or pastureland.

As in the case of Alternative 1, Alternative 2 would temporarily impact these soils by the use of heavy machinery to excavate a trench and lay the pipeline. The raw water pipeline would not have a permanent effect on the topography, geology or soil. Overall, impacts of Alternative 2 on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects.

Texoma 72-inch blending pipeline

Alternative 2 would entail the construction of approximately 25 miles of a new, 72-inch underground pipeline to transport water from Lake Texoma to the Texoma Balancing Reservoir to blend with water supplied by the downsized LBCR. This new proposed pipeline would parallel the existing NTMWD pipeline from Lake Texoma and there would be temporary and short-term, negligible to slight impacts to soils during construction. The right-of-way corridor is already a disturbed site from the original Lake Texoma pipeline construction and ongoing maintenance. Although disruption to topography and geology may occur during construction, no permanent impacts are expected.

Texoma 84-inch blending pipeline

Alternative 2 would also include the construction of a new eight-mile spur underground pipeline from the existing NTMWD 96-inch raw water pipeline carrying Lake Texoma water to the WTP at Wylie. For the purpose of this analysis, it is assumed that the soil types that would be disturbed during the construction phase are similar to those for the raw water pipeline. Alternative 2 would temporarily impact soils by the use of heavy machinery to excavate a trench, and lay the 84-inch blending pipeline Overall, impacts of Alternative 2 on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects on the topography, geology, or soil.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

For construction of the WTP, TSR, and related facilities, Alternative 2 would have the same impacts and occur in the same location as Alternative 1. The proposed Water Treatment Plant and Terminal Storage Reservoir would be located at a site near Leonard. The grading limits or footprint of the WTP is 186.2 acres, while the grading limits/footprint of the TSR to the north is 153.5 acres. These connected actions would permanently impact soils within the grading limits by covering them with facilities or removing them from agricultural production. The predominant soil type at this site is the Fairlie-Dalco complex, which consists of deep, moderately alkaline, clayey soils on low slopes of 3-5 percent.

Overall, developing the proposed water treatment plant and terminal storage reservoir would have a slight effect on soils and no permanent effect on topography or geology

Operation Phase

The only potential effects on topography, geology, or soils from operation of the components of Alternative 2 are from operation of the proposed reservoir. The relocated road and new bridge, raw water pipelines, WTP, and TSR would not have effects on topography, geology, or soils during the operation phase.

Lower Bois d'Arc Creek Reservoir

With regard to topography, the reservoir would have a conservation pool elevation 515 feet MSL, and would have a storage capacity of 135,200 AF, for a total footprint of 9,305 acres (including the dam) approximately half the acreage of Alternative 1. Reservoir operations are not expected to adversely impact geological resources unless slope stability was to become an issue along the embankment and shoreline. Fluctuating water levels, which might be more pronounced for this alternative than for Alternative 1, have the potential to create unstable slopes, thus increasing the potential for small slides, which would impact both the topography and geology of the slopes, especially if erosion during slides were to occur. However, in most places bank slopes would not be relatively low, given the relatively gentle topography of the area. Best management practices, such as using riprap to stabilize banks, and monitoring shoreline conditions would be implemented to decrease the potential of these impacts. Impacts from operations under Alternative 2 on geology would thus be considered slight.

Impacts to soils from the operation of the dam and reservoir are expected to be moderate. The soils within the footprint of the reservoir would be permanently altered once inundated by water. These soils would become anaerobic with altered chemical and biological processes. Sediment would also be expected to gradually accumulate within the reservoir and may collect ahead of the dam discharge area.

As with Alternative 1, operating the downsized dam and reservoir would have a long-term adverse impact on Prime Farmland Soils within the reservoir footprint by eliminating these soils from potential use in agriculture. The acreage of Prime Farmland Soils directly affected would be slightly less than under Alternative 1. However, as discussed above, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from FPPA restrictions. While the total Prime Farmland acreage would be unavailable for agriculture, impacts from the smaller LBCR are exempt from consideration and protection under the FPPA, as indicated in Appendix P.

Table 4.4-2, compiled by Coffman (2013), contains estimated and measured sediment yield values from seven locations with similar climate, soils, geology, land use/land cover, and topography to the LBCR watershed. These estimates assume a total contributing drainage area for LBCR of 297 square miles at the proposed dam site, and that the proposed reservoir is not yet present. The sediment yields in Column 2 of Table 4.4-2 were multiplied by the LBCR watershed drainage area to calculate estimated average annual sedimentation rates (Column 3). Sedimentation rates with the proposed reservoir in place would be lower by a factor of approximately 0.09. Actual sedimentation rates in the proposed LBCR would depend on land use and land cover around the reservoir, the erodibility of the soils not inundated by the reservoir, potential future erosion control measures, thickness of soils, and the climate.

The calculated sedimentation rates for the LBCR in Table 4.4-2 vary by a factor of almost five, from 107 AFY to 475 AFY. Coffman (2013) considers those rates based on volumetric surveys of Lake Bonham and Pat Mayse Lake (near Paris) conducted by TWDB to be the most representative for the proposed reservoir.

Table 4.4-2. Measured and Modeled Sediment Yields from Similar Areas and Calculated LBCR Sedimentation Rates

Data Source	Sediment Yield (AF/mi^2/year)[a]	Corresponding LBCR Sedimentation Rate (AFY)[b]
Bois d'Arc Creek (Texas Dept. of Water Resources, 1982)	0.36	106.9

Data Source	Sediment Yield (AF/mi^2/year)[a]	Corresponding LBCR Sedimentation Rate (AFY)[b]
George Parkhouse Res. No. 2 (proposed) (Texas Dept. of Water Resources, 1982)	0.91	270.3
Lake Crook (Texas Dept. of Water Resources, 1982)	0.77	228.7
Report on New Bonham Reservoir (FNI [1984] from Texas Board of Water Engineers [1959])	1.60	475.2
Lake Bonham Volumetric Survey (TWDB, 2005)	0.94	279.2
Jim Chapman Lake Volumetric Survey (TWDB, 2008a)	1.50	445.5
Pat Mayse Lake Volumetric Survey (TWDB, 2008b)	0.93	276.2

[a] acre-feet per square mile per year.

[b] acre-feet per year

Source: Coffman, 2013

These surveys used a type of sonar to measure the bathymetry (underwater topography) and depth of waters throughout the reservoirs surveyed at a given water surface elevation (typically the conservation or normal pool elevation). Bathymetry and depth data were then combined to calculate reservoir storage at that water surface elevation. The current storage was then compared to the initial storage of the reservoir at the same elevation. Any reduction in storage was thus attributed to sedimentation, although it is still possible that some of the difference may be attributed to the different methods used to measure or calculate the storage volume.

Assuming a sedimentation rate of 0.94 AF/mi^2/year (the same as for the 2005 Lake Bonham Volumetric Survey), the proposed LBCR would lose approximately 11,167 AF of storage capacity at the normal pool elevation (534 feet) after its initial 40 years; this represents approximately three percent of the initial reservoir capacity of 367,609 AF. After 100 years of sedimentation at this rate, LBCR would have lost approximately 7.5 percent of its capacity. These predictions may over-estimate the sedimentation rate slightly, because they include the total contributing LBCR drainage area of 297 square miles, and do not account for the reduction in contributing drainage area resulting from land surface inundation from the reservoir itself; that is, lands which would be submerged so that they would no longer erode and contribute sediment.

As noted earlier, sediment accumulation in reservoirs and lakes is a natural and predictable process. Based on the calculations and estimates above, sedimentation in the proposed LBCR is not anticipated to be a significant issue. If at some point in the future, sedimentation is deemed to be a problem for the reservoir, sedimentation rates in the upstream watershed could be reduced by implementing a sediment management program. Such a program could include an educational component: instructing land owners and farmers about the benefits of sediment BMPs such as increased productivity through decreased loss of soil and nutrients. It could also include incentives or support for additional sediment yield reduction actions such as stream channel erosion protection measures, changes to agricultural practices (e.g., contour farming, terracing, filter strips, critical pasture planting and converting crop land to pasture land), and construction of sediment control structures in the watershed upstream.

4.5 WATER RESOURCES

The following sections address the potential environmental consequences of the No Action Alternative, as well as potential impacts associated with the construction and operational phases for the full-sized LBCR (Alternative 1) or smaller LBCR (Alternative 2) on surface water resources, groundwater resources, existing water rights and inter-basin water transfers within the affected environment. In the main body of Section 4.5, analysis of the effects on water resources during construction and operation is presented jointly because a clear separation of construction and operational impacts has not been fully quantified. Table 4.5-1 is a summary of the water resource impacts that were identified Alternatives 1 and 2.

Table 4.5-1. Summary of Impacts to Water Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Surface Hydrology			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	No change from current condition.
Duration	50 – 100+ years (long-term)	50 – 100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	
Stream Channels (Fluvial Geomorphology)			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	No change from current condition.
Duration	50 – 100+ years (long-term)	50 – 100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	
Surface Water Quality			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint.	No change from current condition.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	
Groundwater Resources	No change	No change	No change from current condition
Existing Reservoirs	No change	No change	No change from current condition.

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Operation Phase			
Surface Hydrology			
Size	Reservoir footprint only 16,641 acres; 120,000 AFY firm yield provided by the full sized LBCR reservoir Sedimentation rate of 0.94 AF/mi2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) 7.5 percent loss of storage capacity over 100 years	Reservoir footprint only 8,600 acres; 86,100 AFY firm yield provided by smaller LBCR reservoir. Sedimentation rate of 0.94 AF/mi2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (515 feet) 21percent loss of storage capacity over 100 years	No change from current condition.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	
Stream Channels (Fluvial Geomorphology)			
Size	Total = 651,140 LF (123.3 miles): Intermittent 286,139 LF (54.2 miles or 120 acres); Intermittent/Ephemeral 365,001 LF (69.1 miles or 99 acres)	Total = 348,928 LF (66.1 miles): Intermittent 166,286 LF (31.5 miles); Intermittent/Ephemeral 182,642 LF (34.6 miles)	No change from current condition.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate (less than Alternative 1)	
Surface Water Quality			
Size	Reservoir footprint 16,641 acres; Total Streams = 651,140 LF (123.3 miles) Total Dissolved Solids 221 – 330 mg/L	Reservoir footprint 8,600 acres; Total Streams= 348,928 LF (66.1 miles) Total Dissolved Solids <250 mg/L	Slight impact if development in the area continues.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	
Groundwater Resources			
Size	0	0	Moderate impact on groundwater due to increased groundwater withdrawals if development continues
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	None	None	
Severity	None	None	
Existing Reservoirs	No change if mitigation measures are performed on Lake Bonham Dam.	Lake Texoma withdrawal of 28,700 AFY	No change from current condition.

4.5.1 No Action Alternative

Under the No Action Alternative, there would be no change from current conditions for surface hydrology, stream channels, or existing reservoirs. Impacts on surface water and groundwater from ongoing and new development that may still occur under the No Action Alternative are discussed below.

Surface Water Resources

The No Action Alternative is expected to result in continuing minor changes to the hydrology and hydraulics of Bois d'Arc Creek and affected tributaries over time, as these channelized streams continue to evolve towards a state of dynamic equilibrium. The *Final Environmental Report Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir* prepared for North Texas Municipal Water District (NTMWD) discusses potential impacts that could result from increased runoff due to ongoing and future development and urbanization, particularly in the nearby City of Bonham. The report is included as Appendix Q of this Revised DEIS. Potential impacts may include changes to temperature, dissolved oxygen, suspended sediment, and other water quality parameters. The most severe flooding in the watershed is caused by constrictions created at the point where bridges cross watercourses. These crossings may restrict streamflow and increase the magnitude and duration of flooding events. The Highway 82 and Highway 65 crossings of Bois d' Arc Creek have been identified as crossings that restrict stream flow during high water events. The greatest hydrologic impact expected to result from the No Action Alternative would be the potential for continued flooding, which may be worsened due to development in the Bois d'Arc Creek watershed, including the construction of new roads and bridges. Development of new roads and bridges, parking lots, and residential and commercial areas would include land disturbance and the construction of impervious surfaces, which could lead to a temporary increase in erosion and permanent increase in runoff that may reach surface waterbodies.

Surface water quality would remain similar to the existing conditions under the No Action Alternative. Development in the project area could affect water quality through increases in turbidity from erosion and sedimentation. Increased channelization could also result from development, which could lead to the disturbance or removal of vegetation, increased flows and reduced freshwater availability, and accelerated delivery of pollutants, all of which would affect surface water quality.

Based on past land use in the area, lands within the proposed reservoir footprint under the No Action Alternative could be subject to timber harvesting, which would require the clearing of wetlands (i.e., forested wetlands) and construction of new stock ponds. These activities could lead to effects on surface water quality of waters of the U.S., including wetlands, primarily in the form of increased turbidity and sedimentation.

Under the No Action Alternative, ongoing and new development may still occur. Federal, State or local permits are required for development projects and typically include surface water discharge restrictions and water quality protection measures. Under the No Action Alternative, it is assumed that there would be slight additional adverse impacts on surface waters because of permitted development. Effects on surface waters would not change considerably and Bois d'Arc Creek water quality would continue to support all of its current instream uses.

Ongoing and new development could influence surface water resources in other ways through increases in the occurrence and magnitude of floods from changes or increases in flows; increases in erosion and runoff from land disturbance and new impervious surfaces; increases in turbidity from erosion and sedimentation; and changes in or removal of vegetation, reductions in freshwater availability, and the acceleration of the delivery of pollutants from channelization. There would be an overall increase in the amount of non-point source surface water pollution. These potential direct and indirect adverse impacts on surface water resources under the No Action Alternative would likely be slight to moderate compared to existing conditions.

Groundwater Resources

The population in Fannin County is projected to steadily increase over the next several decades (Region C Water Planning Group, 2015). Due to the increase in population, water demands would also increase. To meet increasing water demands, additional pumping of groundwater from the major aquifers in the region, including the Woodbine and Northern Trinity, could occur. Areas of Fannin County that have limited well production capacity could potentially experience groundwater supply shortages and decreased production rates. The need for deeper groundwater wells could also potentially result in decreased water quality, as groundwater of lesser quality is pumped from the deeper wells. As a result, the No Action Alternative could have a moderate adverse impact on local aquifers.

4.5.2 Alternative 1

LBCR Reservoir Water Storage

The drainage area above the proposed dam site is 327 square miles or approximately 77 percent of the entire Bois d'Arc Creek watershed. The total storage volume of the proposed Lower Bois d'Arc Creek Reservoir is 367,609 acre-feet. The reservoir water depth would range between 72 feet at the dam and approximately four feet at the upstream extent of the reservoir, under normal pool conditions, as shown in the reservoir profile in Figure 4.5-1. The profile also indicates that water depth under normal pool conditions would be 19 feet at reservoir mile 12, and 11 feet at reservoir mile 13 (Appendix M). Water depth would be approximately four feet at reservoir mile 15, a depth that would occur for over three miles on the upstream end of the reservoir under normal pool conditions. At 75 percent capacity, the reservoir pool elevation would be 529.9 feet, 4.1 feet less than the normal pool elevation. At 50 percent capacity, the reservoir pool elevation would be at 520.3 feet, 13.7 feet less than the normal pool elevation. Figure 4.5-2 presents a plan view map of the fill levels of the proposed LBCR based on the elevation profile previously discussed and shows the lateral extent and reaches of the reservoir at the various given elevations and capacities, including the extent at normal pool elevation (534.0 feet MSL), 75 percent capacity, 50 percent capacity, and flood easement elevation (545.0 feet MSL).

Operation of the proposed LBCR will be conducted in compliance with Texas water law and the Water Permit. Some of the specific operational considerations NTMWD will implement, including requirements of the Water Permit, are included in the proposed operations plan (Appendix D):

- Storage – LBCR is authorized to impound 367,609 acre-feet of State water for municipal, industrial, agricultural and recreational use.
- Diversions – NTMWD is authorized to divert up to 175,000 acre-feet per year at a maximum diversion rate of 365.15 cfs from any point on the perimeter of the reservoir.
- Pass-Throughs - Pass-throughs are inflows that are released through (or "passed through") the LBCR Dam to Bois d'Arc Creek. Pass-throughs do not include releases of stored water. For purposes of the proposed operation plan, the terms "pass-through" and "release" are used interchangeably.)
    - Downstream senior water rights - In compliance with State water law, NTMWD will pass inflows through the dam for existing water right holders. There are two existing water rights on Bois d'Arc Creek between the LBCR and the confluence with the Red River and thirteen Texas water rights on the Red River downstream of the confluence with Bois d'Arc Creek.

- Environmental flows – NTMWD will pass inflows through the dam in compliance with the environmental flow requirements in the Water Permit. The environmental flow regime is based on the Texas Instream Flow Program and requires seasonal base flow and pulse flow releases.
- Wastewater discharges – The NTMWD will also pass the effluent return flow of the City of Bonham that is discharged upstream of LBCR for environmental flow purposes downstream of the dam. The City's discharges have historically ranged from <1 cfs to 3.5 cfs, with an average of 1.8 cfs over the last three years. (Note: All effluent return flows to the LBCR are considered as inflow to the reservoir and will be considered for environmental flow purposes. NTMWD has control over the City of Bonham's effluent return flows and has committed to pass these flows for environmental purposes during subsistence conditions.)

Reservoir storage capacity could be reduced over time by the sediment that accumulates within the reservoir. Sediment yield is the total quantity of silt and sediment deposited in a reservoir by surface runoff and erosion from the surrounding drainage area. Excess sedimentation in a reservoir causes reduced storage capacity.

Sedimentation in reservoirs and natural water bodies, such as ponds and lakes, occurs naturally as a result of erosion of the land surface by flowing water within an upstream watershed, as well as erosion from stream channel banks and sediment transport along stream beds. Erosion and sedimentation rates vary throughout the year as well as from year to year due to climatic conditions, land use/land cover, and existing conditions (e.g., soil types, topography). The sedimentation rate is the rate at which sediment accumulates, typically measured in units of mass per unit time or units of volume per unit time. Reservoir sedimentation is correlated directly with the upstream watershed sediment yield. Several methods are available to estimate the potential sedimentation rate for a proposed reservoir, including the production of sediment discharge rating curves using measured sediment concentrations in stream water; estimations of watershed sediment yields using available erosion prediction equations such as the Modified Universal Soil Loss Equation; and comparisons to measured sedimentation rates in existing reservoirs with similar climate, soils, land use/land cover and topography (Coffman, 2013).

Table 4.5-2 contains estimated and measured sediment yield values from seven locations with similar climate, soils, geology, land use/land cover, and topography as the LBCR watershed. These estimates assume a total contributing drainage area for LBCR of 327 square miles at the proposed dam site, and that the proposed reservoir is not yet constructed. The sediment yields in Column 2 of Table 4.5-2 were multiplied by the LBCR watershed drainage area to calculate estimated average annual sedimentation rates (Column 3). (Sedimentation rates with the proposed reservoir in place would be lower by a factor of approximately 0.09). Actual sedimentation rates in the proposed LBCR would depend on land use and

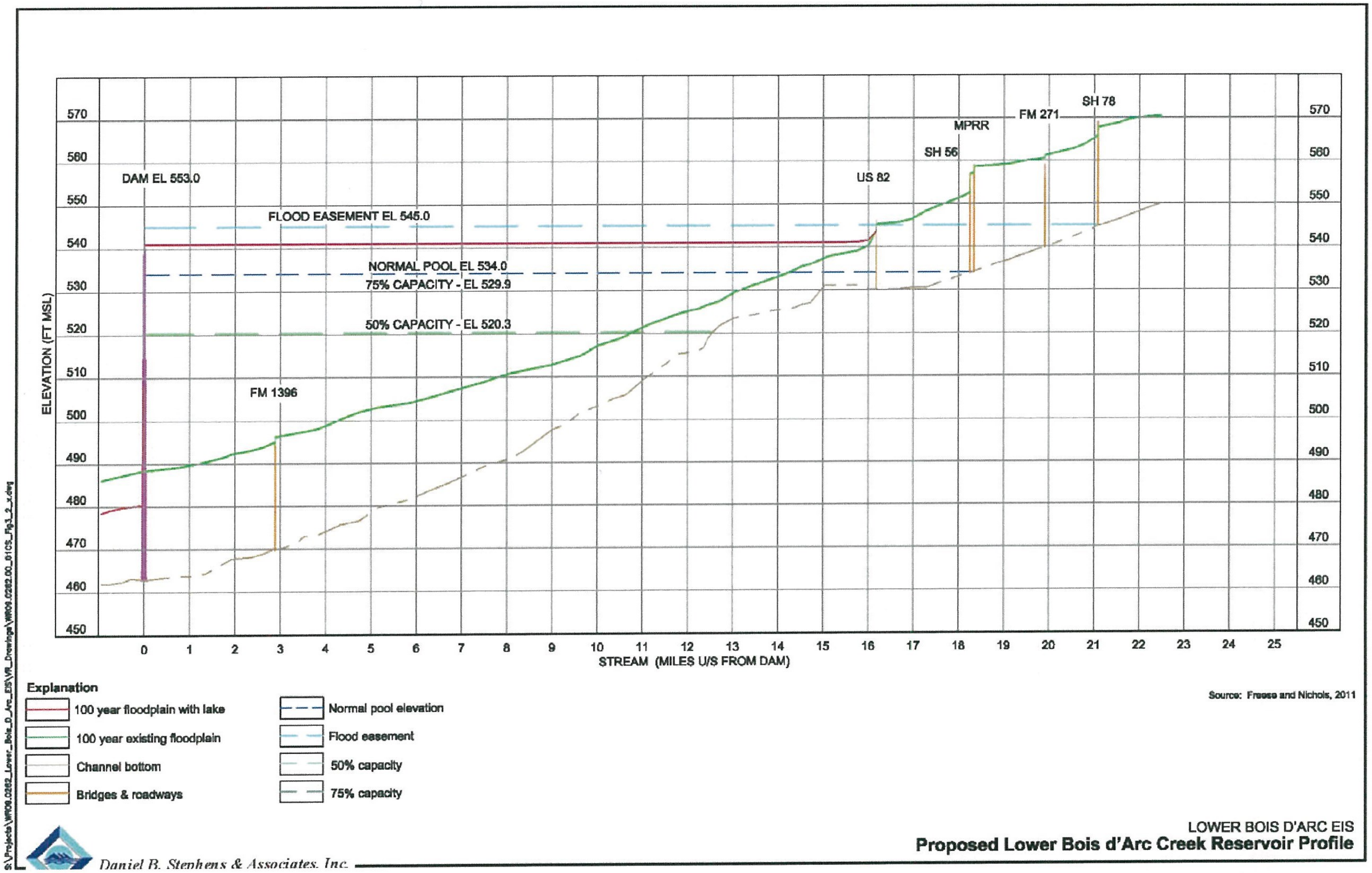


Figure 4.5-1. Profile of Proposed LBCR for Alternative 1

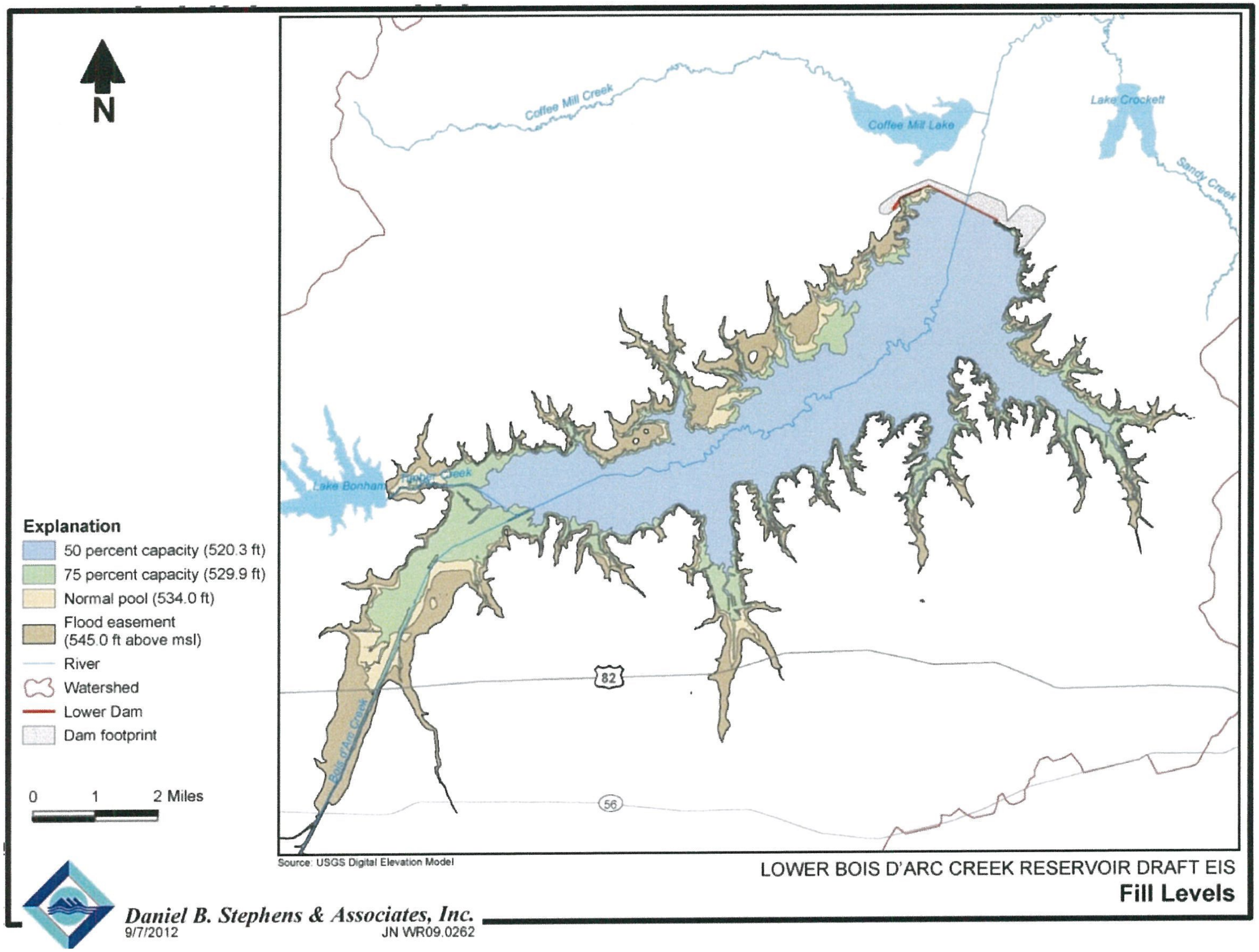


Figure 4.5-2. Proposed LBCR fill levels for Alternative 1

land cover around the reservoir, the erodibility of the soils not inundated by the reservoir, potential future erosion control measures, thickness of soils, and the climate.

Table 4.5-2. Measured and Modeled Sediment Yields from Similar Areas and Calculated LBCR Sedimentation Rates

Data Source	Sediment Yield (AF/mi²/yr)	Corresponding LBCR Sedimentation Rate (AFY)
Bois d'Arc Creek (Texas Dept. of Water Resources, 1982)	0.36	106.9
George Parkhouse Res. No. 2 (proposed) (Texas Dept. of Water Resources, 1982)	0.91	270.3
Lake Crook (Texas Dept. of Water Resources, 1982)	0.77	228.7
Report on New Bonham Reservoir (FNI [1984] from Texas Board of Water Engineers [1959])	1.60	475.2
Lake Bonham Volumetric Survey (TWDB, 2005)	0.94	279.2
Jim Chapman Lake Volumetric Survey (TWDB, 2008a)	1.50	445.5
Pat Mayse Lake Volumetric Survey (TWDB, 2008b)	0.93	276.2

AF/mi2/yr = acre-feet per square mile per year; AFY = acre-feet per year; TWDB = Texas Water Development Board.
Source: Coffman, 2013

The most representative sedimentation rates for the proposed LBCR shown in Table 4.5-2 are the rates based on volumetric surveys of Lake Bonham and Pat Mayse Lake (near Paris) conducted by TWDB. Lake Bonham is upstream in the same watershed and Pat Mayse Lake is nearby. The calculated sedimentation rates for the LBCR vary by a factor of almost five, from 107 AFY to 475 AFY.

The reservoir sedimentation surveys used a type of sonar to measure the bathymetry (underwater topography), and the depth of waters throughout the reservoirs was surveyed at a given water surface elevation (typically the conservation or normal pool elevation). Bathymetry and depth data were then combined to calculate reservoir storage at that water surface elevation. The current storage was then compared to the initial storage of the reservoir at the same elevation. Any reduction in storage was thus attributed to sedimentation, although it is still possible that some of the difference may be attributed to the different methods used to measure or calculate the storage volume.

Assuming a sedimentation rate of 0.94 AF/mi^2/year (the same as for the 2005 Lake Bonham Volumetric Survey), the proposed LBCR would lose approximately 11,167 AF of storage capacity at the normal pool elevation (534 feet) 40 years after construction, which represents approximately three percent of the initial reservoir capacity of 367,609 AF. Sedimentation at this rate would result in a loss of approximately 7.5 percent of the LBCR's capacity 100 years after construction. These predictions are conservative because they include the total contributing LBCR drainage area of 327 square miles and do not account for the reduction in contributing drainage area resulting from land surface inundation for the reservoir (lands which would be submerged so that they would no longer erode and contribute sediment).

As noted earlier, sediment accumulation in reservoirs and lakes is a natural and predictable process. Based on the above calculations and estimates, sedimentation in the proposed LBCR is not anticipated to be a severe impact. If sedimentation is deemed to be a problem for the reservoir at some point in the future, sedimentation rates in the upstream watershed could be reduced by implementing a sediment management program. Examples of sediment management strategies include 1) educating land owners and farmers about the benefits of sediment BMPs such as increased productivity through decreased loss of soil and nutrients, and 2) incentives or support for additional sediment yield reduction actions such as stream channel erosion protection measures, changes to agricultural practices (e.g., contour farming, terracing, filter strips, critical pasture planting and converting crop land to pasture land), and construction of sediment control structures in the watershed upstream.

Stream Channels and Open Water Features within the Bois d'Arc Creek Watershed

Under Alternative 1, the constructed dam and spillways would cover approximately 427 acres, and the reservoir would inundate approximately 16,641 acres. As such, the combined construction and inundation footprint of the proposed reservoir would be 17, 068 acres or only about 6 percent of the entire Bois d'Arc Creek watershed (272,000 acres). Approximately 120 acres (286,139 linear feet) of existing intermittent streams, 99 acres (365,002 linear feet) of intermittent/ephemeral streams and 78 acres of open water features occur within the total area associated with the combined construction and inundation footprint of the reservoir (Table 4.5-3 and Appendix C).

Table 4.5-3. Potential Project Impact Area Within the Combined Construction and Inundation Footprint of Alternative 1

Project Component and Affected Water Resource	Temporary Impact (linear feet)	Permanent Impact (linear feet)	Temporary Impact (acres)	Permanent Impact (acres)
Dam and reservoir				
Streams	--	651,140	--	219
Open waters	--	--	--	78
Raw water pipeline, WTP & TSR				
Streams	4,355	0	0.44	0
Open waters	0	0	0.10	0
Combined distance/acreage	**4,355**	**651,140**	**0.54**	**297**

-- = not applicable; TSR = terminal storage reservoir; WTP = water treatment plant

The operational phase of the project will have the largest potential impact on streams and open water features. Following construction of the proposed LBCR, areas within the project footprint would be inundated to an elevation of 534 feet above mean sea level under normal operating conditions. As a result, approximately 651,024 linear feet (123.3 miles) of intermittent and intermittent/ephemeral streams located within the proposed project site would be affected by inundation. In contrast, construction of the dam and spillways would likely impact less than 1 mile of stream channel within the 427 acre area construction footprint.

Stream Channel Form (Fluvial Geomorphological Processes)

The majority of streams within the proposed reservoir footprint, including Bois d'Arc Creek and its major tributaries, were extensively modified in the 20th century by channelization and other human actions (e.g., widespread deforestation and agricultural development in the watershed). The Rapid Geomorphic Assessment (RGA) and Instream Flow Study documented that contemporary stream conditions in Bois d'Arc Creek are generally poor. Table 4.5-4 shows the existing stream length and Stream Quality Units (SQUs) within the reservoir footprint that would be directly impacted by Alternative 1. Waters from these streams could be permanently converted from a flowing (lotic) to a still (lentic) state from construction of the reservoir.

Table 4.5-4. Impacts Proposed LBCR on Streams as Measured by Length in Feet and SQUs

Stream Quality Factor (SQF)	Existing Length (ft)	Existing Stream Quality Units (SQU's)
0.0 - 0.09	39,597	2,729
0.1 - 0.19	116,842	15,512
0.2 - 0.29	164,786	37,535
0.3 - 0.39	125,191	40,463
0.4 - 0.49	145,736	64,159
0.5 - 0.59	58,872	31,519
0.6 - 0.69	0	0
0.7 - 0.79	0	0
0.8 - 0.89	0	0
0.9 - 0.99	0	0
1.0	0	0
Total	**651,024**	**191,917**

ft = feet

Source: Modified from Table 2, Coffman and Cardenas (2016)

Surface Hydrology

This section describes impacts on existing surface waters in the project area, including Lake Bonham, waters of the U.S., and water rights and interbasin transfers. This section evaluates the potential impacts related to hydrology, drainage, and flooding that could result from implementation of Alternative 1.

Flood Flows

A detailed 100-year floodplain was delineated as a part of the Environmental Report prepared in support of the 404 Permit application, concluding that the 2-year and 100-year floodplains cover approximately 43 percent and 55 percent, respectively, of the proposed Lower Bois d'Arc Creek Reservoir project site Figure 4.5-3 shows the existing and proposed 100-year floodplains at the proposed reservoir site. Figure 4.5-4 displays the existing and proposed two-year floodplains on Bois d'Arc Creek downstream of the proposed dam site. Flooding within the City of Bonham was also evaluated because the city has experienced frequent flooding in the past and concern has been raised over the potential for the proposed reservoir to exacerbate the problem. Water surface profiles for 10-, 50-, 100-, and 500-year floods were developed using the USACE HEC-RAS model to analyze any potential flooding impacts to the City of Bonham. The profiles prepared highlighted the existing floodplain restrictions that occur as a result of two bridges, located at Highways 82 and 56. The study indicated that the historic flooding upstream of the Highway 82 and 56 bridges is due to the constriction of the floodplain in these two areas. The analysis concluded that building the proposed Lower Bois d'Arc Creek Reservoir would not increase flooding upstream of Highway 82, including at Highway 56, and the present analysis concurs with this conclusion. Figure 4.5-1, the profile of the proposed LBCR, shows US 82 and SH 56 in relation to the existing 100-year floodplain and the 100-year floodplain after the lake is in place if the project were built.

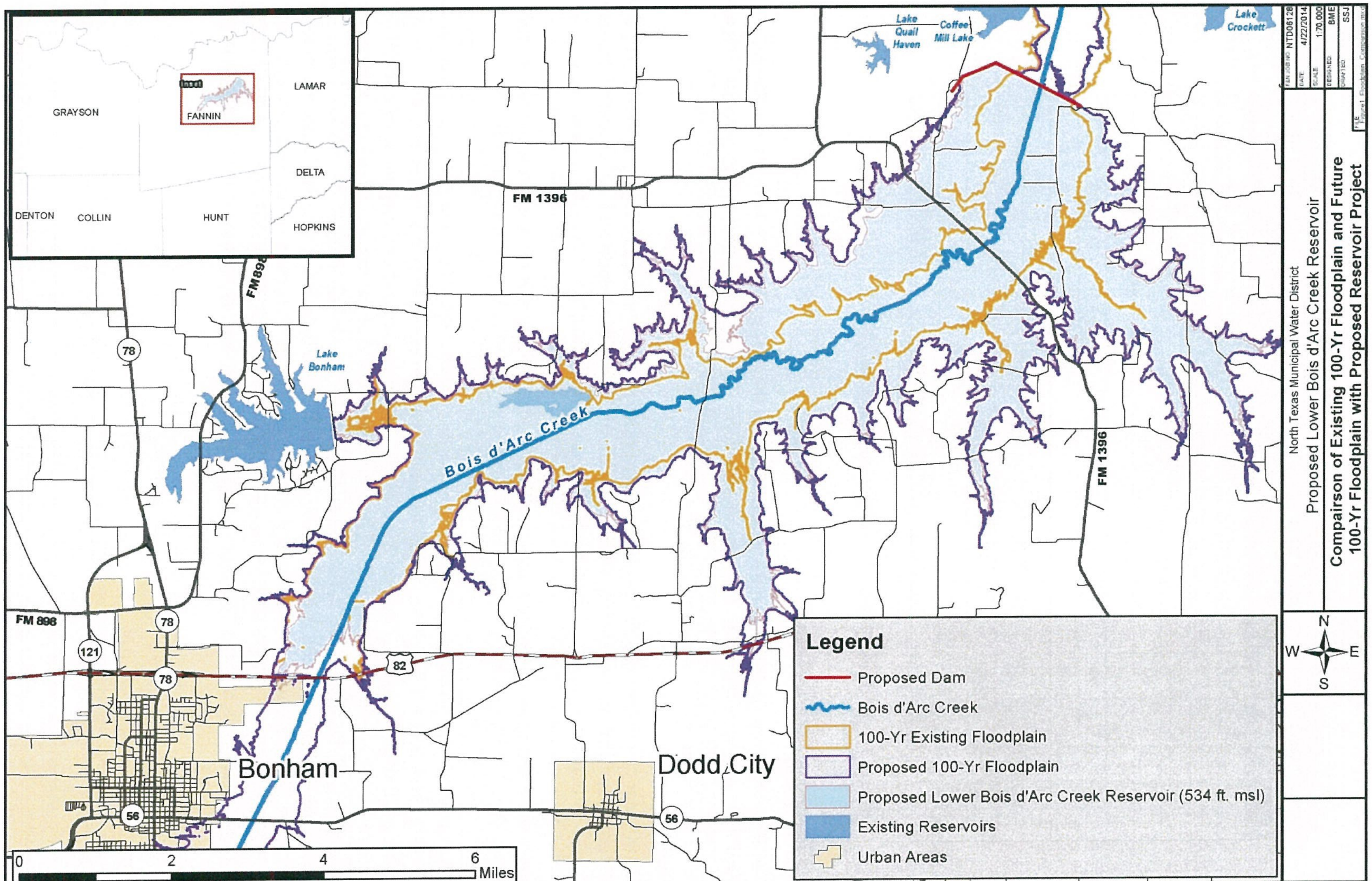


Figure 4.5-3. Existing and Proposed 100-year Floodplains at the Lower Bois d'Arc Creek Reservoir Site

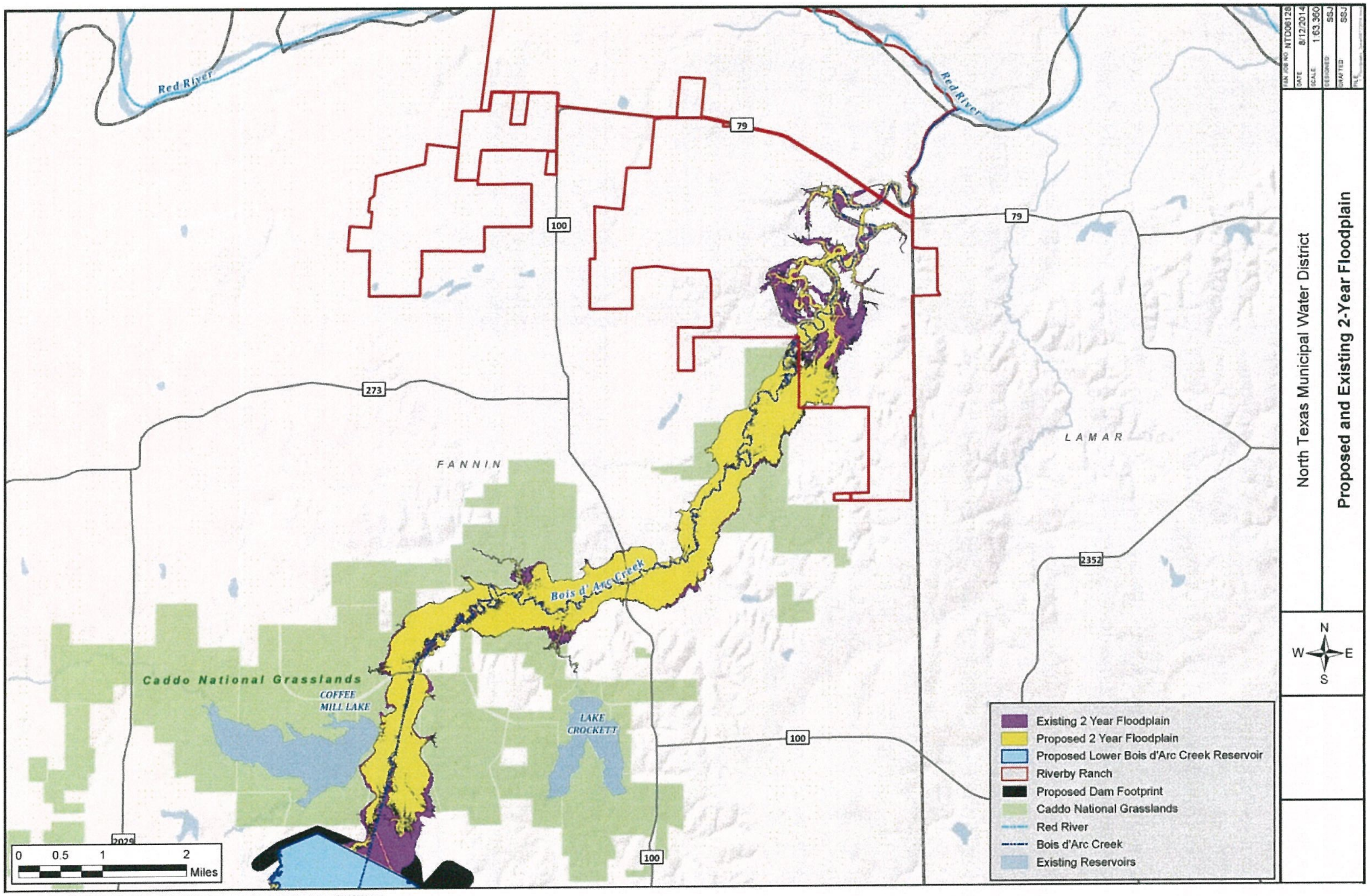


Figure 4.5-4. Existing and Proposed Two-year Floodplains on Bois d'Arc Creek Downstream of the LBCR Dam Site

An analysis conducted in 2016 of the potential impacts of the proposed LBCR on flood events used two hydrologic/hydraulic models developed by the USACE: HEC-HMS and HEC-RAS 2D. The HEC-HMS model applies specific rainfall events to the watershed and calculates the runoff hydrographs which are then utilized by the HEC-RAS 2D model. HEC-RAS delineates the geographic boundaries of the floodplain from a specific rain event. The HEC-RAS 2D (Version 5.0) is an updated model that permits a more precise delineation of floodplain hydrology over the entire watershed. It better portrays the hydraulic flows of tributaries to Bois d'Arc Creek (Watters and Kiel, 2016).

The 2016 study analyzed four hypothetical flood events with the LBCR dam in place to predict potential effects on overbanking flows into the downstream wetlands within the Bois d'Arc Creek floodplain:

1. Two-year flood event with the LBCR dam in place and no spills from the reservoir
2. Two-year flood event with the LBCR dam in place and spills from the reservoir
3. Five-year flood event with the LBCR dam in place and no spills from the reservoir
4. Five-year flood event with the LBCR dam in place and spills from the reservoir

The two-year event was selected because it represents the flood conditions prevailing in at least half of the years. The five-year rainfall event was also selected for analysis because the HGM model for forested wetlands considers the five-year floodplain in the functional assessment of riverine wetlands. For those conditions with no spills from the reservoir, it was assumed that the only water released through the dam would be the 3 cfs base flow required by the LBCR water right permit. Bois d'Arc Creek was modeled as if only the 3 cfs flow was in the creek before the two-year event was applied. This was a conservative assumption, especially during the rainy season in May and June. For those conditions with the reservoir spilling, it was assumed that it was full prior to the storm event and that upstream flood waters were routed through the reservoir before spilling downstream. This allowed for some attenuation of the flood hydrograph (Watters and Kiel, 2016).

Under the two-year flood event with the LBCR dam in place and no spills, flows in Bois d'Arc Creek and associated tributaries would continue to provide overbanking flows to the adjacent floodplain and wetland areas. As shown in Figure 4.5-5, overbanking flows would inundate low-lying areas within the floodplain. The areas that would not be inundated tend to be those immediately adjacent to the creek bank, which may be from spoils that were deposited next to the creek bank when it was channelized and/or from sediment deposition from previous overbank floods. Other areas might be flooded and/or retain water from direct precipitation but may not be differentiated in the model simply due to the one-foot resolution of the Light Detection and Ranging (LiDAR) data. When the dam spills during a two-year flood event, additional areas within the existing two-year floodplain would also be inundated as shown in Figure 4.5-6.

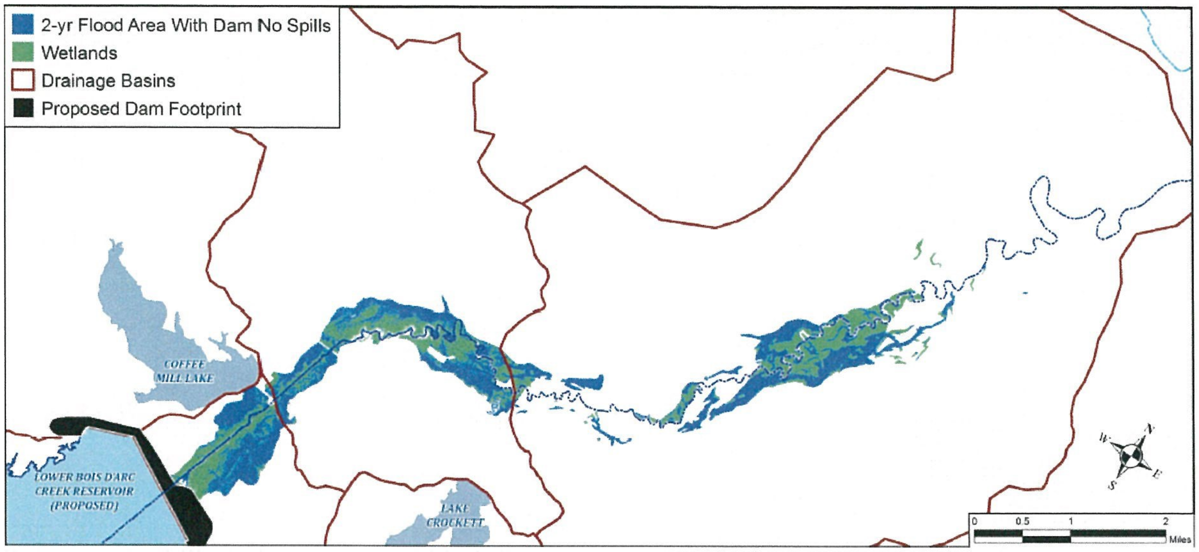


Figure 4.5-5. Two-year Flood Event on Bois d'Arc Creek with LBCR Dam and No Spills, Showing Inundation Area

Source: Figure 4.3-6 in Watters and Kiel, 2016

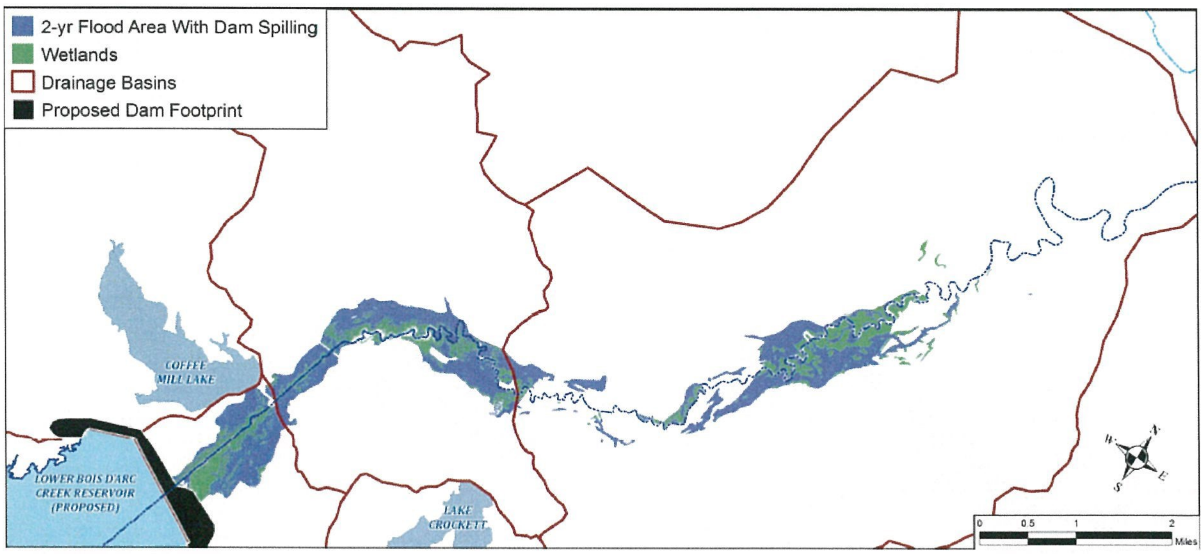


Figure 4.5-6. Two-year Flood Event on Bois d'Arc Creek with LBCR Dam and Spills, Showing Inundation Area

Source: Watters and Kiel, 2016

In the case of the five-year flood event and no spills from the LBCR dam, nearly all of the existing wetland areas within the floodplain would be inundated as shown on Figure 4.5-7. When the LBCR dam spills, Figure 4.5-8 indicates that additional wetland areas within the five-year floodplain would be inundated.

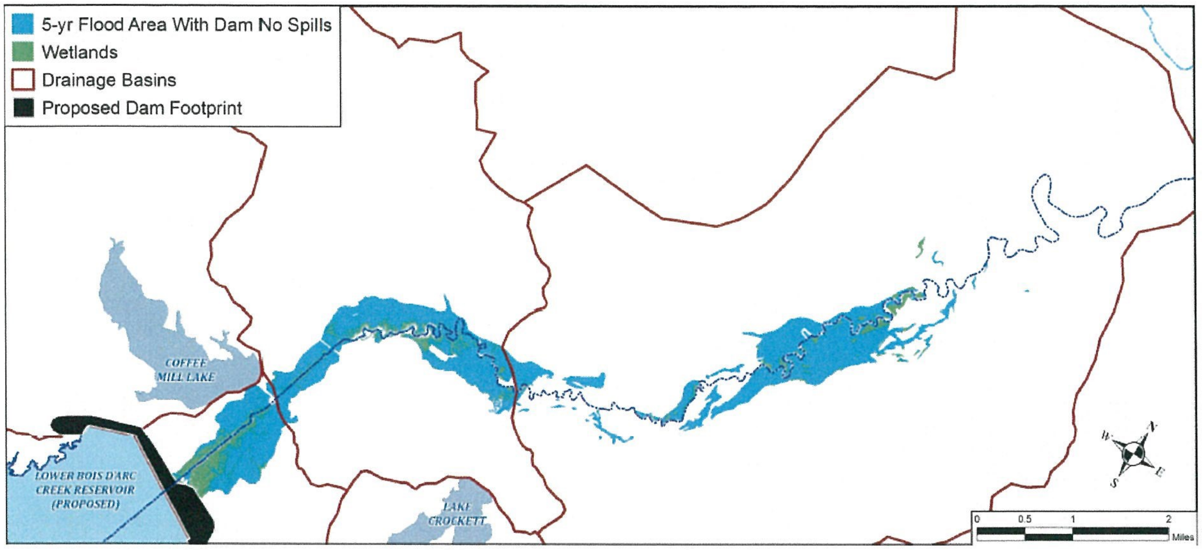


Figure 4.5-7. Five-year Flood Event on Bois d'Arc Creek with LBCR Dam and No Spills, Showing Inundation Area

Source: Figure 4.3-8 in Watters and Kiel, 2016

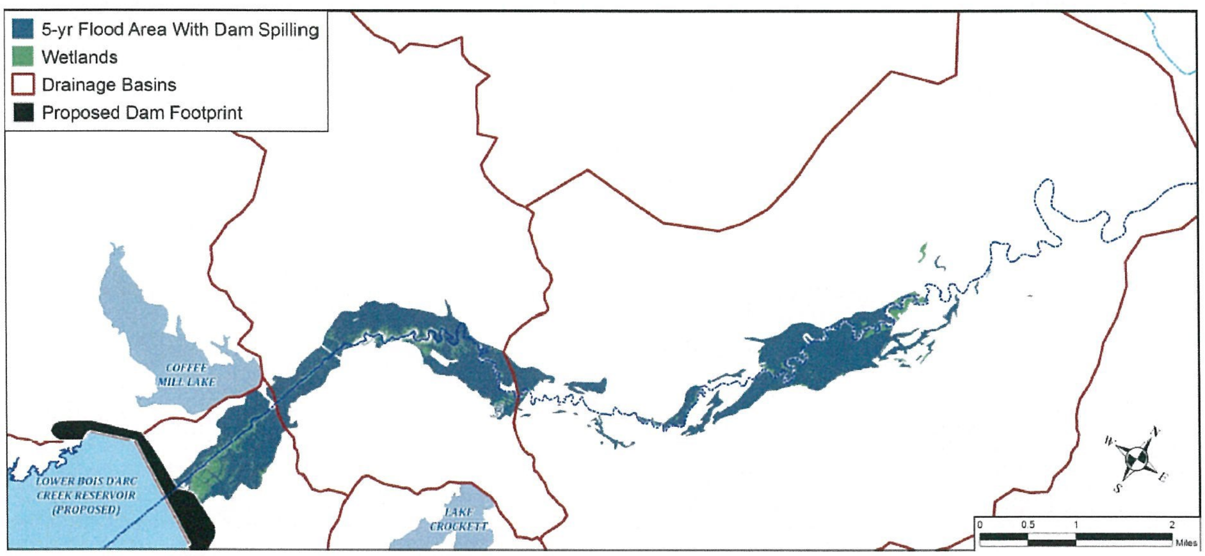


Figure 4.5-8. Five-year Flood Event on Bois d'Arc Creek with LBCR Dam and Spills, Showing Inundation Area

Source: Figure 8 in Watters and Kiel, 2016

Based on the results of modeling two-year and five-year flood hydrology, overbanking flows would continue with the LBCR dam in place. In most years, inundation of some of the downstream floodplains would occur from overbanking flows alone, and 84 percent of the downstream floodplains are expected to be inundated at least once every five years. When the reservoir is spilling in a 5-year flood event, 92 percent of the downstream wetlands would be inundated. The three additional sources of floodplain hydrology – direct precipitation, overland flow, and subsurface discharge from springs and seeps – would not be altered with the LBCR dam in place and functioning. During most years, these water sources are important in furnishing the floodplain hydrology needed to sustain inundation and/or saturation for two weeks during the growing season. When all four sources of water are taken into account, there is likely to be adequate wetland hydrology to sustain the existing downstream floodplains after implementation of the proposed LBCR, and impacts from construction of the proposed LBCR would be slight.

Navigation Flows

Discharges at USGS gages on Bois d'Arc Creek and the Red River were evaluated to determine whether or not there would be an observable or significant impact to the flows, water supply, and navigation in the Red River as a result of the proposed project. While there is no USGS gage on the Red River in Fannin County, the "Red River at Denison Dam near Denison, Texas" (USGS 07331600) gage is located upstream in Grayson County, just below Lake Texoma, approximately 65 river miles upstream of the Bois d'Arc Creek-Red River confluence. Average daily mean discharge values were summed for the period of record on this gage (1945 to 2010), yielding an average annual discharge value of 3.5 million acre-feet (USGS, 2011b).

The "Red River near De Kalb, Texas" (USGS 073368270) gage is located 112 miles downstream of the Bois d'Arc Creek-Red River confluence in Bowie County near the state line. Average daily mean discharge values were summed for this gage for its period of record (1969 to 2010), yielding an average annual discharge of 10.3 million acre-feet (USGS, 2011b). Data were also evaluated for the "Red River near Hosston, Louisiana" (USGS 07344400) stream gage, located approximately 110 miles downstream of the Texas state line and 30 miles north of Shreveport, Louisiana. Average daily mean discharge values were summed for the period of continuous record for this gage (1958-1968, since October 1968 the gage only records flows below 5,000 cfs), yielding an average annual discharge of 13.0 million acre-feet.

The minimum daily mean discharge values were also summed for the "Red River at Denison Dam near Denison, Texas"; "Red River near De Kalb, Texas"; and "Red River near Hosston, Louisiana" gages for their periods of record, yielding minimum annual discharges of approximately 45,000, 900,000, and 1.6 million acre-feet, respectively (USGS, 2011a and 2011b). Based on these totals for flow in the Red River, the predicted reduction in flow volumes caused by diversions from Bois d'Arc Creek is not expected to substantially impact water supply or flows in the Red River, as these diversions would be driven by hydrological conditions within the Bois d' Arc Creek watershed. No adverse water supply impacts are predicted to occur at the "Red River near De Kalb, Texas" or "Red River near Hosston, Louisiana" gages.

The closest USGS gage on the Red River downstream of its confluence with Bois d'Arc Creek is located at Arthur City (USGS 07335500). Approximately half the flow at this gage originates as releases from Lake Texoma, which consist mostly of water from a hydropower plant and can vary substantially on any given day. In recent years, on average, approximately 3 to 4 percent of the total flow at the Arthur City gage originated from the Bois d'Arc Creek watershed above the proposed dam site. Table 4.5-5 shows daily average flows at several selected gages in the area in cubic feet per second. The relatively small contribution of Bois d'Arc Creek to Red River flows can be appreciated, especially during low flow periods. Median flows on Bois d'Arc Creek at FM 409 (downstream of the proposed dam site) are 5 cfs compared to 2,150 cfs on the Red River at the Arthur City gage. At 25 percent low flows, Bois d'Arc Creek at FM 409 is 0 cfs, while the Red River at the Arthur City gage is 873 cfs.

While their influence is measurable, Bois d'Arc Creek flows have only a small effect at present on overall flows in the Red River at the nearest downstream gage at Arthur City. Therefore, intercepting and diverting up to 175,000 AFY of Bois d'Arc Creek's annual discharge to the Red River for the LBCR project would have only a minor effect on downstream flows in the Red River.

Table 4.5-5. Daily Average Flows at Selected Gages in the Bois d'Arc Creek and Red River Area, July 2006 to June 2014[1]

Relative Total Water Flow	Red River at Denison Dam [2]	Bois d'Arc Creek at FM 1396	Bois d'Arc Creek at FM 409 [3]	Red River at Arthur City, TX	Red River near De Kalb, TX
Maximum	38,379	11,600	12,400	80,800	97,800
90%	8,856	152	145	17,590	28,490
75%	3,535	40	37	5,288	9,265
Median	1,304	4	5	2,150	3,510
25%	174	0	0	873	1,623
10%	124	0	0	456	850
Minimum	61	0	0	177	351

FM = Farm to Market; TX = Texas.
[1] Values in cubic feet per second (cfs)
[2] Daily average flows at the Denison Dam gage were calculated from hourly instantaneous values.
[3] Bois d'Arc Creek at FM 409 began operation in June 2009.
Source: Albright, 2014b.

The USACE lists navigable waters for the Red River as including "from the U.S. Highway 71 bridge at the Texas-Arkansas state line upstream to the Oklahoma-Arkansas state line and from Denison Dam on Lake Texoma upstream to Warrens Bend, approximately 7.25 miles north-northeast of Marysville, in Cooke County, Texas" (USACE, 1999). Downstream of its confluence with Bois d'Arc Creek, the Red River runs along the northern boundary of two Texas water planning regions: C and D. Region C includes Cooke, Grayson, and Fannin counties bordering the Red River and 13 other counties to the south and southwest. Region D includes Lamar, Red River, and Bowie Counties bordering the Red River, and 16 other counties to the south. The Region C water plan lists the same navigable waters as the USACE source, citing "the segment of the Red River from Denison Dam forming Lake Texoma upstream to Warrens Bend in Cooke County." The Region D water plan indicates that the Red River is navigable below Shreveport-Bossier City in Louisiana, and also notes that a Southwest Arkansas Navigation Study is underway, which would make the Red River navigable from Shreveport, Louisiana through southwest Arkansas to near Texarkana, Texas. The minimum flow required for the navigable sections of the Red River is 1,200 cfs (USACE, 1989).

The possibility of reduced discharge from Bois d'Arc Creek having an adverse effect on the prospects for navigation in the Red River's navigable sections downstream of its confluence was evaluated by accessing the minimum daily mean discharges of the two nearest USGS gages downstream of the Bois d'Arc Creek-Red River confluence. The data that were analyzed are from one Red River gage located near De Kalb, Texas and another Red River gage located near Shreveport, Louisiana. These locations have contributing drainage areas of 47,348 and 57,041 square miles, respectively. As noted earlier, there is no USGS gage on the Red River in Fannin County.

Since navigability is dependent on daily flows and not annual discharge, the minimum daily mean discharges were evaluated for these three stream gages. The minimum daily mean discharge measurement at the Red River near the De Kalb, Texas gage was 254 cfs from 1969 to 2010, with the minimum daily mean discharges being less than the 1,200 cfs minimum navigation discharge requirement on 199 days of the year during this period (USGS, 2011b). This stream gage is located in Bowie County near the state line, in a section that is not defined as navigable. Evaluating the 10th percentile of daily mean values instead of the minimum daily mean discharge yields a minimum of 788 cfs, with the 10th percentile of daily mean values being less than the navigational requirement for 41 days of the year during this period (USGS, 2011b).

The minimum daily mean discharge measurements at the Red River near Hosston, Louisiana stream gage was 1,310 cfs for 1957-1994 (although records for this gage are discontinuous), with the minimum daily mean discharge exceeding the 1,200 cfs minimum navigation discharge requirement on every day of the year during this period (USGS, 2011a). There is no 10th percentile of daily mean values listed in the USGS dataset for this period (USGS, 2011a). This stream gage is located approximately 110 miles downstream of the Texas state line and 30 miles north of Shreveport, Louisiana.

Based on where the Red River is defined as navigable, the predicted reduction in flow volume in the Red River caused by removing up to 175,000 acre-feet of water annually (242 cfs, if timed evenly throughout the entire year) from one of its tributaries is not expected to adversely affect navigation on the navigable sections of the Red River (the Red River is not defined as navigable between the Bois d'Arc Creek-Red River confluence and Shreveport-Bossier City in Louisiana). The minimum daily mean discharge value at the Red River near DeKalb, Texas gage was less than the navigability flow requirement for approximately 55 percent of the days during the period of record; however, this gage is not located within a navigable reach. The minimum daily mean discharge value at the Red River near Hosston, Louisiana stream gage exceeded the minimum navigability flow requirement every day during the period of record, indicating that the Red River is navigable well upstream of Shreveport-Bossier City in Louisiana, where the navigable section begins. Water supply demand varies through the year, and the highest daily amounts required from the LBCR would be in late summer and early fall. However, these withdrawals would be taken from stored supply in the late summer/early fall, not from flows in Bois d'Arc Creek, which are quite minimal or non-existent in these months. Thus, the withdrawals would have no effect on navigability in the Red River.

Impacts to Existing Water Rights and Interbasin Water Transfers

Using the TCEQ Red River Water Availability Model (WAM), several existing water rights in the Bois d'Arc Creek watershed and water rights below the confluence of Bois d'Arc Creek and the Red River were identified and evaluated for impacts in the 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir.* In comparing the standard reliability measurements for existing water rights, the impact evaluation determined that "the proposed reservoir causes no injury to existing water rights" (Appendix R). This is a reasonable conclusion, one supported by TCEQ when it issued a Water Use Permit for the full-sized LBCR (Alternative 1) in June 2015.

Pursuant to Title 30 of Texas Administrative Code (TAC), §297.18, Subchapter B, "no person may take or divert any state water from a river basin and transfer such water to any other river basin without first applying for and receiving a water right or an amendment to a water right authorizing the transfer" and "the projected impacts of the proposed transfer that are reasonably expected to occur on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries in each basin" should be assessed (TAC, 1999). As such, as part of its application submitted to the TCEQ for a Texas water right for the proposed LBCR, NTMWD also applied for an interbasin water transfer of 175,000 AFY from the Red River basin to the Trinity and Sulphur River basins.

The 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir* identified "no impacts associated with the interbasin transfer to water rights in the Trinity or Sabine River Basins." Alternatives 1 and 2 would only transfer water to the Trinity and Sulphur River Basin. Proposed LBCR water would be delivered to the proposed new WTP near Leonard, located in southwest Fannin County and the Trinity River Basin. TCEQ granted a Water Use Permit to NTMWD for LBCR in June 2015 that included an authorization for interbasin water transfer. The permit states: "Permittee is authorized an interbasin transfer to use the water appropriated hereunder within the Trinity

River Basin, and within that portion of Fannin County located in the Sulphur River Basin" (Appendix F-1).

Other Reservoirs Within the Bois d'Arc Creek Watershed

The only other reservoir in the Bois d'Arc Watershed potentially affected by Alternative 1 is Lake Bonham. Lake Bonham is located immediately upstream of the proposed Lower Bois d'Arc Creek Reservoir on Timber Creek (shown on Figure 4.5-9). The elevation of the top of the Lake Bonham Dam is 584 feet MSL, and its maximum height is 70 feet. The dam is an earthen embankment with a drop inlet, morning glory-type principal spillway (also called a "glory hole" or bell-mouth spillway, into which water can enter from around the entire perimeter) and an earthen cut emergency spillway with a narrow pilot channel (Miles, 2014). The bottom of Lake Bonham Dam is located at an elevation of approximately 514 feet MSL (TWDB, 2011b). The normal pool elevation for the proposed Lower Bois d'Arc Creek Reservoir is 534 feet MSL. This elevation corresponds to 50 feet below the top of the Lake Bonham dam, therefore, if the proposed Lower Bois d'Arc Creek Reservoir backs up far enough on Timber Creek to meet the Lake Bonham dam, 20 feet of the dam would be submerged at the normal pool elevation. Several significant impacts have been identified as a result of the anticipated partial submersion of the Lake Bonham Dam by the proposed Lower Bois d'Arc Creek Reservoir. These include stability of the dam's embankment, reduction in the discharge capacity of the emergency and service spillways and outlet works, and increased complexity of dam safety inspections.

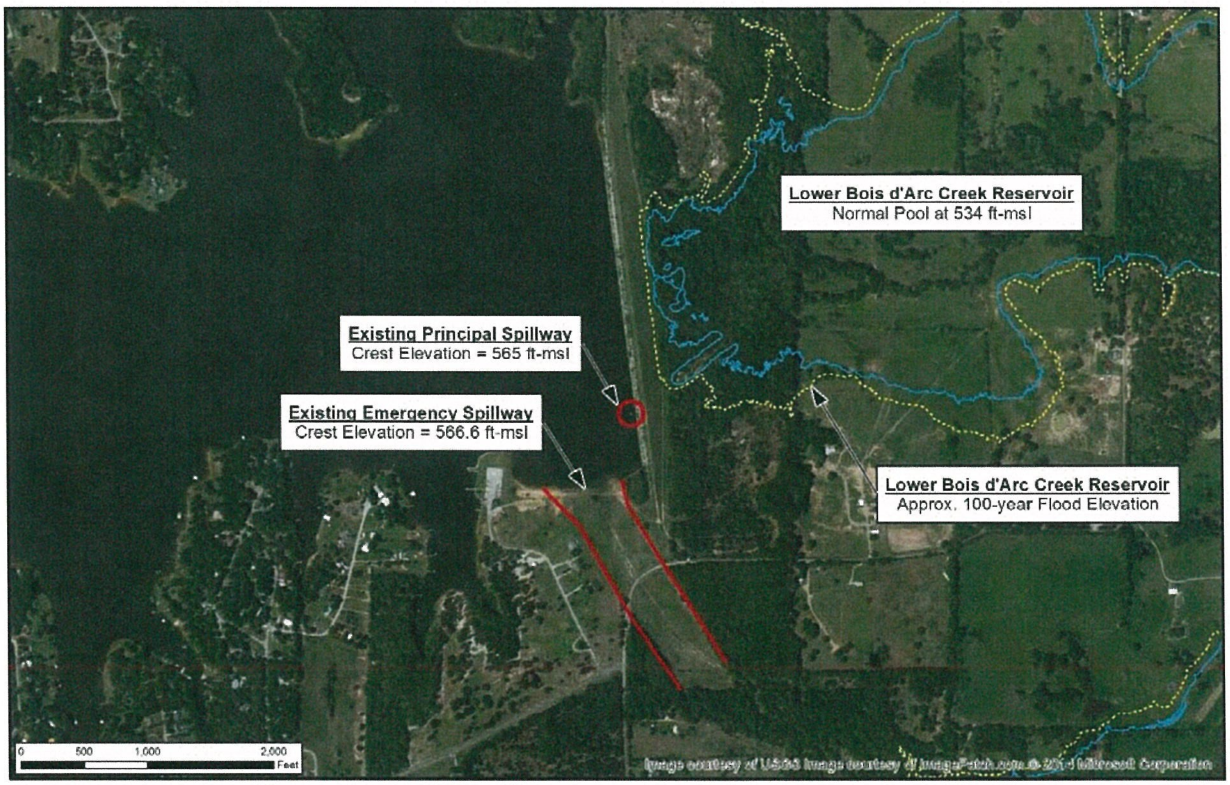


Figure 4.5-9. Aerial Photograph of Lake Bonham Dam with LBCR Pool Superimposed

A detailed discussion about these five impacts to the Lake Bonham Dam is provided below. Protection of the Lake Bonham Dam would be provided as a part of the LBCR project. The preliminary design and cost estimate assumes protection of the front side of the dam and appurtenant facilities with rip rap, which will be completed prior to filling LBCR.

Dam/Embankment Stability Impacts

The downstream toe of Lake Bonham Dam would become submerged when the surface elevation of LBCR reaches 524 feet MSL. At a surface elevation of 534 feet MSL (LBCR normal full pool), approximately 900 feet of the downstream toe of the dam would be inundated. During these storage conditions, the Lake Bonham Dam embankment could experience erosion damage through wave action generated by LBCR. High water levels may also adversely affect the performance of the embankment's internal drainage system by impeding the system's ability to safely convey seepage through the embankment (Miles, 2014).

Proposed modifications to address these two issues include 1) placing a toe berm on the downstream slope of Lake Bonham Dam to armor and protect it from waves generated by LBCR and 2) modifying the drainage system to provide a blanket drain and a toe drain collector system below the proposed berm, which would be integrated into the existing system. The new drains would also have lateral outlets through the soil cement slope protection that would be located above elevation 534 feet MSL to permit sufficient drainage.

Emergency Spillway Impacts

The crest elevation of the Lake Bonham Dam emergency spillway is approximately 567 feet MSL. This is over 30 feet above the LBCR normal pool elevation of 534 feet MSL. This elevation difference would allow the safe passage of releases through the emergency spillway. In addition, the configuration of the emergency spillway in combination with the normal pool elevation of LBCR would ensure the spillway would not be eroded by water stored in LBCR (Miles, 2014).

Service Spillway Impacts

Lake Bonham Dam's service spillway stilling basin is at elevation 524 feet MSL. LBCR water elevations at or higher than 524 feet MSL may result in a decrease in the discharge capacity of the service spillway. Higher pool elevations in the LBCR, under both normal and flood conditions, would submerge the downstream outlet of the principal spillway and reduce its discharge efficiency by an average of about 17 percent (Miles, 2014).

Proposed increases to the discharge capacity of the emergency spillway's pilot channel would address the impacts of this reduced discharge capacity of the service spillway when storage in LBCR is at or above 52 feet MSL (Miles, 2014). Various hypothetical flood frequency events were modeled for Lake Bonham to determine the necessary modifications. Results of the modeling indicate that the proposed modifications should mitigate the flooding impacts of the LBCR on Lake Bonham Dam. In addition to modifying the emergency spillway pilot channel, a solid concrete wall would be constructed at the downstream end of the stilling basin to permit inspections of the stilling basin and conduit when the outlet is submerged beneath the LBCR pool. A small sluice gate would also be installed in this wall to allow the stilling basin to be dewatered for inspection (Miles, 2014).

Outlet Works Impacts

The outlet works for Lake Bonham Dam consist of one 18-inch concrete pipe that discharges into the service spillway conduit. The intake for this pipe is located approximately 200 feet north of the service spillway drop inlet structure at an elevation of 538 feet MSL. Under normal conditions, LBCR would not affect the discharge capacity of these outlet works because they are four feet above the proposed normal pool.

Dam Safety Inspection Impacts

Regular dam safety inspections are required for Lake Bonham Dam. Safety inspections have been ongoing throughout its period of service and are expected to continue after completion of the LBCR. Minor suggested changes to the procedures for these inspections would include dewatering of the stilling basin to observe its interior walls and the service spillway conduit, along with observations of the new internal drainage system outlets to confirm appropriate functioning (Miles, 2014).

Flood routing through Lake Bonham Dam during high flow events would be similar to existing conditions, with the exception of reduced service spillway discharges, which would be compensated for by increased emergency spillway discharges. The routing of large flood events through Lake Bonham Dam was taken into consideration in modeling of similar flood events for LBCR, and thus there would be no substantial impact to operations during high flow events.

Operation of LBCR could result in adverse impacts on the operation of Lake Bonham Dam. These effects would be avoided by implementing the measures described above including modifications to the downstream toe of the embankment, the embankment drainage system, the emergency spillway pilot channel, the service spillway, and the dam inspection procedures

Surface Water Quality Impacts

This section describes existing surface water quality in the project area and evaluates the potential water quality impacts related to downstream Red River and downstream floodplain wetlands that could result from implementation of Alternative 1.

Surface water in the proposed reservoir is expected to have similar or even lower average dissolved mineral concentrations than are currently estimated in Bois d'Arc Creek due to most of the inflows resulting from high-flow events (Appendix M). Historical water quality data for Bois d'Arc Creek and similar north Texas Red River tributaries were analyzed and used to estimate concentrations of total dissolved solids, chloride, and sulfate in runoff that will be captured by the reservoir. The predicted mean values estimated for the proposed reservoir are 221 mg/L total dissolved solids, 19 mg/L chloride, and 38 mg/L sulfate. The primary impact to surface water quality that is anticipated is reduced variability of these parameter concentrations.

Natural Inflow and Estimated Reservoir Water Quality

Alan Plummer Associates, Inc. developed a water-balance model using relationships between flow and water quality to estimate concentrations of chloride, sulfate, and total dissolved solids in the proposed reservoir (Appendix M). Limited water quality and USGS flow gage data were available for Texas tributaries downstream of Lake Texoma when this analysis was performed; however, these data represent the best available data at the time of this report and are an adequate representation of existing conditions based on USGS gages, a Red River Authority sampling station, and NTMWD sampling sites. The relationship between flow and water quality was based on a limited number of samples from Bois d'Arc Creek and Pine Creek. This relationship was compared to trends from the Wichita River, above Lake Texoma, to verify trends in the data (Appendix M).

The water model evaluation used an estimate of natural inflow, a net evaporation value derived using the Red River Basin Water Availability Model, and a water withdrawal rate of 110 million gallons per day (123,000 acre-feet per year). The model assumes that chloride, sulfate, and total dissolved solids would be completely mixed in the reservoir, and a monthly time-step was used to evaluate reservoir level and parameter concentration for the period of 1940 through 1986. Values used for the natural inflow water quality are presented in Table 4.5-6. The water model predictions may include a significant margin of error due to the limited available water quality data for Bois d'Arc Creek at the time of the analysis. However, these data represent the best available data at the time of this report. See the water quality analysis and discussion in Appendix M and Appendix R for further detail.

Table 4.5-6. Natural Inflow Water Quality Data Used in the Water-Balance Model

Parameter	Concentration at Low-Flow (mg/L)	Concentration at High-Flow (mg/L)
Chloride	31	12
Sulfate	61	24
Total dissolved solids	343	137

Source: Appendix M, Appendix R.

The estimated water quality for the proposed Lower Bois d'Arc Creek Reservoir that resulted from the water-balance model is shown in Table 4.5-7.

Table 4.5-7. Estimated Lower Bois d'Arc Creek Reservoir Water Quality

Parameter	Concentration (mg/L)
Chloride, mean	19
Chloride, maximum [a]	29
Sulfate, mean	38
Sulfate, maximum [a]	58
Total dissolved solids, mean	221
Total dissolved solids, maximum [a]	330

mg/L = milligrams per liter.

[a] Total concentration is a maximum 1-year running average.

Source: Appendix M and Appendix R.

The primary impact on water quality that would result from building the proposed reservoir would be a reduction in the variability of water quality in the reach downstream of the reservoir (Appendix M and Appendix R). Existing water quality is adequate and predicted water quality after implementation of Alternative 1 would remain adequate.

The expected chloride, sulfate, and total dissolved solids concentrations in the LBCR would not pose a problem for conventional water treatment processes to produce drinking water that meets state and federal standards. In general, the expected water quality in the reservoir would be amenable to the standardized, widely-used water treatment processes and technologies employed by NTMWD, which include flocculation/ coagulation, sedimentation, triple disinfection, filtration, and pH adjustment.

As a part of the 2010 Instream Flow Study, an analysis of the impact of the proposed reservoir on downstream dissolved oxygen (DO) concentrations was performed. The modeling used an existing Qual-TX model developed by TCEQ to evaluate waste loads in Bois d'Arc Creek, restricting the analysis to areas below the proposed reservoir dam. As described in the Draft Operation Plan (NTMWD, 2014b; an updated version is Appendix D to this EIS), the reservoir dam being proposed by the NTMWD includes a multiple level intake structure that would allow water to be selectively withdrawn from various depths in a manner that would minimize impacts from lake stratification on DO concentrations downstream.

DO and temperature data were reviewed from other comparable North Texas lakes and these data were used in the Qual-TX model. Jim Chapman Lake data were used where they were available because this lake has comparable size, depth, and geology to the proposed Lower Bois d'Arc Creek Reservoir. Data from Lake Texoma, Lake Whitney, Lewisville Lake, and Benbrook Lake were used for the months where Jim Chapman Lake data were not available (April, October, November, and December) since they had comparable geographic latitude, proximity, and depth (Appendix M).

Various flow regimes were modeled including subsistence flow (1 cfs), base flows (3 and 10 cfs), and pulse flows (50 cfs) using the maximum mean temperature and minimum mean dissolved oxygen concentration data from other North Texas lakes (Appendix M). Results of the water quality modeling predicting DO concentrations in Bois d'Arc Creek downstream of the proposed dam are summarized in Table 4.5-8.

Table 4.5-8. Bois d'Arc Creek Water Quality Modeling Results for the Proposed Flow Regimes in the Reservoir Operation Plan

Model Period	Flow Regimes Modeled (cfs)	Mean Input Temperature (°C)	Mean Dissolved Oxygen Input (mg/L)	Resulting Dissolved Oxygen (mg/L)	Corresponding Water Release Depth (feet)	Applicable TCEQ Dissolved Oxygen Standard (mg/L)
April-June	1, 10, and 50	27.2	5.7	5.82	1-20	5.5
July-October	1, 3 50	30.2 19.0	5.0 7.0	5.75	1	5.0
November-March	1, 3	15.8	7.8	8.38	1-40	5.0

°C = degrees Celsius; cfs = cubic feet per second; mg/L = milligrams per liter; TCEQ = Texas Commission on Environmental Quality

Source: Appendix M

The model results predict minimum DO concentrations of 5.82, 5.75, and 8.38 mg/L (depending upon season, flow regime, and parameter inputs), which are all above the applicable TCEQ DO standards. The TCEQ freshwater criteria for DO for a High Aquatic Life Use Subcategory (which includes Bois d'Arc Creek) are a mean of 5.0 mg/L and a minimum of 3.0 mg/L, with a mean of 5.5 mg/L and a minimum of 4.5 mg/L for the spring spawning period. Thus, the reservoir would not have adverse effects on DO, the main water quality parameter for the health of aquatic life. Under existing conditions, during the low-flow to no-flow period of late summer to early fall when water temperature rises, DO concentrations can drop below 5.0 or even 4.0 mg/L. With the reservoir in place, these seasonal DO concentrations would be expected to be slightly higher than at present, which could provide a beneficial impact for the creek.

NTMWD proposes obtaining water quality data collected by the USGS for the "Bois d'Arc Creek at FM 409" gaging station, and by the Red River Authority for the locations that are sampled quarterly as a part of the Texas Clean Rivers Program (FM 78 and FM 100) to monitor the proposed reservoir's impact on water quality below the dam after its construction.

Red River Downstream of the Bois d'Arc Creek Confluence

High salinity is a major water quality issue in the headwaters of the Red River upstream of Lake Texoma to the extent that it limits use of this water for municipal purposes. Since water in Lake Texoma is relatively salty, hydroelectric and other releases from Denison Dam largely determine salinity levels below Lake Texoma. Downstream along the Red River from Lake Texoma, less salty water enters the river from various tributaries and dilutes Denison Dam hydropower releases, gradually reducing salinity in the river (Albright and Coffman, 2014).

USGS reports daily specific conductance data for two stream gages in the vicinity of the proposed Lower Bois d'Arc Creek Reservoir:

- Red River at Arthur City, TX (07335500) - March 2007 to September 2008
- Bois d'Arc Creek at FM 1396 near Honey Grove, TX (07332620) – June 2006 to present

The watershed above the proposed LBCR affects TDS loads at the Red River's Arthur City gage in two ways. First, it contributes relatively low-salinity flow that helps dilute high-salinity releases from Lake Texoma. Second, it contributes dissolved solids that influence TDS loads at Arthur City. Although these loads and salinity concentrations are lower than Lake Texoma, the contribution of the Bois d'Arc Creek watershed can be significant during high flows (Albright and Coffman, 2014).

Analysis of specific conductance data from the FM 1396 and Arthur City gages from August 2007 to September 2008 shows that if the LBCR had been present during this 14-month period, TDS concentrations would have increased by 1.2-1.4 percent, representing a slight impact.

Golden Algae

Golden algae (*Prymnesium parvum*) are a toxic algal species that can cause extensive fish kills. Rivers, ponds, and reservoirs in north-central Texas have been susceptible to these events. Four Texas river systems (Brazos, Canadian, Colorado, and Red) and at least 29 Texas reservoirs have been affected by golden algae since 2001 (TPWD, 2011b). Golden algae-like cells have also been identified in four other reservoirs within the Trinity River and Sulphur River systems (TPWD, 2002). All species of Texas fish are susceptible to golden algae, and the resulting fish kills have the potential to greatly impact the local economies around affected reservoirs by reducing regional water-based recreation opportunities. (TPWD, 2017d).

The TPWD has developed management guidelines in an effort to control golden algae toxic events. For areas that are at high risk for the introduction of golden algae, the TPWD recommends that a prevention and mitigation plan be in place (TPWD, 2011b).

The following questions are used to determine whether a waterbody is in a high risk area for golden algae toxic events (TPWD, 2011b). The answers for the proposed LBCR are in italics, below:

- Have previous toxic golden algae events taken place? *Not Applicable (because the reservoir does not exist).*
- Is golden algae known to be present in the waterbody? *Not Applicable (because the reservoir does not exist).*
- Is the waterbody in the region of the state where toxic golden algae events are common? *Yes (at Lake Texoma and other water bodies in the Red River Basin).*
- Are alkaline soil and high pH (>7.0) water conditions present for the waterbody in question? *Yes. Measured pH in sampling conducted on Bois d'Arc Creek near Bonham was 8.1.*
- Does the waterbody have fairly salty water (high conductivity)? *Not considered excessive. Salinity (chloride) predicted in LBCR is below the favorable range for golden algae.*

Based on these risk factors, golden algae are unlikely to become a problem for the LBCR in the future. If it were to become problematic, treatments for use in public waters include algal treatments that are approved by the EPA and TDA (the most successful treatments have been with copper-based algaecides such as chelated copper compounds) as well as ultraviolet light treatment and ozonation for small volumes of water (TPWD, 2011b).

The TPWD monitors for algal blooms and provides golden algae bloom status reports on their website (TPWD, 2017d). Texas lakes within the Red River Basin that were found to have golden algae present as of January 2011 included Plum Lake, the Lebanon Pool area and the Red River arm of Lake Texoma, and Lake Diversion at the intake for the Dundee State Fish Hatchery (TPWD, 2011b). Each of these instances has occurred upstream of Bois d'Arc Creek, although the algae could spread to other lakes and reservoirs that are at risk for such blooms in the future. Golden algae can be spread from site to site via water or equipment that is used in multiple lakes (e.g., boats and trailers) (TPWD, 2011b), and so equipment cleaning could be important to keep from introducing this alga and other invasive species into the new reservoir.

Potential Impacts to Stream Channels and Open Water Features from the Proposed Pipeline

To connect the reservoir to the service area, a raw water transmission pipeline would be required to convey and deliver water from the proposed reservoir to a proposed new water treatment plant, the North WTP near the City of Leonard in southwest Fannin County (as described in Section 2.2.5 of this document). The proposed project includes approximately 35 miles of pipeline right-of-way. Jurisdictional water and wetland areas were avoided to the degree possible when selecting an alignment for this pipeline by consideration of existing right-of-way (ROW) and the possible use of horizontal directional drill technology for installing the pipeline beneath streams or water bodies (as opposed to open trenching, which may also be used). A Preliminary Jurisdictional Determination (PJD) was conducted in the fall of 2013 for the pipeline route and the proposed sites of connected facilities near Leonard (i.e., the terminal storage reservoir and the water treatment plant). The PJD found that the chosen pipeline alignment crosses 39 waters of the United States, including 36 streams (one perennial, 7 intermittent, and 28 ephemeral), one on-channel impoundment, and two upland/off-channel stock ponds. Based on the pipeline route selection and construction technology, the only potential impacts on waters of the United States from construction of the raw water pipeline to the North WTP near Leonard would be temporary; there would be no permanent adverse effects.

A number of stream crossings were avoided because the pipeline alignment follows high ground (upland) over approximately half its length along the divide between the Sulphur River basin and the Red River basin. Temporary impacts to Ward, Honey Grove and Bullard Creeks would be avoided by using horizontal directional drilling to install the pipeline at these stream crossings and staging areas would be located within the uplands. Overall impacts from pipeline construction to waters of the U.S. would be none to slight.

The proposed new water treatment plant and terminal storage reservoir (TSR) would occupy a site northwest of the City of Leonard. The location and design of the WTP and TSR are shown in Figures 2.2-12 through 2.2-17 in Chapter 2 of this Revised DEIS. The project site for the WTP and TSR is currently used primarily for livestock grazing and hay production. Within the area investigated in a 2010 PJD of waters of the U.S. for the project site, the tracts mostly consist of areas containing upland herbaceous vegetation, with wooded areas occurring along riparian corridors and fence lines (Alan Plummer Associates, 2010).

The PJD conducted in the fall of 2013 determined there are no jurisdictional waters or wetlands present within the planned footprints of either the North WTP near Leonard or its associated TSR. The sites for these two facilities were selected in upland areas to entirely avoid permanent impacts to waters of the U.S. including wetlands. USACE completed an Approved Jurisdictional Determination (AJD) in 2015, which confirmed that no impacts to waters of the U.S. or wetlands would occur from the proposed North WTP or related facilities (USACE, 2015c)

Groundwater Resources

The proposed LBCR project is not located directly over the recharge zone for any major or minor groundwater aquifer in Texas. The Woodbine and Northern Trinity aquifers, which are located in the area of the proposed LBCR, are confined and separated by relatively impermeable clay and carbonate units (Appendix M). The hydraulic head created by the impounded water reservoir could potentially serve as a source of recharge water for the subsurface aquifers due to water seepage, though this scenario is highly unlikely because the uppermost zone of the Woodbine aquifer is located between 500 and 1,000 feet below ground surface.

Other minor aquifers located above the Woodbine aquifer in the study area, including the Austin Chalk, the Blossom Aquifer and undefined alluvium aquifer(s), as well as a shallow, unconfined aquifer present beneath the proposed reservoir project area, are not considered to be significant aquifers in Fannin County. Groundwater wells completed in the undefined alluvium aquifer are presumably producing water from the Red River alluvium, which is located in the northern portion of the county adjacent to the Red River.

According to well location data obtained from the TWDB, very few existing groundwater wells are expected within the footprint of the proposed reservoir project, and the current existence and use of these wells has not been verified. The increase in surface water supply to the area as a result of the proposed reservoir project could potentially reduce the amount of groundwater pumping in the area, thereby allowing for increased aquifer recharge, storage and production. Therefore, the proposed project is not expected to have an adverse impact on local groundwater resources, and due to the potential increased aquifer recharge, storage, and production, could result in beneficial impacts.

4.5.3 Alternative 2

Smaller LBCR Reservoir Water Storage

The downsized LBCR in Alternative 2 (shown in Figure 2.3-1 of this Revised DEIS), with a lower conservation pool elevation of 515 feet MSL, would have a storage capacity of 135,200 AF, which is approximately 37 percent of the 367,609 AF storage capacity of Alternative 1. The surface area of the downsized LBCR in Alternative 2 would be approximately 8,600 acres, approximately half the acreage of the proposed reservoir for Alternative 1. The footprint of the dam would be about 90 percent of the size of the dam for Alternative 1 and would be constructed at the same location. The dam's outlets and spillways for Alternative 2 would be designed to safely pass the Probable Maximum Flood instream flow requirements for Bois d'Arc Creek downstream, as specified in the Texas water right permit for the full-sized LBCR of Alternative 1. The firm yield of the downsized LBCR would be approximately 86,100 (Kiel, 2015a; Appendix M).

As a consequence of its smaller storage capacity, the downsized LBCR would provide a less reliable water supply during drought events. With less storage capacity, the downsized LBCR would be more vulnerable than the full-sized LBCR to new droughts, which would decrease water supplies during times of decreased precipitation, and to climate change, which would affect evaporation rates. Figure 4.5-10 shows a comparison of storage capacities between the full-sized LBCR and the downsized LBCR. The volume of water in the downsized LBCR and full-sized LBCR would be below 50,000 acre-feet about nine percent and three percent of the time, respectively.

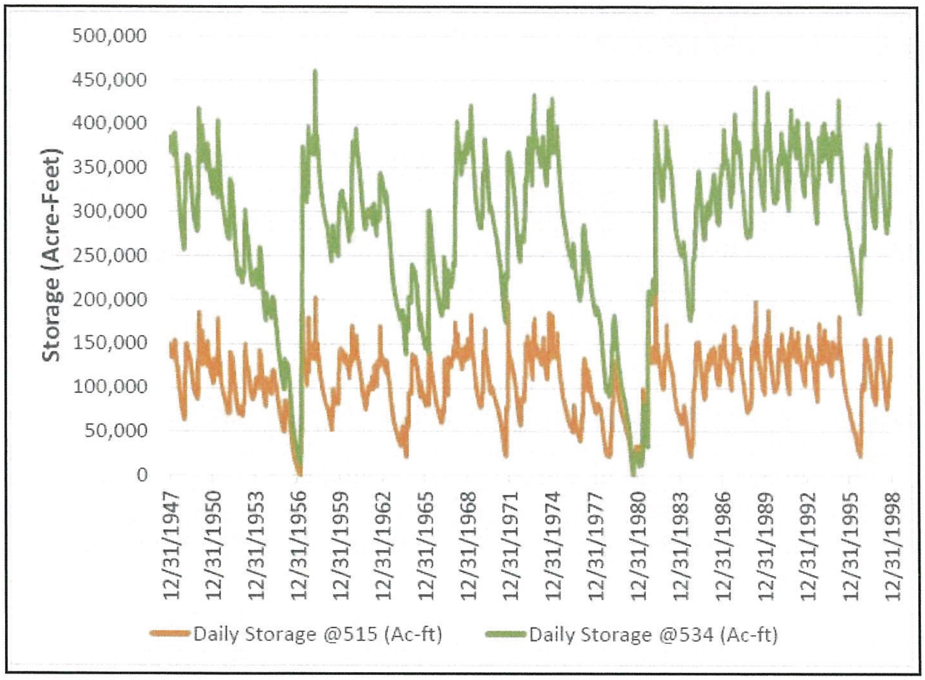


Figure 4.5-10. Comparison of Storage Traces Between a Full-scale LBCR (Alternative 1) at 534 MSL and a Smaller-scale LBCR (Alternative 2) at 515 MSL Elevation Based on Historic Record

Reservoir storage capacity of the downsized LBCR would be reduced over time by the deposition of sediment into the reservoir from surface runoff and erosion in the upstream drainage area. Because of its smaller size compared to the full-sized LBCR, the downsized LBCR would proportionately lose relatively more water storage capacity than the full-scale LBCR.

Assuming the same rate of sedimentation for the downsized LBCR and full-sized LBCR (0.94 AF/mi^2/year), the downsized LBCR would lose approximately 11,167 AF of storage capacity after its initial 40years of operation. This loss of storage capacity would comprise approximately eight percent of the initial reservoir capacity (135,200 AF), compared to three percent of the initial reservoir capacity lost for the full-sized LBCR after its initial 40 years of operation. Using the estimated same rate of sedimentation (0.94 AF/mi^2/year), the downsized LBCR and the full-sized LBCR would lose approximately 21 percent and 7.5 percent storage capacity, respectively, after 100 years of operation.

The downsized LBCR would not adversely affect existing water rights in the Bois d'Arc Creek watershed or water rights below the confluence of Bois d'Arc Creek and the Red River. There would be no impacts from the downsized LBCR associated with the interbasin transfer of water rights in the Trinity River Basin.

Stream Channels and Open Water Features within the Bois d'Arc Creek Watershed

The downsized LBCR would inundate approximately 8,600 acres, including waters, wetlands, and uplands within the Alternative 2 footprint. The downsized LBCR would also impact 3,800 acres of land around the perimeter of the proposed reservoir for the flood pool. The total potential impacted area from construction of the downsized LBCR would be 13,105 acres, which is approximately 58 percent of the potential impacted area of Alternative 1 (22,642 acres) (Kiel, 2016b). In addition, the downsized LBCR could impact an estimated 348,928 linear feet of streams, which would be approximately half of the 651,024 linear feet streams potentially impacted by Alternative 1. Making the assumption that Stream

Quality Factors (SQF's) are evenly distributed across the entire reservoir footprint, the impacted area under the downsized LBCR could affect approximately 95,000 Stream Quality Units (SQU's).

Surface Hydrology

Flood Flows

The downsized LBCR in Alternative 2 would have a conservation pool elevation of 515 feet MSL, 19 feet below Alternative 1's conservation pool elevation of 534 feet MSL. Construction and operation of the downsized LBCR would not increase upstream or downstream flooding along Bois d'Arc Creek compared to existing conditions.

Downstream Navigation

The firm yield of the downsized LBCR is estimated to total 86,100 AFY or approximately 68 percent of the 120,665 AFY firm yield of the full-scale LBCR. Although less water would be diverted from the Bois d' Arc Creek watershed in Alternative 2, water would be diverted from Lake Texoma in this alternative. The combined effect of diverting water from Bois d' Arc Creek and Lake Texoma would result in the same effect on flows in the Red River as discussed under Alternative 1, which concluded that there would be no adverse effect on navigation. The operation of a smaller LBCR in combination with diversions from Lake Texoma would not adversely affect navigation on the Red River.

Other Reservoirs in the Bois d'Arc Creek Watershed

The normal pool of the downsized LBCR would be 19 feet lower than the normal pool of the full-sized LBCR (515 versus 534 feet MSL). As indicated under Alternative 1, the Lake Bonham Dam embankment, spillway, outlets, and drainage system could be adversely affected when the LBCR surface elevation reaches 524 feet MSL. Under Alternative 2, the Lake Bonham Dam and facilities would not be affected because the surface elevation of the smaller LBCR would not be high enough to encroach on the embankment, spillways, outlets, or drainage system.

Under Alternative 2, up to 28,700 AFY of water would be withdrawn from Lake Texoma for blending with water from the downsized reservoir. NTMWD already has a water right to withdraw this water, so Alternative 2 would not have any impact on Lake Texoma. No other reservoirs in the Bois d'Arc Creek Watershed would be affected by Alternative 2.

Surface Water Quality Impacts

The quality of water stored in the downsized LBCR is expected to be similar to the quality of water stored in the full scale LBCR. As indicated under Alternative 1 above, the primary impact on water quality that would result from building the proposed reservoir would be a reduction in the variability of water quality in the reach downstream of the reservoir (Appendix M and Appendix R). Existing water quality is adequate and predicted water quality after implementation of Alternative 2 would remain adequate.

The expected chloride, sulfate, and total dissolved solids concentrations in the downsized LBCR would not pose a problem for conventional water treatment processes to produce drinking water that meets state and federal standards. In general, the expected water quality in the reservoir would be amenable to the standardized, widely-used water treatment processes and technologies employed by NTMWD, which include flocculation/ coagulation, sedimentation, triple disinfection, filtration, and pH adjustment.

As stated under Alternative 1, USGS reports daily specific conductance data for two stream gages in the vicinity of the proposed LBCR:

- Red River at Arthur City, TX (07335500) - March 2007 to September 2008
- Bois d'Arc Creek at FM 1396 near Honey Grove, TX (07332620) – June 2006 to present

The watershed above the proposed LBCR affects TDS loads at the Red River's Arthur City gage in two ways. First, it contributes relatively low-salinity flow that helps dilute high-salinity releases from Lake Texoma. Second, it contributes dissolved solids that influence TDS loads at Arthur City. Although these loads and salinity concentrations are lower than Lake Texoma, the contribution of the Bois d'Arc Creek watershed can be significant during high flows (Albright and Coffman, 2014).

Analysis of specific conductance data from the FM 1396 and Arthur City gages from August 2007 to September 2008 shows that if the LBCR had been present during this 14-month period, TDS concentrations would have increased by 1.2-1.4 percent, representing a slight impact.

Potential Impacts to Stream Channels and Open Water Features by the Proposed Pipelines

The impacted area of the related facilities and connected actions, including the raw water pipeline, terminal storage reservoir, and North water treatment plant, from construction of the downsized LBCR would be the same as for Alternative 1 and would have the same impacts ranging from none to slight. In Alternative 2, an additional 25-mile, 72-inch diameter raw water pipeline would be installed alongside the existing raw water pipeline from Lake Texoma to the Texoma Balancing Reservoir. Based on the pipeline route selection and construction technology, the only potential impacts on waters of the United States would be temporary. Overall impacts from Lake Texoma pipeline construction to waters of the U.S. would be none to slight.

Groundwater Resources

As indicated in Section 4.5.2.7, according to well location data very few existing groundwater wells are expected within the footprint of the proposed reservoir project, and the current existence and uses of these wells have not been verified. The increase in surface water supply to the area as a result of the downsized LBCR could potentially reduce the amount of groundwater pumping in the area, thereby allowing for increased aquifer recharge, storage and production. Therefore, similar to Alternative 1, the smaller reservoir in Alternative 2 is not expected to have an adverse impact on local groundwater resources, and could result in beneficial impacts due to the potential increased aquifer recharge, storage and production.

4.6 BIOLOGICAL RESOURCES

The following sections address the potential effects of Alternatives 1 and 2 on the available biological resources located within the project area. Discussion of environmental consequences of the No Action Alternative, Alternative 1, and Alternative 2 includes potential effects on upland and wetland habitats, aquatic biota, and terrestrial wildlife.

Construction impacts are those resulting from construction of the dam facilities and associated infrastructure. Dam facilities construction includes the dam, which would be a zoned earthen embankment, and a spillway and outlet works that would extend downstream from the dam centerline. The spillway would consist of an approach channel, a concrete weir, a chute, a hydraulic jump stilling basin, an outlet channel and a multi-level intake tower located near the dam. An uncontrolled broad crested weir structure emergency spillway would also be located in the right abutment of the dam.

Additional impacts would result from the construction of a raw water intake pumping station close to the southeastern end of the proposed LBCR dam site; a new electrical substation next to the proposed pumping station; a raw water pipeline that would run from just downstream of the proposed LBCR dam site in a southwesterly direction for approximately 35 miles to just west of Leonard; a raw water treatment plant (the North WTP) just west of the town of Leonard, Texas; and a rail spur off of the Missouri-Kansas-Texas Railroad routed through uplands along existing roads with a terminus at the WTP site. For Alternative 2, an additional 25-mile pipeline would be constructed from Lake Texoma to the Texoma

Balancing Reservoir. Details of the dam facilities and other associated infrastructure are presented in Chapter 2. Other impacts would occur with the extension of existing rural road FM 897 and construction of a new bridge over the reservoir along that alignment to replace FM 1396 which would be lost to inundation.

Clearing of vegetation must occur to accommodate the dam facilities; the Lower Bois d'Arc Creek Dam Conceptual Clearing Plan (Appendix T) provides guidance on the clearing process. The objectives of the plan are to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the proposed reservoir; to improve human access to shore locations by creating shore access locations for boat ramps, bank fishing, etc. through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline (NTMWD, no date-b; NTMWD, 2015b).

Operational impacts are those resulting after completion of the dam facilities including inundation of Bois d'Arc Creek and streams within the project footprint and surrounding habitat for the reservoir, on-going maintenance activities, and consequent anticipated development and recreation activities. Operational impacts also include the required low-flow releases that would pass from the reservoir through the multi-level intake tower and low-level outlet works and discharge to the service spillway chute and higher velocity pulse flows that would be released from the reservoir through multiple levels of sluice gates located in the service spillway.

The project footprint discussed for biological resources includes the proposed reservoir site, raw water pipeline, water treatment facility, and mitigation site, all of which are located in Fannin County and the pipeline from Lake Texoma which is in Grayson County. Impacts associated with the construction and operation of each alternative are summarized in Table 4.6-1. Impacts are presented for wetland habitat, open water and aquatic biota, upland habitat, terrestrial wildlife, threatened and endangered species, and invasive plants; however, the numbers presented are not additive, as impacts associated with each category may occur in the same habitats.

Table 4.6-1. Summary of Impacts to Biological Resources for Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Wetland Habitat			
Size	Construction of the dam and impoundment of water: 4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres (514 HUs) of emergent wetlands, and 49 acres (23 HUs) of scrub shrub wetlands.	Construction of the dam and impoundment of water: 2,909 acres (2,502 FCUs) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, and 27 acres (12 HUs) of scrub shrub wetlands.	Continued degradation of channelized streambed.
Duration	100+ years (long-term)	100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate	Slight

Impact Factors	**Magnitude of Impacts**		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Aquatic Habitat			
Size	78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (123.3 miles) of streams comprised of 286,139 linear feet (LF) (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams.	78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ephemeral streams.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	100+ years (long-term)	100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Slight	Slight (less than Alternative 1)	Slight
Upland Habitat			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP)	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP)	Additional rural home development over unknown amount of acreage in project area
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Terrestrial (Upland) Wildlife			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development.
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Threatened and Endangered Species			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development
Duration	3-4 years	3-4 years	Variable
Likelihood	None to low	None to low	None to low
Severity	None to slight	None to slight (less than Alternative 1)	None to slight (less than Alternatives 1 and 2)
Invasive Species			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Operation Phase			
Wetlands			
Size	4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres of emergent wetlands (514 HUs), 49 acres (23 HUs) of scrub shrub wetlands.	2,909 acres (2,502 FCUS) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, 27 acres (12 HUs) of scrub shrub wetlands, and 20 acres of open water with a conservation pool elevation of 515 feet MSL.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate	Slight
Aquatic Habitat			
Size	78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (123.3 miles) of streams comprised of 286,139 linear feet (LF) (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams.	78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ephemeral streams.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight to moderate (adverse)
Upland Habitat			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Additional rural home development over unknown amount of acreage in project area
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	>50-100+ years (long-term)
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Terrestrial (Upland) Wildlife			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Threatened and Endangered Species			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	Low to medium	Low to medium	None to low
Severity	Slight to moderate	Slight to moderate (less than Alternative 1)	None to slight (less than Alternatives 1 and 2)
Invasive Species			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	Medium	Medium (less than Alternative 1)	High
Severity	Slight to moderate	Slight to moderate	Slight

FCU=Functional Capacity Units; HU=Habitat Units; LF=Linear Feet; WTP=Water Treatment Plant; ft=feet; MSL=Mean Sea Level

4.6.1 No Action Alternative

Habitat

As described in Section 3.4, there are eight habitat types within the project footprint of the affected environment that would require mitigation. Theses habitat types include the wetland habitats of forested wetland, scrub shrub wetland, emergent wetland, and open water; and the upland habitats of upland deciduous forest, riparian woodland /bottomland hardwood, grassland/old field, and upland shrubland. The most dominant vegetated habitat types are forested wetlands followed by emergent wetland.
Under the No Action Alternative, the proposed reservoir, dam, pipeline, and water treatment plant would not be built; therefore, no direct removal of vegetation and no inundation of vegetation related to project activities would occur.

Wetlands

Under the No Action Alternative, no direct impacts would occur to the wetland vegetation communities. However, changes to the environment would likely be variable in duration with a high likelihood of occurrence and slight severity. The continuing pattern of steady population growth in Fannin County is expected to continue over the next few decades, as are the current practices of silviculture, forestry and logging, and limited land clearing for agricultural purposes. The native wetland vegetation communities would experience negative changes in cover should there be an increase in agricultural use of land in the area or an increase in development of residential communities and commercial areas and associated infrastructure including roads and bridges, particularly should additional channelization or diversions occur.

The addition of new residential communities and commercial areas would lead to the disturbance of native wetland habitats, partial or entire removal of native wetland habitat vegetation, increased flows and reduced freshwater availability, accelerated delivery of contaminants and pollutants to the watershed, and could lead to the introduction of non-native and invasive plant species as well as the introduction of domestic animals such as dogs and cats. Effects from non-native invasive plant species introduction, activities of domestic pets, and increased contaminants and pollutants would result in a reduction in native plant cover and a reduction in habitat suitability and native wildlife diversity. Positive effects on native wetland habitats could occur in areas where agricultural activity has ceased; a natural succession of native wetland plant communities could occur. Any substantive change to vegetation communities in the area would come from projects unrelated to the proposed reservoir, dam, WTP and pipeline. Under the No Action Alternative, without additional agriculture, development, or modifications to the watershed, adverse effects to the vegetation communities or habitat of the proposed project site and surrounding area would be expected to be slight and would be expected to change based upon anticipated slight to moderate changes of the hydrology and hydraulics of Bois d'Arc Creek and affected tributaries over time; historic trends in the area would be expected to continue for several decades.

Forested Wetlands

The forested wetland vegetation community observed in the Bois d'Arc Creek watershed has overall relative low diversity. While this could be indicative of the immature condition of some areas of the forested wetlands as a direct result of the decades-long logging activities, such operations have not been prevalent within properties owned and managed by the USFS in the Caddo National Grasslands areas downstream of the proposed reservoir, which have been shown to have similar functional capacity as the upstream areas. Under the No Action Alternative without additional agriculture, development, or modifications to the watershed, the 4,602 acres (4,035 Functional Capacity Units) of forested wetlands observed in the Bois d'Arc Creek watershed would not be expected to experience significant changes, but may gradually and slightly increase in value over time.

Emergent Wetlands

Under the No Action Alternative, no impacts would occur to the 1,223 acres (514 HUs) of emergent wetlands in the project footprint. However, changes could occur due to additional agriculture, development, or modifications to the watershed vegetation as a result of the excessive erosion and downcutting in Bois d'Arc Creek. These trends would affect the ability of emergent wetlands to persist in various portions of the project footprint.

Scrub Shrub Wetlands

Under the No Action Alternative, no impacts would occur to the 49 acres (23 HUs) of scrub shrub wetland vegetation. However, changes to this cover type would occur if additional agriculture, development, or modifications to the watershed occurred. Because the scrub shrub wetlands are wetlands in successional transition between emergent wetlands and bottomland wetland forests, the continuing bank instability and erosion in Bois d'Arc Creek could affect persistence of scrub shrub wetlands in certain locations within the project footprint. Some of the scrub shrub wetlands would likely undergo succession and become forested wetlands while new scrub shrub would be created by natural forces.

Upland Habitats

As noted above, projected population growth in Fannin County over the coming decades is likely to result in substantial development in the county, leading to the conversion of an unknown amount of the upland habitat within the project footprint to developed land uses, such as rural residential. This would entail long-term habitat loss to some extent, including forest, grassland/old field, cropland, and tree and scrub savanna.

Open Water Habitats and Biota

Under the No Action Alternative, no direct and immediate impacts would occur to the 78 acres of open water and associated aquatic life. Terrestrial habitat would not be converted to lacustrine habitat at the proposed reservoir site. Changes would nevertheless occur and would be long-term in duration with a high likelihood of occurrence and moderate severity. Any substantive change to aquatic life would come from projects unrelated to Alternatives 1 and 2 such as changes in agricultural practices and development that could occur near or within the surface waters of the area. Without changes in the watershed, Bois d'Arc Creek is expected to continue to down-cut and erode. As the channel becomes even more incised, lateral connectivity with the surrounding floodplain would continue to decrease. Due to the unstable nature of much of the stream banks along Bois d'Arc Creek and easily erodible bed materials, the stream channel will continue to enlarge. This would further reduce longitudinal connectivity at low flows and continue to constrain aquatic species to specific habitats that contain water (e.g., pools).

Fish

Under the No Action Alternative, no direct impacts would occur to fish populations. The majority of the fish species) collected from Bois d'Arc Creek during this instream flow study were generalist species (81 percent), with only a few that are characteristically found only in flowing water or considered fluvial specialists. The slight to moderate changes in the hydrology of Bois d'Arc Creek and tributaries that are anticipated to occur over time are expected to continue to support existing populations of generalist fish species and contribute to overall low biodiversity.

Benthic Macroinvertebrates

Under the No Action Alternative, no impacts would occur to benthic macroinvertebrates. Due to the ongoing degradation of the watercourses, the dominance of collector-gatherer, predator, and scraper species (representing more than 80 percent of the population) would continue. The presence of few filter-feeding or shredder species, which is an indicator of ecological degradation, would also continue.

Terrestrial (Upland) Habitat and Species

Under the No Action Alternative, effects to wildlife habitat and wildlife in the project footprint of Alternatives 1 and 2 would likely be slight and adverse. Few effects to wildlife would be likely to occur in the area of the proposed reservoir, dam, pipelines, and WTP near Leonard from the No Action Alternative. Existing wildlife habitats would not be removed, replaced or converted at these sites except for changes due to possible agricultural, residential, and other development; additionally, natural succession would occur where not interrupted by natural or human disturbances. These changes or growth are anticipated to follow historic patterns and continue at a gradual though perhaps increasing rate, in conjunction with expected population growth and development in Fannin County, much of which would occur regardless of whether or not Alternative 1 or Alternative 2 is implemented. Any substantive change to wildlife populations in the project footprint under the No Action Alternative would be from additional rural home construction, timber harvest, an increase or intensification of agriculture practices, or abandonment of agricultural fields to old fields, grass fields, or eventually, woody habitat. There could also be changes in upland small and large game hunting intensity (increasing or decreasing) as human population grows and with changes in the populations of native species such as deer, rabbit, and squirrel or of competing invasive species, like feral hogs.

Threatened and Endangered Species

Under the No Action Alternative, effects to both federal and state-listed threatened and endangered species would be none to slight and associated with independent actions in the area. Any effects are expected to be gradual and result over time from an increase in population, development, or agricultural activity. Because of the small number of potential threatened or endangered species in Fannin County and lack of suitable habitats within the proposed reservoir and dam site, effects to threatened and endangered species under the No Action Alternative would likely be no more than slightly adverse.

Invasive Species

Invasive plant species – especially grasses and forbs – are generally found in disturbed soil conditions.

Surface disturbance and construction activities from increased development in the project area could facilitate the establishment and spread of noxious weeds. Aggressive non-native species could become established if ground disturbance during construction is extensive and lengthy. Construction equipment could aid in the facilitation of invasive species by transporting an invasive species from one area to another (FHWA, 1999). Invasive species – both plants and animals – can harm native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other resources (e.g., sunlight), preventing them from reproducing, changing food webs, and modifying ecosystem conditions. Overall effects of invasive species under the No Action Alternative are expected to be slight in severity, of high likelihood, and long-term.

4.6.2 Alternative 1

Impacts Associated with Project Phases

In general, the impacts to biological resources are best described based on two project phases: 1) construction and 2) operations.

Construction Phase

Clearing of vegetation for the dam, reservoir, and associated structures under Alternative 1 would result in direct and permanent elimination of a variety of vegetation cover types and wildlife habitat within the proposed 17,068-acre reservoir footprint. Before inundation of the proposed reservoir, much but not all of the standing woody material, including dead and living trees and shrubs five feet tall or taller, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed in accordance with the reservoir clearing plan. Trees and shrubs that are not cleared would eventually drown and die, gradually decomposing underwater but contributing to underwater habitat structure for a number of years. The partial reservoir clearing would take place approximately two years preceding reservoir inundation. Areas used for construction of the dam and associated facilities would be cleared earlier. Both hand and machine clearing could take place, and cleared materials would be placed in windrows or piles and left to dry and eventually burned depending on fire danger conditions.

Raw water transmission facilities including the intake pump stations at the edge of the reservoir near the dam and the 35-mile long, 90-96 inch raw water pipeline would be constructed fully in uplands or existing right-of-way (ROW) and would avoid wetlands habitat. However, during construction, a temporary construction easement is proposed for a total width along the alignment of the pipeline of 70 feet. After construction, the permanent easement would be 50 feet wide. The proposed WTP and TSR would be located on NTMWD-owned property near the city of Leonard in Fannin County. There would be no effects to wetland vegetation, since the entire construction area is located on upland.

In addition to clearing and direct inundation, potential effects from general construction activities include soil compaction, possible spills of fuels and/or other materials, introduction and spread of invasive species, erosion, and an increase in construction dust.

Construction of the dam and reservoir would result in soil compaction of the proposed dam site and surrounding area, although the vegetation is scheduled to be removed during the dry season, which would reduce possible impacts of soil compaction. Excessive soil compaction can impede root growth by altering the structure of soil, decreasing a plant's ability to take up nutrients and water. Soil compaction also increases water runoff and soil erosion. Surface water runoff and sediment from areas disturbed by construction could adversely affect local vegetation by exposing soils and transporting sediment off site. Since vegetation would be cleared two years before inundation, the soil in this area would be exposed and experience soil erosion. A storm water pollution prevention plan (SWPPP) and erosion and sedimentation control plan would be implemented to minimize the potential for contamination of surface or groundwater resources.

Possible spills of fuels and/or other material could cause shifts in population structure, abundance and diversity, and distribution of plant species. Some materials could remain in the environment long after a spill event. With appropriate oversight, any spills during construction of the dam and reservoir would be expected to be small, contained, and remedied appropriately.

During construction, adverse effects to local vegetation outside of the proposed reservoir site might occur as a result of fugitive dust emissions from construction machinery and worker traffic along unpaved roads (Ko and Alberico, no date). Dust emissions could reduce photosynthesis by reducing the light penetrating into the leaves of plants and could increase the growth of plant fungal disease (Farmer, 1993). Dust from construction related activities would be short-term and controlled by dust suppression measures (e.g., water spraying) as required by regulation. After construction, local off-site vegetation is expected to recover in a reasonable time. Construction equipment and surface disturbance could aid in the facilitation of invasive plant species by transporting an invasive species from one area to another (FHWA, 1999). Aggressive non-native species could become established if ground disturbance during construction is extensive and lengthy.

Individual and population-level impacts to wildlife during the construction phase would include displacement of those individual animals whose habitat is eliminated, with probable declines in overall local population numbers, as displaced individuals are forced into neighboring territories where they would compete with already established members of their species for limited food supplies and other resources. Other construction-related adverse effects would include collisions with construction equipment and workers' personal vehicles, direct mortality of smaller vertebrates and invertebrates unable to avoid bulldozers and scrapers during land clearing, and noise and general disturbance impacts from intensive construction activity.

During construction of the proposed dam and reservoir, short-term, localized adverse effects to wildlife are expected to occur from noise, light pollution, and general disturbance. Wild animals rely on meaningful sounds for communicating, navigating, avoiding danger and finding food. Noise pollution is defined as any human sound that alters the behavior of animals or interferes with their daily functions (FHWA, 2011). The level of impact from noise on wildlife depends on decibel levels, durations, and the physical characteristics of the environment (Ouren et al., 2007). Noise pollution can harm the health, reproduction, survivorship, habitat use, physical distribution, abundance or genetic distribution of wildlife (FHWA, 2011). Noise can also lead to changes in behavior, including avoidance behavior and changes in normal patterns (Radle, 1998). For example, intrusion-induced behaviors, such as nest abandonment and decreased nest attentiveness have led to species decline (USFS, 2009). As noted, impacts would be localized to the general vicinity of the proposed dam and reservoir during construction.

Injury or mortality of wildlife may result from collisions with vehicles and construction equipment. These effects normally remain localized and limited to the immediate vicinity of a construction project site and are not expected to impact the population of affected species as a whole. Birds are especially susceptible to collisions with stationary objects (USFWS, 2002).

Operations Phase

Operation of the proposed reservoir would result in continued permanent effects to vegetation communities as a result of inundation as well as indirect effects to vegetation outside of the immediate project footprint. Potential adverse effects to biological resources include an increase in recreational activities and an increase in residential housing and commercial establishments along the shoreline of the proposed reservoir. Anticipated increases in recreation and residential housing would result in an increase in vegetation removal, soil compaction, soil erosion, surface water runoff, and an increase in the introduction and facilitation of invasive plant species. Recreational users could trample vegetation, increasing soil compaction and soil erosion, and surface water runoff along the reservoir shoreline. Soil erosion and surface water runoff would degrade nearby water sources, including the proposed reservoir.

Operating the proposed reservoir could affect the vegetation along the stream channel downstream of the dam, including within the Caddo National Grasslands. The presence of the dam and reservoir and the proposed operation plan, including water releases, would reduce or eliminate large erosive flow events and would allow vegetation along banks to become better established. This would increase stream bank stability from deeper and denser vegetative roots. The plant matter on the bank faces would deflect flowing water away from the banks, reducing shear stress from moving water on stream banks. Vegetation downstream within the Caddo National Grasslands would follow this trend and any adverse effects to this area would likely be slight.

To provide recreational enjoyment and for emergency purposes, shoreline vegetation would be removed in certain locations for user access to the reservoir. A number of landing sites would be identified along the future reservoir shoreline. Clearing at these sites might require the removal of stumps and other vegetation to ensure safe access/exit to the shoreline. To minimize environmental effects, hand clearing would be considered at landing sites above the high water mark. In addition, large woody debris within the reservoir would be removed as necessary.

4.6.2.2 Habitat

Overall the wetland habitats with the greatest acreage of loss from implementation of Alternative 1 would be forested wetland and emergent wetland, with 4,602 acres (4,035 FCUs) and 1,223 acres (514 HUs) of impacts, respectively. Additional losses would occur to scrub shrub wetland and habitats (49 acres/23 Hus). Table 4.6-2 summarizes the habitat impacts associated with Alternative 1. Under Alternative 1, subject to the provisions of the Section 404 permit, Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the LBCR footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed in designated areas in accordance with the Conceptual Clearing Plan (Appendix T).

Table 4.6-2. Habitat Impacts Associated With Alternative 1

Cover Type	Area (acres)	Habitat Units	Functional Capacity Units
Forested Wetland	4,602	--	4,035
Scrub Shrub Wetland	49	23	--
Emergent Wetland	1,223	514	--
Open Water	78	--	--
Upland Deciduous Forest	2,216	1,058	--
Riparian Woodland/ Bottomland Hardwood	1,728	434	--
Grassland/Old Field	4,761	2,896	--
Shrubland	64	--	--

Note: Forested wetlands were assessed using the Modified East TX HGM Methodology. All other cover types were assessed using the USFWS's HEP Procedures.

Wetlands

Under Alternative 1, overall effects to the wetland vegetation communities of the affected environment during construction and operations would likely be long-term (100+years) in duration with a high likelihood of occurrence and moderate severity. More information on the specific vegetation communities is provided below.

Forested Wetlands

During the construction of the dam and related facilities and inundation of the reservoir under Alternative 1, approximately 4,602 acres (4,035 HUs) of forested wetlands would be directly and permanently eliminated by clearing, direct fill impact or and/or inundation. Ninety-two percent (11 of 12) of the twelve tree species identified are classified either as facultative (equally likely to occur in wetlands or uplands) or facultative upland (usually found on non-wetland sites), indicating that these forested wetlands are comprised of tree species adapted to temporary or seasonal flooding, rather than semi-permanent flooding, inundation, or saturation. Because the tree community is already dominated by facultative and facultative upland species (rather than obligate wetland or facultative wetland species), the majority of forested wetland areas not cleared mechanically for the project and that will be subject to inundation would not be expected to survive.

Forested wetlands within the temporary construction pipeline easement would revert to their respective cover types over time. Within the permanent 50-foot pipeline easement, however, forest cover types would be converted to grassland following re-vegetation of the easement and would be maintained as such. After reservoir impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b). The downstream corridor below the dam along Bois d'Arc Creek is expected to continue to function as forested wetlands after the construction of the dam because hydric soils will remain in place and would continue to be supported by periods of saturation and inundation during the growing season; the existing riparian community is comprised of facultative species, which are "equally likely to occur in wetlands and non-wetlands" (Lichvar et al., 2012). Existing species can tolerate hydrology changes; there are no expected changes to plant communities or wildlife habitat, and multiple sources of hydrology will remain to support wetlands.

Emergent Wetlands

Construction of the dam and impoundment of water under Alternative 1 within the normal pool elevation of 534 feet MSL would result in the removal of 1,233 acres (514 BHUs) of emergent wetland vegetation by direct fill impact or inundation of waters of the habitat. However, emergent wetlands are expected to develop following inundation and during the operation phase within the littoral zone of the proposed reservoir; they would provide a functional wetland community which would offset some of the impacts resulting from the proposed reservoir project.

Many of the areas where these littoral wetlands are expected to develop are currently functioning emergent wetlands and would continue to function as emergent wetlands following impoundment of the reservoir. The existing wetlands would also serve as a seed source for the newly developed littoral wetlands, helping to establish vegetation. Based on a review of data collected from seven freshwater reservoirs located within the North Texas area, on average, approximately 16 percent of the total surface area of the lakes/reservoirs surveyed develop submerged, emergent, or floating leaved (or a combination of) vegetation within the littoral zone.

If similar conditions were to develop at the proposed Lower Bois d'Arc Creek Reservoir site (reservoir area at conservation pool elevation is approximately 16,641 acres), this would equate to approximately 2,663 acres (16 percent of 16,641 acres) of littoral zone wetland development. However, a more conservative approach, and one that would have a greater probability of occurring, is to use the reservoir area between elevations 531-534 feet MSL, which equates to the development of approximately 1,400 acres of littoral zone wetlands along the shoreline of LBCR. More information is available in the Mitigation Plan (Appendix C).

Scrub Shrub Wetlands

Construction of the dam and impoundment of water under Alternative 1 within the normal pool elevation of 534 feet MSL would result in the removal of 49 acres (23 HUs) of scrub shrub wetland vegetation by direct fill impact or inundation of waters. Clearing of habitat for the dam and associated structures would directly remove some scrub shrub habitat. Because it is dominated by plants in successional transition between herbaceous wetlands and bottomland hardwood forests, much of the habitat in the inundation footprint would not survive, however the habitat in the newly established transition zones would be expected to recover.

Upland Habitats

Upland Deciduous Forest

Approximately 2,216 acres (1,058 HUs) of upland deciduous forest would be permanently eliminated or converted to other habitat types by Alternative 1 at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. A much smaller area of upland deciduous forest or woodland patches – about 10 acres – would be permanently removed along the maintained 50-foot-wide raw water pipeline corridor and at the North WTP. This area would be converted to grassland and kept free of trees. Overall, the permanent loss of 2,216 acres at the reservoir site would represent a slight, long-term impact on the upland deciduous forest resource in Fannin County.

Riparian Woodland/Bottomland Hardwood Forest

Approximately 1,728 acres (434 HUs) of riparian woodland/bottomland hardwood forest would be permanently eliminated or converted to other habitat types by Alternative 1, almost entirely at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures, as well as by the impounded water of the reservoir. Virtually no riparian woodland/bottomland hardwood forest would be eliminated along the raw water pipeline and at the North WTP. Overall, the permanent loss of 1,728 acres of the regionally scarce riparian woodland/bottomland hardwood forest resource would represent a moderate, long-term impact.

Grassland/Old Field

Approximately 4,761 acres (2,896 HUs) of grassland/old field habitat would be permanently eliminated or converted to other habitat types by Alternative 1, mostly at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures and by the impounded water of the reservoir. Virtually no grassland/old field would be permanently eliminated along the raw water pipeline. Grassland within the proposed 70-foot wide temporary easement and 50-foot permanent easement would be restored through re-vegetation upon completion of construction. Up to 300 acres or more of grassland/old field habitat at the WTP site would be developed into the WTP and terminal storage reservoir (TSR). Overall, the permanent loss of 4,761 acres at the reservoir site and several hundred acres

Reservoir Pool

- Expect similar aquatic species found in the instream study to thrive in lake environment
- Expect similar water quality conditions to existing North Texas Lakes
    - Some stratification during hot summer months
- May decrease sediment loading downstream due to reduced hydraulic gradient and current velocities

at the WTP/TSR site would represent a slight, long-term impact on grassland/old field habitat in Fannin County.

Shrubland

Approximately 64 acres of shrubland would be permanently eliminated or converted to other habitat types by Alternative 1, almost entirely at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. Overall, the permanent loss of 64 acres at the reservoir site would represent a slight, long-term impact on shrubland in Fannin County.

Aquatic Habitats and Aquatic Biota

The effects of dam and reservoir construction activities under Alternative 1 to 78 acres of open water and associated aquatic life would be both adverse and beneficial. Overall effects of construction and operations under Alternative 1 would likely be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight to moderate severity. Impounding Bois d'Arc Creek and converting riparian bottomland hardwood forests and stream habitats to open water, marsh, and mudflats would have both beneficial and adverse indirect effects on aquatic species. The effect of reservoir impoundment on many fish species would likely be beneficial due to the increased acreage of deep open water for foraging and reproducing.

Operation of the proposed reservoir could result in indirect adverse effects to aquatic biota outside of the immediate footprint. Potential adverse effects might occur from an increase in recreation and residential housing along the shoreline of the proposed reservoir. Increases in recreation and residential housing would result in an increase in habitat removal, soil compaction, soil erosion, and surface water runoff, and might facilitate the introduction of invasive species. Depending on how much recreation and development would increase, adverse effects could be small to medium in extent.

Recreational users could trample species habitat and food sources. Recreational users could also increase soil compaction, soil erosion, and surface water runoff. Soil erosion and surface water runoff could degrade nearby water sources, including the proposed reservoir. Recreational users could facilitate the spread of invasive species into the reservoir area because invasive species can travel from one location to another on vehicles, pets, and people. Invasive species could become established, replacing the natural habitat and food source for native wildlife species.

Bois d'Arc Creek experiences rapid rises and falls in response to rainfall events and extended periods of little or no flow, which determines what aquatic species survive in this extreme flow dynamic. During project construction, stream habitat would be inundated and converted to lacustrine (lake-like) habitat. Diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently flooded are expected to change as a result of the creation of a permanent water source with both shallow and deep water lentic (still water) habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream (lotic or flowing water) habitats would be disadvantaged. The abundance of species that are more generalist or versatile are expected to experience little change.

The reservoir would increase the surface area, depth, and the volume of water of the Bois d'Arc stream system, which in turn would alter the water quality. Current stream velocities would decrease to almost zero throughout most of the reservoir, causing sediment particles to fall from suspension, and water that exhibited low transparency (high turbidity) as a flowing stream carrying a substantial load of suspended sediments could become relatively clear. Because of the proposed reservoir's depth and lack of water movement, the reservoir would be expected to stratify; i.e. to develop distinct warmer layers near the surface and colder layers toward the bottom, during the late spring through fall months. A strong temperature gradient known as a thermocline could develop in the late summer months, which could become a barrier between the lighter, well-oxygenated surface water and colder, oxygen-starved deeper water. Due to this barrier, low dissolved oxygen (DO) levels could occur in the proposed reservoir in deeper water during very hot summer months which could be harmful to some aquatic biota. By October the DO levels would be expected to increase from the summer months and exceed the High Aquatic Life criterion of 5.5 mg/L throughout the reservoir pool.

Effects to the aquatic biota downstream of the dam would be mitigated through periodic, regulated releases of reservoir water to Bois d'Arc Creek below the dam (environmental flow releases). These releases would be performed to compensate for losses of stream function and wildlife habitat, and are expected to enhance instream uses below the dam. The flow regime required in the draft water right permit would maintain flowing water in the creek channel, provide for connectivity between pools, maintain existing aquatic habitat and communities, and protect water quality downstream. The proposed pulse flow regime is expected to provide sufficient flows to benefit and maintain habitat without causing erosion and channel degradation and to meet seasonal criteria for dissolved oxygen concentration (Watters and Kiel, 2016).

Fish

Dam construction and operation under Alternative 1 would cause the loss of riverine habitat and consequently the loss of fish found only in rivers and streams. These effects would be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight severity.

Dewatering activities during project construction may impact aquatic resources by stranding finfish and shellfish. Other harmful construction activities can trample, dredge, or fill areas with sessile (immobile) aquatic resources such as attached plants and mussels. To avoid or reduce these potential impacts, TPWD may recommend relocating aquatic life – including but not limited to, fish, turtles, and mussels – to one or more areas of suitable habitat away from the project footprint. Such relocation activities would be approved and carried out under the authority of a TPWD *Permit to Introduce Fish, Shellfish or Aquatic Plants into Public Water.* An Aquatic Resource Relocation Plan (ARRP) is used to plan resource handling activities and to assist in the permitting process with TPWD (Melinchuk, 2015).

After inundation and during the operation phase, the current riverine habitat in the proposed reservoir site would be converted to lacustrine habitat. A Reservoir Clearing Plan has been developed to guide the process of removing vegetation so as to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir. The species composition after inundation is expected to shift towards more pool-associated species, largely composed of sunfish (Centrarchids *spp.*), temperate bass (Moronidae *spp.*), catfish (Ictalurids *spp.*), and suckers (Catostomids *spp.*). The magnitude of this change depends upon impoundment size, position of the impoundment along the stream, stream size, and current species composition. The newly created lacustrine habitat would compensate for some of the loss of fish species that are found only in rivers and streams through the increased numbers of pool-associated fish species.

Current aquatic habitat in the proposed site is degraded because Bois d'Arc Creek has been channelized and stream flows are inconsistent with intermittent periods of no flows; the proposed reservoir and dam would create a more stable lacustrine environment. A study conducted in Illinois found that a creek in which 48 fish species were documented prior to impoundment supported a total of 74 species and two hybrids after inundation (Taylor et al., 2001). The increase in species richness was attributed to introductions of non-native species from other regions and creation of favorable habitat for certain species. Six species from pre-impoundment were not found post-impoundment. Other studies have shown little change in overall fish species richness, substantial reductions in richness, and large shifts in dominant species within assemblages (Appendix M).

The dominant fish in the proposed reservoir are expected to include combinations of longear sunfish, bullhead minnow, freshwater drum, logperch, and orange spotted sunfish. Other fish that are expected to be common in the proposed reservoir include gizzard shad, threadfish shad, bluegill, redear sunfish, channel catfish, white bass, and largemouth bass. Fish species found generally abundant in other Texas reservoirs could also become abundant in the proposed reservoir. Chapter 3 contains information on the fish species that were collected in the Bois d'Arc watershed during four separate studies. To determine if these species would be likely inhabitants of the proposed reservoir, each species' preferred habitat was reviewed. If a species' habitat included a lacustrine environment or the species had previously been found in a reservoir, the species was considered as likely to survive in the proposed reservoir. Thirty-three of the species currently found in the Bois d'Arc watershed were determined to be likely to survive in the proposed reservoir; ten were determine to be unlikely to survive in the proposed reservoir. The results of these studies are shown in Table 4.6-3.

Table 4.6-3. Fish Species Documented in Bois d'Arc Creek and Likelihood of Survival in the Reservoir Environment

Scientific Name	Common Name
Likely to Survive In Reservoir Environment	
Ameiurus melas	Black bullhead
Ameiurus natalis	Yellow bullhead
Aplodinotus grunniens	Freshwater drum
Carpiodes carpio	River carpsucker
Cyprinella lutrensis	Red shiner
Cyprinella venusta	Blacktail shiner
Cyprinus carpio	Common carp
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Threadfin shad
Fundulus notatus	Blackstrip topminnow
Gambusia affinis	Western mosquitofish
Ictalurus punctatus	Channel catfish
Ictiobus bubalus	Smallmouth buffalo
Labidesthes sicculus	Brook silverside
Lempois macrochirus	Bluegill
Lempois megalotis	Longear sunfish
Lepisosteus oculatus	Spotted gar
Lepisosteus osseus	Longnose gar
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted sunfish
Lepomis microlophus	Redear sunfish
Micropterus punctulatus	Spotted bass
Micropterus salmoides	Largemouth bass
Notemigonus crysoleucas	Golden shiner
Noturus gyrinus	Tadpole madtom
Percina caprodes	Logperch
Percina macrolepida	Bigscale logperch
Pimephales vigilax	Bullhead minnow
Pomoxis nigromaculatus	Black crappie

Scientific Name	Common Name
Pomoxis annularis	White crappie
Pylodictis olivaris	Flathead catfish
Notropis amabilis	Texas shiner
Lepomis cyanellus	Green sunfish
Not Likely to Survive in Reservoir Environment	
Campostoma anomalum	Central stoneroller
Lythrurus fumeus	Ribbon shiner
Moxostoma erythrurum	Golden redhorse
Notropis atrocaudalis	Blackspot shiner
Notropis stramineus	Sand shiner
Noturus nocturnus	Freckled madtom
Percina sciera	Dusky darter
Phenacobius mirabilis	Suckermouth minnow
Percina phoxocephala	Slenderhead darter
Etheostoma gracile	Slough darter
Unknown if Likely to Survive in Reservoir Environment	
Cyprinella hybrid	*
Lepomis hybrid	*

Sources: Freese and Nichols, 2010a; Texas A&M, no-date
*Data and reports do not identify which species of fish contribute to the hybrid family classification

Because of the changed flow rate downstream, vegetation along downstream stream banks is anticipated to be denser than what is currently there, reducing the amount of erosion. Release criteria in the prescribed environmental flows would maintain the existing geomorphic features and remove accumulated fine sediments from those features while reducing the potential for additional erosion or downcutting below the reservoir. In general, changes in flow regime downstream of reservoirs can negatively affect fish species with narrow habitat requirements. These species use temperature or flow for reproductive cues, are substrate-specific spawners, and depend on higher flows for egg dispersal. Additional adverse effects may include nutrient limitation, water temperature changes, and loss of stream connectivity. Indirect effects from reduction in habitat diversity could result from predation and altered community structure. However, given that the majority of fish species documented from Bois d'Arc Creek are habitat generalists, little adverse effect is expected on downstream fish community and biodiversity provided there is water flowing in the creek (Watters and Kiel, 2016).

During long-term operations at the LBCR, it is expected that fish populations would be managed in the reservoir by an entity other than NTMWD for the benefit of a sports fishery. Aquatic life downstream of the dam would be managed by means of the proposed water releases and instream flow regime. These measures have been approved by TCEQ in the form of special conditions to the water right permit (Appendix F). Downstream of the reservoir, likely effects of Alternative 1 on aquatic life would be largely beneficial, due to the ability of water managers to control flows throughout the year, thereby avoiding excessively erosive discharges during storm events as well as periods of little and no flow later in the season, both of which tend to be harmful to aquatic species and habitat. Pulse flows throughout the year may assist certain species that require those cues for spawning, reproduction, and movement.

Benthic Macroinvertebrates

Impacts under Alternative 1 to benthic macroinvertebrates are expected to be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight severity. Slight adverse effects to invertebrates would occur due to construction and inundation of the proposed dam and reservoir. Invertebrates occupy habitats with both still and running waters, including slow-moving muddy rivers. Most invertebrates spend most of their life cycle attached to submerged rocks, logs, and vegetation. In a stream environment, invertebrate habitat includes the rocks and sediments of the stream bottom, the plants in and around the stream, leaf litter and other decomposing organic material that falls into the stream, and submerged logs, sticks, and woody debris. These organisms rely on these areas for shelter, food, and dissolved oxygen (USEPA, 2009). The aquatic habitat available for invertebrates would be changed in the proposed reservoir pool from a riverine habitat to a lacustrine habitat. In general, invertebrates of streams are adapted to these environments. Organisms that inhabit reservoirs do not usually require highly oxygenated waters. The reservoir habitat created could support a productive invertebrate community, although the overall species diversity of macroinvertebrates would likely decrease (Young et al., 1976).

Adverse effects to invertebrates as a whole are expected, though adverse effects to mussel species from the proposed reservoir and dam are not expected to occur. Table 3.4-5 in Chapter 3 of this EIS lists mussel species found in the proposed reservoir site. Since many of these species occur in lacustrine environments, they are expected to adapt to life in the proposed reservoir.

Because the raw water pipeline route crosses mostly upland habitat and open farmland and completely avoids valuable habitats such as forested wetlands, impacts to aquatic species are mostly indirect, and potentially include water quality degradation from soil compaction, soil erosion, and surface water runoff. There would be minimal direct, temporary impacts to waters and wetlands, and a SWPPP would be developed to address soil erosion and surface water runoff. Due to the size, nature, and location of the proposed pipeline construction, any effects to aquatic species would be adverse, negligible to slight in severity, short-term, small in extent, probable, and slight in precedence and uniqueness.

Increased recreational use of the proposed reservoir area could facilitate and spread invasive species as well as increase soil compaction, soil erosion, and surface water runoff. Boat propellers, bilges, and livewell tanks could introduce invasive species from one water body to another, both into the Lower Bois d'Arc Creek Reservoir from other lakes and from this reservoir to other lakes. Stocking fish for recreation could introduce non-native predators or parasites into the aquatic environment. Soil compaction, soil erosion, and surface water runoff could degrade the water quality of the reservoir, adversely affecting aquatic life. Impacts from operation of the reservoir would be adverse, slight to moderate in severity, long-term, medium in extent, and probable.

Downstream of the proposed reservoir, existing macroinvertebrate communities should not change greatly, as long as adequate flows are maintained, which is likely to be the case as this will be required by permit.

Terrestrial (Upland) Habitat and Wildlife Species

Adverse effects from the proposed dam and reservoir construction and operation on wildlife are of high likelihood, and would be expected to be moderate in severity and short-term and long-term in duration. During construction, terrestrial habitats at the dam site and within the cleared areas would be removed and replaced by largely open water lacustrine habitat with perhaps some emergent marsh and other shallow waters at the upper end of the reservoir. Generally, according to the HEP evaluation, the habitat quality (HSI) is the highest for cropland, tree savanna, and shrublands. Riparian woodland/bottomland hardwood habitat is of relatively low quality, with a habitat suitability index of 0.25. Though tree savannas in the proposed site have the highest HSI value of 0.73, there are only 132 acres of tree savannas in the proposed 17,068 acre reservoir site. Shrublands have an HSI of 0.57 and make up 63 acres of the 17,068 acre site. Though croplands have an HSI value of 0.72 and 1,757 acres of the site are croplands, those vertebrates that use croplands (primarily birds and mammals) rely on croplands primarily for food sources.

While some direct mortality to birds, small mammals, reptiles and amphibians may occur during construction (inadvertent destruction of dens, nests, hiding organisms, etc. by heavy equipment,) most terrestrial wildlife within the project site would be displaced and would relocate to adjacent and nearby areas. These nearby areas may already be occupied territories by members of the same species or related species with similar habitat or food requirements and thus would be incapable of supporting a higher population density. In that case, further displacement or mortality of wildlife would occur. Because of the loss of habitat, effects on wildlife would be moderate in severity. Construction of the reservoir would also result in the creation of habitat for migratory waterfowl, shorebirds, and wading birds that to some extent would offset habitat losses for other types of wildlife.

The greatest short-term and long-term adverse effects, both direct (mortality) and indirect (habitat loss) would occur to reptiles, amphibians, and small mammals, which have smaller territories or home ranges that would be completely eliminated. However, these population declines would be insignificant in the context of county-wide and regional populations of these organisms.

Impounding Bois d'Arc Creek and converting riparian bottomland hardwood forests and stream habitats to open water, marsh, and mudflats would have both beneficial and adverse indirect effects on migratory birds. The effect on migratory waterfowl (ducks, geese, swans) would likely be somewhat beneficial due to their ability to take advantage of open water for foraging, loafing and resting. The effect on shorebirds is likely to be neutral or mixed, but the net effect would probably be positive due to an increase in shallow flooded areas and mudflats, especially at the upstream end of the reservoir. The indirect effect on neotropical migratory, forest-dependent songbirds such as warblers and vireos and grassland-dependent birds like the dickcissel would be negative due to the disappearance of their habitats from the site.

Construction of the reservoir, dam, and access roads would result in a small amount of localized habitat fragmentation. Habitat fragmentation is defined as "an ecological process in which a large patch of habitat is divided into smaller patches of habitats", and it is considered a growing threat to species existence (Al-jabber, 2003). Habitat fragmentation can isolate wildlife populations, decreasing population productivity. Construction of the roads, the dam and associated water transmission facilities could create wildlife barriers and alter migration patterns and species dispersal. Effects of habitat fragmentation from road construction and reservoir inundation would be long-term and adverse but of slight severity. The project area and surroundings are already quite fragmented, as reflected by the variety and configuration of existing habitat types.

Threatened and Endangered Species

Due to the lack of habitat and lack of occurrence records of federal listed threatened and endangered species, adverse effects to federally listed threatened and endangered species are not expected to occur as a result of construction and operation of the proposed dam and reservoir. Section 7 of the ESA requires federal agencies to consult with the USFWS to ensure that actions they authorize, fund, or carry out will not "jeopardize" listed species. The USFWS Species by County list for Fannin County (USFWS, 2013) includes three species – the bald eagle (delisted and in recovery), the interior least tern (endangered) and the black bear (similarity of appearance with the Louisiana black bear subspecies, which is threatened) as known or believe to occur in Fannin County. However, bald eagles have been delisted and the project area contains no nesting sites and limited foraging habitat for interior least terns, and while potential habitat for black bears does occur within the reservoir footprint; none have ever been documented on-site.

No direct adverse impacts to the interior least tern would be anticipated. The project site lacks suitable nesting habitat and foraging habitat during nesting season is generally confined to within two to four miles of the nest site.

No direct adverse impacts to the black bear would be anticipated from the proposed of the dam and reservoir. While potential habitat is present for the black bear, only one siting has occurred in Fannin County, in 1977. Also, the preferred habitat of the black bear consists of expansive forests with escape cover and minimal human disturbance. Though there is little developed land in the project area, agricultural fields are a large part of the proposed site.

In sum, since the federally listed species for Fannin County are unlikely to be found on site or in adjacent areas, indirect impacts are not anticipated.

The TPWD county list website (TPWD, 2014) identifies 20 state threatened and endangered animal species (nine birds, two mammals, five fish, three reptiles, and one insect) as potentially occurring in Fannin County, Texas. While the majority of the species on the TPWD list do not have suitable habitat on the proposed site, three fish (blackside darter, blue sucker, and creek chubsucker), four mussels (Louisiana pigtoe, sandbank pocketbook, Texas heelsplitter, and Texas pigtoe), and one reptile (timber/canebrake rattlesnake) all do. To date, the American burying beetle has not been documented within the proposed reservoir and dam site, or anywhere else in Fannin County, and adverse effects are not anticipated. It is unlikely that the beetle occurs on the proposed dam and reservoir site.

Adverse impacts are possible to the three Texas state-threatened fish species, the four mussel species, and the timber/canebrake rattlesnake due to the construction and inundation of the proposed dam and reservoir. Though possible habitat of these species exists within the proposed reservoir site, none of the fish species was observed during four separate fish collection surveys within the Bois d'Arc Watershed. It is unlikely that any of these fish species currently inhabits this area. However, four state-threatened mussel species were not specifically targeted in surveys and could be present. Potential adverse effects to all these state-listed species would be of low to medium likelihood, slight to moderate severity, and long-term duration.

Invasive Species

As noted above, the spread of invasive plant species is often facilitated by disturbing soils. Most of the potential impacts associated with invasive terrestrial plant species would be initiated during the construction phase and some of these invasions and encroachments would be perpetuated during the long-term operation phase of Alternative 1.

With lake-based recreation underway, recreational users could also facilitate spread of invasive species into the reservoir area, both aquatic and terrestrial portions, because invasive species can travel or "hitchhike" from one location to another via vehicles, boats, boots, pets, and people.

Invasive species – both plants and animals – can harm native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other resources (e.g., sunlight and space in water bodies), preventing them from reproducing, changing food webs, and modifying ecosystem conditions.

Overall, the effects of invasive species on the project area under Alternative 1 are anticipated to be long-term, of medium likelihood, and slight to moderate in severity.

4.6.3 Alternative 2

Impacts Associated with Project Phases

Construction Phase

Clearing of wetland vegetation for the dam, reservoir, and associated structures under Alternative 2 would be similar to Alternative 1, though on a somewhat smaller scale due to the downsized dimensions of the reservoir footprint. The downsized LBCR impacts 790 acres for construction of the dam, spillway and pump station. The effects of construction of the downsized dam would be long-term (more than 50 to over 100 years), high in likelihood and of moderate severity. Subject to the provisions of the Section 404 permit, revised Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the downsized LBCR footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed. NTMWD prepared first a preliminary Reservoir Clearing Plan and then a Conceptual Clearing Plan to guide the reservoir footprint clearing process. Under Alternative 2, the objectives of these plans would remain the same: to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir; to improve human access to shore locations by creating shore access locations for boat ramps and bank fishing through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline.

Both hand and machine clearing would be used in Alternative 2. The preferred method is mechanical clearing by shear-blading during the dry season. Under this method, the cleared material would be deposited in windrows or piles and left to dry and eventually burned as fire danger conditions allow. Machine clearing has the advantage of shearing stumps off at ground level, along with all other vegetation, and minimizes the amount of woody and organic debris remaining on site and entering the water after reservoir flooding. It may also be necessary to utilize hand clearing where it is not possible to operate mechanical clearing equipment due to site location or conditions. Clearing would occur to allow the establishment of access and safe landing sites along the reservoir shoreline to facilitate eventual lake-based recreational development. Consideration would be given to both wood salvage and environmentally sensitive areas that may require specific treatment during clearing operations. Flagging or marking of clearing boundaries and on-site supervision would be carried out for the successful implementation of all aspects of reservoir clearing.

Operations Phase

The downsized LBCR would inundate 8,600 acres. The effects of operation of the downsized dam and reservoir on wetland vegetation would be long-term (more than 50 to over 100 years), high in likelihood, and moderate in severity. Trees and shrubs that were not cleared from the reservoir footprint would eventually drown and die, gradually decomposing underwater but contributing to underwater habitat structure for a number of years. After impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b).

Under Alternative 2, as in Alternative 1, year-to-year and seasonal operation of the reservoir would be governed by an operation plan which would be similar to that already drafted for Alternative 1 (NTMWD, 2015b). In general, Alternative 2 would impound up to 135,200 AF of water and produce an estimated firm yield of 86,100 AFY, an average of 108 million gallons per day (mgd). The conservation pool, or normal water surface, of the reservoir would be maintained at an elevation of 515.0 feet MSL, though actual water surface and shoreline would fluctuate above and below this level. In a typical year, the reservoir would be fullest in May and June and would drop during the drier months of late summer due to less precipitation and in-flow and more surface evaporation, with the lowest elevations typically occurring in September and October. However, the water levels would also fluctuate during extended periods of dry conditions versus wet conditions. The reduced diversions from the downsized reservoir would result in an average downstream flow of approximately 34,500 AFY of additional water past the LBCR impoundment compared to Alternative 1. Much of this aggregate volume would be during high, ephemeral flows associated with storm events rather than during longer base flow periods. During base flow periods, as in the case of Alternative 1, environmental flows from the downsized reservoir would probably provide for limited instream habitat.

Downstream impacts from the downsized LBCR would be similar to the full-scale project because of the need to meet TCEQ's water right permit instream flow requirements. Please see the discussion under "Downstream Impact Analysis" in Section 4.6.2.3. Because the smaller LBCR would have 37 percent of the storage capacity of Alternative 1, it would have less ability to detain high inflows from storm events, and more of these high-flow events would spill and be passed to downstream habitats. Thus, this downsized alternative would have a less pronounced effect on moderating the severity and frequency of overbanking and erosive downstream flows and floods.

As with Alternative 1, with Alternative 2 the LBCR would provide lake-based recreational opportunities, such as boating, fishing, water-skiing, swimming, and other water sports. NTMWD would collaborate with county and state authorities to facilitate development of recreation infrastructure (e.g., docks, marinas, beaches, campgrounds, access roads, utilities) at the downsized LBCR.

Habitat

In general those wetland habitats impacted the most by Alternative 2 would be forested wetland and emergent wetland, with 2,909 acres (2,502 FCUs) and 684 acres (237 HUs) of impacts, respectively. Implementation of Alternative 2 would include installation of a dam and associated facilities located at the same site as Alternative 1 (the proposed full-scale LBCR project). The dam and spillways under Alternative 2 would have almost the same footprint as the infrastructure for the full-sized LBCR. The downsized dam would be lower in height compared to Alternative 1 which would result in a smaller reservoir.

Incidental areas between the dam and the conservation pool (515 feet MSL) are expected to be disturbed during construction and are included in the limits of construction. Based on these assumptions, the limit of construction of the smaller LBCR is estimated at 9,390 acres (Kiel, 2016b), which is slightly more than half that of the full-sized LBCR (Alternative 1). A map of vegetation cover types within the downsized reservoir footprint may be found in Figure 3.4-4. The service spillway and outlet works for Alternative 2 would be slightly smaller versions of those proposed for Alternative 1. The potential impact to wetlands of the downsized Alternative 2 is estimated at approximately 3,620 acres; this includes impacts to forested wetlands, scrub shrub wetlands, and emergent wetlands (Table 4.6-4). Most of the wetlands and forested wetlands occur at the lowest elevations, which lie along the river banks, and these areas would be impacted first as the lake fills. All of these impacts are associated with the reservoir and dam; there are no wetland impacts associated with the other project components (raw water pipelines and WTP).

Table 4.6-4. Habitat Impacts Associated With Alternative 2

Cover Type	Area (acres)	Habitat Units	Functional Capacity Units
Forested Wetland	2,909	--	2,502
Scrub Shrub Wetland	27	12	--
Emergent Wetland	684	287	--
Open Water	78	--	--
Total	3,620	299	2,502

Note: Forested wetlands were assessed using the Modified East TX HGM Methodology. All other cover types were assessed using the USFWS's HEP Procedures.

Wetlands

Under Alternative 2, overall effects to the wetland vegetation communities of the affected environment during construction and operations would likely be long-term more than 50 to over 100 years) in duration with a high likelihood of occurrence and moderate severity. More information on the specific vegetation communities is provided below.

Forested Wetlands

Construction of the dam and associated infrastructure under Alternative 2 would impact 2,909 acres (2,502 FCUs) of forested wetlands. All of the impacts on vegetation from dam construction discussed in Section 4.6.2.1 for Alternative 1 would also occur with the downsized LBCR, to approximately half the extent. Overall, effects of construction and operations on forested wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Most of the forested wetlands occur at the lowest elevations along the river banks, and would be impacted first as the lake fills; therefore, because the majority of the forested wetlands is already dominated by facultative and facultative upland species, the forested wetlands not cleared mechanically for the project and that would be subject to inundation would not be expected to survive.

The operational phase of a reduced dam structure would result in a smaller reservoir with a normal pool elevation of 515 feet MSL. See Section 4.6.2.1 for a more detailed discussion of effects related to operations. After reservoir impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b). As with Alternative 1, indirect adverse effects to vegetation outside of the immediate project footprint as a result of potential adverse effects brought about by an increase in recreation and residential housing along the shoreline of the proposed reservoir would be expected.

Emergent Wetlands

Overall, effects of construction and operations on emergent wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Construction of the dam and impoundment of water under Alternative 2 within the normal pool elevation of 515 feet MSL would result in the removal of 684 acres (287 HUs) of emergent wetland vegetation by direct fill impact or inundation of waters. However, during the operational phase, as in Alternative 1, emergent wetlands are expected to develop after inundation along the lake edges.

Scrub Shrub Wetlands

Overall, effects of construction and operations on scrub shrub wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Construction of the dam and impoundment of water under Alternative 2 within the normal pool elevation of 515 feet MSL would result in the removal of 27 acres (12 HUs) of scrub shrub wetland vegetation by direct fill impact or inundation. Clearing of habitat for the dam and associated structures would directly remove some scrub shrub habitat. Most of the scrub shrub wetlands occur at the lowest elevations along the river banks, and would be impacted first as the lake fills; therefore, the scrub shrub wetlands not cleared for the project and that would be subject to inundation would not be expected to survive.

Upland Habitats

Upland Deciduous Forest

Approximately 999 acres (423 HUs) of upland deciduous forest would be permanently eliminated or converted to other habitat types by Alternative 2, at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. A much smaller area of upland deciduous forest or woodland patches – about 10 acres – would be permanently removed along the maintained 50-foot-wide raw water pipeline corridor from the LBCR to the North WTP and at the WTP itself. This area would be converted to grassland and kept free of trees. Loss of upland deciduous forest along the eight miles of new pipeline corridor carrying raw water from Lake Texoma for blending is expected to be none to slight, as the new pipeline will parallel an existing pipeline. Overall, the permanent loss of 999 acres at the reservoir site would represent a slight, long-term impact on the upland deciduous forest resource in Fannin County.

Riparian Woodland/Bottomland Hardwood Forest

Approximately 714 acres (179 HUs) of riparian woodland/bottomland hardwood forest would be permanently eliminated or converted to other habitat types by Alternative 2, almost entirely at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures, as well as by the impounded water of the reservoir. Virtually no riparian woodland/bottomland hardwood forest would be eliminated along the raw water pipeline carrying water from blending from Lake Texoma, or along the raw water pipeline from the downsized LBCR to the North WTP. Overall, the permanent loss of 714 acres of the regionally scarce riparian woodland/bottomland hardwood forest resource would represent a moderate, long-term impact.

Grassland/Old Field

Approximately 2,270 acres (1,348 HUs) of grassland/old field habitat would be permanently eliminated or converted to other habitat types by Alternative 2, mostly at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures and by the impounded water of the reservoir. Virtually no grassland/old field would be permanently eliminated along either of the raw water pipelines (from Lake Texoma and from LBCR to the North WTP). In both cases, grassland within the proposed 70-foot wide temporary easement and 50-foot permanent easement would be restored through re-vegetation upon completion of construction. Up to 300 acres or more of grassland/old field habitat at the WTP site would be developed into the WTP and terminal storage reservoir (TSR). Overall, the permanent loss of 2,270 acres at the reservoir site and several hundred acres at the WTP/TSR site would represent a slight, long-term impact on grassland/old field habitat in Fannin County.

Shrubland

Approximately 16 acres of shrubland would be permanently eliminated or converted to other habitat types by Alternative 2, almost entirely at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. Overall, the permanent loss of 16 acres at the reservoir site would represent a slight, long-term impact on shrubland in Fannin County.

Table 4.6-5. Upland Habitat Impacts at Reservoir Site from Alternative 2

Type of Habitat	Area (acres)	Habitat Units
Upland Deciduous Forest	999	423
Riparian Woodland /Bottomland Hardwood	714	179
Grassland / Old Field	2,270	1,348
Shrubland (acres)	16	--

Aquatic Habitats and Aquatic Biota

Overall, effects of construction and operations on open water habitats and biota would be long-term with a moderate likelihood of occurrence and slight to moderate severity. The effects of constructing the smaller dam and reservoir on aquatic life would be both adverse and beneficial.

Within the smaller reservoir site there are 27 acres of scrub shrub wetland, 684 acres of emergent/ herbaceous wetland, 115 acres of riverine habitat, 16 acres of lacustrine habitat, and 2,909 acres of forested wetland which would all be eliminated and/or altered by a downsized alternative, with a larger share converted to the open water, variable-depth aquatic habitat of a reservoir/lake, and a smaller share buried beneath the dam structure. Approximately 325,000 linear feet of stream length along Bois d'Arc creek and its tributaries would be modified and converted from lotic to lentic conditions, or buried under the dam structure.

The ecological phenomena, processes, and conditions that would occur as a result of the downsized LBCR would be essentially the same as with Alternative 1, but on a smaller scale. In general, diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently inundated are expected to change as a result of the reservoir, which would provide a permanent water source and create both shallow and deep water lentic habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream habitats would be disadvantaged. The relative abundance of other species that are more generalist or versatile may be little changed. See Section 4.6.2.3 for a more in-depth discussion of these impacts.

While the full-scale Alternative 1 and the downsized Alternative 2 differ primarily in size and scale, there may be one qualitative difference in their operation and functioning that could have implications for the type and quality of habitat that develops around the lake fringe. A smaller reservoir may be subject to greater water level fluctuations and partial drawdown, especially during periods of prolonged drought, than the full-scale reservoir. This is a consequence of the higher priority both of meeting NTMWD's higher water demands during drought conditions and of adhering to stipulated water releases to maintain instream flow requirements and aquatic habitat downstream of the dam, per conditions of NTMWD's water rights permit from TCEQ, than of maintaining a constant water level within the reservoir. If these more frequent fluctuations do occur, the lake edge may offer less stable conditions under which wetland habitat (e.g., emergent herbaceous vegetation) could develop and thrive. The smaller reservoir may be ringed more often by a less productive or sterile zone of dried mudflats that offer little habitat value for aquatic biota.

Fish

Dewatering activities during project construction may impact aquatic resources by stranding finfish and shellfish. Other harmful construction activities can trample, dredge, or fill areas with sessile (immobile) aquatic resources such as attached plants and mussels.

It is not possible to predict whether fish species diversity within the reservoir would be greater or less than the number of species currently inhabiting Bois d'Arc Creek within the reservoir footprint. Adverse impacts would be less than significant. Downstream of the reservoir, likely effects of Alternative 2on aquatic life would be largely beneficial, although not as beneficial as with Alternative 1, due to the ability of water managers to control flows throughout the year (although with less ability to manipulate downstream flows than with Alternative 1), thereby avoiding excessively erosive discharges during storm events as well as periods of little and no flow later in the season, both of which tend to be harmful to aquatic species and habitat. Pulse flows throughout the year may assist certain species that require those cues for spawning, reproduction, and movement within the creek.

After inundation, the current riverine habitat in the smaller reservoir site would be converted to lacustrine habitat. As with Alternative 1, the species composition after inundation would likely shift towards more pool-associated species, largely composed of sunfish (Centrarchids), temperate bass (Moronidae), catfish (Ictalurids), and suckers (Catostomids). Fish species that are found only in rivers and streams would tend to disappear, but the newly created lacustrine habitat and corresponding increase in pool-associated species would compensate for some of these losses. The loss of riverine habitat and fish found only in rivers and streams would be long-term, slight in severity, and medium in extent. See the discussion under "Fish" in Section 4.6.2.3, for a more detailed consideration of the expected shifts in fish abundance and diversity.

Benthic Macroinvertebrates

Under the downsized Alternative 2, short-term and long-term adverse effects to invertebrates would occur due to construction and inundation of the smaller dam and reservoir. These impacts would be similar in type to those of Alternative 1 (see Section 4.6.2.3), but smaller in extent. No direct effects and slight indirect effects on aquatic life would be expected at the site of the proposed water treatment plant, terminal storage reservoir, and related facilities because they are located entirely on upland habitat, completely avoiding open waters and wetlands. FM 1396 construction would occur primarily on upland sites and construction of the new bridge over the reservoir would occur prior to impoundment, therefore most direct effects on aquatic biota would be avoided. However, a small amount (under one-half acre) of jurisdictional waters appears to be present along the proposed alignment and would likely require fill or some other disturbance to construct the road, which could potentially result in a negligible impact on localized aquatic biota. Indirect effects from erosion would be mitigated by implementing a SWPPP and Construction General Permit.

Terrestrial (Upland) Habitat and Wildlife Species

The types of impacts of Alternative 2 on terrestrial wildlife habitat and wildlife species would essentially be the same as for Alternative 1, though not as severe because they would occur on approximately half the scale or less. See Section 4.6.2.4 for more detailed discussion. Overall impacts of Alternative 2 would be long-term, of medium likelihood, and moderate severity.

Threatened and Endangered Species

The types of impacts of Alternative 2 on threatened and endangered species would essentially be the same as for Alternative 1, though not as severe because habitat disturbance and loss would occur on roughly half the scale as with Alternative 1. See Section 4.6.2.5 for more detailed discussion of potential effects on threatened and endangered species. No effects from Alternative 2 would be expected on federally-listed species, but effects on one or more state-listed aquatic species are possible. Overall impacts of Alternative 2 on threatened and endangered species would be long-term, of low to medium likelihood, and slight to moderate severity.

Invasive Species

The kinds of impacts of Alternative 2 related to invasive species would be very similar to those for Alternative 1. See Section 4.6.2.6.

As in the case of Alternative 1, lake-based recreation associated with Alternative 2 could facilitate spread of invasive species into the reservoir area, both aquatic and terrestrial portions, because invasive species can travel ("hitchhike") from one location to another via vehicles, boats, boots, pets, and people.

Invasive plant and animal species can cause harm to native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other crucial resources, preventing them from reproducing, changing food webs, and modifying ecosystem conditions.

Overall, the effects of invasive species on the project area under Alternative 2 are expected to be long-term, of medium likelihood, and slight to moderate in severity.

4.6.4 Mitigation

4.6.4.1 Project Area

A mitigation plan was developed to offset impacts to waters of the United States, which includes wetlands, as a result of the construction and inundation of the LBCR project. The complete mitigation plan can be found in Appendix C. The plan was developed in accordance with the applicable federal statutory and regulatory requirements, particularly, Regulatory Guidance Letter 02-2, "Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899" and the "Aquatic Resource Mitigation and Monitoring Guidelines" (USACE, 2004).

As proposed, the LBCR project encompasses approximately 20,732 acres of land (excluding proposed mitigation acres); of which 19,872 acres lie within the Bois d'Arc Creek watershed. For purposes of the mitigation plan, the scope of the LBCR project consists of:

- 19,768 acres, which includes 16,641 acres for the reservoir (conservation pool elevation 534 feet MSL), 2,700 acres of storage lands (between 534 and 541 feet MSL) and 427 acres for the dam and spillways;
- 860 acres associated with the proposed raw water pipeline, water treatment plant, terminal storage reservoir, and rail spur; and
- 104 acres associated with the relocation of FM 1396 outside of the reservoir footprint

Mitigation Objectives

The plan objective is to mitigate for unavoidable adverse impacts to a mix of habitats such as uplands and waters of the United States, including wetlands, in the project area. Compensatory mitigation would be provided for forested wetlands, emergent wetlands, scrub shrub wetlands, open water, and streams that would be permanently impacted as a result of constructing the proposed LBCR. This mitigation would be achieved through wetland restoration and enhancement as well as stream restoration and enhancement at the nearby Riverby Ranch and Upper Bois d'Arc Creek (BDC) Mitigation Site.

Riverby Ranch is a historic active Ranch site with cattle farming activities. As a result of Riverby Ranch being converted to a mitigation site, the cattle would be removed and the land would no longer support cattle farming. The Upper BDC Mitigation site is located along Bois d'Arc Creek upstream of the proposed reservoir site and was selected to avoid fragmentation of the proposed mitigation. The creation of the reservoir would offset impacts to open waters and some of the stream impacts, and it would provide the means for creating emergent wetlands in shallow areas around the lake (littoral wetlands). The development of the reservoir also would enhance Bois d'Arc Creek through reductions in the frequency of destructive high flow events and the passage of sustainable environmental flows to enhance and maintain existing downstream habitats. Specific plan objectives are to mitigate for impacts to:

- 4,035 FCUs of forested wetlands
- 514 HUs of emergent wetlands
- 23 HUs of scrub shrub wetlands
- 78 acres of open water
- 192,377 SQUs of streams

The impacts to 49 acres (23 HUs) of scrub shrub wetland at the reservoir site would be mitigated by restoring 150 acres (103.5 HUs) of scrub shrub wetlands habitat at the Riverby Ranch mitigation site, resulting in a mitigation surplus of 80.5 HU for this habitat type. In addition to restoring 150 acres of scrub shrub wetlands, NTMWD proposes to preserve 98 acres of existing scrub shrub wetlands at Riverby Ranch for a total scrub shrub mitigation area of 248 acres.

Mitigation would occur in three main areas: 1) On-site mitigation at the proposed reservoir site; 2) near-site mitigation on the nearly 15,000-acre Riverby Ranch; and 3) near- site mitigation on the 1,900-acre Upper Bois d'Arc Creek Mitigation Site (Figure 4.6-1). Important points to note are that most of the proposed aquatic and terrestrial mitigation would occur on the Riverby Ranch, a single, nearly 15,000-acre tract of land located downstream of the proposed reservoir site and partially within the Bois d'Arc Creek watershed (the remainder is located within the Red River Basin). The remaining terrestrial mitigation area is located adjacent to the project site. The reservoir site, Riverby Ranch, and Upper BDC Mitigation sites are proximal to each other and to lands enrolled in the Pintail Farms Wetlands Reserve Program (WRP) area and the nearby Caddo National Grasslands.

The proposed mitigation areas would contribute to conservation of contiguous lands within the Bois d'Arc Creek watershed and support the USACE's preference to mitigate for projects using a watershed or ecosystem approach. With implementation of the proposed mitigation plan, approximately 50,170 acres of aquatic and terrestrial habitat along an approximately 42-mile long corridor adjacent to and connected by Bois d'Arc Creek would be protected in perpetuity.

Impacts and Mitigation

The Habitat Evaluation Procedure (HEP) methodology was used to evaluate emergent, scrub shrub, and terrestrial resources that could be impacted following construction of the proposed reservoir and its related components. Impacts for emergent and scrub shrub wetlands were measured using Habitat Units (HU), a metric specific to the HEP methodology, however, HU mitigation credits were only used for the proposed emergent wetland mitigation. It was agreed on by the inter-agency assessment team that scrub shrub wetland mitigation be measured in acres because there is limited opportunity to improve the habitat value of the existing scrub shrub wetlands at the proposed mitigation sites. The Modified East Texas Hydrogeomorphic Method (HGM) was used to assess the functions of forested wetlands. The proposed impacts and mitigation credits for forested wetlands were measured using Functional Capacity Units (FCUs). The Rapid Geomorphic Assessment (RGA) tool was used to assess stream quality. Stream impacts and mitigation credits were measured using RGA Stream Quality Units (SQUs). A summary of potential net impacts to resources and proposed compensatory mitigation to offset those impacts is shown in Tables 4.6-6, 4.6-7 and 4.6-8.

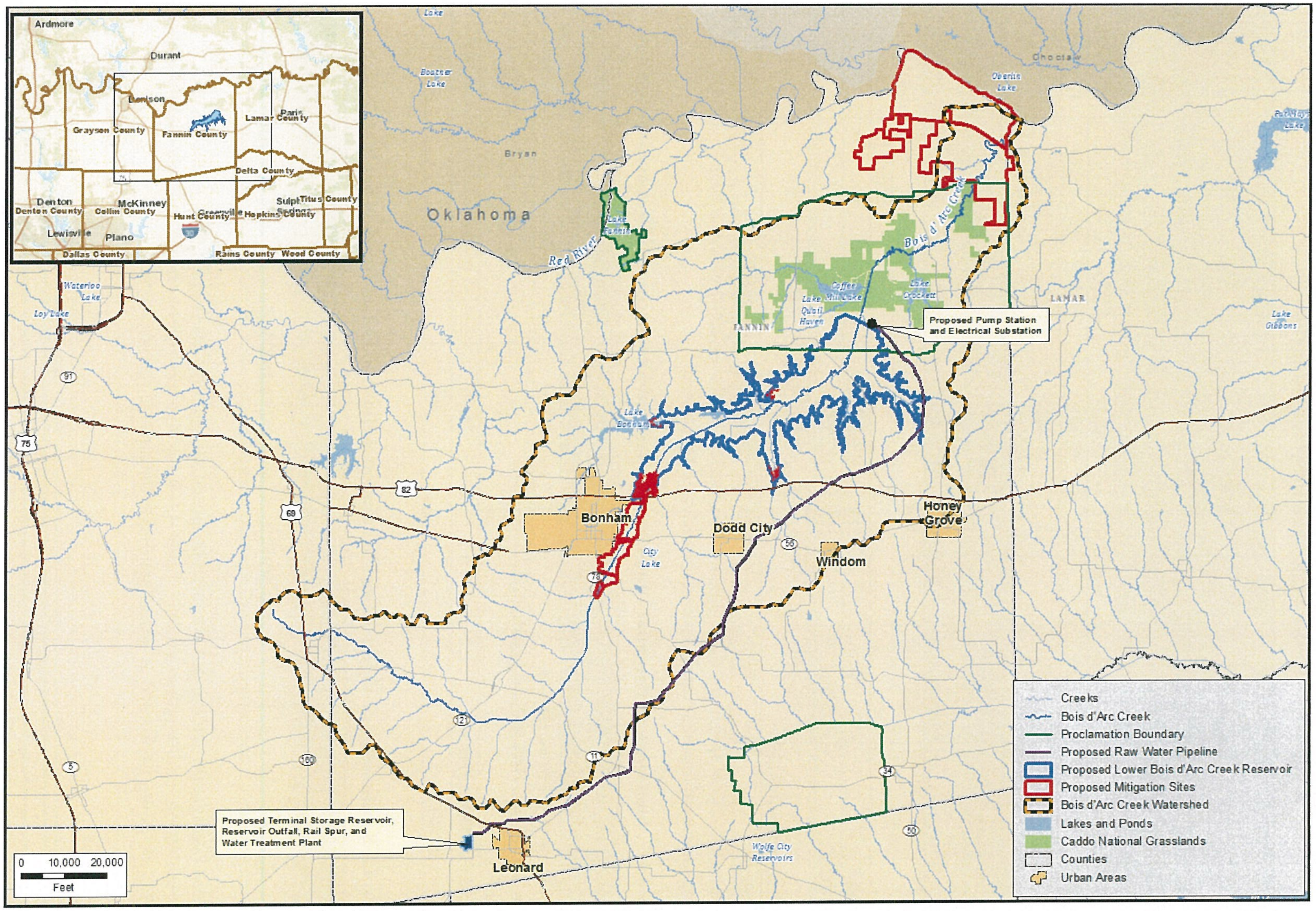


Figure 4.6-1. Location of Project Mitigation Sites at the Proposed Reservoir, at Riverby Ranch and at the Upper Bois d'Arc Creek Mitigation Site

Table 4.6-6. Summary of Potential Net Impacts to Waters of the United States and Proposed Mitigation

Type of Water of the United States	Acres Impacted	Functional Capacity/ Habitat Units Impacted (FCU/HU)	Acres Mitigated	Functional Capacity/ Habitat Units Mitigated (FCU/HU)	Net Change in Acres Mitigated - Impacted	Net Change in FCU/HU Created - Impacted
Forested Wetland	4,602	4,035	5,801	4,675	(+) 1,199	(+) 640
Emergent Wetland	1,223	514	3,082	957	(+) 1,859	(+) 443
Scrub Shrub Wetland	49	23	248	103.5	(+) 199	(+) 80.5
Open Waters	78	N/A	16,036[1]	N/A	+) 15,958	N/A
	Linear Feet Impacted	**SQUs**	**Linear Feet Mitigated**	**SQUs**	**Linear feet**	**SQUs**
Streams[2]	651,140	192,377	392,265	181,153	(-) 258,875	(-) 11,224
Perennial	None	None	65,247	10,565	-	-
Intermittent	286,139	85,100	125,667	46,425	-	-
Intermittent/Ephemeral	365,001	107,277	41,140	15,491	-	-
Ephemeral	N/A	N/A	160,212	108,672	-	-

[1]This represents the offset of open waters by the creation of the reservoir, less the acreage identified for littoral wetlands.
[2]For a complete description of stream classifications refer to Appendix C.

Table 4.6-7. Summary of Potential Impacts to Terrestrial Resources and Proposed Mitigation

Terrestrial Resource Type	Amount Impacted	Amount of Mitigation	Net Gain (+) – Net Loss
Upland Deciduous Forest (HUs)	1,058	742	(-) 316
Riparian Woodland/Bottomland Hardwood Forest (HUs)	434	855	(+) 421
Grassland/Old Field (HUs)	2,896	2,393	(-) 503
Shrubland (acres)	64	41	(-) 23

Table 4.6-8. Summary of the Proposed Mitigation Actions to Offset Impacts to Open Waters

Impacts to Open Waters (acres)	Near-Site Mitigation (acres)	On-Site Mitigation (acres)	Net Gain (+) – Net Loss of Open Waters
(-) 78	(+) 50	(+) 16,036	(+) 16,008

The proposed mitigation throughout the three proposed mitigation sites (Figure 4.6-1) consists of creation, restoration, and/or enhancement. Table 4.6-9 summarizes where on-site and near-site mitigation components are being performed in accordance with the aquatic resource types.

Table 4.6-9. Summary of On-Site and Near-Site Mitigation Associated with the Proposed LBCR Project

Aquatic Resource Type	Mitigation Component					
	On-Site		Riverby Ranch Site		Upper BDC Site	
	Reservoir Site	Reservoir/ Littoral Wetlands	Restoration	Enhancement	Restoration	Enhancement
Wetlands						
Forested						
			X	X	X	
Emergent			X	X		
Scrub						
Shrub		X				
Non-	X		X	X		X
wetlands				X		X
Streams						
Open water						

Once initial construction of the mitigation components are completed, the mitigation sites would be monitored as provided for in the Monitoring Requirements and Performance Standards sections of the plan (Appendix C). Monitoring reports would be submitted every year for the first five years, every other year from year five until year 15, and again in year 20 for all components of the proposed mitigation plan. As such, all components of the proposed mitigation plan would be monitored for 20 years.

Site Protection, Management, and Financial Assurances

The compensatory mitigation, resulting from construction of the LBCR, would provide long-term protection through USACE- approved deed restrictions for the time the NTMWD owns and controls the properties. Should the properties be transferred to a third-party land manager other than a governmental entity, a conservation easement, or some other similar USACE-approved agreement, shall be placed on the properties for perpetual protection.

All sites proposed as part of this mitigation plan would be managed long-term as compensatory mitigation areas associated with impacts to waters of the United States, including wetlands. The long-term management of the mitigation site would be provided by the NTMWD until the USACE has determined that the mitigation project is meeting its performance standards or is on an acceptable trajectory to meeting those standards. An adaptive management approach would be used to assess mitigation conditions to facilitate project success with the final goal of native habitats that are stable and self-sustaining over time. If monitoring reports indicate that mitigation progress is falling short of success standards, coordination with the USACE and applicable federal, state or local agencies would be initiated regarding the need for additional adaptive management measures to increase the likelihood of meeting performance standards and overall mitigation goals and objectives. Once the USACE determines the mitigation project is fulfilling the compensatory mitigation requirements, and the mitigation site is self-sustaining, NTMWD may seek to convey the mitigation site and long-term management to a public agency (i.e., state or federal resource agency).

NTMWD has made a commitment to mitigating for impacts to natural resources by already purchasing the approximately 15,000-acre Riverby Ranch Mitigation Site and portions of the 1,900-acre Upper BDC Mitigation Site that would be used for compensatory mitigation.

4.7 AIR QUALITY AND GREENHOUSE GAS EMISSIONS

This section discusses the air regulations that could apply to the project and the air quality impacts and greenhouse gas emissions that would occur under each alternative. For Alternatives 1 and 2, the air quality impacts from construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.7-1.

Table 4.7-1. Summary of Impacts Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Air Quality Control Region 215[a]	Air Quality Control Region 215 [a]	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	
Operation Phase			
Size	Air Quality Control Region 215[a]	Air Quality Control Region 215[a]	Possible slight decrease in air quality from current conditions as Fannin County population and tailpipe emissions increase.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	Medium	Medium	
Severity	Slight	Slight	

[a] Air Quality Control Region 215 encompasses 19 counties and includes those portions of Fannin County where Alternatives 1 and 2 would occur.

4.7.1 Regulatory Review

The CAA, as amended in 1990, mandates that states develop a State Implementation Plan (SIP) that explains how the state will comply with the Clean Air Act and achieve and maintain attainment of the National Ambient Air Quality Standards (NAAQS). The Texas SIP[5] applies to industrial sources, commercial facilities, and residential development activities. Regulation occurs primarily through a process of reviewing engineering documents and other technical information, applying emission standards and regulations in the issuance of permits, performing field inspections, and assisting industries in determining their compliance status.

TCEQ has the authority to issue permits for the construction and operation of new or modified stationary source air emissions in Texas. TCEQ air permits are required for any facility that will emit or currently emits regulated pollutants and must comply with the following regulations of the Clean Air Act: New Source Review, Prevention of Significant Deterioration, Title V Permitting, National Emission Standards for Hazardous Air Pollutants (HAPs), and New Source Performance Standards. TCEQ air permits are not required for mobile sources, such as trucks. An overview of the applicability of the Clean Air Act air regulations to the project is shown in Table 4.7-2.

[5] The Texas SIP was initially approved in May 1972 and is revised as needed to comply with new federal or state requirements, when new data improves modeling techniques, when a specific area's attainment status changes, or when an area fails to reach attainment (TCEQ 2017).

Table 4.7-2. Clean Air Act Regulatory Review for Alternatives 1 and 2

Clean Air Act Regulation	Applicability to Alternatives 1and 2
New Source Review	New Source Review permitting protects air quality when factories, industrial boilers, and power plants are built or modified. Because none of the alternatives would involve construction or operation of any of these facilities, the project would be exempt from New Source Review permitting requirements. However, it is possible that a permit would be required for emergency back-up generators if they became part of the project.
Prevention of Significant Deterioration	Prevention of Significant Deterioration (PSD) applies to new major sources or modifications at existing sources of air pollutants where the area the source is located is in attainment or unclassifiable. There are no existing sources of air pollutants associated with the project, therefore, the project would not be subject to PSD review.
Title V permitting requirements[a]	A Title V Permit requires sources of air pollutants to obtain and operate in compliance with an operating permit. A Permit is required if a source has actual or potential emissions greater than or equal to 100 tons per year. Because the construction and operation activities under Alternatives 1 and 2 would be below this threshold, a Title V Permit is not required.
National Emission Standards for Hazardous Air Pollutants	National Emission Standards for Hazardous Air Pollutants (NESHAP) are stationary source standards for hazardous air pollutants (HAPs). HAPs are those pollutants that are known or suspected to cause cancer or other serious health effects. Because the potential HAP emissions would not exceed NESHAP thresholds for any of the alternatives, the use of Maximum Available Control Technology would not be required.
New Source Performance Standards	New Source Performance Standards (NSPS) are technology based emission standards which apply to new, modified, and reconstructed facilities in specific source categories such as manufacturers of glass, cement, rubber tires, and wool fiberglass. Because neither alternative would involve construction or operation of any of these types of facilities, the project would be exempt from NSPS permitting requirements. However, it is possible that emergency generators and boilers would be subject to NSPS if they became part of the project.

[a] This threshold only applies to areas that are in attainment. Because the project is located in an attainment area, the 100 tons per year of any air pollutant threshold was used.
Source: USEPA, 2017b

While the Clean Air Act regulations listed in Table 4.7-2 do not apply to the project, there are more specific Texas State regulations that apply to activities that are likely to occur during construction. These regulations are outlined in TCEQ Regulation Title 30, Part 1, Chapters 101 through 118. They include the following:

- General Air Quality Rules (Chapter 30 Texas Administrative Code [TAC] 1.101);
- Air pollution from Visible Emissions and Particulate Matter (Chapter 30 TAC 1.111.A);
- Air pollution from Open Burning (Chapter 30 TAC 1.111.B);
- Air pollution from Motor Vehicle (Chapter 30 TAC 1.114); and

- Air pollution from VOCs (Chapter 30 TAC 1.101).

Fugitive Dust Control

The grading and site-preparation phases of dam and reservoir construction would generate fugitive dust emissions. Chapter 30 TAC 1.111.A requires reasonable precautions to prevent particulate matter from becoming airborne. Such precautions can include:

- Using water for dust control when grading roads or clearing land;
- Applying water on dirt roads, materials stockpiles, and other surfaces that could create airborne dust;
- Paving roadways and maintaining them in a clean condition;
- Covering open equipment when conveying or transporting material likely to create objectionable air pollution when airborne; and
- Promptly removing spilled or tracked dirt or other materials from paved streets.

Open Burning

Project activities would likely include the burning of construction or demolition material and land-clearing debris, which may require a permit (30 TAC 1.111.B). Before burning, the appropriate state and local agencies would be contacted to acquire the necessary open burning permits. The open burning ordinance includes, but is not limited to, the following:

- All reasonable efforts shall be made to minimize the amount of material burned;
- The material to be burned shall consist of brush, stumps, and similar waste and lean burning demolition material;
- The burning shall be at least 300 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted;
- The burning shall be conducted at the greatest distance practicable from highways and air fields
- The burning shall be attended at all times and conducted to ensure the best possible combustion with a minimum of smoke being produced;
- The burning shall not be allowed to smolder beyond the minimum period of time necessary for the destruction of the materials; and
- The burning shall be conducted only when the prevailing winds are away from any city, town, or developed area.

4.7.2 No Action Alternative

The No Action Alternative is not expected to appreciably affect air quality within AQCR 215 because land uses at and within the vicinity of the proposed LBCR site are not expected to substantially change. However, due to overall expected population growth in the region and a commensurate increase in traffic and tailpipe emissions of criteria pollutants from vehicles, there may be a slight decrease in air quality in the region.

Under the No Action Alternative, there would be no water treatment plant, raw water pipeline, or reservoir to affect greenhouse gas (GHG) emissions. This alternative would not have any direct impact on the climate, and would not contribute to climate change. Although there would be no GHG emissions, the No Action Alternative, by foregoing the development of greater water storage capacity that could be drawn upon during dry periods and droughts, would constitute a riskier approach to water management under future climatic conditions compared to Alternatives 1 and 2.

4.7.3 Alternative 1

Alternative 1 would involve the construction and operation of a dam and reservoir on Bois d'Arc Creek and construction and operation of other project components including water pipelines, a water treatment plant (WTP), a terminal storage reservoir (TSR), a new road extension, and a new bridge over the new reservoir. This section describes the potential air impacts that would result from implementing Alternative 1.

Estimated Criteria Pollutant Emissions and General Conformity

As explained in Section 3.5 of this EIS, EPA's General Conformity Rule under the Clean Air Act ensures that the actions taken by federal agencies do not interfere with a state's plans to attain and maintain the National Ambient Air Quality Standards (NAAQS) (40 CFR 93.153(b)). Because Air Quality Control Region (AQCR) 215, which encompasses the entire proposed project area, is in attainment, the General Conformity Rule requirements do not apply. However, for completeness, all direct and indirect emissions of criteria pollutants were estimated for the construction phase of the proposed project and compared to the General Conformity Rule *de minimis* threshold rates to determine whether implementation of Alternative 1 would impact the air quality in the region. The emissions included in Table 4.7-3 include air emissions from reservoir clearing and construction of the dam, water pipelines, and all other project components (described below in more detail). As shown in Table 4.7-3, the total direct and indirect emissions associated with the construction phase of Alternative 1 would not exceed the *de minimis* threshold rates. Therefore, the project would be exempt from the General Conformity Rule requirements. Any later indirect emissions during operations would not be within the USACE's continuing program responsibility, and the USACE cannot practicably control them.

Table 4.7-3. Alternative 1 Emissions Compared to General Conformity Rule Thresholds

Activity	Estimated Annual emissions (short tons per year)		*de minimis* threshold (short tons per year)
	CO	NO_x	
Site preparation and construction	1.8	5.8	100

Note: Emissions of all other criteria pollutants and their precursors would be appreciably lower than those of CO and NO_x.
Source: Freese and Nichols, 2011b

Reservoir and Dam

Construction

The use of heavy construction equipment, deliveries to the site, fugitive dust, and burning of cleared vegetation material from the reservoir footprint would cause short-term, slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the proposed reservoir and dam are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

Long-term negligible adverse and long-term slight beneficial impacts on air quality would occur from operation of the proposed reservoir and dam. Long-term negligible adverse impacts would occur from recreational visitors (personal vehicles and watersport engines [i.e., motorboats]), increased development around the lake which could result in additional vehicles on roadways, and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint.

Raw Water Transport Pipelines

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the proposed pump station and pipeline are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Operation of the proposed pipeline would have no direct impacts on air quality locally, as there would be no ongoing sources of air emissions associated with this part of the project. However, there are both fossil fuel and non-fossil fuel based electricity providers in the surrounding area that could provide electricity to pump the water through the pipeline. If a fossil fuel based provider is used, there would be indirect impacts from increased emissions of criteria pollutants at the electricity generation site. These emissions would not occur if a non-fossil fuel generator was used.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the WTP, TSR, and related facilities are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Long-term slight adverse impacts on air quality from operation of the proposed WTP, TSR, and related facilities would potentially be caused by air emissions from vehicles used for worker commutes and delivery of equipment and supplies and the use of generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term minor adverse impacts on air quality. All emissions of criteria pollutants from the FM 1396 relocation and new bridge construction are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

For purposes of analysis, it was assumed that the commuters currently utilizing FM 1396 would utilize the new FM 897 extension and the new bridge. Therefore, the overall traffic would not increase and the long-term impacts on air quality from vehicular use of the proposed FM 897 extension and new bridge would be negligible.

Summary of Air Quality Impacts

Overall, short-term slight adverse and long-term slight beneficial impacts to air quality would be expected with the implementation of Alternative 1. During construction activities, short-term emissions would be limited to fugitive dust and diesel emissions from construction and delivery equipment and from the burning of cleared vegetation material. Direct and indirect air emissions would not be expected to exceed the annual *de minimis* threshold rates or to contribute to a violation of any federal, state, or local air regulations. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint, although these may well be offset or more than offset by localized population growth, development, and greater tailpipe emissions from increased levels of traffic by new residents and recreationists both around and on the new lake.

Mitigation of Air Quality Impacts from Construction

In the event that a Section 404 permit is issued and the project is implemented, EPA Region 6 recommended that NTMWD, its contractors, and all responsible parties develop mitigation measures to control PM_{10} emissions and fugitive dust during construction. These mitigation measures would be included in a detailed Construction Emissions Mitigation Plan that would identify Best Management Practices (BMPs) for the construction effort. The BMPs would be designed to reduce air quality impacts associated with emissions of criteria pollutants (NOx, CO, CO_2, PM, and SO_2) and specifically to minimize potential exposure of individuals near the construction sites to PM_{10} from fugitive dust and heavy equipment tailpipe emissions.

Greenhouse Gas Emissions

Alternative 1 would generate a relatively small amount of GHG emissions during both construction and operation (primarily from pumping raw water to the treatment plant), and in the short term it would represent an incremental, but overall negligible, contribution to climate change. Although there would be an incremental increase in greenhouse gases, Alternative 1 would constitute a more effective approach to water conservation and management under future conditions when compared to the No Action Alternative. As the climate becomes hotter and potentially drier (NRC, 2011), having more water storage capacity to take advantage of heavy precipitation and runoff storm events would become more important.

GHG emissions in the vicinity of the future reservoir would likely increase due to long-term local population growth, additional recreational visitors, increased vehicular usage and power generation, and general development in the lake vicinity. These increases would be offset at a one-to-one basis by these same activities not occurring at other locations. For example, individuals who moved to the area would no longer emit GHG's at the location they otherwise would have lived at without implementing Alternative 1.

A carbon footprint is an inventory of the GHG emissions caused by a project, event, or product over a given period of time, and is often expressed in terms of carbon dioxide (CO_2) equivalent. CO_2 equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. Table 4.7-4 shows estimates of GHG emissions during the construction, the lake inundation (impoundment of water), the embodied emissions from the raw materials used, and the electricity consumption over one hundred years. Given the long duration of the reservoir, Alternative 1 would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to climate change. The total amount of GHG emissions that would occur over the 100-year life of the project represents approximately 0.7 percent of Texas' annual GHG emissions (641 million metric tons of CO_2 equivalent in 2013) (Climate Central, 2015).

Table 4.7-4. Carbon Dioxide Equivalent Emissions During the 100-Year Life of the Project

Total Carbon Dioxide Equivalents (tons)				
Lake Inundation	Construction	Embodied in Fabrication Materials	Power Use	Total
1,018,000	5,000	188,000	3,305,500	4,517,000

Long-term slight beneficial effects from augmenting water storage capacity in North Texas would be expected. Although there would be negligible direct effects from the emissions on climate change, Alternative 1 would constitute a more effective approach to water management under future conditions associated with reductions in available precipitation when compared to the No Action Alternative. As noted above, total available precipitation will likely decrease in the coming decades and beyond. As available precipitation decreases and summer deficits increase when compared to historical conditions, drought contingency operations would be required more frequently when compared to historical operations. In general, maintaining adequate water storage capacity is an important strategy in adapting to predicted climate change in Texas, a future that is likely to be drier and hotter and with lower available precipitation.

Reservoir and Dam

There would be slight adverse effects from GHG emissions associated with Alternative 1. Lake inundation, that is, initial impoundment of the water in Bois d'Arc Creek, would account for approximately 1,018,000 tons of CO_2 equivalent, much of which would take place in the first five to ten years after the dam was built. GHG emissions from reservoir inundation includes the GHG that are currently being removed or sequestered by existing vegetation within the reservoir site, and, for the first 10 years, the GHG emitted by the biomass that would decompose after inundation as a result of conversion to permanently flooded land. After that, any additional GHG emissions from the reservoir would be from organic material that would have decomposed with or without the reservoir.

Raw Water Pipeline and Pump Station

Small amounts of GHG emissions associated with the proposed raw water pipeline would have an incremental, but overall negligible, contribution to climate change. All emissions of GHG from construction and operation of the pipeline are included in Table 4.7-4. The largest component of ongoing GHG emissions due to the project is the use of power to run the single pump station at the start of the pipeline near the edge of the lake; however, these emissions would be indirect and controlled at the point of power generation. Alternative methods of supplying water to the region such as piping it in from a remote location or desalination would have a much larger carbon footprint.

Water Treatment Plant, Terminal Storage Reservoir and Related Facilities

Small amounts of GHG emissions associated with the proposed WTP, TSR, and related facilities would have an incremental, but overall negligible, contribution to climate change. All emissions of GHG from construction and operation of the WTP, TSR, and related facilities are included in Table 4.7-4. The largest component of ongoing GHG emissions due to the project is the use of power to run the pump stations and WTP; however, these emissions would be indirect and controlled at the point of power generation.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As in the case of other connected actions, small amounts of GHG emissions would be associated with construction (heavy construction equipment) and operation (motorized vehicles) of these facilities.

4.7.4 Alternative 2

Similar to Alternative 1, Alternative 2 would involve the construction and operation of a dam and reservoir on Bois d'Arc Creek. However, under Alternative 2, the reservoir would be smaller and the project would include construction and operation of an additional pipeline for blending water from Lake Texoma. The construction and operation of other project components described under Alternative 1 including the water pipeline, WTP, TSR, a new road extension, and a new bridge over the new reservoir would be the same under Alternative 2. This section describes the potential air impacts that would result from implementing Alternative 2.

Estimated Emissions and General Conformity

The footprint of the proposed smaller-scale LBCR is within the larger boundaries of Alternative 1 in AQCR 215. Potential areas where new pipelines would need to be constructed for Lake Texoma blending are located within Fannin and Grayson counties, which are both in attainment with NAAQS. Therefore, the entire project area for this alternative is in attainment and the General Conformity rule of the CAA does not apply. The total direct and indirect emissions associated with constructing and operating the proposed smaller-scale LBCR would be less than the total emissions under Alternative 1 (shown in Table 4.7-3). Therefore, the total direct and indirect emissions associated with this alternative would not exceed the *de minimis* threshold rates, and overall impacts to air quality under this alternative would be slight.

Reservoir and Dam

Construction

As in Alternative 1, short-term slight adverse air quality impacts from construction of the smaller-scale LBCR would be caused by heavy construction equipment, deliveries to the site, and fugitive dust. Due to the reduced amount of construction required for the smaller-scale LBCR, annual emissions of criteria pollutants from construction of the reservoir and dam would be approximately 10 percent lower than emissions estimated for Alternative 1 and would not exceed the annual *de minimis* threshold rates. These emissions would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

As in Alternative 1, long-term negligible adverse impacts and long-term slight beneficial impacts on air quality would occur from operation of the smaller-scale reservoir and dam. Long-term negligible adverse impacts would occur from recreational visitors (personal vehicles and watersport engines [i.e., motor boats]), increased development around the lake which could result in additional vehicles on roadways, and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new source of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ. Due to the smaller scale of the LBCR, there would likely be fewer recreational visitors, less development, and fewer generators associated with this alternative than for Alternative 1. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint.

Raw Water Transport Pipelines

Construction

As in Alternative 1, heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the pump station and LBCR pipeline would be similar to emissions under Alternative 1, and would not exceed the annual *de minimis* threshold rates. Emissions associated with construction of the new pipeline for delivery of Lake Texoma water for blending with LBCR water are expected to be slight, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of the construction phase.

Operation

Operation of the proposed pipelines would have no direct impacts on air quality locally, as there would be no ongoing sources of air emissions associated with this part of the project. However, there are both fossil fuel and non-fossil fuel based electricity providers in the surrounding area that could provide electricity to pump the water through the pipelines. If a fossil fuel based provider is used, there would be indirect impacts from increased emissions of criteria pollutants at the electricity generation site. Because Alternative 2 would involve operation of a second water pipeline, additional electricity would be required to pump the water. Therefore, the impacts from operating the two pipelines would be greater than Alternative 1. These emissions would not occur if a non-fossil fuel generator was used.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

As in Alternative 1, heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. Emissions of criteria pollutants from construction of the WTP, TSR, and related facilities would be similar to emissions under Alternative 1 and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Long-term slight adverse impacts from operation of the proposed WTP, TSR, and related facilities would potentially be caused by air emissions from vehicles used for worker commutes and delivery of equipment and supplies and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Similar to alternative 1, Alternative 2 would include FM 1396 inundation and relocation and new bridge construction. The combined length of the new road and bridge and therefore the air emissions resulting from construction would be approximately the same under Alternatives 1 and 2. Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts to air quality. All emissions of criteria pollutants from road and bridge construction would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

For purposes of analysis, it was assumed that the commuters currently utilizing FM 1396 would utilize the new FM 897 extension and the new bridge. Therefore, the overall traffic would not increase and the long-term impacts on air quality from vehicular use of the proposed FM 897 extension and new bridge would be negligible.

Summary of Air Quality Impacts

Overall, the impacts of Alternative 2 on air quality would likely be similar to but somewhat lower than the impacts of Alternative 1. Short-term slight adverse and long-term slight beneficial impacts to air quality would be expected with the implementation of Alternative 2. During construction activities, short-term emissions would be limited to fugitive dust and diesel emissions from construction and delivery and from the burning of cleared vegetation material. Direct and indirect air emissions would not be expected to exceed the annual *de minimis* threshold rates or to contribute to a violation of any federal, state, or local air regulations. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the project footprint, although these may well be offset by localized population growth, development, and greater tailpipe emissions from increased levels of traffic by new residents and recreationists in the vicinity of the new lake.

Mitigation of Air Quality Impacts from Construction

In the event that the Section 404 permit is issued and the project is implemented, EPA Region 6 recommended that NTMWD, its contractors, and all responsible parties develop mitigation measures to control PM_{10} emissions and fugitive dust during construction. These mitigation measures would be included in a detailed Construction Emissions Mitigation Plan that would identify BMPs for the construction effort. The BMPs would be designed to reduce air quality impacts associated with emissions of criteria pollutants (NOx, CO, CO_2, PM, and SO_2) and specifically to minimize potential exposure of individuals near the construction sites to PM_{10} from fugitive dust and heavy equipment tailpipe emissions.

Greenhouse Gas Emissions

Similar to Alternative 1, Alternative 2 would have short-term slight adverse climate effects and long-term slight beneficial effects. Overall adverse effects would be smaller than Alternative 1; however, the GHG emissions associated with power use would be higher under Alternative 2 due to the additional power required to operate the Lake Texoma pipeline. The long-term beneficial effects of Alternative 2 would be lower than Alternative 1 due to the reduced addition of storage capacity.

Long-term slight beneficial effects from augmenting water storage capacity in North Texas would be expected. Although there would be negligible direct effects from the emissions on climate change, Alternative 2 would constitute a more effective approach to water management under future conditions associated with possible reductions in available precipitation when compared to the No Action Alternative. However, it would result in reduced benefits compared to Alternative 1 due to its smaller storage capacity.

GHG emissions associated with Alternative 2 would result from the same actions and processes as Alternative 1: lake inundation, facilities construction, release of CO_2 embedded in fabrication materials, and power use. Table 4.7-5 shows estimates of GHG emissions during construction, lake inundation (impoundment of water), embodied emissions from the raw materials used, and electricity consumption over one hundred years. Given the long duration of the reservoir, Alternative 2 would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to climate change. The total amount of GHG emissions that would occur over the 100-year life of the project represents approximately 0.6 percent of Texas' annual GHG emissions (641 million metric tons of CO_2 equivalent in 2013) (Climate Central, 2015). Total GHG emissions would be approximately 11 percent lower than those of Alternative 1.

Table 4.7-5. Carbon Dioxide Equivalent Emissions During the 100-Year Life of the Project

Total Carbon Dioxide Equivalents (tons)				
Lake Inundation	Construction	Embodied in Fabrication Materials	Power Use	Total
487,500	4,840	182,000	3,347,500	4,021,840

Reservoir and Dam

There would be slight adverse effects from GHG emissions associated with Alternative 2. Lake inundation, that is, initial impoundment of the water in Bois d'Arc Creek, would account for approximately 487,500 tons of CO_2 equivalent, much of which would take place in the first five to ten years after the dam was built. GHG emissions from reservoir inundation includes the GHG that are currently being removed or sequestered by existing vegetation within the reservoir site, and, for the first 10 years, the GHG emitted by the biomass that would decompose after inundation as a result of conversion to permanently flooded land. After that, any additional GHG emissions from the reservoir would be from organic material that would have decomposed with or without the reservoir.

LBCR Raw Water Pipeline, Texoma Water Conveyance Pipeline, and Pump Stations

Similar to Alternative 1, small amounts of GHG emissions associated with construction of the proposed raw water transport pipeline would have an incremental, but overall negligible, contribution to climate change. While these emissions would increase with the additional construction of a pipeline for conveyance of water from Lake Texoma, construction emissions would still be negligible.

The largest component of ongoing GHG emissions under Alternative 2 is the use of fossil fuel electrical power to run the pump stations. Alternative 2 requires pumping in two locations: at the pumping station by the edge of the LBCR as in Alternative 1, and a pumping station to convey Lake Texoma water to a reservoir where the blending would occur. These emissions would be indirect and controlled at the point of power generation. Overall, long-term GHG emissions from pumping water under Alternative 2 would be greater than Alternative 1.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Similar to Alternative 1, small amounts of GHG emissions associated with the proposed WTP, TSR, and related facilities would have an incremental, but overall negligible, contribution to climate change. Power use to operate the pump stations and WTP is the largest source of ongoing emissions; however, these emissions would be indirect and controlled at the point of power generation. Because Alternative 2 would produce less treated water than Alternative 1, emissions associated with operating the WTP, TSR, and related facilities would be lower than Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Similar to Alternative 1, small amounts of GHG emissions would be associated with construction (heavy construction equipment) and operation (motorized vehicles) of these facilities under Alternative 2. These emissions would be approximately the same as Alternative 1.

4.8 ACOUSTIC ENVIRONMENT (NOISE)

This section discusses the noise impacts that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the noise impacts discussed in the following subsections is provided in Table 4.8-1.

Table 4.8-1. Summary of Impacts to the Acoustic Environment Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Area within 800 feet of construction or work areas	Area within 800 feet of construction or work areas	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight (beneficial and adverse)	Slight (beneficial and adverse)	
Operation Phase			
Size	Area within 400 feet of the WTP or water pipeline pumping stations and the area in and around the reservoir	Area within 400 feet of the WTP or water pipeline pumping stations and the area in and around the reservoir	Slight increase in ambient noise levels likely caused by the expected population growth and development over the coming decades.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	Medium	Medium	
Severity	Slight (beneficial and adverse)	Slight (beneficial and adverse)	

4.8.1 No Action Alternative

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth. These changes would result in an increase in noise, although not to the degree attributable to the construction or operation of Alternatives 1 or 2.

4.8.2 Alternative 1

Implementation of Alternative 1 would have short-term slight adverse and long-term slight beneficial and adverse effects on the noise environment. Short-term slight increases in noise would result from the temporary use of heavy equipment during land clearing and construction, estimated to last 3 to 4 years. Beneficial effects would result from most of the existing sources of noise within the reservoir footprint, such as agricultural equipment, automobile traffic, and lawn maintenance equipment ending with acquisition of the land for the proposed dam and reservoir. However, there are likely to be long-term noise impacts from the increase in traffic associated with recreational and real estate development at and in the vicinity of the reservoir. Other long-term noise impacts would result from traffic passing over the new bridge, operation of the water pumping stations, and operation of the WTP. To ensure project construction activities would not violate any federal, state, or local noise ordinance, BMPs would be implemented to reduce potential noise impacts. These BMPs are discussed further in the following sections.

Reservoir and Dam

Construction

Construction of the dam and clearing of the reservoir area would have short-term slight adverse effects on the noise environment. Noise would primarily be caused by tree clearing activities and the use of cranes, concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. As shown in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet.

Table 4.8-2. Noise Levels Associated with Outdoor Construction

Construction phase	dBA L_{eq} at 50 feet from Source
Ground clearing	84
Excavation, grading	89
Foundations	78
Structural	85
Finishing	89

dBA = A-weighted decibel; L_{eq} = equivalent sound level
Source: USEPA, 1974

With multiple pieces of equipment operating concurrently, noise levels can be relatively high during daytime periods at locations within several hundred feet of active construction sites. The zone of relatively high construction noise levels typically extends to distances of 400 to 800 feet from the site of major equipment operations. Locations (i.e., noise sensitive receptors) more than 800 feet from construction sites seldom experience appreciable levels of construction noise (USEPA, 1974). Given the temporary nature of proposed construction activities and the surrounding low population density, these effects would be slight.

Although construction-related noise impacts would be slight, the following BMPs would be implemented to further reduce any noise impacts:

- Construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential areas and recreational areas; and
- Construction equipment mufflers would be properly maintained and in good working order.

Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, particularly equipment operators, would wear personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Operations

There are no sources of noise associated with operating the proposed reservoir and dam; therefore, its operation would have negligible effects to the existing noise environment. Upon the initial acquisition of land on which the dam and reservoir would be located, most existing sources of noise on that land, such as agricultural activities, automobile traffic, and lawn maintenance equipment, would end. This return to natural quiet and the absence of manmade noise would have a slight beneficial effect on the noise environment.

However, if recreational and real estate development occur at the LBCR, then there would be noise associated with these activities such as the use of motor boats in the reservoir and personal vehicles around the reservoir. This noise would be compatible with the end use of the property; for example, noise from motor boats and personal vehicles is typical for lakes and lakeside areas and would likely not be unexpected nor objectionable to visitors and adjacent residents.

Raw Water Pipeline

Construction

Construction of the pipeline would have short-term slight adverse effects on the acoustic environment. These effects would be primarily due to noise from heavy construction equipment and vehicles during the construction of the pipeline. The noise would be similar in nature to construction noise described above for the dam and reservoir, though on a smaller scale. Heavy equipment would not be fixed in one location but would move along the pipeline route as construction progressed. Construction noise would be temporary and would subside at a particular location as activities progressed to a new location. There are some nearby residents who could experience annoying levels of noise; however, given the temporary nature of proposed construction activities, these effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during construction of the raw water pipeline to further reduce any noise impacts.

Operations

Operation of the proposed pipeline would have long-term slight adverse effects on the noise environment. All equipment would be enclosed at the pumping stations, but some mechanical noise could be audible at close range. Some noise due to the use of backup generators would occur during power outages. Noise from the generators is estimated to range from 74 dBA to 91 dBA at 23 feet, depending on the sound attenuation implemented (Cummins, 2016). Noise from these generators would be expected to decrease to less than 50 dBA within 300-400 feet of each pumping station. Noise from generators would be both intermittent and temporary in nature lasting only as long as the power outage. The effects would be slight.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Construction of the proposed WTP, TSR, and related facilities would have a short-term slight adverse effect on the acoustic environment. As noted above in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 dBA at a distance of 50 feet. Given the temporary nature of proposed construction activities, noise effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during construction of the WTP, TSR, and related facilities to further reduce any noise impacts.

Operations

Operation of the WTP would have long-term slight adverse effects on the noise environment. All equipment would be enclosed, but some mechanical noise could be audible at close range. The noise effects from operating the WTP would be similar to the impacts discussed for the pumping stations in Section 4.8.2.2.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Construction of the proposed new road and bridge would have a short-term slight adverse effect on the acoustic environment. As with other components of the proposed project described above in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 dBA at a distance of 50 feet. Given the temporary nature of proposed construction activities, these effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during relocation of FM 1396 and construction of the new bridge to further reduce any noise impacts.

Operations

Traffic flow along the proposed FM 897 extension would have adverse effects on the nearby acoustic environment comparable to the effects of traffic on FM 1396 at present. Traffic traveling over the bridge could cause slight adverse acoustic impacts for recreationists utilizing the proposed lake. However, if the area around the new reservoir becomes more developed, the noise associated with traffic on the proposed FM 897 extension and the new bridge could increase.

4.8.3 Alternative 2

Under this alternative, there would be short-term slight adverse and long-term slight beneficial and adverse effects on the noise environment. Short-term slight increases in noise from the temporary use of heavy equipment during land clearing and construction would result in an adverse impact; these activities are estimated to last 3 to 4 years. Under this alternative, the extent of this impact would be similar to Alternative 1 due to similar reservoir clearing and construction activities that would occur. Beneficial effects would result from most of the existing sources of noise within the reservoir footprint, such as agricultural activities, automobile traffic, and lawn maintenance ending with acquisition of the land for the proposed dam and reservoir. However, there are likely to be long-term noise impacts from the increase in traffic associated with recreational and real estate development at and in the vicinity of the reservoir. Other long-term noise impacts would result from traffic passing over the new bridge, operation of the water pumping stations, and operation of the WTP. To ensure project construction activities would not violate any federal, state, or local noise ordinance, BMPs would be implemented to reduce potential noise impacts. These BMPs are discussed further in the following sections.

<u>Reservoir and Dam</u>

Construction

Similar to Alternative 1, construction of the dam and clearing of the downsized reservoir area would have short-term slight adverse effects on the noise environment. Noise would primarily be caused by tree clearing activities and the use of cranes, concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. The noise levels generated by construction equipment would be the same under this alternative as Alternative 1 (see Table 4.8-2). Given the temporary nature of the proposed construction activities, these effects would be slight. The effects from this alternative would be similar to the effects from Alternative 1 due to the similar duration of construction.

Although construction-related noise impacts would be slight, the following BMPs would be implemented to further reduce any noise impacts:

- Construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential areas and recreational areas; and
- Construction equipment mufflers would be properly maintained and in good working order.

Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, particularly equipment operators, would wear personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Operations

There are no sources of noise associated with operating the proposed reservoir and dam; therefore, its operation would have negligible effects to the existing noise environment. Upon the initial acquisition of land on which the dam and reservoir would be located, most existing sources of noise on that land, such as agricultural activities, automobile traffic, and lawn maintenance equipment, would end. This return to natural quiet and the absence of manmade noise would have a slight beneficial effect on the noise environment.

However, if recreational and real estate development occur at the LBCR, then there would be noise associated with these activities such as the use of motor boats in the reservoir and personal vehicles around the reservoir. Such noise would be compatible with the end use of the property; for example, noise from motor boats and personal vehicles is typical for lakes and lakeside areas and would likely not be unexpected nor objectionable to visitors and adjacent residents.

Raw Water Pipelines

Construction

Construction of the proposed pipelines from the new reservoir to the WTP and from Lake Texoma to the WTP for blending with LBCR water would have short-term slight adverse effects on the noise environment, primarily due to noise from heavy equipment and vehicles during construction. These effects would be slightly greater than those described for Alternative 1 due to the additional Texoma pipeline that would be constructed under Alternative 2.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during construction of the raw water pipelines to further reduce any noise impacts.

Operations

Pipeline operation would have long-term slight adverse effects on the noise environment. These effects would be slightly greater than those under Alternative 1 due to the increased number of pumping stations required for the Texoma pipeline.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Construction of the WTP, TSR, and related facilities would have short-term slight adverse effects on noise. These effects would be the same as those described under Alternative 1.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during construction of the WTP, TSR, and related facilities to further reduce any noise impacts.

Operations

Operation of the WTP would have long-term slight adverse effects on the noise environment. All equipment would be enclosed, but some mechanical noise could be audible at close range. The noise effects from operating the WTP would be similar to the impacts discussed for the pumping stations under Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Construction of the proposed new road and bridge would have a short-term slight adverse effect on the acoustic environment. While the bridge constructed under Alternative 2 would be shorter, the total distance of the bridge and road would be the same under both alternatives. Therefore, the impact would be similar to the impact described under Alternative 1.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during relocation of FM 1396 and construction of the new bridge to further reduce any noise impacts.

Operations

Traffic flow along the proposed FM 897 extension would have adverse effects on the nearby acoustic environment comparable to the effects of traffic on FM 1396 at present. Traffic traveling over the bridge could cause slight adverse acoustic impacts for recreationists utilizing the proposed lake. The impacts would be the same as those described under Alternative 1. However, if the area around the new reservoir becomes more developed, the noise associated with traffic on the proposed FM 897 extension and the new bridge could increase.

4.9 RECREATION

The effects analysis considers how visitor experiences would change with implementation of Alternative 1 or 2 and what contributes or detracts from desirable visitor opportunities. Desirable visitor opportunities can be described as the ability to experience the fundamental resources and values within their natural settings. The nonmarket value of the activity includes the recreational experience itself (e.g., birdwatching), the aesthetic value (including natural and scenic landscape values) of recreation amenities and conditions, and the fulfillment of aesthetic values (e.g., sighting an eagle).

The type, duration, timing, and proximity of construction (short-term, temporary, or intermittent) and operation (long-term) activities is compared to the location, type, and usage of land and water-based recreational resources. Access is considered as it relates to traffic or delays, visitation and visitor spending, and revenue at nearby lakes and reservoirs and local recreational outfitters. For each alternative, potential impacts on visitation, visitor spending, recreational experience and aesthetic value are categorized in terms of severity, duration, size or physical extent, and likelihood – and are summarized in Table 4.9-1 below.

Table 4.9-1. Summary of Impacts to Recreation Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Small (localized)	Small (localized)	No change from current condition
Duration	3-4 years (short-term), temporary, or intermittent	3-4 years (short-term), temporary, or intermittent	
Likelihood	High	High	
Severity	Moderate (direct, adverse) Slight (Indirect, adverse and beneficial)	Slight (direct, adverse) Slight to Moderate (Indirect, adverse and beneficial)	

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Operation Phase			
Size	Medium (regional)	Medium (regional)	No change from current condition
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	Medium	Medium	
Severity	Severe (beneficial) Slight to Moderate (direct, adverse)	Severe (beneficial) Slight (direct and indirect, adverse)	

4.9.1 No Action Alternative

This alternative would not include construction activities in or adjacent to Bois d'Arc Creek, and therefore would not cause any short- or long-term impacts to visitor opportunities, the recreational experience, the aesthetic value of recreation amenities and conditions, or the fulfillment of aesthetic values. Access to both water- and land-based recreational opportunities would remain unchanged.

Bois d'Arc Creek

Bois d'Arc Creek would continue to be used for recreation by private landowners and their guests. The recreational experience and aesthetic value of boating, wildlife observation, bird watching, fishing, hunting, trapping, and enjoyment of scenic natural beauty in Bois d'Arc Creek are expected to remain the same.

Legacy Ridge Country Club

The LRCC would continue to be used as a semi-private golf facility. It is currently partially protected by berms, but part of the golf course is below the 100-year flood plain level at 541 feet MSL. Under the No Action Alternative, the intermittent flooding of the "back nine" holes of the golf course would continue to occur after heavy rain events. This is expected to continue and cause temporary impacts to golfers during closures (which generally last seven days) or until it is deemed "playable."

A housing development is planned on the west side of the golf course and country club, with a lot of the infrastructure – water, electricity, and sewer – already in place. However, golf course real estate without the adjacent golf course would devalue the land considerably given the risk of flooding on the "back nine" (NTEN, 2010). While the reservoir has not been constructed, the owner noted that the "uncertainty of the project negatively impacts us now. Any potential buyer must be informed of the reservoir's impact" (LRCC, 2011). Under the No Action Alternative, the land would not be devalued and is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA and Regional Lakes and Reservoirs

Visitation and visitation expenditures at nearby reservoirs, lakes, and recreational areas are also expected to remain the same. The projected population growth in the region and the (assumed) simultaneous recreational demand would likely put pressure on existing recreational facilities and opportunities within the region, and could degrade the quality of the recreation experience if the parks become overcrowded. That said, county and regional population may not grow as quickly as projected with the selection of the No Action Alternative.

4.9.2 Alternative 1

Under Alternative 1, the reservoir footprint and surface area would be 16,641 acres and the reservoir's normal water surface or conservation pool would be maintained at 541 feet MSL. Alternative 1 would include the construction of water transmission, storage, and treatment facilities, including a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. There are no recreational areas in or around the proposed WTP and TSR and as such are not discussed further. Potential direct and indirect impacts on recreation in and around Bois d'Arc Creek are evaluated for the construction and operation phase of each action alternative.

Construction Phase

Bois d'Arc Creek

Existing recreation activities in Bois d'Arc Creek would cease once the construction phase begins, and last the duration of the three- to four-year construction phase and beyond. Boating, bird watching, fishing, trapping, and enjoyment of scenic natural beauty in Bois d'Arc Creek would no longer be available to private landowners. The size or physical extent of such adverse impacts would be small (localized), given the relatively few number that would be affected.

Values and beliefs associated with recreation link residents to public lands and resources. Landscape appearance and scenery can be important public land amenities, not just as recreational opportunity settings, but also as elements of the region's identity. In 2010, brothers Russell and William Graves released a documentary entitled "Bois d'Arc Goodbye," "...a story about how a creek...transforms. The transformation affects not only the landscape, but people as well. This is a story about a creek's cultural, natural, and historic importance to a rural part of Texas" (Graves, 2010). This concern, while real, is voiced by a few residents and does not necessarily reflect the beliefs of the majority of those that would be affected.

That said, the documentary does appear to generally reflect public comments submitted during the scoping period regarding existing flora and fauna in the project area (USACE, 2010c). The value held by natural resources for purposes other than direct use is called non-use value (Brookshire, 1983). There is value in knowing that Bois d'Arc Creek exists, even for those who do not visit or use it for recreational or other purposes. The existence value of Bois d'Arc Creek reflects the benefit people receive from knowing that it exists, or its intrinsic value. Several commenters – landowners and local residents alike – were concerned with the destruction of Bois d'Arc Creek and the wildlife it supports.

Legacy Ridge Country Club

The owner of the Legacy Ridge Country Club (LRCC) has indicated the possibility of replacing the "back nine" portion of the golf course located below 541 MSL, which would be a costly and lengthy process (LRCC, 2011). It is unclear if the new "back nine" would be available at the time construction of the proposed LBCR begins. For purposes of this analysis, it is assumed the "back nine" would not be, and that the NTMWD would lease the approximately 47 acres of land below 541 MSL from the LRCC (LRCC, 2011). Under this scenario, the LRCC would continue to operate its existing golf course, including the "back nine" portion which would be located immediately southwest of the upstream edge of the proposed reservoir.

The use of heavy equipment, clearing and grading of land, and the construction of access roads would cause scenic degradation, decreased air quality, and distractions to golfers (e.g., noise) on the "back nine" holes. Emissions from the use of heavy equipment, airborne dust, and soil surface disturbance could degrade the air quality and adversely affect the golfing experience. As discussed in Section 4.6, Acoustic Environment (Noise), increased noise levels would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. To minimize the effects of noise impacts, construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as recreation areas; and construction equipment mufflers would be properly maintained and in good working order. Depending on the exact location of construction activities and therefore the distance to the golf course, potential impacts would be either direct and indirect, and last the duration of the construction phase.

Revenue would likely decline during the construction phase, as would beneficial impacts to labor income, value added, and jobs associated with non-local visitor spending at the LRCC. Its owner would continue to have difficulty selling real estate on the west side of the golf course and country club, and would likely be forced to sell at a loss.

Caddo National Grasslands WMA

Construction activities at the reservoir would not cause any of the recreational facilities at Caddo National Grasslands WMA to close. However, the use of heavy equipment, clearing and grading of land, and the construction of access roads could cause short-term impacts to recreationists in the Bois d'Arc Unit, which (as shown in Figure 3.7-1) includes several campsites, multi-use trails, recreational fishing and boating lakes, and hunting opportunities. The use of heavy equipment would likely cause scenic degradation and distractions to users (e.g., noise), particularly those at CR 2285 and CR 2700 or hunters seeking a natural outdoor recreational experience.

Emissions from the use of heavy equipment, airborne dust, and soil surface disturbance could also degrade the air quality and directly and indirectly affect recreationists in the southern portion of the Bois d'Arc Creek Unit and throughout. Depending on the exact location of construction activities and therefore the distance to the recreational facility or recreationist, potential impacts would be either direct and indirect, and last the duration of the construction phase.

Visitors might avoid activities in the southern portion of the Bois d'Arc Creek Unit, opting for quieter or more pleasant recreational experiences offered in other parts of Caddo National Grasslands WMA. This could cause a higher concentration of visitors at other facilities and degrade the experience for all visitors in the northern parts of the Bois d'Arc Creek Unit.

As discussed in Section 4.13.2.3.1, the construction phase would create a total of about 5,000 person-years of employment, or 5,000 full-time jobs for one year. While a portion of the construction workforce would be hired locally (in Fannin County) and a portion would be hired regionally (from surrounding counties); a portion would also relocate from outside of the region. An increase in the local population due to the presence of the construction workforce may also affect the recreational experience – for hunters specifically – at Caddo National Grasslands WMA. Caddo National Grasslands WMA is the only recreational area in Fannin County that in addition to boating, camping, swimming, hiking, fishing, and picnicking opportunities; offers hunting opportunities. As such, any increase in hunting in Fannin County would likely occur on the Bois d'Arc Creek Unit at the Caddo National Grasslands WMA. Visitor spending at restaurants, recreation outfitters, or other businesses in the local area would benefit in terms of jobs, labor income, and value added; but it could also degrade the experience for existing hunters seeking solitude and quiet.

As discussed in Section 4.12 (Transportation), congestion would increase in the immediate project area due to additional vehicles and traffic delays. FM 1396 is an existing two-lane TXDOT asphalt road that runs from Ravenna; east across the county transecting the proposed reservoir; and south to Honey Grove and Ladonia. FM 1396 would not be available during (or after) the construction phase, and as such recreationists from the south or southeastern portion of Fannin County using FM 1396 to access the Bois d'Arc Creek Unit could experience longer travel times. Recreationists accessing the Bois d'Arc Creek Unit from FM 100 could also be affected by increased traffic and time delays due to increased congestion and additional vehicles in the project area.

Recreationists accessing the Ladonia Unit from SH 34 could also experience traffic and delays during construction of the 35-mile pipeline to the Leonard WTP. Pipeline construction would not be fixed in one location but would progress along the pipeline. Any congestion or increase in traffic associated with construction of the pipeline that would increase travel time for hunters or campers accessing the Ladonia Unit would be temporary and intermittent, and last for the duration of pipeline-related construction activities but not for the full duration of the three- to four-year construction phase. Given the distance from the Ladonia Unit to the pipeline, the limited hunting that occurs on this unit, and the single camping facility available (CR 3910), there would be no impacts to hunting opportunities or the recreational experience of campers or hunters.

Regional Lakes and Reservoirs

Construction activities would directly affect visitation and the recreational experience at Bonham City Lake, which is located immediately west of the upstream edge of the proposed reservoir. Similar to Caddo National Grasslands WMA and the LRCC, adverse impacts during picnicking, camping, boating, fishing, and swimming would occur due to scenic degradation, air quality impacts, and disturbances (e.g., noise). Given the proximity to the proposed LBCR, visitation would be expected to decrease for the duration of the construction period.

Construction activities may indirectly increase visitation at regional reservoirs from the portion of the construction workforce that has relocated from outside of the region; and their spending at local reservoirs would have an economic benefit to the county. Increased visitation may also put pressure on existing recreation facilities; and degrade the experience for other visitors. Any indirect impact on the recreational experience or benefit from the revenue of additional visitor spending at or around a lake would be slight.

Operation Phase

Bois d'Arc Creek

Existing recreation activities for private landowners in Bois d'Arc Creek would permanently cease in the long-term. Similar impacts would continue to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek.

Alternative 1 would create a new, 16,641-acre water supply reservoir that would serve as a major new outdoor recreation asset for Fannin County and the region. At this stage, no specific recreational facilities, activities, designs or locations have been chosen. However, Fannin County's Draft Comprehensive Plan for the LBCR (Fannin County's Plan), published in July 2016, includes plans for public access points, opportunities for both passive and active recreation, and trail connections that are summarized below.

- *Public Access Points* – Public access points were identified to give all residents and visitors sufficient access; near areas for suitable marina locations; where nonresidential uses could potentially develop; and in areas where parkland was identified. Further site evaluations are needed to be certain that these areas are suitable for recreational areas.
- *Recreational Areas* – Develop recreational areas adjacent to the lake near proposed boat docks, marinas, and areas where major thoroughfares are located. Parks for active recreation to include camping, playgrounds, swimming areas, trails (paved and unpaved), and fitness trails/exercise areas. Parks for passive recreation to include nature preserves, bird watching, pier fishing, picnic areas, and pavilions.
- *Trail Connections* – Connect as many parks and recreational amenities as possible so that visitors can travel freely between them. The trails should also tie into the regional trail network to increase the accessibility of the lake. All trails should be multi-purpose to allow walkers, runners,

and cyclists; and can either be paved or left natural depending on the environment of the area (Fannin County, 2016).

Figure 3.9-1 below is from Fannin County's Plan, and shows the location of potential marinas, recreation areas, boat ramps, park areas, and trails.

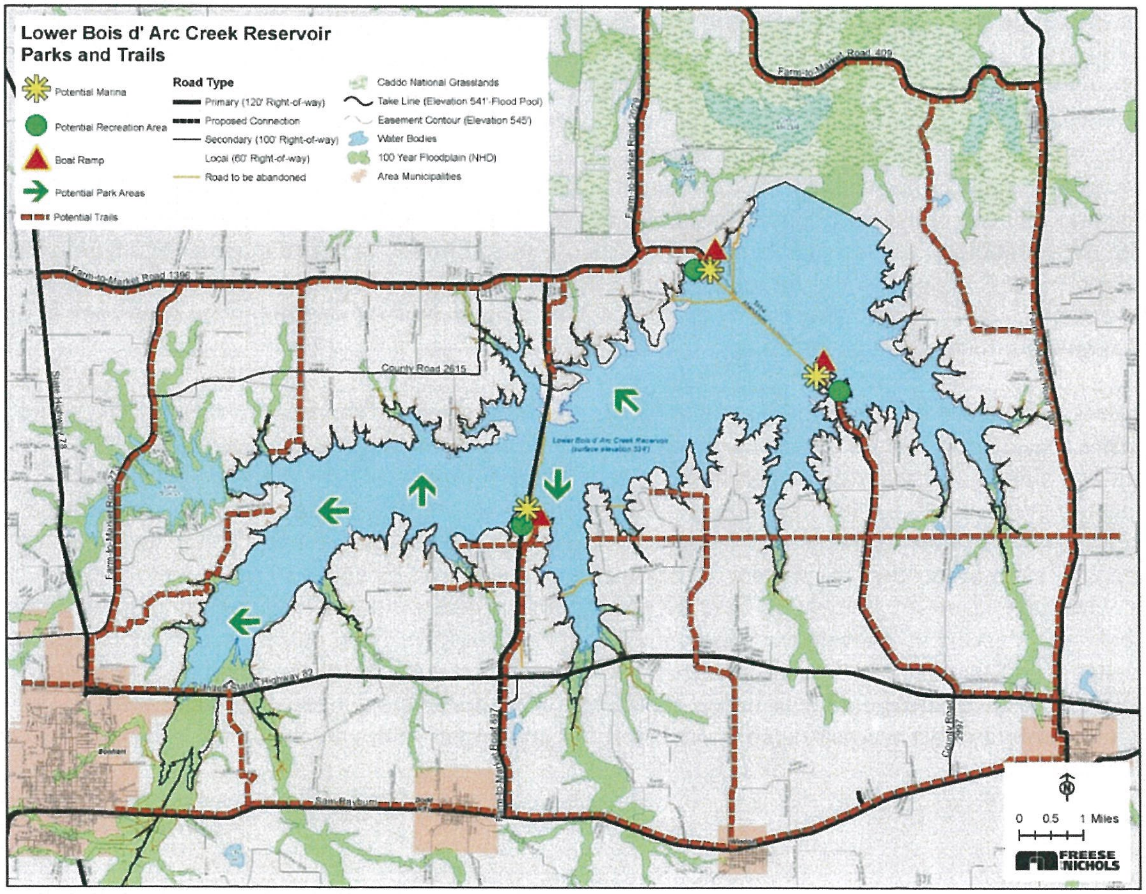


Figure 4.9-1 Potential Marinas, Recreation Areas, Boat Ramps, Park Areas, and Trails at LBCR

Source: Fannin County, 2016.

Public scoping comments and input from interested parties (Fannin County's Plan) emphasized the importance of boating and fishing at the proposed LBCR. The planned boat ramps, marinas, and fishing piers would provide facilities for new fishing and boating opportunities. The biological analysis has indicated that the reservoir should be able to support high-quality recreational fishing opportunities for species such as smallmouth buffalo, yellow bullhead, channel catfish, green sunfish, warmouth, bluegill, longear sunfish, redear sunfish, largemouth bass, and white crappie. Parks, campgrounds, parks, and trails would provide several new opportunities for swimming; camping; biking, running, and walking; and birdwatching. As discussed in the Socioeconomics section (4.13.2.3.2), once the reservoir is fully developed, non-local recreational visitors are estimated to spend between \$16.7 and \$21.9 million annually. This spending would generate between \$21.2 and \$28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by \$6.2 to \$8.3 million (Clower, 2012).

Residential homes (e.g., single family, two-family, manufactured home) are also planned for development around the lake, the majority on larger properties (i.e., one acre) in an effort to maintain the rural character of the area (Fannin County, 2016). At least 2,100 new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. Weekend and vacation residents would be expected to bring an equivalent of $10 million in household income that would be used for local purchases (Clower, 2012). Nonresidential development would be primarily located along major thoroughfares and limited throughout the 5000-foot lake buffer or planning area surrounding the lake, and would generally include restaurants, hotels, small shops, and marinas. By modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, Fannin County would realize a net increase in economic activity of between $80.7 and $89.2 million per year once full development is reached. This activity would support 517 to 572 permanent jobs, or the equivalent of $13.3 to $14.7 million in salaries and wages. Fannin County's Plan also recommends developing standards for future recreational vehicle (RV) parks and camping areas, which would be located within the nonresidential land use since they fall within the commercial category (Fannin County, 2016). In addition to residential homes and hotels, the development of RV parks would further support overnight stays – similar to the facilities available at Lake Texoma. This could further encourage annual visitation and visitor spending; and contribute to the impact on labor income, value added, and jobs created.

Concerns were raised during scoping about whether the water level and shoreline of the new lake would fluctuate considerably. Since the primary purpose of the reservoir is water supply, not lake-based recreation, maintaining a constant shoreline is not the highest priority. There would be considerable fluctuation in lake level, as shown in Figure 4.9-2 (from Fannin County's Plan). Based on the historic hydrologic record of 50 years, the lake is projected to be between 516 and 534 feet about 80 percent of the time; over 534 feet about 10 percent of the time; and under 516 feet about 10 percent of the time. Even when lake levels are below 516 feet, the majority of the lake would still be deep enough for fishing and boating. Varying lake levels were taken into account when identifying public access points because the upper end of the lake (the western portion) would be the first part of the lake to experience limited access in a season of drought, due to higher elevations. Therefore, it is unlikely that water level fluctuation would affect access to recreational facilities and opportunities created under Alternative 1.

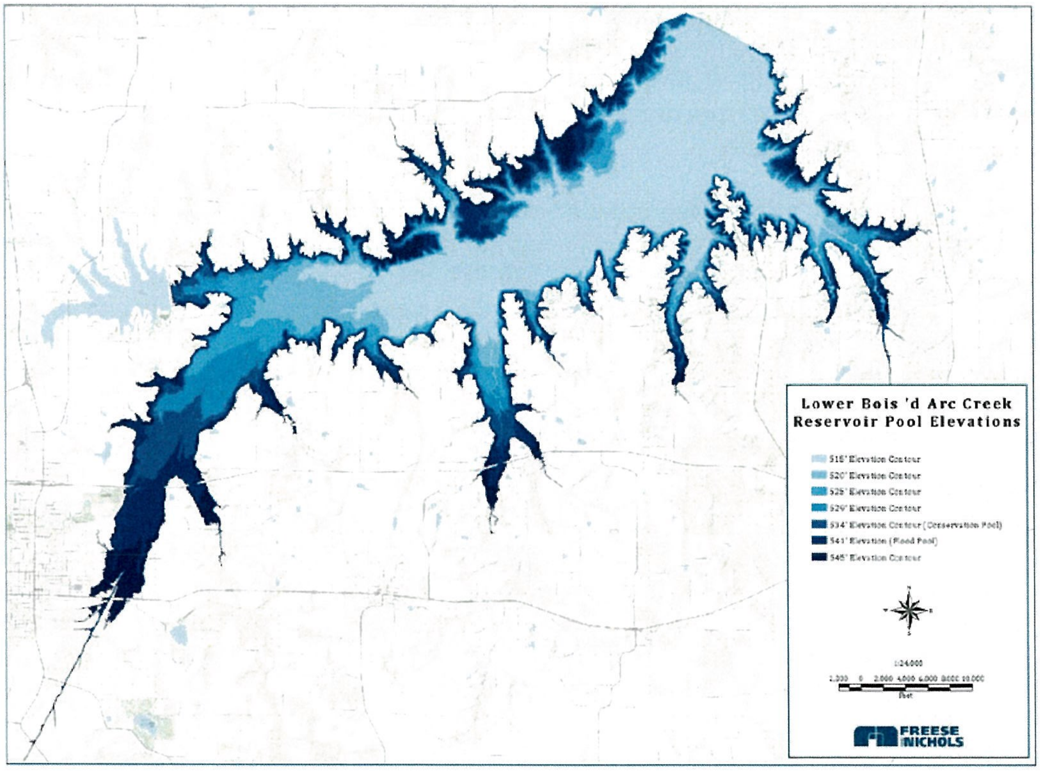


Figure 4.9-2. Lower Bois d'Arc Creek Reservoir Pool Elevations

Source: Fannin County, 2016

As shown in Table 3.7-3 and discussed in the affected environment section, water fluctuation, the number and type of recreational facilities and opportunities, and surface area vary at existing, regional reservoirs and lakes; and it is difficult to tell in these cases if any one factor directly increases or decreases visitation. Lake Texoma and Lake Tawakoni, while considerably larger than the proposed LBCR, are used as the main case studies in this analysis because both reservoirs experience considerable fluctuation and other commonalities make them comparable to each other and to the proposed LBCR. While Lake Tawakoni has about half the surface area of Lake Texoma, it received less than one percent of the visitors Lake Texoma received in FY 2012. At Lake Texoma, water fluctuation does not appear to affect visitation; in the case of Lake Tawakoni, it would appear that it might.

While not directly comparable to the proposed LBCR or regional reservoirs, it should be noted that a study on the effect of Tennessee Valley Authority (TVA) reservoir water levels on recreational fishing concluded that water levels were not a major barrier to participation but levels did affect the number of trips taken by anglers. In the case of the TVA reservoirs, lower water levels left many coves and boat ramps landlocked for much of the year, restricting the ability of reservoir anglers to launch boats (Jakus et al., 2000). As noted above, varying lake levels were taken into account when identifying public access points to avoid or minimize scenarios where access to the proposed LBCR is limited.

In these cases, it is more likely that water fluctuation does not much affect visitation at either reservoir; that instead factors such as additional housing facilities and land-based recreational opportunities and higher-quality recreational fishing at Lake Texoma increase visitation. In addition to camping, RV sites, and motels offered at Lake Tawakoni, Lake Texoma also offers cabin, lake house, and condo rentals. Hunting opportunities are available on 39,125 acres in the Tawakoni WMA compared to 90,000 acres at

Lake Texoma, not including additional opportunities at the adjacent Hagerman NWR (TPWD, 2017b; USACE, no date-c). Lake Texoma offers 25 miles of equestrian and hiking trails, while Lake Tawakoni offers five miles of hiking trails (USACE, no date-c; TPWD, no date-f). While both offer fishing, Lake Texoma is stocked with more types of fish and is one of the few reservoirs in the United States where striped bass reproduces naturally.

Based on Fannin County's Plan, the proposed LBCR is envisioned to combine elements of both Lakes Texoma and Tawakoni. In addition to developing RV sites, campsites, and multi-use trails for biking, running, and walking (but not equestrian), like Lake Texoma, LBCR would develop residential housing units and hotels. Like both lakes, LBCR would provide water-based recreational facilities (boat ramps, marinas) to support boating and fishing. And like both lakes, hunting (including deer-hunting) would be available at or near the proposed LBCR. While the proposed LBCR itself does not currently include plans for public hunting areas, the adjacent Caddo National Grasslands WMA may (perhaps inadvertently) increase visitation by appealing to all types of recreationists.

Legacy Ridge Country Club

The proposed LBCR would cause severe impacts to the "back nine" holes of the golf course after heavy rain events, which were constructed in the Lower Bois d' Arc Creek 100-year floodplain with the expectation that there would be periodic inundation. Once the proposed LBCR construction is complete, it is expected that the inundation pattern would be similar but with sustained ponding at depths that will damage the golf course's vegetation and drainage system. The water surface profile upstream of Highway 82 would be influenced by the release of the impoundment through the 150-foot wide service spillway. Depending on the volume of runoff and frequency of storm events, the inundation time on the golf course can be expected to extend seven days. With water standing on the golf course for this length of time it can reasonably be expected that the health of grass on the course would be compromised; sediment would build up within the flooded areas; and that drains for the greens and tee boxes would become blocked and increase the water table, creating saturated soils within low areas of the golf course. Minor maintenance level repairs; replacement of portions or all of the fairway grass in the "back nine" holes; and replacement of portions of the greens could be required at various elevations and locations (Boyd, 2010).

Prolonged closures and costly damage to the golf course would cause moderate to severe adverse impacts to the LRCC. Non-local visitation would likely decrease as the golf course would essentially be reduced to a nine-hole golf course part of the time. Impacts to visitation would depend on the frequency and runoff of storm events and the duration of closures. Decreased revenue at the LRCC would be expected to continue into the operations phase, as well as the associated impacts to labor income, value added, and jobs associated with non-local visitor spending.

Because the LRCC receives 80 percent of its revenue coming from out-of-town golfers and the repair costs could be high, it would be at risk of eventually closing as a result (NTEN, 2010). The closure of the LRCC would also cause adverse impacts to local golfers who account for the other 20 percent of revenue. Closure of the LRCC would adversely impact labor income, value added, and jobs associated with non-local visitor spending. Whether the LRCC closes or not, its owner would continue to have difficulty selling real estate on the west side of the golf course and country club, and would likely be forced to sell at a loss.

Caddo National Grasslands WMA

In the long-term, access to Caddo National Grasslands WMA would essentially be the same with the replacement of FM 1396 with FM 897. Visitors travelling from the south may experience slightly higher travel times given that FM 897 is west of the FM 1396, and due to potential traffic from those accessing the LBCR. The proposed LBCR would likely not directly affect the water-based recreational opportunities or experience at lakes within the Caddo National Grasslands WMA, because the LBCR is not directly upstream from these lakes. As such, the biological or hydrological characteristics of these lakes or other recreational areas would not be altered.

It is difficult to say whether visitation at the Caddo National Grasslands WMA would increase or decrease overall as a result of the proposed LBCR. Generally speaking, both LBCR and the Caddo National Grasslands WMA would offer similar recreational opportunities, including boating, swimming, fishing, picnicking, trail, camping, and wildlife watching opportunities. LBCR would offer opportunities on a much larger scale, and ultimately visitation would depend on personal preference (with the exception of hunting, discussed further below). Some Caddo National Grasslands WMA visitors may shift to the LBCR, especially if the fishing experience is deemed higher-quality. Some Caddo National Grasslands WMA visitors may continue undeterred, especially those seeking a smaller-scale, quieter recreational experience. With the projected population growth, it may be that eventually neither would be able to offer quiet experiences in solitude.

Given that Caddo National Grasslands WMA is the closest recreational area offering hunting opportunities, visitation as it relates to hunting would be expected to increase. As a result, the recreational experience for hunters may be degraded for those seeking solitude and quiet. Visitation at other regional WMAs or public hunting lands may also increase as an indirect result of the LBCR and the degraded hunting experience at Caddo National Grasslands. Local and regional outfitters would likely benefit from increased revenue in the long-term.

NTMWD has purchased and proposes to restore and enhance natural habitats at the 15,000-acre Riverby Ranch in order to mitigate the impacts of Alternative 1 to waters of the United States. Under Alternative 1, the Riverby Ranch would be transferred to the USFS and managed for conservation and recreation as part of the Caddo National Grasslands WMA. Currently, wildlife on Caddo National Grasslands WMA includes white-tailed deer, small mammals, coyotes, bobcats, red fox, waterfowl, bobwhite quail, turkey and songbirds, all of which are likely to benefit from the additional 15,000 acres of habitat. In the long-term, the additional recreational opportunities for hunting and wildlife viewing would likely cause visitation to increase.

Regional Lakes and Reservoirs

Similar to the above discussion of visitation impacts on the Caddo National Grasslands WMA, it is difficult to say if visitation at Bonham City Lake would increase or decrease overall as a result of LBCR. In general, Bonham City Lake and LBCR offer similar opportunities, including boating, fishing, swimming, camping picnicking. However, the recreational opportunities offered at LBCR would be on a much larger scale and also include trails and facilities conducive to overnight stays (e.g., RV, residential units, hotels). LBCR visitors could "spill over" into Bonham City Lake, especially existing or new residents seeking to avoid crowds on long or popular summer weekends. But Bonham City Lake visitors could also shift to LBCR if recreational opportunities are deemed higher-quality.

During the public meeting for Fannin County's Plan, one of the key takeaways was that a connection between the LBCR and Bonham City Lake is important – specifically throughout the parks (Fannin County, 2016). As shown in Figure 4.9-1, recreational areas are proposed south and east of Bonham City Lake and potential LBCR trails would connect visitors to Bonham City Lake via FM 273 and CR 2610. As described in the affected environment, both access points for Bonham City Lake – Bonham City Lake Recreation Area and North Ramp – are accessible off of FM 273. Bonham City Lake Recreation Area can be accessed via Recreation Road 3 (perpendicular to FM 273 and CR 2610), and the North Ramp can be accessed via Fannin County Road 2524 and Boat Ramp Road (directly off of FM 273). Connecting two LBCR recreational areas and Bonham City Lake access points with trails would likely increase visitation at Bonham City Lake by incorporating it into LBCR.

It is also difficult to discern whether the introduction of a new recreational reservoir in Fannin County would affect visitation at other regional reservoirs. Despite fishing, boating, camping, wildlife viewing, picnicking, and hunting opportunities currently available in Fannin County, it is possible for some Fannin County residents to visit (or continue to visit) regional reservoirs, ostensibly to experience these recreational opportunities on a larger scale. But with the introduction of a large reservoir with high-quality recreational opportunities, it is expected that Fannin County residents would visit LBCR instead of travelling to visit regional reservoirs. As such, the LBCR is expected to cause visitation to decrease at regional lakes and reservoirs. Any decrease in visitation from Fannin County residents would likely be imperceptible if projected population growth in the region is realized. Businesses located in Fannin and surrounding counties would likely offer goods and services to new permanent and weekend residents. The economic activity of these counties, including spending by households drawn to the new reservoir, would increase economic output in the broader region by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012).

Conclusion

During the construction phase, the severity of direct, adverse impacts on recreation would be moderate overall. The use of heavy equipment, clearing and grading of land, and the construction of access roads would cause scenic degradation, decreased air quality, and distractions (e.g., noise) to nearby recreationists. Impacts would be felt most at Caddo National Grasslands WMA, Bonham City Lake, and LRCC, and as such the size or physical extent of impacts would be small (localized). Given the proximity to construction activities, the likelihood of impacts would be high. Displaced recreationists in combination with newly relocated construction workers could cause an increase in visitation at regional lakes and reservoirs. Indirect, beneficial impacts from construction workers' recreational spending would be slight. Pipeline-related construction impacts would be temporary and intermittent, and dam and reservoir-related construction impacts would last the duration of the construction phase.

Recreational activities in Lower Bois d'Arc Creek would cease during the construction and operation phase, and adverse impacts as they relate to the Bois d'Arc Creek's existence and non-use value would be felt by private landowners and local residents alike. Adverse impacts to the LRCC are highly likely in the long-term, as flooding could cause costly damage to the "back nine" holes of the golf course, prolong closures, and decrease visitation. While the likelihood would be low, if the LRCC closes due to decreased revenue, increased repair costs, and devalued real estate, adverse impacts to the owners of LRCC would be severe.

Once the reservoir is operational, the numerous recreational opportunities that would be provided with the development of boat ramps, marinas, trails, parks, and campgrounds would create direct, beneficial impacts. These benefits would be felt by residents and outfitters in Fannin County as well as in the region, therefore the size or physical extent would be medium (regional). Non-local recreational visitors are estimated to spend between $16.7 and $21.9 million annually, which would generate between $21.2 and $28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by $6.2 to $8.3 million. Economic impacts would become more and more positive or beneficial over time, especially with the development of residential units. Weekend and vacation residents would be expected to bring an additional equivalent of $10 million in household income that would be used for local purchases (Clower, 2012). Indirect, adverse impacts from decreased visitation at regional lakes and reservoirs would be slight, and economic output in the broader region would increase by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012). It is unclear whether considerable water fluctuation would ultimately impact visitation at LBCR, but access points would be strategically sited in locations less vulnerable to changes in water level to avoid affecting access to recreational facilities and opportunities. The development of real estate, hotels, and RV sites would encourage overnight stays, and adjacent hunting opportunities at Caddo National Grasslands WMA diversifies the land-based opportunities available in the area. While the likelihood of beneficial impacts would be moderate in light of the aforementioned unknowns, overall the beneficial impacts to Fannin County would be severe due to the economic stimulus that would be associated with the recreational reservoir.

4.9.3 Alternative 2

Under Alternative 2, the reservoir's normal water surface, or conservation pool, would be maintained at 515 feet MSL, and have a surface area of approximately 8,600 acres – about half the surface area of Alternative 1. The reservoir footprint (9,390 acres) under Alternative 2 would also be roughly half the size of the reservoir footprint under Alternative 1. Many of the potential impacts on visitation, visitor spending, recreational experience and aesthetic value are would be similar to Alternative 1, and differences in impacts from the downsized reservoir under Alternative 2 are noted throughout the analysis. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. As such, impacts associated with the 35-mile pipeline are summarized throughout the section but the detailed analysis is not repeated.

The blending portion of Alternative 2 would include a new 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Additional impacts on the recreational experience and access to opportunities in Fannin and Grayson counties are analyzed below.

<u>Construction Phase</u>

Bois d'Arc Creek

Under Alternative 2, existing recreation activities would cease in the majority of Bois d'Arc Creek once reservoir construction begins, and last the duration of the three- to four-year construction phase and beyond. Boating, bird watching, fishing, trapping, and enjoyment of scenic natural beauty would no longer be available to Bois d'Arc Creek landowners within the reservoir's footprint. Recreation activities would continue in the western portion of Alternative 1's reservoir footprint, or the area directly east of Bonham City Lake and LRCC. The size or physical extent of such adverse impacts would be smaller than under Alternative 1, but still be considered small (localized) overall, given the relatively few number of people that would be affected. Similar impacts as they relate to existence and non-use values associated with Bois d'Arc Creek and the wildlife it supports would also likely occur to affected private landowners and Fannin County residents.

Legacy Ridge Country Club

Impacts to the LRCC would be similar to those described under the No Action Alternative; impacts from construction activities under Alternative 1 would not occur. The "back nine" holes would be located about five miles southwest of the upstream edge of the proposed reservoir. Given this distance, construction activities would not affect air quality or cause scenic degradation to golfers. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise, so construction activities would not cause distractions to golfers, either.

For purposes of this analysis, it is assumed that the NTMWD would not lease any land from the LRCC, given that the "back nine" holes of the golf course would not be affected by the reservoir's conservation pool elevation (515 feet MSL). It would continue to be used as a semi-private golf facility, and the intermittent flooding on the "back nine" would continue to occur after heavy rain events. This is expected to continue and cause temporary impacts to golfers during closures (which generally last seven days) or until it is deemed "playable." Revenue is not expected to decrease as a result of construction activities.

The land with proposed real estate development would not be devalued and is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA

Under Alternative 2, construction activities at the reservoir would cause similar impacts at Caddo National Grasslands WMA as those described under Alternative 1. The use of heavy equipment, clearing and grading of land, and the construction of access roads could cause short-term impacts to recreationists throughout the Bois d'Arc Creek Unit. The recreational experience at campsites CR 2285 and CR2700, the hunting area surrounding CR 2285, and fishing and boating in Coffee Mill Lake would be impacted due to degraded scenery and air quality and increased distractions (e.g., noise). Visitors seeking to distance themselves from construction activities near the dam and spillway may increase the concentration of visitors in other areas and degrade the recreational experience for all visitors in the Caddo National Grasslands WMA.

As described in 4.14.3 of the socioeconomics section, the construction of Alternative 2 would be about $46 million more expensive than Alternative 1, or 7.8 percent more expensive. Given that it is unlikely that Fannin County and the surrounding counties could supply the trained construction workforce under Alternative 1, an even larger portion of labor would likely be filled from outside of the area for the construction phase of this alternative. With additional construction workers relocating from outside the region, construction activities may further indirectly increase visitation at Caddo National Grasslands WMA. As such, visitation during construction activities could be slightly higher compared to Alternative 1, especially given that Caddo National Grasslands is one of the few recreational areas in Fannin County that offers hunting opportunities on public lands. Visitor spending at restaurants, recreation outfitters, or other businesses in the local area would benefit in terms of jobs, labor income, and value added; but it could also degrade the experience for existing hunters seeking solitude and quiet. The indirect, adverse impact on the recreational experience or benefit from the revenue of additional visitor spending in the area would be more severe under Alternative 2.

FM 1396 transects the reservoir under both Alternatives 1 and 2, and would not be functional during the construction phase of either alternative. Travel times for recreationists accessing either the Bois d'Arc Creek Unit or Ladonia Unit could be prolonged under this alternative as well. The same 35-mile pipeline to the Leonard WTP that would be constructed under Alternative 1 would also be constructed under this alternative, and would not cause impacts accessing hunting opportunities or the recreational experience of campers or hunters at the Ladonia Unit.

Regional Lakes and Reservoirs

Unlike Alternative 1, construction activities under Alternative 2 would not cause direct impacts to visitation or the recreational experience of Bonham City Lake visitors. Bonham City Lake is located about three miles west of the upstream edge of the proposed reservoir under Alternative 2. Any scenic degradation, increase in noise levels, or impacts to air quality would not be seen, heard, or felt by recreationists at Bonham City Lake.

Under this alternative, construction of the additional 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas could cause temporary impacts to the access and the recreational experience of two Lake Texoma facilities. Visitors traveling west/northwest or east/southeast to access or return from Lake Texoma could experience some congestion and traffic, as they would be travelling perpendicular to the north/south directional 25-mile pipeline. The northern-most portion of the pipeline would be located within a few miles of Grandpappy Point and Eisenhower State Park, both of which offer picnic and camping areas, and construction activities could impact visitors due to scenic degradation and increased air emissions. Pipeline construction would not be fixed in one location but would progress along the pipeline. Slight, indirect impacts would be temporary and last for the duration of construction activities for the northern-most portion of the pipeline, but not for the full duration of the three- to four-year construction phase.

Construction of the eight-mile pipeline spur connecting the proposed North WTP in Leonard to the existing pipeline from Texoma to Wylie would not have any impacts because no recreational areas are located close by.

With additional construction workers relocating from outside the region, construction activities may further indirectly increase visitation at regional lakes and reservoirs. Any indirect, adverse impact on the recreational experience or benefit from the additional visitor spending at or around a lake would be more severe under Alternative 2.

Operation Phase

Bois d'Arc Creek

As under the construction phase of Alternative 2, recreational activities would continue in the western portion of Alternative 1's reservoir footprint, or the area east of Bonham City Lake and LRCC. However, existing recreational activities for private landowners in the majority of Bois d'Arc Creek would permanently cease in the long-term. Impacts to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek would be similar to those discussed under Alternative 1.

Alternative 2 would create a new, 8,600-acre water supply reservoir – about half the surface area of the reservoir under Alternative 1 – that would also serve as a major new outdoor recreation asset for Fannin County and the region. While Fannin County's Plan was developed for Alternative 1, for purposes of this analysis it is assumed that many of the same public access points, opportunities for passive and active recreation, and trail connections would also be developed in those areas overlapping with Alternative 2; but that some would be eliminated to adjust for a downsized reservoir or re-sited to apply to Alternative 2.

As such, three potential recreation areas, the proposed trails to the north, east, and south of the reservoir, the three marinas and public access points, and the new bridge crossing at FM 897 (replacing FM 1396) would presumably still be developed under Alternative 2. The reservoir under Alternative 2 would still support high-quality recreational fishing opportunities and the planned boat ramps, marinas, and fishing piers would provide facilities for new fishing opportunities.

However, it is assumed that two potential park areas included in Fannin County's Plan – one near the intersection of FM 273 and US Highway 82 and the other near Bonham City Lake – would not be developed under Alternative 2 because they would not be located on the reservoir's western shore under this alternative. Similarly, it is assumed that potential trails along CR 2610, FM 273, parts of FM 1396 located north of Bonham City Lake, and US Highway 82 near Bonham would not be developed. If an alternative trail under Alternative 2 does not connect Bonham City Lake to the proposed LBCR, the benefits of incorporating Bonham City Lake into LBCR would not occur. Generally speaking, the development of fewer park areas and trails under this alternative would create less severe beneficial impacts than Alternative 1 by providing fewer land-based opportunities for pier fishing; camping; biking, running and walking; and birdwatching. Once the reservoir is fully developed, fewer non-local recreational visitors are expected and therefore spending would be less under Alternative 2 than under Alternative 1. While their spending would still generate economic activity, support jobs, and increase local earnings, beneficial economic impacts would be less severe under this alternative.

It is also assumed that residential homes would still be planned for development around the lake under Alternative 2. Some of the larger, one-acre properties located west of FM 897 could not be developed under this alternative at the location(s) proposed in Fannin County's Plan. If these properties are not re-located (along the western boundary of the reservoir, for example), weekend and vacation residents would be expected to bring less than the equivalent of $10 million in household income that would be used for local purchases under Alternative 1. Under Alternative 1, nonresidential development including restaurants, hotels, small shops, and marinas are planned in areas that would overlap with Alternative 2, and as such are also expected to contribute to overnight stays and overall visitation. Developing standards for future RV parks and camping areas, as recommended in Fannin County's Plan under Alternative 1, would also further support overnight stays; encourage annual visitation and visitor spending; and contribute to the impact on labor income, value added, and jobs created.

The reservoir's conservation pool for this alternative would be maintained at an elevation of 515 feet MSL, but the actual water surface and shoreline would fluctuate above and below this level. Assuming the public access points planned under Alternative 1 would be the same under Alternative 2, it is unlikely that water level fluctuation would affect access to recreational facilities and opportunities under either alternative. Varying lake levels were taken into account when identifying public access points because the upper end of the lake (the western portion) would be the first part of the lake to experience limited access in a season of drought, due to higher elevations. As discussed under Alternative 1 and the affected environment, water fluctuation, the number and type of recreational facilities and opportunities, and surface area vary at existing, regional reservoirs and lakes; and it is difficult to tell if any one factor directly increases or decreases visitation. However, factors such as additional housing facilities and land-based recreational opportunities and higher-quality recreational fishing do appear to increase visitation in Lake Texoma's case. If fewer residential units, recreational areas, and trails are developed under Alternative 2, visitation is expected to be lower than under Alternative 1. The adjacent Caddo National Grasslands WMA would (perhaps inadvertently) contribute to visitation under Alternative 2 as well as under Alternative 1 by appealing to all types of recreationists.

Legacy Ridge Country Club

As discussed under the construction phase, it is assumed for purposes of this analysis that the NTMWD would not lease any land from the LRCC, given that the "back nine" holes of the golf course would not be affected with this reservoir's lower conservation pool elevation (515 feet MSL). Operation of the downsized reservoir would not cause adverse impacts to the LRCC, which would continue to be used as a semi-private golf facility. Intermittent flooding of the "back nine" would continue to occur after heavy rain events, but in contrast to Alternative 1 prolonged flooding and costly repairs would not occur. Once operational, the reservoir is expected to directly increase visitation at LRCC from "spillover" out of town LBCR visitors and golfers, benefiting LRCC as well as the local economy. The land with proposed real estate development could increase in value given its proximity to the reservoir, or at least is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA

Long-term impacts to access and visitation at Caddo National Grasslands WMA would be similar to those described under Alternative 1. Access would essentially be unaffected once FM 1396 is replaced with FM 897. The proposed LBCR would likely not directly affect the water-based recreational opportunities or experience at lakes within the Caddo National Grasslands WMA, because the LBCR is not directly upstream from these lakes. As such, the biological or hydrological characteristics of these lakes or other recreational areas would not be altered. Visitation could increase or decrease once the reservoir is operational, and would depend on personal preference because both the Caddo National Grasslands WMA and LBCR would offer the same opportunities (with the exception of hunting). As under Alternative 1, because Caddo National Grasslands WMA is one of the few recreational areas that offers hunting opportunities, visitation as it relates to hunting would be expected to increase, and the recreational experience may be degraded for those seeking solitude and quiet. Impacts would be less severe under Alternative 2 if overall visitation to the LBCR is lower than under Alternative 1.

Regional Lakes and Reservoirs

As under Alternative 1, it is difficult to say if visitation at Bonham City Lake would increase or decrease overall as a result of a new, recreational reservoir. Any increase in visitation is expected to be lower compared to Alternative 1 if trails are not developed to connect Bonham City Lake to the downsized reservoir. And as under Alternative 1, it is difficult to discern whether the introduction of a new recreational reservoir would affect visitation at other regional lakes and reservoirs. Despite the smaller size of the reservoir under this alternative, Fannin County residents would still be expected to visit LBCR instead of travelling to visit regional lakes and reservoirs. As such, any decrease in visitation at regional lakes and reservoirs is expected to the same as under Alternative 1. Spending by new permanent and weekend residents drawn to the downsized recreational reservoir would still benefit businesses located in Fannin and surrounding counties and increase economic output in the broader region, though the increase in local income and the number of jobs supported would be lower compared to Alternative 1.

Conclusion

Compared to Alternative 1, adverse impacts during the construction phase and beneficial impacts during the operation phase would generally be less severe, but overall impacts to recreation would be similar. During the construction phase, the severity of direct, adverse impacts would be slight overall – less severe than under Alternative 1. Given the smaller reservoir footprint, any scenic degradation, increase in noise levels, or impacts to air quality would not be seen, heard, or felt by recreationists at Bonham City Lake or LRCC. However, the aforementioned impacts would be felt by recreationists at Caddo National Grasslands WMA, so the size or physical extent of impacts would be small (localized). Given the proximity of Caddo National Grasslands WMA to dam and spillway construction activities, the likelihood of impacts would be high. Displaced recreationists in combination with (even more) newly relocated construction workers could cause an increase in visitation at regional lakes and reservoirs. Indirect, beneficial impacts from construction workers' recreational spending would be slight to moderate – more severe compared to Alternative 1. Pipeline-related construction impacts would be temporary and intermittent, and dam and reservoir-related construction impacts would last the duration of the construction phase.

Under Alternative 2, recreational activities would continue in the western portion of Alternative 1's reservoir footprint during both the construction and operation phases. However, existing recreational activities for private landowners in the majority of Bois d'Arc Creek would permanently cease. The size or physical extent of slightly adverse impacts in Bois d'Arc Creek would be small (localized), directly affecting a smaller number of private landowners compared to Alternative 1. Impacts to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek would be similar to those discussed under Alternative 1, and are highly likely to occur based on public scoping comments.

Once the reservoir is operational, many of the same, numerous recreational opportunities and facilities that would be provided under Alternative 1 would also be provided under Alternative 2. While the surface area of the reservoir under Alternative 2 is about half the size of the reservoir under Alternative 1, the severity of beneficial impacts is not proportional to the size of the reservoir. Local and non-local visitor spending would be somewhat less impactful to the local economy compared to Alternative 1, but would still generate millions in economic activity and support hundreds of new jobs. Therefore, direct, beneficial impacts would be severe under this alternative as well. Visitation is still expected to increase at nearby recreational areas due to "spillover" from the LBCR reservoir, including at LRCC, but beneficial economic impacts from increased visitation would be somewhat less severe than under Alternative 1 if overall visitation is lower under Alternative 2. Assuming that Fannin County residents would still visit the downsized LBCR under Alternative 2, any decrease in visitation at regional lakes and reservoirs would be the same as under Alternative 1. As under Alternative 1, it is unclear whether considerable water fluctuation would ultimately impact visitation at LBCR, but access points would be strategically sited in the same locations less vulnerable to changes in water level to avoid affecting access to recreational facilities and opportunities. While the likelihood of beneficial impacts would be medium in light of the aforementioned unknowns, either alternative is expected to transform Fannin County as a recreational destination and benefit residents and outfitters in Fannin County as well as the region.

4.10 VISUAL RESOURCES

The visual resources analysis conducted for this revised DEIS involves defining and, to the extent possible, quantifying the potential visual impacts from construction and operation of the dam and reservoir for each alternative. A summary of the visual resources impacts discussed in the following sections is provided in Table 4.10-1.

Table 4.10-1. Summary of Impacts to Visual Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Viewshed of the reservoir and dam footprint	Viewshed of the reservoir and dam footprint	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	
Operation Phase			
Size	Viewshed of the reservoir and dam	Viewshed of the reservoir and dam	Slight change to visual character of landscape likely caused by the expected population growth and development over the coming decades.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	

The BLM Visual Resource Management (VRM) process, described in Section 3.8, was used to evaluate impacts to visual resources in the project area. The VRM consists of two stages, the visual resource inventory which rates the visual appeal of a tract of land (described in Section 3.8) and the visual resource contrast rating. The visual resource contrast rating involves comparing the proposed project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture (BLM, 1986b):

Form – The mass or shape of an object or of objects which appear unified.

Line – The path that the eye follows when perceiving abrupt differences in form, color, or texture.

Color – The property of reflecting light of a particular intensity and wavelength to which the eye is sensitive.

Texture – The aggregation of small forms or color mixtures into a continuous surface pattern.

Table 4.10-2 outlines the criteria for the contrast rating process used in this analysis. The impacts to visual resources that would occur under each alternative were determined using these criteria and the VRM results presented in Section 3.8. A discussion of the impacts to visual resources under each alternative is provided in the following sections.

Table 4.10-2. Criteria for the Visual Resource Contrast Rating Process (BLM, no date-b)

Degree of Contrast	Criteria
None	The element contrast is not visible or perceived.
Weak	The element contrast can be seen but does not attract attention.
Moderate	The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong	The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

4.10.1 No Action Alternative

Under the No Action Alternative, the reservoir and dam would not be constructed. Therefore, the visual environment at the proposed site would remain unchanged, at least in the short term. The No Action Alternative would have no immediate impacts to visual resources. Over the long term, it is difficult to predict how land use changes may incrementally and cumulatively affect visual resources in the region. However, if the population in the region grows and development proceeds in tandem, the Bois d'Arc Valley may lose some of its existing rural appearance, in which open space is currently dominant.

4.10.2 Alternative 1

Construction

It is estimated that the construction of the proposed dam would require 3 to 4 years. The dam would be 10,400 feet long with a maximum height of 90 feet. Due to the height of the proposed dam, the viewshed of visitors to the Caddo National Grasslands and travelers on FM 1396 would be affected during construction. Tree clearing for construction of the proposed reservoir would occur prior to construction of the embankment of the dam, and would likely have less of a visual impact than the construction of the dam due to the more localized nature of the tree clearing. Tree clearing would only occur in select areas of the proposed reservoir footprint, primarily along Bois d'Arc Creek. The viewshed of travelers along County Road 2945 would be most affected by the tree clearing. The visual resource contrast rating of reservoir clearing and dam construction activities would be 'moderate' – begins to attract attention and begins to dominate the characteristic landscape. Overall, the impacts to visual resources related to construction of the proposed dam and reservoir would be moderate and end once construction activities are completed.

Operation

Based on the large size of the proposed reservoir (16,641 acres), the large size of the proposed dam (10,400 feet long, and 90 feet high), and the complete change in land use that would occur under the proposed project, the visual resource contrast rating of Alternative 1 would be 'Strong' – demands attention, will not be overlooked, and is dominant in the landscape. The form, line, color, and texture of the environment would all change noticeably if Alternative 1 is implemented.

As described in Section 3.8.2, the affected environment was divided into three SQRUs (the Bois d'Arc Creek and surrounding wetlands [SQRU-1], cropland and grassland [SQRU-2], and forested areas [SQRU-3]). Two of the units were given ratings of Class IV (SQRU-2 and -3), and the unit that includes the Bois d'Arc Creek was given a rating of Class III (SQRU-1), primarily due to the presence of water. According to BLM's standards, the change to the characteristic landscape of Class III areas should be limited to moderate changes and the level of change to the characteristic landscape of Class IV areas can be high. Because the area rated as Class III (SQRU-1) would still retain the presence of water (the proposed reservoir), and the other two SQRUs are rated as Class IV, the proposed action would meet the management objectives for each Class. However, even though the management objectives would be met, the addition of a dam and reservoir would noticeably impact visual resources of the area.

An aerial view of the existing landscape within the proposed reservoir footprint is shown in Figure 4.10-1, and an example of the type of contrast to be expected as a result of implementation of Alternative 1 is shown in Figure 4.10-2. Figure 4.10-2 depicts an existing reservoir about 60 miles southwest of the proposed project shown solely for reference purposes of what a 'Strong' contrast rating would potentially look like. Any viewer would notice the new lake environment, whether a local resident looking out a window or a commuter on a nearby road. Figure 4.10-3 shows the areas from which the proposed reservoir and associated dam would be visible. This viewshed should be interpreted as a maximum viewshed because it only accounts for topography and does not take into account tree or building obstruction. Actual visibility of the reservoir from a given site would depend on the presence or absence of obstructions. Overall, implementation of Alternative 1 would result in severe impacts to the viewshed and visual resources.

Conclusion

Due to its size and prominence, Alternative 1 (in particular, construction and operation of the proposed dam and reservoir) would have a severe, long-term impact on visual resources; however, whether this impact would be regarded as adverse or beneficial would depend on the values of each individual observer. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Bois d'Arc Creek as a loss outweighing any gain provided by a lake setting, while other individuals would regard the permanent addition of a lake on the landscape as an aesthetic asset to the community. Other members of the public would appreciate both the aesthetic loss and the aesthetic gain.

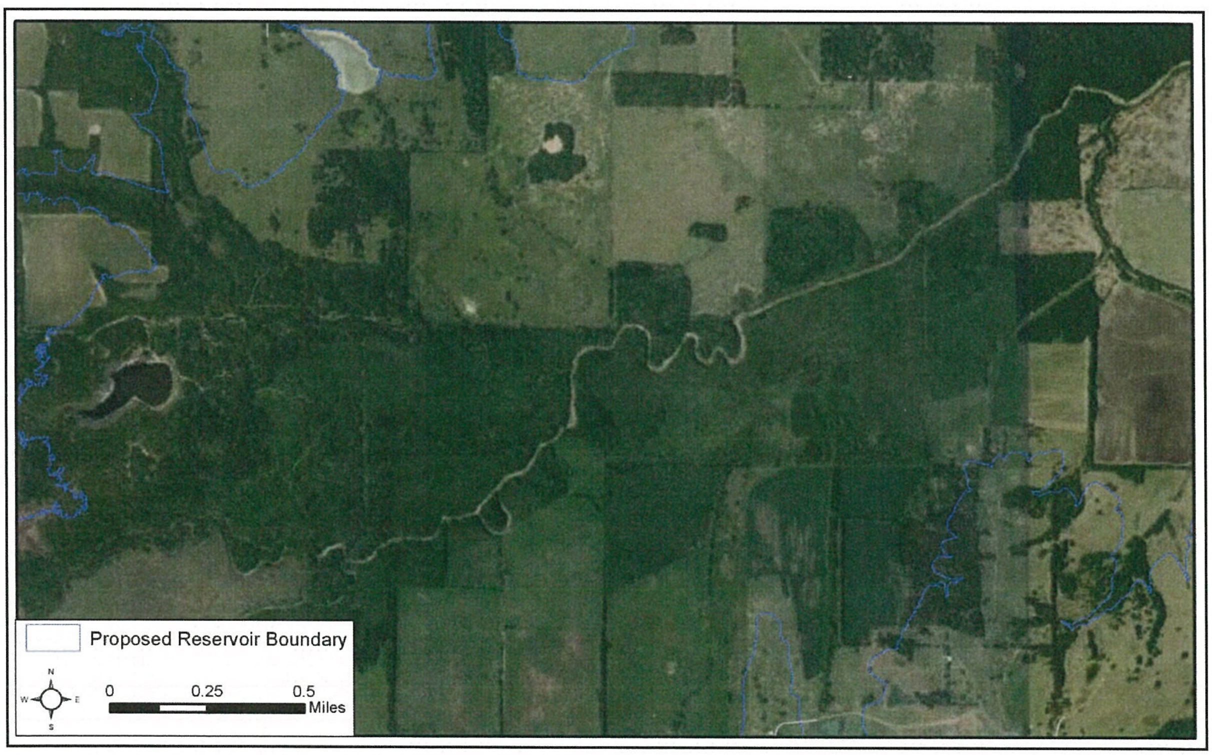


Figure 4.10-1. Aerial Imagery of the Existing Landscape Within the Proposed Reservoir Footprint (ESRI, 2010)

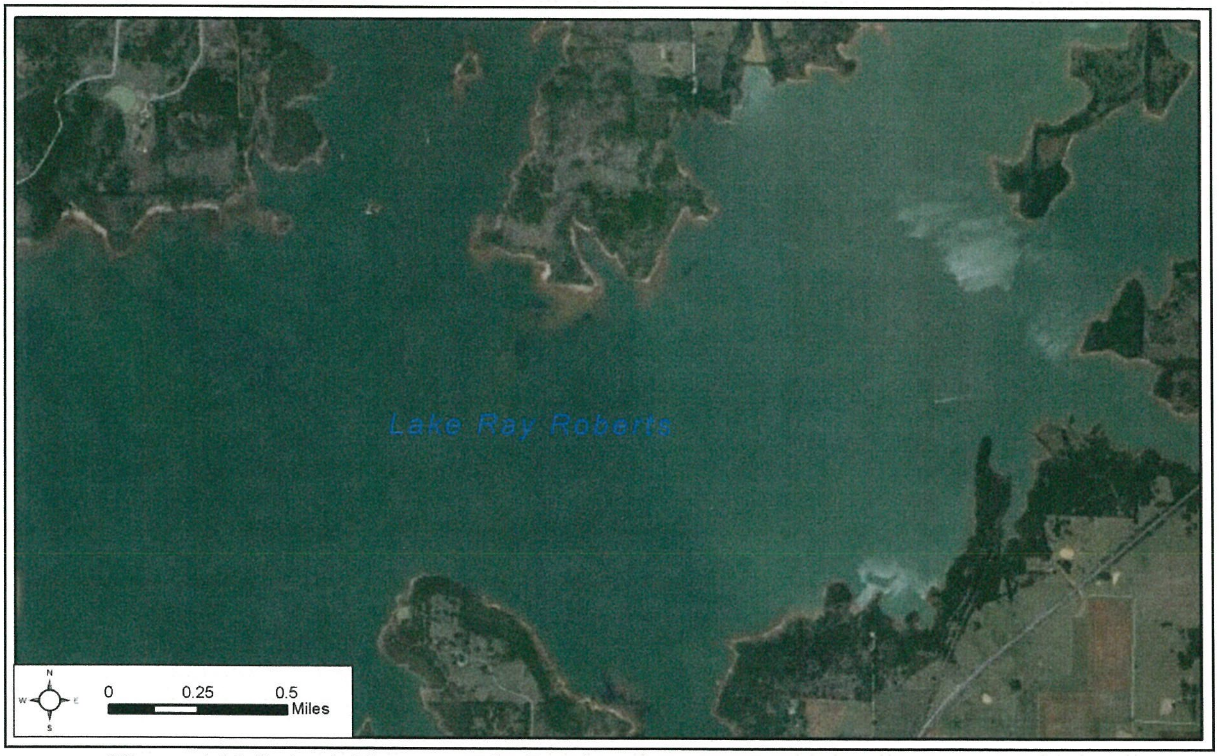


Figure 4.10-2. Aerial Imagery of a Portion of Nearby Lake Ray Roberts (ESRI, 2010)

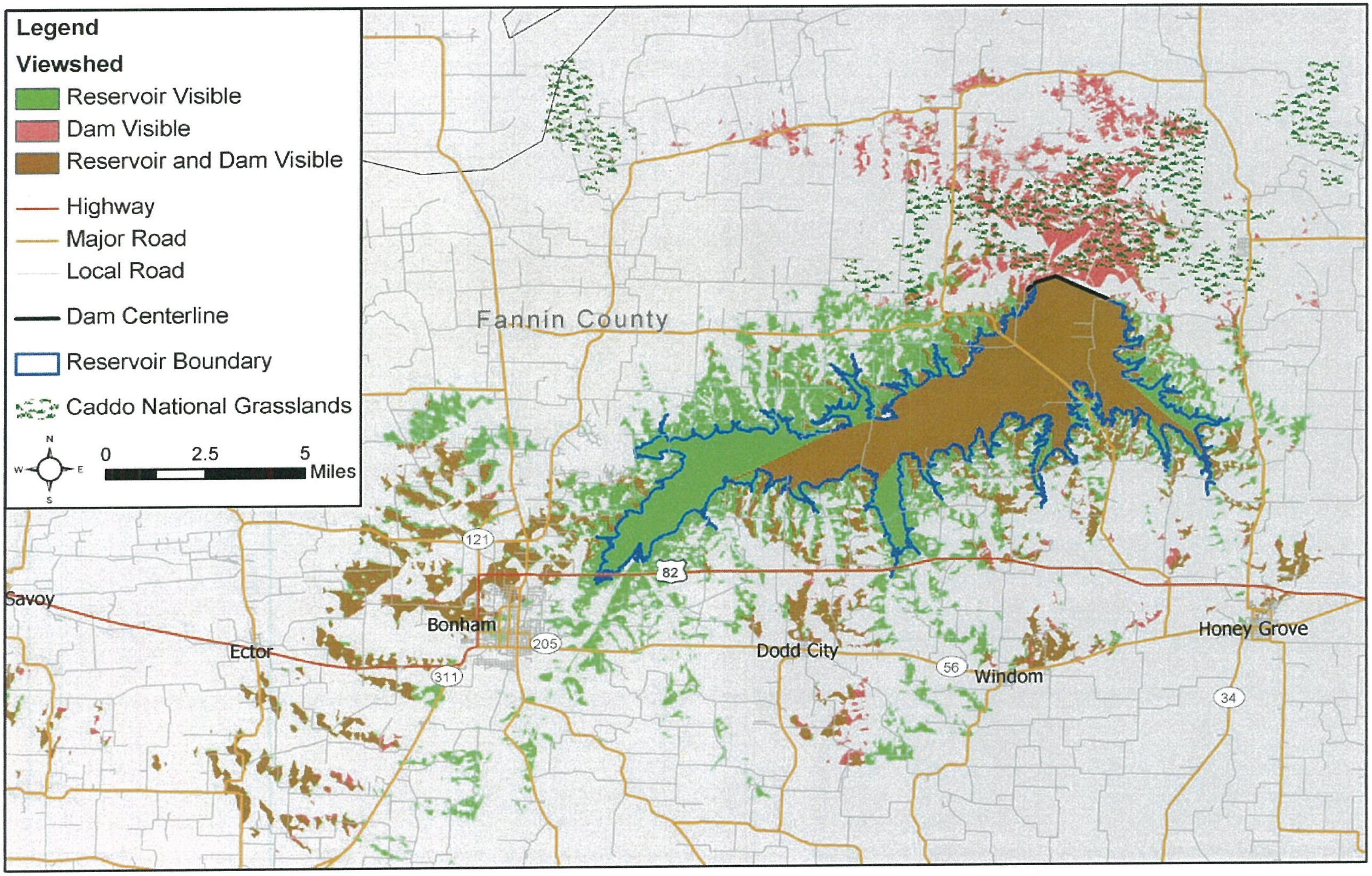


Figure 4.10-3. Viewshed of the Proposed Reservoir and Dam (ESRI, 2010)

4.10.3 Alternative 2

Construction

Alternative 2, the downsized LBCR with Lake Texoma blending, would entail dam and reservoir construction on a smaller scale than Alternative 1. The project construction would have a similar duration as Alternative 1 (estimated to be 3 to 4 years), and would be built within the same project footprint. The visual resource contrast rating of reservoir clearing and dam construction activities would be 'moderate' – begins to attract attention and begins to dominate the characteristic landscape. Overall, impacts of construction on visual resources would be similar to the impacts that would be anticipated to occur under Alternative 1. Visual impacts specific to dam and reservoir construction would be similar to but less than the impacts anticipated under Alternative 1, due to the reduced amount of reservoir clearing activity that would be required for the downsized reservoir.

Operation

While the proposed reservoir would be smaller under this alternative, it would still represent a complete change in land use/land cover and a major alteration in the viewshed. The visual resource contrast rating would be 'Strong' – demands attention, will not be overlooked, and is dominant in the landscape. The form, line, contrast, and color of the environment in view would all change dramatically due to implementation of Alternative 2. Similar to Alternative 1, the affected environment under Alternative 2 would include three SQRUs with Class III and IV inventory values and the operation of the dam and reservoir would meet the management objectives of each SQRU; however, the addition of a dam and reservoir would noticeably impact visual resources of the project area.

Conclusion

Similar to Alternative 1, Alternative 2 (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources. Whether this impact would be regarded as beneficial or adverse would depend on the values of each individual observer.

4.11 UTILITIES

This section discusses the impacts to utilities that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.11-1.

Table 4.11-1. Summary of Impacts to Utilities Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Power lines within the proposed reservoir footprint and utilities within the footprint of the proposed pipeline (reservoir to WTP)	Power lines within the proposed reservoir footprint and utilities within the footprints of the proposed pipelines (reservoir to WTP and Lake Texoma to WTP)	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Operation Phase			
Size	New utilities constructed to accommodate potential increase in area development	New utilities constructed to accommodate potential increase in area development	Likely increase in demand for local and regional utility services caused by the expected population growth and development over the coming decades. This increase is expected to be met by local and regional utility providers.
Duration	30 years	Less than or equal to 30 years	
Likelihood	High	High	
Severity	Moderate	Moderate (less than Alternative 1)	

4.11.1 No Action Alternative

The No Action Alternative would not provide the needed water supply for NTMWD's member cities and customers. As discussed in Section 1.5, the projected shortage by 2025 without implementation of any additional water supply projects is about 59,000 acre-feet per year.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This projected growth may result in an increase in demand for local and regional utility services. These future demands are expected to be met by local and regional utility providers.

4.11.2 Alternative 1

The NTMWD service area is projected to have water shortages of 59,000 acre-feet per year by 2025. If Alternative 1 is implemented, the resulting growth in the economy would create a demand for new utilities including electrical service, water supply services, and other municipal services that the local jurisdictions and utility companies would need to provide.

Construction

Construction activities would cause short-term, slight adverse impacts to utilities. The overhead power lines that run within the vicinity of the proposed reservoir footprint would need to be raised or removed and relocated before the proposed reservoir could be filled. Both demolition and construction of the overhead powerlines would occur within the footprint of the proposed reservoir site.

During construction of the pipeline from the proposed reservoir to the WTP, electrical transmission lines, gas/petroleum pipelines, and other minor utilities located within the pipeline footprint would be impacted. As construction progresses, these utilities would be crossed or bypassed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

Moderate impacts to utilities would occur over 30 years (NTMWD, 2010a) from operation of the proposed reservoir. As a result of the potential increase in development that would likely be caused by operation of the proposed reservoir, the demand for publicly-provided utility services would also likely increase. 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. Development of these areas could include the construction of large, single family residential areas, commercial uses such as retail centers to support the single family residential areas, and water-based facilities such as marinas. As a result, the existing utility services in the region would need to be expanded to accommodate the increased demand in already developed areas and to provide service to newly developed areas.

Regionally, construction of the LBCR would help ensure that future water needs of the NTMWD region are met. After completion of the proposed reservoir, treated surface water would be provided from the reservoir to present and future NTMWD customers (NTMWD, 2007a). NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni, and also practices water reuse and the use of interim supplies. NTMWD would optimize its water supplies by operating the proposed LBCR as part of its overall system, relying primarily on water supply sources closer to its service area during relatively wet times and increasing water use from sources farther away from its service area during drier times. The new water supply would be capable of meeting the demands of the new population growth directly and indirectly related to the creation of the proposed LBCR.

4.11.3 Alternative 2

Construction

Construction activities would cause short-term, slight adverse impacts to utilities. Under Alternative 2, the overhead power line within the vicinity of the proposed reservoir footprint would be located almost entirely outside the footprint of the reservoir's conservation pool. This is due to the lower conservation pool elevation and smaller reservoir footprint under Alternative 2. While the power line route may cross three very small drainage channels at the extreme edge of the conservation pool in the Bullard Creek area located in the south-central portion of the reservoir, demolition and relocation of the power line would likely not be needed.

Similar to Alternative 1, a pipeline would be constructed from the proposed reservoir to the WTP and the impacts to utilities within the pipeline footprint would be the same as those described under Alternative 1. However, under Alternative 2, an additional pipeline from Lake Texoma to the WTP would be constructed. During construction, electrical transmission lines, gas/petroleum pipelines, and other minor utilities located within the pipeline footprint would be impacted. As construction progresses, these utilities would be crossed or bypassed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

The presence of a new reservoir in this location, irrespective of size, would be expected to result in increased development as described in Section 4.11.2.2, with associated demand for publicly-provided utility services. It is reasonable to conclude, however, that a smaller reservoir (with a smaller footprint and shorter length of developable shoreline) would lead to development at a reduced scope from that which may be anticipated for the larger reservoir, with a corresponding decrease in utility demands. Therefore, the impacts to utilities would be moderate but slightly less than the impacts described under Alternative 1.

Regionally, construction of the LBCR would help ensure that future water needs of the NTMWD region are met. After completion of the proposed reservoir, treated surface water would be provided from the reservoir to present and future NTMWD customers (NTMWD, 2007a). NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni, and also practices water reuse and the use of interim supplies. NTMWD would optimize its water supplies by operating the proposed LBCR as part of its overall system, relying primarily on water supply sources closer to its service area during relatively wet times and increasing water use from sources farther away from its service area during drier times. The new water supply would be capable of meeting the demands of the new population growth directly and indirectly related to the creation of the proposed LBCR. However, water supply from the reservoir under Alternative 2 would be fully utilized by approximately 2031, and other water supplies would need to be sought and developed at an earlier date than they would under implementation of Alternative 1.

4.12 TRANSPORTATION

This section discusses the impacts to transportation resources that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.12-1.

Table 4.12-1. Summary of Impacts to Transportation Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint	Roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	
Operation Phase			
Size	5 roadways closed and 10 roadways rerouted and/or rebuilt due to proposed reservoir operation	4 roadways closed and 7 roadways rerouted and/or rebuilt due to proposed reservoir operation	Population growth expected to occur in the region may result an increase in traffic on the local and regional transportation network. The existing road network is expected to be able to accommodate increases in traffic resulting from this growth.
Duration	100+ years	100+ years	
Likelihood	High	High	
Severity	Moderate	Moderate	

4.12.1 No Action Alternative

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This growth may result an increase in traffic on the local and regional transportation network. The existing roadway network is expected to be able to accommodate increases in traffic resulting from this long-term growth.

4.12.2 Alternative 1

This section provides a discussion of the potential environmental impacts to transportation resources that would result from implementing Alternative 1. It is estimated that the construction phase of Alternative 1 (including all components) would last 3 to 4 years. Impacts were assessed primarily by reviewing existing traffic conditions of public roadways and the types and frequency of activities that may require use of these roadways. The closure of one or more primary or secondary roadways would constitute a moderate to major impact to traffic and transportation resources. Alternative 1 would have no impact to regional airports or passenger and freight rail services because they are not located near any project activities.

Dam and Reservoir

Construction

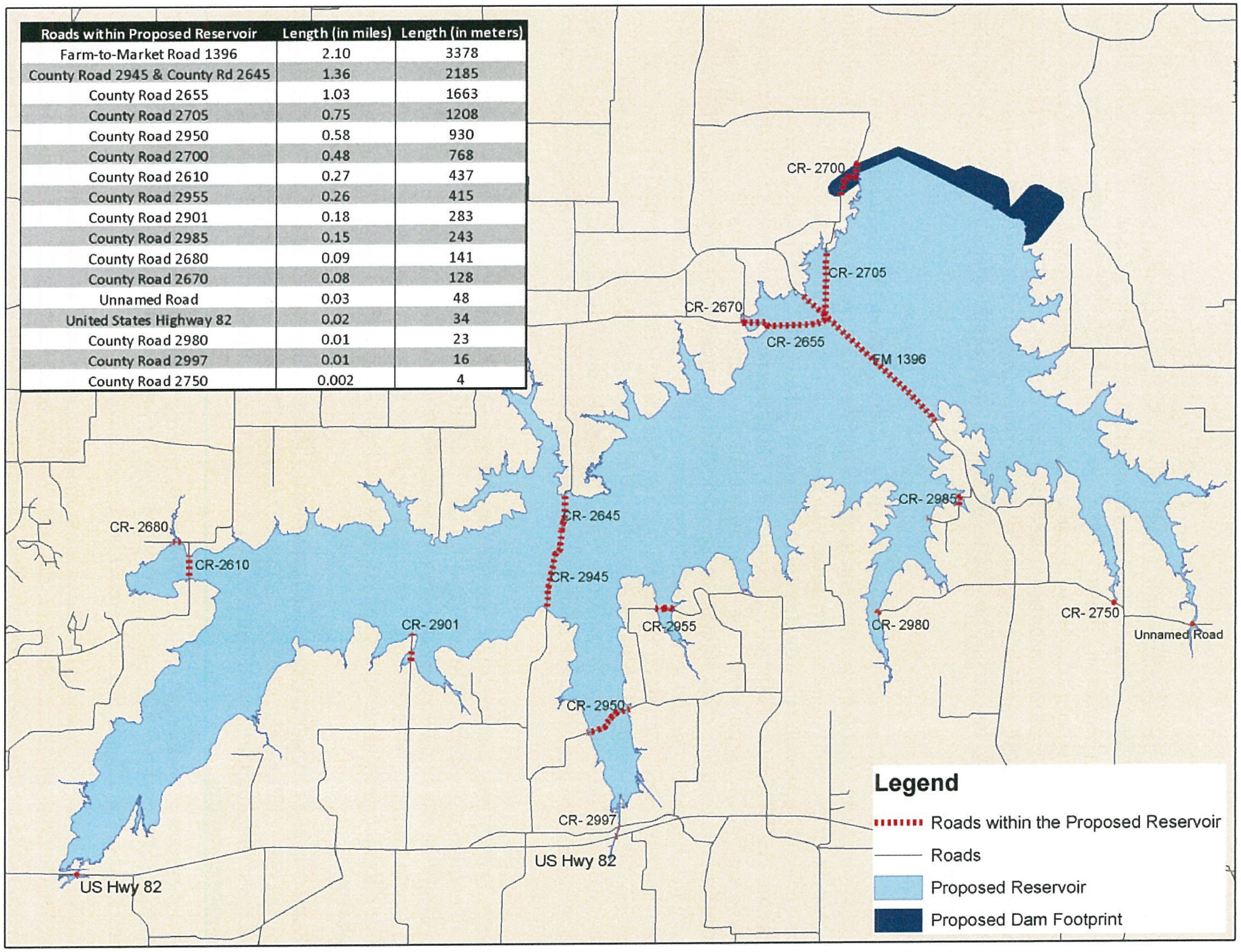
During construction of the dam and reservoir, congestion would increase in the immediate area due to additional construction vehicles, delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and road closures and detours (FM 1396 in particular). While the existing transportation infrastructure not affected by construction of the dam and reservoir would be sufficient to support the increase in vehicle traffic resulting from the construction activities described above and because some roadways would be relocated, moderate impacts on traffic and transportation resources would occur. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

The establishment of the proposed dam and reservoir would have noticeable long-term beneficial and adverse effects on transportation resources and traffic. The permanent closure of roadways and rerouting of traffic from some secondary and tertiary roadways in the area would result in adverse effects, while new roads and road improvements would result in beneficial effects. NTMWD has developed a Transportation Plan (Freese and Nichols, 2011c) to provide adequate access to and across the proposed reservoir and surrounding properties. The Transportation Plan examined anticipated impacts to area residents and recommended transportation network modifications that would address these impacts while maximizing the transportation and recreational opportunities of the proposed reservoir. Information contained within the report includes geographic, geological, and cost data with respect to proposed modifications of the transportation network located within the proposed Lower Bois d'Arc Creek Reservoir footprint. The findings are preliminary in nature and a detailed topographic survey, property survey, geotechnical investigation, and design would be required to further define acceptable proposed improvements.

The primary TxDOT road that would be impacted by the proposed reservoir is FM 1396, which would be rerouted and replaced as described in section 4.12.2.4. In addition to FM 1396, there are 27 county road crossings identified within the footprint of the proposed reservoir, shown in Figure 4.12-1. These roadways would primarily have serviced residents living in the footprint of the proposed reservoir who would have relocated prior to construction. As shown in Table 4.12-2, the Transportation Plan recommended:

- Replacing and reconstructing (9 road crossings) –The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.
- Road closure (5 crossings) – The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.
- Leave in place (13 crossings) – The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.



Roads within Proposed Reservoir	Length (in miles)	Length (in meters)
Farm-to-Market Road 1396	2.10	3378
County Road 2945 & County Rd 2645	1.36	2185
County Road 2655	1.03	1663
County Road 2705	0.75	1208
County Road 2950	0.58	930
County Road 2700	0.48	768
County Road 2610	0.27	437
County Road 2955	0.26	415
County Road 2901	0.18	283
County Road 2985	0.15	243
County Road 2680	0.09	141
County Road 2670	0.08	128
Unnamed Road	0.03	48
United States Highway 82	0.02	34
County Road 2980	0.01	23
County Road 2997	0.01	16
County Road 2750	0.002	4

Figure 4.12-1. Roadways Affected by Alternative 1

Table 4.12-2. Roadways Affected by Alternative 1 and Transportation Plan Recommendation[a]

Road Name	Crossing Name	Needed?	Crossing Type	Distance (feet)	Detour Distance (feet)[b]	Transportation Plan Recommendation
CO RD 2980	Ward Creek	Yes	Bridge	1,375	N/A	Replace/reconstruct[c]
CO RD 2610	Timber Creek	Yes	Bridge	1,971	1,056	Replace/reconstruct[c]
CO RD 2680	Sandy Branch	Yes	Bridge	1,400	N/A	Replace/reconstruct[c]
CO RD 2770	Honey Grove Creek Tributary	Yes	Bridge is out	626	N/A	Replace/reconstruct[c]
CO RD 2985	Unknown	Yes	Large CMP	690	N/A	Replace/reconstruct[c]
CO RD 2980	Yoakum Creek	Yes	Unknown	929	N/A	Replace/reconstruct[c]
CO RD 2900	Onslott Creek	Yes	Bridge	1,831	N/A	Replace/reconstruct[c]
CO RD 2610	Bois d'Arc Creek Tributary	Yes	Bridge	495	N/A	Replace/reconstruct[c]
CO RD 2625	Bois d'Arc Creek Tributary	Yes	2 Large CMP	1,384	N/A	Replace/reconstruct[c]
CO RD 2655	Edge of Water	No	N/A	852	60	Close road[d]
CO RD 2670	Unnamed	No	Small CMP	1,049	0	Close road[d]
CO RD 2955	Pettigrew Branch	No	Large CMP	1,847	1553	Close road[d]
CO RD 2950	Bullard Creek	No	Bridge and CMP	3,538	8492	Close road[d]
CO RD 2917	Bullard Creek	No	Bridge	2,007	0	Close road[d]
CO RD 2725	Unnamed	No	Bridge	95	3701	Leave in place[e]
CO RD 2730	Honey Grove Creek Tributary	No	Small crossing	517	926	Leave in place[e]
CO RD 2745	Honey Grove Creek Tributary	No	Large CMP	540	1180	Leave in place[e]
CO RD 2745	Bois d'Arc Creek Tributary	Yes	Small crossing	101	N/A	Leave in place[e]
FM 1396	Bois d'Arc Creek Tributary	Yes	Small RCB	441	N/A	Leave in place[e]
CO RD 2955	Unknown	No	Large CMP	1,211	2400	Leave in place[e]
US 82	Cottonwood Creek	Yes	5 multiple RCB	661	N/A	Leave in place[e]
US 82	Bullard Creek	Yes	Bridge	1,901	N/A	Leave in place[e]
CO RD 2900	Burns Branch	No	Bridge	146	882	Leave in place[e]
CO RD 2900	Onslott Creek	Yes	Large RCP	77	N/A	Leave in place[e]
CO RD 2610	Timber Creek	Yes	RCP or CMP	220	N/A	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	376	7826	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	297	7826	Leave in place[e]

[a] The FM 1396 crossing of Bois d'Arc Creek is not included in this table but is described in Section 4.12.2.4.

[b] The additional detour distance is calculated only if there is another feasible route to access the area. If there are no other feasible routes, then the additional detour distance is not applicable.

[c] The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the

Road Name	Crossing Name	Needed?	Crossing Type	Distance (feet)	Detour Distance (feet)[b]	Transportation Plan Recommendation

surrounding area would be required and a new road crossing would be constructed at a higher elevation.

[d] The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.

[e] The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed); CMP = corrugated metal pipe; Crossing Type = Description of the type of creek crossing; Distance = Length of road located within the reservoir footprint (lower than elevation 542 feet MSL and between flood easements); N/A = not applicable; Needed? = Is the roadway needed to provide access to homes or businesses?; RCB = reinforced concrete box; RCP = reinforced concrete pipe

Source: Freese and Nichols, 2011c

As a result of the permanent closure of roadways and the potential increase in development that would likely occur as a result of the presence of the proposed reservoir, the number of vehicles using the surrounding roads would increase. However, design improvements would be made to the reconstructed roadways as part of the dam and reservoir construction process to accommodate this increase. For example, the replacement for FM 1396 would be built to higher speed standards than the existing road. These roadway improvements would be able to handle the increased traffic and, while some roads would be permanently closed, overall the impacts to transportation resources would be slightly beneficial when compared to existing conditions.

Raw Water Pipeline

Construction

Construction of the proposed raw water pipeline would have short-term slight adverse effects to transportation resources primarily due to construction of pipeline road crossings, additional traffic because of workers' commutes, and additional traffic associated with delivery of equipment and supplies to the proposed sites. When appropriate, use of existing roads and trails to facilitate construction activities would occur. All construction vehicles would be equipped with backing alarms, two-way radios, and 'slow moving vehicle' signs when appropriate. Although the effects would be slight, contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts.

Operations

Operation of the proposed pipeline would not conflict with any existing roadway or interfere with traffic. There would be some very small increases in traffic due to maintenance activities around the pipeline and pump stations; however, overall conditions would remain comparable to existing conditions. Effects on transportation resources would be negligible.

Water Treatment Plant and Terminal Storage Reservoir

Construction

Construction of the WTP and TSR would have short-term slight adverse effects on transportation resources and traffic. These effects would be similar in nature but on a smaller scale than those outlined for construction of the dam and reservoir. Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. The existing transportation resources would be sufficient to support the increase in vehicle traffic. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

Long-term negligible adverse effects to transportation resources would occur during operations under Alternative 1. Small but unnoticeable increases in traffic due to employees at the WTP would be expected in the area once it is operational.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

As shown in Figure 4.12-1, FM 1396 is an existing two-lane TxDOT asphalt road located within the proposed reservoir footprint. The existing roadway and bridge would be inundated by the proposed reservoir and therefore would need to be raised or relocated as part of the proposed reservoir construction. Various options were investigated for the relocation of FM 1396 with respect to landowner impacts, cost, schedule, and travel time. The current alignment of FM 1396 spans one of the widest portions of the proposed reservoir and would impact recreational uses if rebuilt in the same location.

As discussed in Section 4.12.2.1, NTMWD has developed a Transportation Plan to provide adequate access to and across the proposed reservoir and surrounding properties (Freese and Nichols, 2011c). The Transportation Plan recommends replacing FM 1396 by extending FM 897 North out of Lannius (on US 82 south of the proposed reservoir site) with a new bridge over the proposed reservoir along the approximate alignment of the current crossing of Bois d'Arc Creek by CR 2645. It should be emphasized that at this time these plans are still preliminary; final bridge elevations and lengths have not yet been determined. Safety, recreation, conveyance of water, and a number of other considerations are being taken into account in the final design of the bridge (Freese and Nichols, 2011c).

The replacement of FM 1396 by extending FM 897 is the preferred alignment by Fannin County, TxDOT, and NTMWD. Of the various alternative alignments evaluated in the Transportation Plan, this alignment would require the shortest bridge length, have a similar travel time to the existing FM 1396 alignment, and maximize the water surface area in the future reservoir for recreational purposes. Figure 4.12-2 shows the location of the new bridge and the length of FM 1396 that would be abandoned

TxDOT has requested that the new FM 897 be designed to TxDOT Farm to Market Road standards with a 120-foot right-of-way (ROW) and a 70 mile-per-hour (mph) design speed. TxDOT would assume maintenance of the new FM 897 extension as well as the associated bridge after construction and Fannin County would assume responsibility for portions of FM 1396 not inundated by the reservoir, as shown in Figure 4.12-2. The portion of FM 1396 that would be inundated (solid purple line in Figure 4.12-2) would not be maintained.

Construction activities associated with FM 1396 relocation, FM 897 extension, and new bridge construction would result in traffic congestion from additional construction vehicles, traffic delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic on other roadways due to road closures and detours. While the existing transportation infrastructure not affected by construction activities would be sufficient to support the increase in vehicle traffic, slight short-term adverse impacts on transportation resources and traffic would occur.

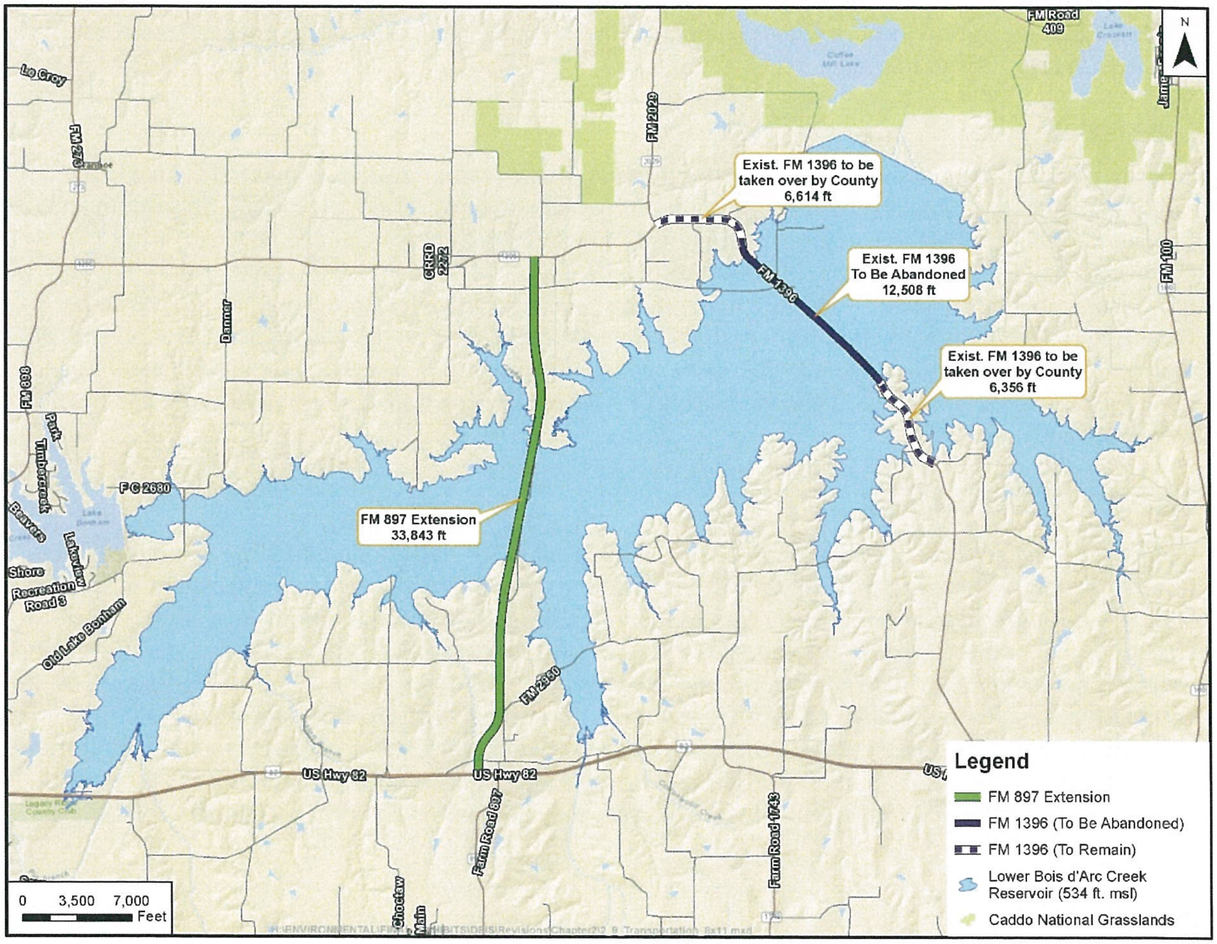


Figure 4.12-2 Proposed FM 1396 Relocation and New Bridge Construction

Operations

Operation of the FM 897 extension and the new bridge would have the same long-term beneficial and adverse effects on transportation resources and traffic discussed under Section 4.12.2.1. Although the existing FM 1396 would be closed, the replacement for FM 1396 would be built to higher speed standards than the existing road and the roadway improvements would be able to handle the increased traffic resulting from operation of the dam and reservoir.

Mitigation

Severe adverse effects to transportation resources would be expected if no relocations or reconstruction of existing roads and bridges were proposed; however, this is not the case. While there would be adverse short-term to medium-term effects, by implementing the recommended transportation mitigation measures discussed in the previous sections (i.e., equipping all construction vehicles with backing alarms, two-way radios, and 'slow moving vehicle' signs, routing and scheduling construction vehicles to avoid conflicts with other traffic, and strategically locating staging areas to minimize traffic impacts), these impacts would be moderate. Once the construction activities are completed, in particular the FM 1396 relocation, the magnitude of long-term effects would generally be moderate.

Planning, development, and implementation of the proposed roadway improvements would be coordinated through TxDOT planners and engineers as well as Fannin County authorities to minimize the magnitude of impacts to local residents and maximize the value and utility of improvements to both residents and visitors to the lake.

Conclusion

Alternative 1would have short-term adverse effects on transportation resources and traffic due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be both beneficial and adverse. After construction of the proposed dam, the reservoir would close FM 1396 and 5 secondary roadways, and motorists would be rerouted. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for 9 road crossings that would be rebuilt at a higher elevation and the new road and bridge built to replace FM 1396. Given the mitigation measures proposed to ameliorate potential adverse impacts, the long-term effects of Alternative 1 on transportation resources and traffic would be moderate.

4.12.3 Alternative 2

Compared to Alternative 1, this alternative would have a similar construction duration (estimated to be 3 to 4 years) and similar types of adverse effects. Most of the same roads would be affected in this alternative compared to Alternative 1, with exceptions that are noted in the following sections. The closure of one or more primary or secondary roadways would constitute a moderate impact to traffic and transportation resources. The impacts of road closures under this alternative would be less than Alternative 1 due to the smaller scale of the reservoir. The impacts of pipeline construction for this alternative would be greater than Alternative 1 because an additional water pipeline would be built from Lake Texoma to the WTP. Similar to Alternative 1, this alternative would have no impacts to regional airports or passenger and freight rail services because they are not located near any project activities.

Dam and Reservoir

Construction

During construction of the dam and reservoir, congestion would increase in the immediate area due to additional construction vehicles, delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic due to road closures and detours (in particular FM 1396). While the existing transportation infrastructure not affected by construction of the dam and reservoir would be sufficient to support the increase in vehicle traffic resulting from the construction activities described above and because some roadways would be relocated, moderate impacts on transportation resources and traffic would occur. However, due to the smaller scale of the reservoir under this alternative, less earth would be moved which would require fewer vehicle trips than Alternative 1. As such, adverse effects resulting from construction activities would be slightly less than Alternative 1. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

The establishment of the proposed dam and reservoir would have noticeable long-term beneficial and adverse effects on transportation resources and traffic. The permanent closure of roadways and rerouting of traffic from some secondary and tertiary roadways in the area would result in adverse effects while new roads and road improvements would result in beneficial effects. NTMWD has developed a Transportation Plan (Freese and Nichols, 2011c) to provide adequate access to and across the proposed reservoir and surrounding properties. The Transportation Plan examined anticipated impacts to area residents and recommended transportation network modifications that would address these impacts while maximizing the transportation and recreational opportunities of the proposed reservoir. Information contained within the report includes geographic, geological, and cost data with respect to proposed modifications of the transportation network located within the proposed Lower Bois d'Arc Creek Reservoir footprint. The findings are preliminary in nature and a detailed topographic survey, property survey, geotechnical investigation, and design will be required to further define acceptable proposed improvements.

The primary TxDOT road that would be impacted by the proposed reservoir is FM 1396, which would be rerouted and replaced as described in section 4.12.2.4. In addition to FM 1396, there are 21 county road crossings identified within the footprint of the proposed reservoir, shown in Figure 4.12-3. These roadways would primarily have serviced residents living in the footprint of the proposed reservoir who would have relocated prior to construction. As shown in Table 4.12-3, the Transportation Plan recommended:

- Replacing and reconstructing (6 road crossings) –The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.
- Road closure (4 crossings) – The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.
- Leave in place (11 crossings) – The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

As a result of the permanent closure or roadways and the potential increase in development that would likely occur as a result of the presence of the proposed reservoir, the number of vehicles using the surrounding roads would increase. However, design improvements would be made to the reconstructed roadways as part of the dam and reservoir construction process to accommodate this increase. For example, the replacement for FM 1396 would be built to higher speed standards than the existing road. These roadway improvements would be able to handle the increased traffic and, while some roads would be permanently closed, overall, the impacts to transportation resources would be slightly beneficial when compared to the No Action Alternative but less beneficial than Alternative 1. The adverse effects of this alternative would be less than Alternative 1 because fewer roads would be closed.

Roads within Smaller Reservoir	Length (in miles)	Length (in meters)
Farm-to-Market Road 1396	1.59	2566
Farm-to-Market Road 1396	0.09	137
Farm-to-Market Road 1396	0.26	420
County Road 2945	0.88	1411
County Road 2705	0.55	880
County Road 2700	0.48	768
County Road 2655	0.33	524
County Road 2645	0.33	533

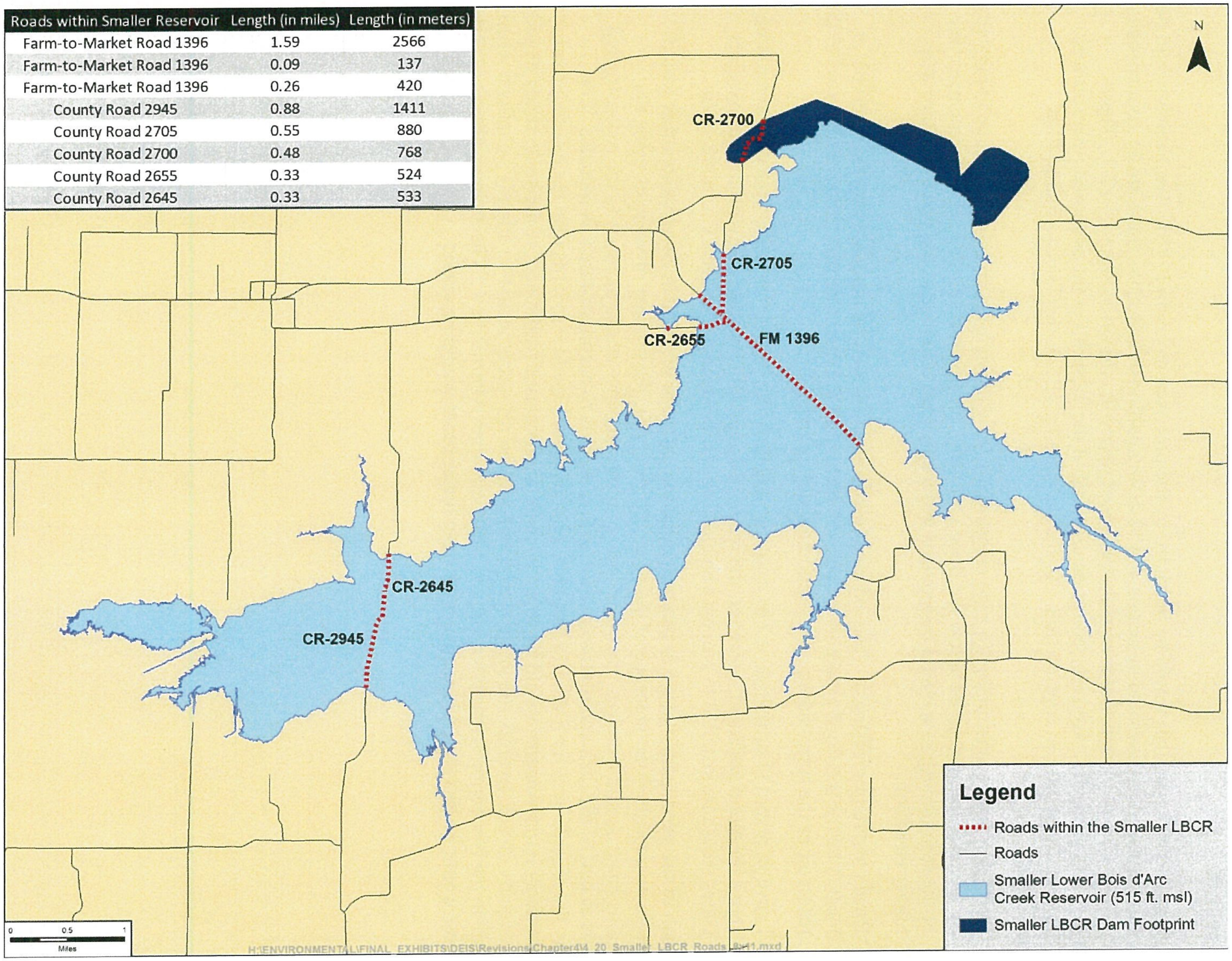


Figure 4.12-3. Roadways Affected by Alternative 2

Table 4.12-3. Roadways Affected by Alternative 2 and Transportation Plan Recommendation[a]

Road Name	Crossing Name	Needed?	Crossing Type	Distance (ft)	Detour Distance (ft)[b]	Transportation Plan Recommendation
CO RD 2610	Timber Creek	Yes	Bridge	1,971	1,056	Replace/reconstruct[c]
CO RD 2770	Honey Grove Creek Tributary	Yes	Bridge is out	626	N/A	Replace/reconstruct[c]
CO RD 2985	Unknown	Yes	Large CMP	690	N/A	Replace/reconstruct[c]
CO RD 2980	Yoakum Creek	Yes	Unknown	929	N/A	Replace/reconstruct[c]
CO RD 2900	Onslott Creek	Yes	Bridge	1,831	N/A	Replace/reconstruct[c]
CO RD 2625	Bois d'Arc Creek Tributary	Yes	2 Large CMP	1,384	N/A	Replace/reconstruct[c]
CO RD 2655	Edge of Water	No	N/A	852	60	Close road[d]
CO RD 2670	Unnamed	No	Small CMP	1,049	0	Close road[d]
CO RD 2955	Pettigrew Branch	No	Large CMP	1,847	1553	Close road[d]
CO RD 2917	Bullard Creek	No	Bridge	2,007	0	Close road[d]
CO RD 2725	Unnamed	No	Bridge	95	3701	Leave in place[e]
CO RD 2730	Honey Grove Creek Tributary	No	Small crossing	517	926	Leave in place[e]
CO RD 2745	Honey Grove Creek Tributary	No	Large CMP	540	1180	Leave in place[e]
CO RD 2745	Bois d'Arc Creek Tributary	Yes	Small crossing	101	N/A	Leave in place[e]
FM 1396	Bois d'Arc Creek Tributary	Yes	Small RCB	441	N/A	Leave in place[e]
CO RD 2955	Unknown	No	Large CMP	1,211	2400	Leave in place[e]
CO RD 2900	Burns Branch	No	Bridge	146	882	Leave in place[e]
CO RD 2900	Onslott Creek	Yes	Large RCP	77	N/A	Leave in place[e]
CO RD 2610	Timber Creek	Yes	RCP or CMP	220	N/A	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	376	7826	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	297	7826	Leave in place[e]

[a] The FM 1396 crossing of Bois d'Arc Creek is not included in this table but is described in Section 4.12.3.4.

[b] The additional detour distance is calculated only if there is another feasible route to access the area. If there are no other feasible routes, then the additional detour distance is not applicable.

[c] The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.

[d] The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.

[e] The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed); CMP = corrugated metal pipe; Crossing

Road Name	Crossing Name	Needed?	Crossing Type	Distance (ft)	Detour Distance (ft)[b]	Transportation Plan Recommendation

Type = Description of the type of creek crossing; Distance = Length of road located within the reservoir footprint (lower than elevation 542 feet MSL and between flood easements); N/A = not applicable; Needed? = Is the roadway needed to provide access to homes or businesses?; RCB = reinforced concrete box; RCP = reinforced concrete pipe Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed)

Source: Freese and Nichols, 2011c

Raw Water Pipelines

Construction

Alternative 2 includes an additional water pipeline from Lake Texoma to the WTP. Similar to Alternative 1, construction of the proposed raw water pipelines would have short-term slight adverse effects to transportation resources primarily due to construction of pipeline road crossings, additional traffic because of workers' commutes, and additional traffic associated with delivery of equipment and supplies to the proposed sites. When appropriate, use of existing roads and trails to facilitate construction activities would occur. All construction vehicles would be equipped with backing alarms, two-way radios, and 'slow moving vehicle' signs when appropriate. Although the effects would be slight, contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts. Overall, due to construction of the additional pipeline, the construction impacts under Alternative 2 would be slight but greater than Alternative 1.

Operations

Operation of the proposed pipelines would not conflict with any existing roadway or interfere with traffic. There would be some very small increases in traffic due to maintenance activities around the pipeline and pump stations, but these effects would be negligible. Overall conditions would remain comparable to existing conditions as described for Alternative 1.

Water Treatment Plant and Terminal Storage Reservoir

Construction

Construction of the WTP and TSR would have short-term slight adverse effects on transportation resources and traffic. The effects from WTP and TSR construction under this alternative would be identical to Alternative 1 and would be similar in nature but on a smaller scale than those outlined for construction of the dam and reservoir. Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. The existing transportation resources would be sufficient to support the increase in vehicle traffic. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

Long-term negligible adverse effects to transportation resources would occur during operations under Alternative 2. Small but unnoticeable increases in traffic due to employees at the WTP would be expected in the area once it is completed. Overall, the impacts under Alternative 2 would be identical to the impacts under Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

As discussed in Section 4.12.2.4, FM 1396 is an existing two-lane TxDOT asphalt road located within the proposed reservoir limits. The existing roadway and bridge would be inundated by the proposed reservoir and therefore would need to be raised or relocated as part of the proposed reservoir construction. Various options were investigated for the relocation of FM 1396 with respect to landowner impacts, cost, schedule, and travel time. The current alignment of FM 1396 spans one of the widest portions of the proposed reservoir and would impact recreational uses if rebuilt in the same location.

As discussed in Section 4.12.2.4, NTMWD's Transportation Plan examined several options to relocate FM 1396 and build a new bridge crossing the proposed LBCR. NTMWD's preferred option would be to extend the existing rural road FM 897 two to three miles to the west of FM 1396 and build an entirely new bridge over the reservoir along that alignment. Of the various alternative alignments evaluated in the Transportation Plan, this one would require the shortest bridge length, have a similar travel time to the existing FM 1396 alignment, and maximize the water surface area in the future reservoir for recreational purposes. The existing FM 1396 and bridge crossing over Bois d'Arc Creek would be abandoned and inundated by the reservoir.

The principal difference between Alternative 2 and Alternative 1 is that the new bridge on FM 897 spanning the reservoir would be slightly shorter (because the smaller reservoir would not be as wide) and the portion of the new paved road on FM 897 would be relatively longer. However, the total length of the FM 897 extension and new bridge as a replacement for FM 1396 and the existing bridge would be the same under Alternatives 1 and 2.

Similar to Alternative 1, TxDOT has requested that the new FM 897 be designed to TxDOT Farm to Market Road standards with a 120-foot ROW and a 70-mph design speed. TxDOT would assume maintenance of the new FM 897 extension as well as the associated bridge after construction and Fannin County would assume responsibility for portions of FM 1396 not inundated by the reservoir. The portion of FM 1396 inundated by the reservoir would not be maintained.

Similar to Alternative 1, construction activities associated with FM 1396 relocation, FM 897 extension, and new bridge construction under Alternative 2 would result in traffic congestion from additional construction vehicles, traffic delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic on other roadways due to road closures and detours. While the existing transportation infrastructure not affected by construction activities would be sufficient to support the increase in vehicle traffic, slight short-term adverse impacts on transportation resources and traffic would occur.

Operations

Operation of the FM 897 extension and the new bridge would have the same long-term beneficial effects on transportation resources and traffic discussed under Section 4.12.3.1. The replacement for FM 1396 would be built to higher speed standards than the existing road and the roadway improvements would be able to handle the increased traffic resulting from operation of the dam and reservoir.

Mitigation

Severe adverse effects to transportation resources would be expected if no relocations or reconstruction of existing roads and bridges were proposed; however, this is not the case. While there would still be adverse short-term to medium-term effects, by implementing the recommended transportation mitigation measures discussed in the previous sections (i.e., equipping all construction vehicles with backing alarms, two-way radios, and 'slow moving vehicle' signs, routing and scheduling construction vehicles to avoid conflicts with other traffic, and strategically locating staging areas to minimize traffic impacts), these impacts would be moderate. Once the construction activities are completed, (in particular the FM 1396 relocation, the magnitude of long-term effects would generally be moderate.

Planning, development, and implementation of the proposed roadway improvements would be coordinated through TxDOT planners and engineers as well as Fannin County authorities to minimize the magnitude of impacts to local residents and maximize the value and utility of improvements to both residents and visitors to the lake.

Conclusion

Alternative 2 would have short-term adverse effects on transportation resources and traffic due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be both beneficial and adverse. After completing construction of the downsized dam, the reservoir would close FM 1396 and 4 secondary roadways, and motorists would be rerouted. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for 6 road crossings that would be rebuilt at a higher elevation and the new FM 1396 road and bridge. Given the mitigation measures proposed to ameliorate potential adverse impacts, the long-term effects of this alternative on transportation resources would be moderate, although smaller in magnitude than Alternative 1.

4.13 Environmental Contaminants and Toxic Wastes

This section discusses the potential impacts from environmental contaminants and toxic wastes that could occur under each alternative. For purposes of analysis, only the footprint of the reservoir was considered because of concerns that contaminants and wastes could impact the water of the reservoir once the area was inundated. A summary of the impacts discussed in the following sections is provided in Table 4.13-1.

Table 4.13-1. Summary of Impacts from Environmental Contaminants and Toxic Wastes Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Reservoir footprint (16,641 acres)	Reservoir footprint (8,600 acres)	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	Low	Low	
Severity	None	None	
Operation Phase			
Size	Reservoir footprint (16,641 acres)	Reservoir footprint (8,600 acres)	No change from current conditions.
Duration	100+ years	100+ years	
Likelihood	Low	Low	
Severity	Slight	Slight	

4.13.1 No Action Alternative

Under the No Action Alternative, the construction of the dam, reservoir, WTP, TSR, and pipeline(s) would not occur. No further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants. There would be no change to the existing conditions discussed in Section 3.11.

4.13.2 Alternative 1

Construction

The desktop study described in Section 3.11 did not identify any recognized or potential environmental concerns in the project area. However, subsequent to the study a local resident informed NTMWD of suspected illegal disposal and burning of tires on property already purchased by NTMWD and located within the proposed LBCR footprint (Chambers, 2012). NTMWD arranged for an environmental investigation of the site, which indicated highly localized contamination with somewhat elevated concentrations of certain heavy metals and other chemicals of concern.

This dumping and disposal site was cleaned up by a contractor late in 2012. The contractor recycled almost 16 tons of tires and excavated, transported, and disposed over 2,000 tons of mixed soil and debris at the NTMWD landfill. All field investigations at the site were done by early 2013. Tests conducted on soil and waste samples indicate that it is eligible for "no further action" approval from TCEQ. A summary report was prepared on the investigation of the site and its cleanup and was submitted to TCEQ on September 16, 2013; however, TCEQ has not responded (Chambers, 2013; NTMWD, 2014b).

In May 2016, NTMWD's contractor, FNI, reviewed available water quality and permitting records for the Bonham Landfill to determine the likelihood of environmental contaminants from the landfill contaminating the waters of Bois d'Arc Creek. In a report published on May 10, 2016, FNI determined that, because of the landfill's location outside the proposed reservoir project area and the 500-year floodplain, as well as the continuing TCEQ supervision over the closed landfill, there was no evidence that the landfill had negatively impacted the waters of Bois d'Arc Creek. This report was based on an evaluation of nine years of water quality testing data for Bois d'Arc Creek.

No further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants at the proposed project site. No adverse effects are expected with regard to environmental contaminants and toxic waste.

Operation

If the proposed reservoir is constructed and operated, NTMWD, TCEQ, and possibly other state or federal agencies would conduct periodic assessments of water quality, so that if a source of contamination were to become evident, it would be addressed in the appropriate manner.

4.13.3 Alternative 2

Construction

The potential impacts from the downsized reservoir alternative would be similar to those from Alternative 1. As in Alternative 1, no adverse effects are expected from environmental contaminants or toxic waste for this alternative. The desktop study, which covered the downsized reservoir alternative footprint, did not identify any recognized or potential environmental concerns in the project area. As described under Alternative 1, all other sources of known environmental contamination have already been addressed in an appropriate manner. Therefore, no further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants at the proposed project site.

Operation

If the reservoir is constructed and operated, NTMWD, TCEQ, and possibly other state or federal agencies would conduct periodic assessments of water quality, so that if a source of contamination were to become evident, it would be addressed in the appropriate manner.

4.14 SOCIOECONOMICS

This section describes potential impacts to output, labor income, employment, taxes, homes, and social landscape in a region of influence (ROI) defined as Fannin, Collin, Lamar, Hunt, Grayson and Delta counties. Impacts are categorized in terms of severity, duration, size or physical extent, and likelihood.

Estimates of the economic value of the proposed project are also provided. Table 4.14-1 summarizes potential impacts to socioeconomic resources under each alternative.

Table 4.14-1. Summary of Impacts to Socioeconomic Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Medium (localized) to Large (multi-county)	Medium (localized) to Large (multi-county)	Large (multi-county)
Duration	Short-term (3-4 years)	Short-term (3-4 years)	Short-term (3-4 years)
Likelihood	High	High	High
Severity	Severe (direct, beneficial) Slight to Moderate (direct, adverse)	Severe (direct, beneficial) Slight to Moderate (direct, adverse)	None
Operation Phase			
Size	Medium (localized) to Large (multi-county)	Medium (localized) to Large (multi-county)	Large (multi-county)
Duration	Medium (Intermittent), Long-term (50-100+ years)	Medium (Intermittent), Long-term (50-100+ years)	Long-term (50-100+ years)
Likelihood	Medium to High	Medium to High	High
Severity	Severe (direct, beneficial)	Severe (direct, beneficial)	Severe (direct, adverse)

4.14.1 No Action Alternative

The No Action Alternative in this EIS consists specifically of not building and operating the dam, reservoir, pipeline, or water treatment facilities. Because the NTMWD does not have a planned back-up option to pursue if the Tulsa District denies the Section 404 permit for the LBCR, the expected water deficits would ultimately remain unaddressed. The NTMWD would continue to plan and implement other strategies to meet the growing water demand.

In the short-term, neither water supply nor projected population growth in the ROI or the NTMWD service area would be directly affected under this alternative. (Grayson and Lamar are included in the defined ROI, but the NTMWD does not supply water to these two counties). If the No Action Alternative is selected, no change would occur to existing residents, businesses, or the social fabric of counties in the ROI.

In the long-term, population for the six counties would continue to grow under the No Action Alternative. Both the populations of the NTMWD service area and of Fannin, Collin, Grayson, and Hunt counties are expected to more than double in the next fifty years. NTMWD supplied 268 million gallons of water daily (mgd) in 2006 to the region it serves. By 2020, the water demand is projected to increase to an estimated 431 mgd (NTMWD, 2007a). In the absence of the proposed project, the population projections may not materialize to the fullest. Therefore, water demand could be comparatively lower and delay the inevitability of insufficient water supplies.

According to the NTMWD "an ample, dependable water supply is essential to economic stability and growth (NTMWD, 2007a)." The Texas Comptroller of Public Accounts (TCPA), citing the Texas Water Development Board (TWDB), states that "if demand is not met it could cost businesses and workers in the state approximately $9.1 billion per year by 2010 and $98.4 billion per year by 2060. Our economy always has and always will rely on clean and abundant water supplies" (TWDB, 2009). Additionally, "failure to provide that water could prove costly. The TWDB estimates that as much as $161 billion in lost income and tax revenue could occur each year in Region C (a 16-county area including Fannin County) if adequate water supplies are not developed" (NTMWD, 2007a). The job and income creation associated with the operations phase of the proposed project (discussed in 4.14.2.3 through 4.14.2.4) would not take place. Further, the expected real estate and business development (also discussed in 4.14.2.3) around the reservoir would not occur.

In the short-term, the No Action Alternative would not impact counties in the ROI or the NTMWD service area because the area's current water needs would be met. While slower population growth might delay the inevitability of insufficient water supplies, ultimately the NTMWD would be unable to supply the growing demand for water and as such adverse impacts would be severe in the long-term. The size or physical extent of both short- and long-term impacts would be large and reach the nine counties to which the NTMWD supplies water, four of which are included in the ROI. The likelihood of both short- and long-term impacts would be high, since projected population is based on trends, though these trends could decrease in rate without the ample provision of water.

4.14.2 Alternative 1

The primary purpose of the LBCR is to provide additional drinking water supply to meet the projected future demand. The LBCR would provide a 16,641-acre water supply reservoir for NTMWD and would produce an estimated firm yield of 120,655 acre-feet of water per year. The project has been studied previously for the Red River Authority and the NTMWD. The reservoir was recommended as a water supply for the NTMWD in the 2001, 2006, and 2011 Region C Water Plans; as well as the 2002, 2007, and 2012 Texas State Water Plan (TWDB, 2002, 2007, 2012).

The NTMWD has identified and prescribed the LBCR as a major source to reconcile the future population growth and the otherwise increased strain on its water resources. Ideally, by 2060 "11 percent of our projected water demand will be met by the LBCR" (NTMWD, 2007a). In addition, experience from other reservoirs in Texas indicates that all new users are not identified before the reservoir is built. After Lake O' the Pines was completed, water from the reservoir was sought by water user groups (WUGs) not identified before the reservoir was constructed and not included in the original planning. Many of these surface water demands stemmed from population growth and decreased ability to rely on groundwater (NETMWD, 2005).

Project Costs

Construction expenditures for Alternative 1 are estimated at $365 million, including design, engineering, and related costs; and conflicts in the project area that would be relocated such as gas pipelines, transmission lines, roads, and cemeteries. It is anticipated that land acquisition for the reservoir, related mitigation areas, and legal fees would cost about $174.1 million. Property owners in the impoundment area and the additional acreage that may be set aside for flood easements would be compensated. Additionally, water transmission facilities including storage facilities, the transport pipeline, and the water intake pump station would cost about $220 million. As shown in Table 4.14-2, total expenditures for the LBCR and related infrastructure would be about $586 million over a three- to four-year period. These are "one-time" costs without likelihood of persistent economic impacts over the life of the dam and reservoir.

Table 4.14-2. Project Cost Estimates for Alternative 1 (120,665 AFY)

Description	Cost
Pre-construction	
Engineering Fees	$64,043,000
Other costs (legal, land acquisition, mitigation)	$174,121,000
Construction	
Dam and Reservoir Construction Costs	$76,645,000
Conflicts	$50,573,000
Transmission Facilities	
Pipeline	$161,851,000
Intake Pump Station	$44,921,000
Terminal Storage	$13,409,000
Total Cost	$585,563,000
Annual Costs*	
Debt Service (6% for 30 years)	$42,540,515
Electricity ($0.09 per kilowatt hour (kWh)	$5,029,275
Operation and Maintenance	$3,891,210
Total Annual Cost	$51,461,000
Unit Costs (Before Amortization)*	
Per Acre-Foot	$427
Per 1,000 Gallons	$1.31
Unit Costs (After Amortization)*	
Per Acre-Foot	$74
Per 1,000 Gallons	$0.23

*Figures based on a 120,665 acre-feet/year yield, $586 million balance, 30-year term, and 6% interest rate.

Dam operation and maintenance (O&M) includes things like controlling vegetation, livestock, and animals; systematic and frequent inspections; repairs as needed; and mechanical and electrical maintenance (TCEQ, 2006). O&M would cost approximately $3.9 million per year. O&M costs were calculated based on the construction cost of the capital improvement. Engineering, permitting, and land acquisition costs were not included. O&M costs were calculated at: one percent of the construction costs for the pipeline; 1.5 percent of the construction cost for the dam; and 2.5 percent of the construction costs for the intake pump station and terminal storage. The figures presented below allow up to 20 percent for construction contingencies; and are also captured in O&M calculations. Electricity to operate the pump station would cost approximately $5 million annually. Other financial costs like annual debt payments and amortization are discussed in greater detail below in 4.14.3.2 under Financing Costs.

Short- and Long-Term Expenditures

Expenditures can be either short- or long-term. Short-term expenditures on the construction of dam, pipeline, pump station, and storage and treatment facilities in Fannin County are expected to occur over a period of three to four years. Short-term expenditures are terminated after the initial outlay or net investment.

Long-term expenditures recur over time and consist primarily of O&M of those items built with the short-term expenditures. O&M costs would recur annually and persist over the life of the dam and reservoir, including storage and treatment facilities. The categories of expenditures and their term are shown in Table 4.14-3.

Table 4.14-3. Short- and Long-Term Expenditures

Expenditures	Term
Dam Construction, Pipeline Construction, Pump Station, and Other Infrastructure	3-4 years
Pipeline, Storage, and Treatment Facilities Construction	3-4 years
Dam Operation and Maintenance	Lifetime (50-100 years)
Pipeline Maintenance	Lifetime (50-100 years)

Source: Clower, 2012.

Financing Costs

No tax revenues would be used to construct the reservoir. NTMWD would fund the construction through water sales; ultimately, financing costs are paid by the users of the water. The LBCR costs, including land acquisition, construction, transmission and treatment facilities, and any other costs would be expected to be financed with contract revenue bonds and by NTMWD.

NTMWD would plan, finance, build, and operate the reservoir coordinating with local, state and federal authorities, including the City of Bonham, Fannin County, TWDB, Texas Commission on Environmental Quality, Texas Parks and Wildlife (TPW), and the USACE, among others. Although land acquisition, permitting, funding, environmental impacts, and mitigation would conform to the standards and guidelines set by these organizations, NTMWD would solely own and operate the LBCR (NTMWD, 2009).

Based on the most recent estimated project cost figures, raw water from the LBCR would be $1.31 per 1,000 gallons. The cost per 1,000 gallons is derived as follows. The probable total cost is $585,563,000. The components of this cost are displayed in the above Table 4.14-2 (Project Cost Estimates for Alternative 1). Annual debt service is the cash required for a particular time period to cover the repayment of interest and principal on a debt. In the case of the LBCR, the annual debt payment would be about $42.5 million assuming 30 years of payments at six percent interest. This annual debt payment also assumes one bond issuance for $585,563,000. The annual O&M cost is $3,891,210, and the sum of the annual debt payment and O&M is $46,431,725. Based on the reservoir's estimated yield of 120,665 acre-feet per year (AFY), the estimated total cost of debt and O&M would be $427 per acre-foot of water, which equates to $1.31 per 1,000 gallons (see Table 4.14-2).

Because the NTMWD would be the owner of the reservoir, there would not be a contract price for the water (NTMWD, 2009). Amortization is the paying off of debt in regular installments over a period of time, or the annual debt payments as described above. Before amortization, the cost of water would be $1.31 per 1,000 gallons. After amortization, water would drop to $0.23 per 1,000 gallons, based on a yield of 120,665 AFY. Costs to deliver water to customers in Fannin County may be less, depending on their location. The projected impact of the reservoir on the NTMWD's wholesale water rate is estimated to be about six percent higher than existing rates (NTMWD, 2009).

The NTMWD impounds or receives, via contract, raw water from several North Texas reservoirs for transmission to, and treatment at, three water treatment plants it owns and operates. Each contracting customer has an unconditional obligation to meet its pro rata share of operating, maintenance, and debt service costs to NTMWD. Furthermore, the contract language allows the district to reallocate costs to its customers at any time for any revenue shortfall (S&P Financial Services LLC, 2009).

Financing costs would potentially create slightly adverse impacts due to the water price increase for NTMWD customers. The size or physical extent of impacts would be large (multi-county) since the project costs are shared by all NTMWD customers. The likelihood of rate adjustment is high, as indicated by the long-term financial plans that have been developed to establish the payment plan. Adverse impacts in the form of more expensive water per 1,000 gallons would be felt in the short-term until after amortization (30 years). In the long-term, impacts to economic resources would be beneficial because the price would drop drastically once the debt is paid off.

Input-Output Model

Estimates of the economic impacts of the proposed project are based on Terry Clower, Ph.D.'s Impact Analysis for Planning (IMPLAN) input-output economic modeling system, originally developed by the Minnesota IMPLAN Group. The figures and discussion of those figures in Tables 4.14-4 through Table 4.14-11 are taken directly from Dr. Clower's March 2012 report "Update of the Economic, Fiscal, and Developmental Impacts of the Proposed LBCR Project" prepared for the NTMWD, included in Appendix E. The economic benefits reported in Dr. Clower's report are likely understated, by the author's estimates. All results are reported in 2011 dollars.

As shown in Table 4.14-4, the modeled impacts include the direct effects of spending for construction activities and consumption spending of new recreationists and residents; the indirect effects of local vendors providing goods and services to the primary firms; and the induced impacts of employees of these firms spending wages on rent, food, entertainment, etc. in the local economy. Economic activity is measured in terms of income and employment generated (or lost) from the proposed project. With increased spending, many different sectors of the economy benefit – not only the directly impacted sector but also many sectors indirectly. For example, an increase in tourism spending at hotels would directly yield increased sales in the hotel sector. The additional hotel sales and associated changes in hotel payments for wages and salaries, taxes, and supplies and services are direct effects of tourist spending. The tourism industry, in turn, buys goods and services from other backward-linked industries (i.e. industries supplying products and services to hotels). Changes in sales, jobs, and income in the linen supply industry, for example, represent indirect effects of changes in hotel sales. Businesses supplying products and services to the linen supply industry represent another round of indirect effects, eventually linking hotels (to varying degrees) to many other economic sectors in the region. Induced effects are the changes in economic activity resulting from household spending of income earned directly or indirectly as a result of tourism spending. For example, hotel and linen supply employees, supported directly or indirectly by tourism, spend their income in the local region for housing, food, transportation, and the usual array of household product and service needs. The sales, income, and jobs that result from household spending of added wage, salary, or proprietor's income are induced effects (Stynes, 2006).

The analysis performed by an input-output model helps account for changes that may occur due to construction. There are many costs associated with building and maintaining the proposed dam and reservoir. All sides of the cost-benefit analysis are analyzed, including costs to the local community and surrounding area as well as benefits the reservoir would bring. For example, the analysis "netted out" some agricultural production that would be lost permanently as a result of impounding the proposed reservoir site; however, the analysis may actually overstate the potential loss since other areas of the county could potentially absorb the productive activities. Table 4.14-4 provides IMPLAN definitions for direct, indirect, and induced effects.

Table 4.14-4. IMPLAN Definitions

Effect	Definition
Direct	Determined by the event as defined by the user (i.e., a $10-million-dollar order is a $10-million-dollar direct effect).
Indirect	The amount of the direct effect spent within the study region on supplies, services, labor and taxes.
Induced	Measures the money that is re-spent in the study area as a result of spending from the indirect effect.

Source: IMPLAN, 2012.

Each of these steps (direct, indirect, and induced) recognizes an important "leakage" from the economic study region spent on purchases outside of the defined area. "Leakage" is the non-consumption uses of income, including savings, taxes, and imports that "leak" out of the main flow between output, factor payments, national income, and consumption. Eventually these leakages stop the cycle (IMPLAN, 2012).

Economic impact assessments for the dam and reservoir and related infrastructure construction projects are examined in two models. The first examines direct, indirect, and induced impacts likely to remain in Fannin County. The second model estimates economic impacts based on the size of the development projects, businesses and residents of nearby counties that would also benefit from the economic activity associated with the construction of the dam. For purposes of this analysis, estimates of the total impacts that would likely occur in a wider economic area are defined by Fannin, Collin, Delta, Lamar, Grayson and Hunt counties.

4.14.2.3.1 Construction Phase

Based on the relative presence, or absence, of industries providing materials and supporting services to dam construction projects, some of the economic activity would "leak" out of the local area. Even still, expenditures that would not leak out would increase total economic activity in Fannin County by $509 million to $563 million. Expenditures would also boost gross county product, or the total value of the goods and services produced by the people of a county during a year (not including the value of income earned outside the county), by $211 million to $233 million (see Table 4.14-5). This new activity would create over 5,000 person years of employment, or 5,000 full-time jobs for one year. Local labor income (salaries, wages, and work benefits) would increase by $165 million to $182 million. Property incomes in the form of rent, royalties, corporate profits, and dividends would increase by $36 million to $40 million. Business taxes from indirect transactions would boost state and local tax revenues by $9.7 million to $10.8 million (Clower, 2012).

Table 4.14-5. Local Economic Construction Impacts in Fannin County

Dam, Pipeline, Water Treatment Plant, Pump Station & Other Infrastructure		
Description	Range of Impacts	
Total Economic Activity	$509,330,002	$562,943,686
Total Gross County Product	$211,355,290	$233,603,216
Total Salaries and Wages	$165,237,561	$182,630,989
Total Person-Years of Employment	4,999	5,525
Property Income*	$36,367,192	$40,195,318
Indirect Business Taxes**	$9,750,537	$10,776,909

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from Water District spending.

Source: North Texas Municipal Water District; Clower, 2012.

When compared with the construction impacts, the non-recurring impacts of developing the LBCR would boost economic activity in Fannin County by an additional $10 million, increase county gross product by $7 million, and support another 100 person-years of employment. Labor income associated with these jobs would increase by $20 million. Property income in the form of rents, royalties, dividends, and corporate profits would increase by $3 million. Indirect business taxes in the form of property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending would increase by approximately $1 million (see Table 4.14-6).

Table 4.14-6. Temporary Local Economic Impacts of Development in Fannin County

Includes Dam, Pipeline, Water Treatment Plant, Pump Station, and Land Acquisition Costs		
Description	**Range of Impacts[1]**	
Total Economic Activity	$521,000,000	$574,000,000
Total Gross County Product	$219,000,000	$241,000,000
Total Salaries and Wages	$169,000,000	$186,000,000
Total Person-Years of Employment	5,100	5,600
Property Income*	$39,000,000	$43,000,000
Indirect Business Taxes**	$10,600,000	$11,700,000

[1]Rounded

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Source: North Texas Municipal Water District; Clower, 2012.

It is difficult to estimate what portion of labor, materials, and equipment would be provided by each county or by the state. Ideally, 100 percent of the labor force would be filled by the local population. As discussed in the affected environment under 3.12.2 (Labor), Fannin County's 2010 labor force consists of approximately 14,005 people, of which 12,698 were employed. It would seem unlikely that Fannin County could supply the entire trained construction workforce for a project of this magnitude. In IMPLAN, the multipliers for new construction sectors reflect what materials could likely be bought locally versus being imported. NTMWD would recruit locally, state-wide and nationally to fill labor and/or professional needs. Equipment and materials would be procured locally as much as possible. However, a substantive amount of specialized equipment and materials required for dam construction would not be available locally. Such items would be shipped from other areas.

Construction of the dam would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers. This effect, known as the employment multiplier effect, takes the impacts from project-related spending into account to determine the number of indirect or induced jobs created in the local economy by an action.

> The Employment Multiplier
>
> A "multiplier" is a number used by economists to determine the impact of a project on the economy. It is the ratio of total change in output or employment to initial change (or direct change). For example, if an industry were to create 100 new jobs it would require materials and services from its supplying industries. If this increase in demand created 50 new jobs in the supplying industries, the employment multiplier would be 1.5 [i.e., 100 (direct) + 50 (indirect and induced)].

These temporary jobs would generate additional wages and benefits to be spent in the local economy. Businesses such as hotels, restaurants, gas stations, and grocery stores in the project area might see some beneficial economic effects from per diem expenditures (meals, lodging, incidentals, etc.) by workers during their time in the local area. Current per diem levels in Fannin, Lamar, and Grayson counties are the standard rate: $77 for lodging and $46 for meals and incidental expenses. Per diems in Hunt and Collin counties are $85 and $99 for lodging and $51 and $61 for meals and incidental expenses, respectively (GSA, 2011). This amounts to $123 a day in Fannin, Lamar, and Grayson counties, $136 per day in Hunt County, and $160 per day in Collin County per person.

Based on the IMPLAN study, the proposed project would have an employment multiplier of 1.1. For every one job as a direct result of the proposed dam and reservoir, an additional 0.1 indirect or induced jobs would be created in the larger economic area defined by Fannin, Hunt, Lamar, Delta, and Grayson counties. Thus, the approximately 5,000 jobs that would be created during construction would ostensibly result in the creation of 500 additional indirect or induced jobs. Most of the approximately 5,500 direct, indirect, and induced jobs created by the project would last only for the duration of the three- to four-year construction phase.

A comparison of figures in Table 4.14-7 below to the Table 4.14-6 above indicates that impacts to the expanded economic region defined by Fannin, Collin, Lamar, Delta, Grayson and Hunt counties would be greater than in Fannin County alone during the same three- to four-year construction period. This spillover reflects these additional counties' abilities to attract a portion of the jobs and business activity related to the development of the reservoir. Total economic activity associated with property acquisition and the construction of the proposed dam, reservoir, and other infrastructure would increase by more than $150 million during the construction phase when compared to Fannin County. Gross area product would also increase by more than $150 million during the same three- to four-year phase. Total labor income paid in the five-county region would potentially be $100 million more than in Fannin County alone. Property income would also rise by about $40 million in Fannin County, while state and local government revenue would increase by about $10 million from indirect business taxes including sales taxes, property taxes, and fees for permits and licenses.

Table 4.14-7. Temporary Economic Impacts of Development in Fannin, Collin, Delta, Lamar, Grayson and Hunt Counties

Includes Dam, Pipeline, Water Treatment Plant, Pump Station and Land Acquisition Costs		
Description	**Range of Impacts**	
Total Economic Activity	$681,688,798	$833,175,198
Total Gross County Product	$347,401,467	$424,601,793
Total Salaries and Wages	$255,942,255	$312,818,275
Total Person-Years of Employment	6,110	6,726
Property Income*	$72,807,443	$88,986,875
Indirect Business Taxes**	$18,651,798	$22,796,642

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Sources: North Texas Municipal Water District; Clower, 2012.

Potentially beneficial impacts from construction costs would be severe due to the creation of jobs, property income, and indirect business taxes. The size or physical extent of impacts would be medium (localized) to large (multi-county), because all of the jobs would not be filled by area residents, a portion would travel from outside of the economic region. The likelihood of impacts would be high, because the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. Impacts would be short-term and last not much longer than the three- to four-year year construction phase.

Impacts to Homes and Social Landscape

While no social surveys have been conducted for this EIS, the scoping process, other public meetings, and media indicate there are at least some residents who generally oppose or opposed the project on certain grounds, including for socioeconomic, cultural, natural, and historic reasons (USACE, 2010c; NTEN, 2009a). Alternative 1 has the potential to alter the socioeconomic landscape by increasing the total population, real estate and business development, and recreational visitors and their spending.

During a 2009 Fannin County Commissioners Meeting, Commissioner Dewayne Strickland voiced several concerns on behalf of his constituents, including whether county residents are being fairly compensated for the land currently being purchased for the lake (NTEN, 2009a). However, the fact that the NTMWD has already acquired 82 percent of the property within the reservoir footprint from landowners suggests that the majority have been willing to sell for the compensation offered.

Although there are some homes – approximately a dozen – in the area, most of the land is currently agricultural or undeveloped. Very few occupied houses have been or will be purchased as part of the project, but those approximately dozen homes were or will be paid fair market value. Some homeowners were paid up to $15,000 for relocation costs as part of the purchase negotiations (McCarthy, 2011b). Land would be purchased outright to an elevation of 541 feet mean sea level (msl) around the proposed reservoir site. Flood easements around the site would be purchased for land with elevations between 541 and 545 feet msl. The proposed permanent easement for the pipeline would be a width of 100 feet. A temporary construction easement would increase the total width of easements along the alignment to 120 feet.

An easement is the right of a person, government agency, or public utility company to use or restrict public or private land owned by another for a specific purpose. Utility easements are strips of land used by utility companies to construct and maintain overhead electric, telephone, and cable television lines as well as underground electric, water, sewer, telephone, and cable television lines. When an easement is obtained, it is added to the title of the property, and it travels with the title through ownership transfers, forever restricting its use. They are usually valid for an indefinite period of time. In fact, it is most common for easements to be valid in perpetuity, and the entity holding it determines the period of time. In the event that neither party can agree on a mutually acceptable price for an easement or sale in fee simple, the proponent, working with the state or county, would have the option of resorting to eminent domain.

The NTMWD has notified the people who own the land needed for this project in writing. Prices for the land are negotiated with each landowner based on the value of their individual property. The NTMWD is required to negotiate with property owners in an effort to reach an agreement on the amount of compensation for property required for this project, which is based on the market value of the land at that time. If negotiations are unsuccessful, the NTMWD must acquire the property required for the project through eminent domain proceedings, and Texas law sets forth specific procedures to determine the final compensation. Whether the property is acquired through negotiation or through eminent domain, a property owner is paid market value for their land (NTMWD, 2007b).

Eminent domain is a power reserved by a government agency, usually at the state or local level, to use its legislatively-granted police power to condemn a piece of property for the "public use," which can include anything furthering the health, safety, and welfare of the general public. It is required that the exercise of the eminent domain power be rationally related to a conceivable public purpose (Callies et al., 1994), and local governments can also condemn private property on behalf of private developers whose actions are purportedly fostering broad economic development aims in an area (MDN, 2005). If eminent domain were to be used by local or state government on behalf of an entity like the NTMWD, the land would then be fully owned by that entity.

In 2010 brothers Russell and William Graves released a documentary entitled "Bois d'Arc Goodbye," "…a story about how a creek…transforms. The transformation affects not only the landscape, but people as well. This is a story about a creek's cultural, natural, and historic importance to a rural part of Texas" (Graves, 2010). This documentary appears to also reflect public comments submitted during the scoping period regarding socioeconomics. This concern, while real, is voiced by a few residents and does not necessarily reflect the beliefs of the majority of those affected. Concerns include the displacement of multi-generational residents, farmers, and ranchers; loss of farming, ranching, family businesses, and rural heritage; and that the culture of the area would change against wishes of longtime residents due to influx of outsiders who do not share values, therefore eroding the social cohesion of the area (USACE, 2010c).

Fannin County has a medium level of community cohesion based on the indicators evaluated in the affected environment (i.e. length of residency, the presence of families or the elderly in communities, ethnic homogeneity, working class families, etc.). However, the social landscape and rural culture in Fannin County have already been changing. Spillover growth from the Dallas-Fort Worth Metroplex is reaching the Bonham area, which is still within reasonable reach of big-city amenities (Clower, 2012). Householders moved into 55 percent of the total 11,824 occupied housing units in 2000 or later. Said otherwise, 6,508 occupied units in Fannin County changed residents in the last decade (USCB, 2010b). The reservoir itself would provide amenities such as convenient access to recreation. The Bonham area is also removed from most urban disamenities such as traffic jams, air pollution, noise, and trash.

Impacts to the local homes and the social landscape would create slight to moderate adverse impacts on the Fannin County's community cohesion. Spillover from the Dallas Fort-Worth metropolitan area has already infused a new class of workers into Fannin County. Drought has further exacerbated already failing farms. The size or physical extent of impacts would be medium (localized) by definition, because the homes that would be impounded are located within the reservoir's footprint. Impacts would be felt in both the short-term and long-term.

4.14.2.3.2 Maintenance and Operation Phase

As displayed above in Table 4.14-2, Project Cost Estimates for Alternative 1, the annual O&M cost is an estimated $3,891,210. Machinery and materials are needed to conduct activities such as controlling vegetation, livestock, and animals; systematic and frequent inspections; repairs as needed; and mechanical and electrical maintenance (TCEQ, 2006). These activities would support 24 direct and indirect jobs paying about $769,000 in annual wages and salaries and increase local economic activity by $2.1 million each year in Fannin County (see Table 4.14-8). The recurring impacts in Table 4.14-8 are net, that is, they account for a small reduction in recurring agricultural activity within Fannin County that would occur as a result of permanently losing agricultural production on the farmland within the reservoir footprint.

Table 4.14-8. Temporary Local Economic Impacts of Development in Fannin County

Description	Impact
Total Economic Activity	$2,137,000
Total Gross County Product	$1,346,000
Total Labor Income	$769,000
Total Jobs	24
Property Income*	$486,000

Description	Impact
Indirect Business Taxes**	$91,000

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Sources: North Texas Municipal Water District; Clower, 2012

The severity of potential beneficial impacts from maintenance costs would be slight due to the creation of jobs and recurring expenditures. The size or physical extent of impacts would be medium (localized), because long-term jobs and economic benefits would be felt most by the NTMWD service area. The likelihood of impacts would be high as the required O&M of a dam and reservoir is established in order for it to serve its main purpose. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

Impacts of Recreational Users

Few studies offer specific guidance on estimating the magnitude of the economic impacts to Fannin County from increased recreational visitors when the proposed reservoir is operational. However, a mid-1990s survey by Texas A&M, Texas Parks and Wildlife Department (TPWD), and the Sabine River Authority assessed anglers' levels of local spending. Results indicated that two-thirds of the survey respondents were non-local residents, with about one-third hailing from outside of Texas. Non-local angler visitors to Lake Fork spent an estimated $14.5 million in Wood, Rains, and Hopkins counties during their fishing trips for goods, lodging, and supplies. This level of spending encourages business development and supports jobs. While some of this employment would be seasonal, North Texas weather patterns permit water-based recreation on a year-round basis (Ditton and Hunt, 1996).

Other lake-based recreational activities like boating and camping would draw additional out-of-area visitors to the region. When combined with non-angler spending, non-local recreational visitors would add $16.7 million to $22 million in new spending for dining, retail goods, and lodging to the Fannin County economy annually (see Table 4.14-9). This spending would generate between $21.2 and $28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by $6.2 to $8.3 million. The proposed reservoir is expected to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Lastly, new households are expected to bring almost $60 million in new income to the area (Clower, 2012).

Table 4.14-9. Recurring Annual Local Economic Impacts of Recreational Out-of-Area Visitor Spending at Lower Bois d'Arc Creek Reservoir

Description	Range of Impact	
Total annual spending: recreational visitors	$16,748,000	$21,982,000
Total economic activity	$21,176,000	$28,233,000
Total salaries and wages	$6,235,000	$8,344,000
Total full-time-equivalent employment	295	393

Source: Clower, 2012

Potentially beneficial impacts to recreation and business development would be severe due to spending from recreational visitors. The size or physical extent of impacts would be large since the reservoir might attract recreationists from outside the immediate region. Given the experience of other reservoirs like Lake Fork, the likelihood of recreational spending impacts would be medium to high. Impacts would be long-term and last as long as the reservoir's lifetime (50-100 years).

Impacts of New Permanent and Weekend Residents

One trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have experienced greater population growth than counties without. According to the Northeast Texas Municipal Water District (NETMWD), population growth and water availability in northeast Texas are positively correlated. They attribute this population growth to people wanting to live near a lake and also a growth in industry and jobs because of additional available water. From 1960 to 2000, the 19 counties in northeast Texas grew by 66.5 percent. Every county that at least doubled its population during that time contains a major reservoir with at least 10,000 acre-feet of water capacity. Every county that decreased in population did not have a reservoir in it for at least part of the 40 years. In counties where reservoirs were constructed, growth rates either reversed (if declining) or increased after completion of the reservoir (NETMWD, 2005). Many recreational lake visitors eventually decide to relocate close by the lake or reservoir. Carefully managed residential development can prove to be a tremendous economic boon for lake county economies (Clower, 2012).

The proposed dam and reservoir would be approximately 50 miles from McKinney and 80 miles from downtown Dallas. Already, spillover growth from the Dallas-Fort Worth Metroplex is reaching the Bonham area. Within reasonable reach of big-city amenities yet removed from most urban disamenities, the proposed reservoir is expected to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Potential growth would be substantial assuming the reservoir would not be impounded until well after the local housing markets have recovered from the Great Recession and sub-prime lending crisis. New households would be expected to bring almost $60 million in new income to the area (Clower, 2012).

In addition, at least 2,100 new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. While relative proximity to the Metroplex might encourage permanent residents; that same proximity might also lower demand for weekend/vacation housing for those only an hour's drive away. Nonetheless, weekend and vacation residents would be expected to bring an equivalent of $10 million in household income that would be used for local purchases (Clower, 2012).

By modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, Fannin County would realize a net increase in activity of between $80.7 and $89.2 million per year once full development is reached. This activity would support 517 to 572 permanent jobs, or the equivalent of $13.3 to $14.7 million in salaries and wages (see Table 4.14-10).

Businesses located in Fannin, Hunt, Lamar, Grayson, and Delta counties would likely offer goods and services to new permanent and weekend residents. As shown in Table 4.14-10, the economic activity of these counties, including spending by households drawn to the new reservoir, would increase economic output in the broader region by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012).

The pace and quality of development would depend on many market-related factors. One critical factor would be the extent to which counties, cities, and towns adopt development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand. Examples of infrastructure developments would include such things as electric services, roads, water services, public safety, and other municipal services (Clower, 2012).

Table 4.14-10. Recurring Annual Economic Impacts of New Resident Spending

Description	Range of Impacts	
Fannin County		
Annual Spending	$70,891,000	$77,764,000
Economic Activity	$80,726,000	$89,223,000
Labor Income	$13,332,000	$14,735,000
Jobs	517	572
Fannin, Hunt, Delta, Grayson, & Lamar Counties		
Economic Activity	$105,294,000	$116,378,000
Labor Income	$21,940,000	$24,250,000
Jobs	857	947

Source: Clower, 2012

New permanent and weekend residents would potentially create beneficial impacts of moderate severity due to increased spending on homes and goods and services. The size or physical extent of impacts would be medium (localized) because the homes and goods and services would be offered in the immediate area. The likelihood of impacts would be high, because the relationship between reservoirs and recreational real-estate development in Texas is well-established. The setting is unique but not entirely unpredictable given its proximity to the Dallas Fort-Worth Metroplex, making the likelihood of potential impacts medium to high. Impacts would be both short- and long-term.

Impacts of New Housing Construction

It was assumed that the new permanent and weekend resident households would be single-family units, which is consistent with most of the development trends experienced in other lake counties. Even if residential real estate demand shifts to the inclusion of multi-family properties, the costs of development would be within the range of possibilities projected below. Consequently, the economic and fiscal impacts of the multi-family properties would be within the projections discussed herein. Because of recent housing market volatility, the estimates of housing prices have been retained from the 2007 study, but results are presented in 2011 dollars. The average cost of land and improvements for permanent resident dwellings would be approximately $127,000 (Clower, 2012). Based on nationwide housing studies, vacation and weekend homes would likely be valued somewhat lower than those of permanent residences. As such, an average market value is estimated at $115,000 per weekend dwelling. Residential construction activity was estimated by assuming a 30-year period, and that 25 percent of the housing values would be represented by land. Almost $288 million in new residential construction activity is expected to occur primarily in Fannin County, as presented below in Table 4.14-11. These construction activities would boost the local economy by about $14.5 million per year, on average (housing construction will not be evenly distributed across the period of development), support an average of 133 long-term full-time equivalent (FTE) jobs, and boost local income by $3.4 million for a 30-year period (Clower, 2012).

Table 4.14-11. Local Economic Impacts of Housing Construction

Description	Impact[1]	
	Total	Average Annual
Construction Spending	$287,805,000	$9,594,000
Economic Activity	$432,538,000	$14,418,000
Labor Income	$102,123,000	$3,404,000
Jobs	3,997	133

[1]30-year development
Source: Clower, 2012

New housing construction would potentially create moderately beneficial impacts due to the creation of jobs. The size or physical extent of impacts would be medium (localized) to large (multi-county), because ostensibly many of the jobs would be filled by area residents, but a portion still would travel from outside of the economic region. The likelihood of impacts would be high, since the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. Impacts would be medium (intermittent) to long-term and last approximately 30 years.

Business Development and Recruitment

One key attraction for businesses looking to open plant sites, distribution centers, and other industrial land uses which might also be looking to relocate themselves is the presence of recreational amenities and quality-of-life features. The presence of a new, reliable source of water would enhance the county's ability to attract and retain businesses, in addition to its strategic location (so close to the Dallas Fort-Worth Metroplex). Projected water demand estimates from the TWDB and the previously described IMPLAN model are used in tandem to estimate the severity of economic activity that could be gained through expanded business activities.

The TWDB expects manufacturing industry water use to rise in Fannin County by eight AFY between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 AFY. Livestock and irrigation uses are not expected to increase over this period, which is reasonable given much of the land that would be impounded is currently grazing and agricultural land. (Projected water usage for livestock and irrigation are substantially lower than current usage estimates.) Mining industry activities are also not expected to increase. Municipal uses are expected to rise by 1,326 AFY, partly to account for the potential increase in households, but also for potential commercial and other non-manufacturing business activities (Clower, 2012).

Using 2000 usage data for Fannin County and adjusted commodity production estimates from IMPLAN, the current economic value of production per acre-foot of water used by use-category was multiplied by projected increase in water usage. The results indicate that manufacturing, commercial (no more than 20 percent of municipal water usage assumed for commercial business activities), and electricity generating activities would increase by $117.9 million annually (Clower, 2012).

An increase in Fannin County's direct economic activity would also create spin-off indirect and induced economic impacts. To improve the accuracy of estimating these indirect and induced impacts, two adjustments were made to the model. First, the induced (household spending) impacts were not included in order to avoid double counting the impacts of permanent resident spending that would be employed by potentially new business activity. Second, current economic models of Fannin County do not adequately represent how the economy would operate 25 years from now. Therefore, the nearby Rockwall County impact multipliers were used, since it currently has a population about equal to TWBD's projected population for Fannin County. As shown in Table 4.14-12, a $117.9 million industrial and commercial output in Fannin County would indirectly create $145 million in economic activity, boost area labor income by $48 million, and support over 1,600 jobs (Clower, 2012).

Table 4.14-12. Economic Impacts of New Industrial and Commercial Activities

Description	Annual Impact[1]
New Direct Activity	$117,866,000
Total economic activity	$145,197,000
Total salaries and wages	$48,111,000
Total full-time equivalent (FTE) employment	1,607

[1] 10-year increase after reservoir development
Source: Clower, 2012

Beneficial impacts from business development and recruitment would potentially be severe due to infusion(s) of capital and their ripple effects. The size or physical extent of impacts would be large, because the proposed project might attract investors from outside the previously defined region. The likelihood of impacts would be high, because the relationship between water supply and development is well-established. Impacts would be long-term and last at least as long as the dam and reservoir's lifetime (50-100 years).

Local Fiscal Impacts

The proposed project would increase economic activity in the area by creating jobs for construction and O&M of the proposed dam and reservoir. These jobs would create additional sales tax revenue, and new residents would pay property taxes that would benefit government operations. As the population grows with economic development from construction and O&M of the dam and reservoir, the tax base would also expand. Although tax revenues would initially decrease due to taxable land in the proposed reservoir site that would be impounded, ultimately the reservoir could attract residential, commercial, and industrial property development that would substantially boost property tax revenues in local taxing jurisdictions.

NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. Most of the funding for these payments in lieu of taxes (PILT) comes from payments to NTMWD from leaseback agreements by former property owners whose properties were purchased by NTMWD (McCarthy, 2017).

Fannin County would eventually experience a net increase in tax revenue from the associated or "ancillary" development likely to occur in conjunction with the dam and reservoir. This net increase in tax revenue would enable the cities and county to build more roads, increase the number of schools and teachers, and provide community services for the increased population. While increased population generates the need for more services, it should be noted that it is unclear whether the increased revenue would be in fact used to address these needs. Those decisions are a function of the political process of local government and may also depend on other outstanding needs.

PILT have already offset lost tax revenue as NTMWD has acquired property for the reservoir; these would have reduced local tax rolls before much of the development occurs were it not for PILT. The area of land to be acquired by NTMWD can generally be described as southwest of the proposed dam and reservoir, at or below 541 feet msl. The affected land parcels were identified using GIS data and software that was provided by the consulting engineers on the LBCR project. Data were obtained from the Fannin County Appraisal District (FCAD) showing the size and taxable value in 2007 for each parcel that would lose land to the reservoir. This includes those parcels that would lose only a portion of their land to the lake and/or floodplain area. In all, about 556 unique parcels were identified between the 541 and 545-foot elevation level. Of these, data for 502 parcels are available on the FCAD online database.

Land valuations for these parcels are based on the average taxable value of land for all other parcels, about $305 per acre including exemptions in 2007. Since 2007, taxable property values in Fannin County, like most areas, have been affected by the downturn in the real estate market. Real property valuations net of new development have increased by an estimated 0.67 percent per year since 2007 for an average taxable value of about $313 per acre. This estimated valuation was assigned to each school district based on their relative portion of land in the project area (Clower, 2012). The analysis of foregone property tax revenues is based on the 2007 analysis with this increased property valuations to reflect estimated average growth of valuations in Fannin County through 2011. Estimates of potential tax losses for Fannin County, the City of Bonham, and affected school districts in the near term are presented below in Table 4.14-13 (Clower, 2012). NTMWD is prepared to be contractually obligated to compensate the county and impacted school districts for any loss in tax revenue as a result of land acquired for the reservoir being taken off tax rolls (NTEN, 2009b).

For those 54 parcels not wholly within the land purchase area, aerial photography and tax records were used to assess the potential loss of taxable improvements on each parcel in the reservoir and flood plain area. For purposes of this analysis, no allowances were made for moving structures. If a structure is located within the 545' elevation line, it is considered lost for taxation purposes. The estimates presented represent taxable values and not market values. The assessed values do not include agricultural and homestead exemptions. It is assumed these same exemptions would continue after the reservoir land purchase (Clower, 2012).

Two parcels, 47 acres of the Legacy Ridge Country Club (LRCC), were treated differently. Table 4.14-13 shows the estimated taxable value of the LRCC for Fannin County, the City of Bonham, and the Bonham Independent School District (ISD) that includes an estimated taxable value of the LRCC. However, it is possible that the LRCC would still be operationally viable upon redrawing of flood plain lines. Therefore, the actual impact on tax revenues may be substantially less than shown when the full value of the LRCC is removed from the tax rolls (Clower, 2012).

As property values begin to rise based on new development near the proposed reservoir, the annual tax losses offset by PILT would diminish and turn to net new revenues for local taxing jurisdictions. The temporary tax losses are shown in Table 4.14-13.

Table 4.14-13. Temporary Annual Tax Revenue Impacts of Land Acquisition[1]

Entity	Value Before	Value After	Difference	Tax rate	Temporary Tax Loss
Bonham ISD	$1,545,679	$1,206,037	$339,643	0.011505	$3,908
Including golf course	$2,593,067	$1,206,037	$1,387,030	0.011505	$15,958
Dodd City ISD	$3,429,167	$2,318,673	$1,110,493	0.01115	$12,382
Honey Grove ISD	$3,965,947	$2,114,933	$1,851,014	0.0135912	$25,158
Sam Rayburn ISD	$7,696,517	$1,550,066	$6,146,451	0.012039	$73,997
Fannin County	$16,641,590	$7,194,981	$9,446,608	0.006081	$57,445
Including golf course	$17,678,708	$7,194,981	$10,483,726	0.006081	$63,752
City of Bonham	$36,909	$29,571	$7,338	0.0067	$49
Including golf course	$1,074,027	$29,571	$1,044,456	0.0067	$6,998
Total loss not including golf course					$172,938
Total loss including golf course					$198,244

[1]2011 valuation estimates including mitigation area

Sources: FCAD, 2010; North Texas Municipal Water District; Clower, 2012

At full development, the taxable value of permanent and weekend residences is approximately $326.2 million[6] generating $5.9 million in county and school district revenues. As such, the net increase in tax revenues would be about $5.7 million at full development, of which $3.9 million would be allocated for Fannin County school districts. Much of this gain in school district revenues would not be accompanied by a proportionate increase in students since a large percentage of the potential property tax revenue would be from weekend or vacation properties. Area municipalities and townships could also benefit from increased property tax revenues depending on the degree to which their taxing jurisdictions are expanded to include land adjacent to the proposed project (See Table 4.14-14).

[1] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

Table 4.14-14. Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending

Description	Impact
Total Taxable Value of Housing (permanent & weekend residents)	$326,200,000
Reduction in Property Value due to Inundation and Mitigation*	($10,484,000)
Net gain in Taxable Property Values	$315,716,000
Estimated New County Property Tax Revenues	$1,920,000
Estimated New School District Property Tax Revenues	$3,910,000
Total Potential** Municipal Sales Taxes (0.01 rate)	$303,000
Hotel Occupancy Tax Revenues**	$183,000

* Includes golf course.

** Value will be impacted by land annexation and business location decisions.

Source: Clower, 2012

Taxable retail sales in Fannin County would increase with new residents and visitors. Local sales tax revenues could potentially increase by upwards of $303,000 per year. Hotels could expect revenues of at least $3.7 million per year for room rentals. Based on a local bed-tax rate of five percent, these expenditures would boost local tax receipts by an additional $183,000 annually. These estimates do not consider the additional taxable property value from stores, bait shops, hotels/resorts, restaurants, and other businesses that might open around the proposed reservoir (Clower, 2012).

Fiscal impacts would likely be slight due to the extraction of property taxation in the short-term, because the affected landowners would be compensated at fair market value, and because NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. The size or physical extent of impacts would be medium (localized) because town and county fiscal operations would be most affected. The likelihood of impacts would be high, because the relationship between local taxes and fiscal health is well-established. Long-term impacts would be beneficial pending development, new permanent and weekend residents, and business investments.

Conclusion

Overall socioeconomic impacts of Alternative 1 on Fannin County and the ROI are multi-faceted and would be both short- and long-term as well as adverse and beneficial. Both the adverse and beneficial impacts would be considered severe. Adverse fiscal and social impacts are more weighted toward the short-term and the fiscal impacts are largely mitigated through NTMWD's payment of PILT to the county; at the same time, there would also be a major short-term economic stimulus associated with construction of the dam, reservoir and related facilities. Over time, socioeconomic impacts associated with Alternative 1 would become more and more positive or beneficial.

On net, over the long-term and the life of the proposed facility (50-100 years or more), socioeconomic effects would be positive for Fannin County. Most but not all Fannin County residents would welcome the short- and long-term economic stimulus provided by the project, in terms of direct added jobs, income, and induced economic activity. As a result of the project, in the future, Fannin County would be more populated, developed, and less rural than it is today (constituting a change in its existing predominantly rural character) or than it would be in the absence of the project. Residents would also enjoy a wider range of recreational and commercial opportunities than at present. Whether or not one sees this tradeoff as good or bad is a question of one's personal values and interests.

4.14.3 Alternative 2

Under Alternative 2, the reservoir's surface area would be approximately 8,600 acres – about half the surface area of Alternative 1. The reservoir footprint (9,390 acres) under Alternative 2 would also be roughly half the size of the reservoir footprint under Alternative 1. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. Alternative 2 would also include two additional pipeline segments: an eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP and a 25-mile pipeline from Texoma to the balancing reservoir near Howe in Grayson County. Many of the potential socioeconomic impacts would be similar to Alternative 1, and differences in impacts from the downsized reservoir or additional pipeline segments are noted throughout the analysis.

Project Costs

Alternative 2 would produce an estimated firm yield of 114,800 AFY. The downsized LBCR would provide 86,100 AFY and the water from Lake Texoma would provide an additional 28,700 acre-feet of water per year. Lake Texoma is a recommended source of additional water supply for the NTMWD in the 2016 Region C Water Plan (Region C Water Planning Group, 2015). Project costs for this alternative are summarized below in Table 4.14-15.

Table 4.14-15. Project Cost Estimates of Smaller LBCR with Blending Alternative (114,800 AFY)

Description	Smaller LBCR (86,100 AFY)	Texoma Blending (28,700 AFY)	Smaller LBCR with Texoma Blending (114,800 AFY)
Project Costs			
Engineering fees	$64,043,000	-	$64,043,000
Other costs (legal, land acquisition, mitigation)	$122,935,300	-	$122,935,300
Dam and reservoir	$68,980,500	-	$68,980,500
Conflicts	$50,573,000	-	$50,573,000
Pipeline	$145,665,900	$107,387,000	$253,052,900
Pump station	$40,428,900	$17,781,000	$58,209,900
Terminal storage	$13,409,000	-	$13,409,000
Permitting and Mitigation – Conveyance System	-	$376,000	$376,000
Total Project Cost	$506,036,000	$125,544,000	$631,579,600
Annual Costs			
Debt Service (6% for 30 yrs)	$36,762,965	$9,120,635	$45,883,570
Electricity ($0.09 per kilowatt hour (kWh)	$3,060,000	$1,330,000	$4,390,000
Operation and Maintenance	$3,671,000	$1,082,000	$4,753,000
Total Annual Cost	$43,494,000	$11,532,635	$55,026,570
Unit costs (before amortization)			
Per acre-foot	$505	$402	$479
Per 1,000 gallons	$1.55	$1.23	$1.47

Description	Smaller LBCR (86,100 AFY)	Texoma Blending (28,700 AFY)	Smaller LBCR with Texoma Blending (114,800 AFY)
Unit costs (after amortization)			
Per acre-foot	$78	$84	$79
Per 1,000 gallons	$0.24	$0.25	$0.24

Additional infrastructure would need to be constructed for the blending portion of this alternative. There is existing infrastructure that conveys Texoma water to the Wylie water treatment plant – the pipeline from the existing Texoma intake and pump station to the Texoma balancing reservoir near Howe, Texas, and a recently built pipeline from the balancing reservoir to Wylie. There is no additional capacity in the pipeline segment from Texoma to the balancing reservoir, so a new, parallel pipeline from Texoma to the balancing reservoir would be needed. The cost of this new parallel pipeline is estimated at about $61 million and right of way (ROW) easements would cost almost $3 million. Improvements at the Texoma pump station, power improvements, and engineering and contingencies would cost approximately $17.8 million. A new pipeline spur from the existing pipeline to Wylie to Leonard terminal storage facility would cost approximately $33.4 million. These costs are included in both tables 4.14-15 (above) and 4.14-16 (below). This additional infrastructure would not conflict with any existing infrastructure (i.e. no need to relocate any gas pipelines, transmission lines, roads, and cemeteries), and therefore would not incur additional conflict costs.

As shown below in Table 4.14-16, engineering fees, conflicts, and terminal storage costs would be the same under both action alternatives. Dam and reservoir costs and other costs (legal, land acquisition, and mitigation) would be higher under Alternative 1, which is to be expected given that the reservoir is about twice the size of the reservoir under Alternative 2. Land acquisition costs under Alternative 2 are assumed to be about 70 percent of the land costs under Alternative 1.

Table 4.14-16. Comparison of Project Costs by Alternative

Description	Alternative 1*	Alternative 2
Project Costs		
Engineering fees	$64,043,000	$64,043,000
Other costs (legal, land acquisition, mitigation)	$174,121,000	$122,935,300
Dam and reservoir	$76,645,000	$68,980,500
Conflicts	$50,573,000	$50,573,000
Pipeline	$161,851,000	$253,052,900
Pump station	$44,921,000	$58,209,900
Terminal storage	$13,409,000	$13,409,000
Permitting and Mitigation – Conveyance System	-	$376,000
Total Project Cost	$585,563,000	$631,579,600
Annual Costs		
Debt Service (6% for 30 years)	$42,540,515	$45,883,570
Electricity ($0.09 per kilowatt hour (kWh)	$5,029,275	$4,390,000

Description	Alternative 1*	Alternative 2
Operation and Maintenance	$3,891,210	$4,753,000
Total Annual Cost	$51,461,000	$55,026,570
Unit costs (before amortization)		
Per acre-foot	$427	$479
Per 1,000 gallons	$1.31	$1.47
Unit costs (after amortization)		
Per acre-foot	$74	$79
Per 1,000 gallons	$0.23	$0.24

*March 2011 costs for Alternative 1 have been adjusted to 2013 dollars for comparison purposes.

Short-term expenditures on the construction of Alternative 2 (including all components) would likely last almost as long as Alternative 1, which was estimated to last three to four years. Actual time to design and construct the infrastructure for the blending portion of this alternative would be less than three years. It is assumed that the design and construction of the additional infrastructure needed for this alternative would occur during the same timeframe as the construction phase. Said otherwise, the design and construction of the additional infrastructure needed for this alternative would not extend the duration of the construction phase for Alternative 2.

The costs for Alternative 2 would be about $46 million more expensive than Alternative 1, or 7.8 percent more expensive. Alternative 2 would cost an additional $3.6 million annually, almost seven percent higher than Alternative 1. Annual debt payments and amortization are discussed further in the 4.14.3.2 under Financing Costs.

Financing Costs

The financing arrangement would be similar to what is described under Alternative 1. No tax revenues would be used to construct the reservoir. NTMWD would fund the construction through water sales; ultimately, financing costs are paid by the users of the water. The LBCR costs, including land acquisition, construction, transmission and treatment facilities, and any other costs would be expected to be financed with contract revenue bonds and NTMWD. NTMWD would solely own and operate the LBCR (NTMWD, 2009).

Under Alternative 2, the total project cost would about $46 million more than Alternative 1 and cost an additional $3.6 million annually. This leads to a 12 percent higher unit cost (before amortization) than under Alternative 1 – $1.47 vs. $1.31 per 1,000 gallons – for the water that Alternative 2 would make available (see Table 4.14-16). The cost per 1,000 gallons is derived as follows. With a probable total cost of $631,579,600 under this alternative, the annual debt payment would be about $45.8 million assuming 30 years of payments at six percent interest. The total annual cost is about $55 million: in addition to the annual debt payment, the annual O&M cost is $4.7 million and electricity is about $4.4 million. Based on the reservoir's estimated yield of 114,800 AFY, the estimated unit costs before amortization would be $479 per acre-foot of water, which equates to $1.47 per 1,000 gallons (see Table 4.14-16).

After amortization (once interest has been repaid and principal on the debt has been paid), the annual costs would consist of those for electricity and O&M, or about $9.1 million. Based on the reservoir's estimated yield of 114,800 AFY, the estimated unit costs after amortization would be $79 per acre-foot of water, which equates to $0.24 per 1,000 gallons. Ultimately the different in unit cost is about one cent per 1,000 gallons, or four percent higher than Alternative 1.

The effects on financing costs of constructing Alternative 2 would be slightly adverse. Potential impacts of Alternative 2 would be slightly more adverse than those of Alternative 1 because water prices for NTMWD customers would be higher than under Alternative 1 – especially before amortization. The likely size or physical extent of impacts would again be medium (localized), because the project costs are shared by all NTMWD customers. The likelihood of rate adjustment is high. Adverse impacts in the form of more expensive water per 1,000 gallons would be felt in the short-term until after amortization (30 years). In the long-term, impacts to economic resources would be beneficial because the price will drop drastically once the debt is paid off – and the cost per 1,000 gallons would be similar to the cost under Alternative 1.

Impacts Based on Input-Output Model

An IMPLAN model was not conducted to estimate economic impacts under this alternative. Economic impacts are compared qualitatively for the dam, reservoir, and related infrastructure construction. The relative impact to the size of the development projects, businesses and residents of nearby counties that would benefit from the economic activity associated with the construction of the dam and reservoir is also compared qualitatively to Alternative 1. Potential impacts would likely occur in a wide economic area and are again defined by Fannin, Collin, Delta, Lamar, Grayson and Hunt counties.

4.14.3.3.1 Construction Phase

Based on the relative presence, or absence, of industries providing materials and supporting services to dam and reservoir construction projects, some of the economic activity would "leak" out of the local area. However, the additional $46 million in expenditures during a shorter timeframe would create greater economic activity compared to Alternative 1. Expenditures would further boost gross county product, or the total value of the goods and services produced by the people of a county during a year not including the value of income earned outside the county. This would create additional person-years of employment and increase local labor income (salaries, wages, and work benefits). Property incomes in the form of rent, royalties, corporate profits, and dividends would further increase, as would business taxes from indirect transactions, state and local tax revenues.

The non-recurring impacts of developing Alternative 2 would boost economic activity in Fannin County, but comparatively less so than under Alternative 1. County gross product; person-years of employment; labor income associated with these jobs; property income in the form of rents, royalties, dividends, and corporate profits; indirect business taxes in the form of property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending would all still be expected to increase, but are expected to increase less than under Alternative 1.

Given that it would seem unlikely that Fannin County and the surrounding counties could supply the trained construction workforce under Alternative 1, an even larger portion of labor would likely be filled from outside of the area for the construction portion of Alternative 2. This would also mean that a larger portion of the construction expenditures (occurring during a shorter period) would likely leak out of the local economy. As such, the higher construction cost would not have a proportionally higher benefit to the local economy; NTMWD would recruit locally, state-wide and nationally to fill labor and/or professional needs. Similarly, equipment and materials would be procured locally as much as possible, but a large amount of specialized equipment and materials would not be available locally and would be shipped from other areas.

That said, the additional workers needed to fulfill construction of the downsized reservoir and additional pipeline and transmission facilities would create a greater number of indirect or induced jobs from project-related spending and the spending decisions of workers. These temporary jobs would generate additional wages and benefits to be spent in the local economy. Under this alternative, businesses such as hotels, restaurants, gas stations, and grocery stores in the project area might see some additional beneficial economic effects from per diem expenditures (meals, lodging, incidentals, etc.) by workers during their time in the local area. A higher portion of the indirect and induced jobs created by the project would last only for the (shorter) duration of the construction phase compared to Alternative 1.

Impacts from the construction phase would be greater than those described under the Alternative 1, but the overall impact ratings would be the same. The construction phase would potentially create severe beneficial impacts. The size or physical extent of impacts would be medium (localized) to large and the likelihood would be high. Impacts would be short-term and would last as long as the three- to four- year construction phase under Alternative 1.

Impacts to Homes and Social Landscape

Alternative 2 also has the potential to alter the socioeconomic landscape by increasing the total population, real estate and business development, and recreational visitors and their spending – though impacts would be slightly less than those described under Alternative 1. Most of the property within the reservoir footprint (under Alternative 1) from landowners has already been purchased, therefore potential impacts would be the same as those discussed under Alternative 1. The number of occupied and unoccupied homes that have been or will be purchased as part of the project would not change under this alternative.

The severity of potential impacts to homes and the social landscape would be almost identical to those described under Alternative 1. Potential adverse impacts would be slight to moderate. The size or physical extent of impacts would be medium (localized) by definition, because the homes that would be impounded are currently located in the reservoir's footprint and would not change under this alternative. Impacts would be felt in both the short- and long-term and would be permanent and irreversible.

4.14.3.3.2 Maintenance and Operation Phase

As displayed above in Table 4.14-16, the annual operating maintenance cost is an estimated $4,753,000, approximately $1 million higher than under Alternative 1. The additional cost for O&M activities would support additional direct and indirect jobs and wages and salaries; and further increase local economic activity in Fannin County as well as surrounding counties. Beneficial impacts described under Alternative 1 would also occur under Alternative 2, and could be slightly more beneficial but overall would not differ from the impact ratings under Alternative 1. The potential beneficial impacts from O&M costs would be slight. The size or physical extent of impacts would be medium (localized). The likelihood of impacts would be high. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

Impacts of Recreational Users

Alternative 2 would create a new, 8,600-acre water supply reservoir that, like Alternative 1, could potentially serve as a major new outdoor recreation asset for Fannin County and the region. It is anticipated that even with the reservoir's smaller surface area, the majority of the lake would still be deep enough for fishing and boating. As such, Fannin County would benefit from increased recreational visitors once the reservoir is operational. However, since Alternative 1 would provide a lake surface area about twice as large, the severity of impacts would likely be lower compared to Alternative 1. Beneficial impacts would not decrease proportionally with lake surface area, as the level of spending for a project this size would still encourage business development and supports jobs. Other lake-based recreational activities like boating and camping would draw additional out-of-area visitors to the region. Non-angler spending and non-local recreational visitors would add less in new spending for dining, retail goods, and lodging to the Fannin County economy than under Alternative 1. This spending would also generate less in economic activity, support comparatively fewer new jobs, and increase local earnings by less than the amount described under Alternative 1. The reservoir is expected to attract fewer full-time resident households over and above anticipated growth for the area over the next 30 years than under Alternative 1. The new income associated with the comparatively fewer full-time resident households would also be lower.

Recreation and business development would potentially create moderate to severe beneficial impacts due to spending from recreational visitors, compared to severe beneficial impacts under Alternative 1. As under Alternative 1; the size or physical extent of impacts would be large and the likelihood of impacts would be medium to high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years).

Impacts of New Permanent and Weekend Residents

As described under Alternative 1, one trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have experienced greater population growth than counties without. From 1960 to 2000, the 19 counties in northeast Texas grew by 66.5 percent. Every county that at least doubled its population during that time contains a major reservoir with at least 10,000 acre-feet of water capacity. Carefully managed residential development around the downsized reservoir under Alternative 2 could also prove to be a tremendous economic boon for Fannin County. Comparatively fewer new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. As such, local purchases from weekend and vacation residents would be lower than under Alternative 1. The combined incomes of permanent residents and the proportional income of weekend residents would result in a relatively lower net increase in activity than under Alternative 1 once the reservoir is operational. This economic activity would support fewer permanent jobs (and salaries and wages) than under Alternative 1. Businesses located in Fannin, Hunt, Lamar, Grayson, and Delta counties offering goods and services to new permanent and weekend residents would still increase economic output in the broader region, boost local income, and support permanent jobs – though less than under Alternative 1.

New permanent and weekend residents would potentially create slight to moderate beneficial impacts due to increased spending on homes and goods and services, or slightly less than those described under Alternative 1. Other impact ratings would be the same as those described under Alternative 1; the size or physical extent of impacts would be medium (localized) and the likelihood of impacts would be high. Impacts would occur in both the short- and long-term.

Impacts of New Housing Construction

As under Alternative 1, new residential construction activity is expected to occur primarily in Fannin County, though spending is expected to be lower under this alternative. These construction activities would still boost the local economy, support long-term full-time equivalent (FTE) jobs, and boost local income for a 30-year period. Potential impacts from new housing construction would be similar to those described under Alternative 1. The potential impacts would be moderate, the size or physical extent of impacts would be medium (localized) to large, and the likelihood of impacts would be high. Impacts would be medium (intermittent) to long-term and last approximately 30 years.

Business Development and Recruitment

As described under Alternative 1, the presence of a new, reliable source of water would enhance the county's ability to attract and retain businesses. It is assumed that TWDB's water use expectations would not generally change for the manufacturing industry, steam electricity generation, livestock and irrigation, mining industry activities, and municipal uses. As such, Fannin County's direct economic activity, area labor income and jobs would still increase from industrial and commercial output in Fannin County, though potential impacts could be less severe due to the decreased water supply under this alternative.

Impacts would be similar to those described under Alternative 1. Business development and recruitment would potentially create severe beneficial impacts; the size or physical extent of impacts would be large; and the likelihood of impacts would be high. Impacts would be long-term and last at least as long as the reservoir's lifetime (50-100 years).

Local Fiscal Impacts

In the short-term, local fiscal impacts would be the same as those under Alternative 1. NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. As described under Alternative 1, new construction would increase economic activity in the area by creating jobs for construction and O&M of the dam and reservoir. These jobs would create additional sales tax revenue, and new residents would pay property taxes that would benefit government operations. Revenue from property taxes and from an expanded tax base would be somewhat less than under Alternative 1. Although tax revenues would initially decrease due to taxable land in the proposed reservoir site that would be impounded, ultimately the reservoir could attract residential, commercial, and industrial property development that would boost property tax revenues in local taxing jurisdictions.

As property values begin to rise based on new development near the proposed reservoir, the annual tax losses offset by PILT would diminish and turn to net new revenues for local taxing jurisdictions. In the long-term, Fannin County would eventually experience a net increase in tax revenue from the associated or "ancillary" development likely to occur in conjunction with the dam and reservoir, though this net increase is expected to be smaller under Alternative 2. This net increase in tax revenue would still enable the cities and county to build more roads, increase the number of schools and teachers, and provide community services for the increased population; though again it is unclear whether the increased revenue would be in fact be used to address these needs, as those decisions are a function of the political process of local government and may also depend on other outstanding needs.

Fiscal impacts would be similar to those described under Alternative 1: potential impacts would be slight and the likelihood of impacts would be high. Long-term impacts would be beneficial pending development, new permanent and weekend residents, and business investments.

Conclusion

Overall, socioeconomic impacts of Alternative 2 on Fannin County and the ROI would be similar to those discussed under Alternative 1. Impacts would be both short- and long-term as well as adverse and beneficial. As under Alternative 1, Alternative 2 would result in a more populated, developed, and less rural Fannin County. The local economy would benefit from direct added jobs, income, and induced economic activity. A wider range of recreational and commercial opportunities would be available to residents, though economic benefits are not assumed to outweigh adverse impacts to the social or rural character of Fannin County; and are ultimately a question of one's personal values.

Compared to Alternative 1, beneficial impacts from the additional short-term stimulus to construct the pipeline and transmission facilities would be greater under this alternative due to additional job creation, spending of those wages, and related increases in economic activity. Annual debt payments and O&M costs would increase the unit cost of water to NTMWD customers (before amortization) by 12 percent. In the long-term, impacts to economic resources would be beneficial since the price will drop drastically once the debt is paid off – and the cost per 1,000 gallons would ultimately be almost the same as under Alternative 1.

Adverse short-term fiscal and social impacts would be the same as those described under Alternative 1. Over time, socioeconomic impacts associated with Alternative 2 would become more and more positive or beneficial, though the severity of the beneficial impacts would be comparatively lower than under Alternative 1. The smaller reservoir under Alternative 2 would attract presumably fewer new permanent and weekend residents and stimulate less new construction and business development. Impacts from recreational users would be less beneficial than under Alternative 1. While Alternative 1 would provide a lake surface area about twice as large, beneficial impacts would not decrease proportionally with lake surface area. Overall, short- and long-term beneficial economic impacts would still occur under Alternative 2.

4.15 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Consideration of the potential consequences of Alternatives 1 and 2 for environmental justice requires three main components:

1. A demographic assessment of the affected community to identify the presence of environmental justice populations that may be affected;
2. An assessment of all potential impacts to determine if any could result in adverse impacts to the affected community; and
3. An integrated assessment to determine whether any disproportionately high and adverse impacts exist for environmental justice populations present in the project area.

Alternatives 1 and 2 would include the construction of a dam and reservoir, and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. As such, Fannin County represents the primary focus and Region of Influence (ROI) for any direct and indirect impacts to environmental justice populations associated with the implementation of either alternative. However, the blending portion of Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Therefore, for Alternative 2, Grayson County is also considered part of the ROI for any direct and indirect impacts related to the construction and operation of that pipeline. Both Fannin and Grayson counties represent the primary focus and ROI for any direct and indirect impacts related to environment justice and protection of children that may be associated with the implementation of Alternative 2.

Where minority, low-income, and/or youth populations are found to represent a high percentage of the ROI, the potential for these populations to be displaced, suffer a loss of employment or income, or otherwise experience adverse effects to general health and well-being is evaluated for potential environmental justice concerns. Impacts are categorized in terms of severity, duration, size or physical extent, and likelihood under each alternative, and are summarized in Table 4.15-1 below.

Table 4.15-1. Summary of Impacts to Environmental Justice and Protection of Children Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Small (localized)	Small (localized)	No change from current conditions.
Duration	Short-term, Temporary and intermittent	Short-term, Temporary and Intermittent	
Likelihood	Low to Medium	Low to Medium	

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Severity	None (direct, adverse); Slight (indirect, adverse)	None (direct, adverse); Slight (indirect, adverse)	
Operation Phase			
Size	Medium (localized)	Medium (localized)	No change from current conditions.
Duration	Long-term (50-100+ years)	Long-term (50-100+ years)	
Likelihood	Low (adverse); High (beneficial)	Low (adverse); High (beneficial)	
Severity	None to slight (adverse); Moderate (beneficial)	None to slight (adverse); Moderate (beneficial)	

4.15.1 No Action Alternative

If the No Action Alternative is selected, no change would occur to the existing counties. Because ongoing activities would be substantially the same as those already occurring, no additional change in community character and setting would be anticipated. Current water distribution operations would be expected to have no effect on the populations of concern. Existing conditions would remain substantially unchanged.

4.15.2 Alternative 1

Alternative 1 would include the construction of a 16,641-acre reservoir and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. Fannin County represents the primary focus and ROI for any direct and indirect impacts that may be associated with the implementation of Alternative 1.

Minority Populations

Fannin County does not constitute an environmental justice population because the percentage of minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in the five surrounding counties. As such, there would be no disproportionate environmental justice impacts to Fannin County overall.

However, a closer look at the distribution of minority populations within Fannin County using block group (BG) data reveals that Honey Grove, Ladonia, and Bonham consist of environmental justice populations, as established in Section 3.13.1.1 (Minority Populations) and shown in Figure 3.13-1: Distribution of Minorities Within Fannin County. Potential impacts to these environmental justice populations resulting from the construction and operation phases are evaluated below.

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on minority populations in Ladonia, Honey Grove and Bonham. The types of impacts from the construction equipment, vehicles, and activities that were evaluated include:

1. Noise Disturbances: Disturbances could occur from an increased level of noise created by construction equipment and vehicles associated with the northeast portion of the pipeline that traverses Honey Grove.

2. Congestion: Congestion would increase in the immediate area due to additional vehicles and traffic delays near the pipeline, affecting environmental justice populations in Honey Grove and Ladonia.
3. Community Cohesion: An increase in travel time or miles traveled during the construction of the pipeline could reduce access to community centers, neighborhood parks, and recreation areas for Honey Grove and Ladonia residents traveling west or north and Bonham residents commuting east or south.
4. Human Health and Safety: Construction workers are inherently exposed to safety risks such as injury by unguarded machinery and dust inhalation by operating heavy machinery and working on construction sites.
5. Job opportunities: Beneficial impacts could include the availability of short-term construction jobs.

During at least a portion of the construction phase, Alternative 1 could result in disproportionate impacts on Honey Grove, Ladonia, and/or Bonham residents. As discussed in Section 4.6, Acoustic Environment (Noise), increased noise levels would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. However, the shortest distance between Ladonia, Honey Grove, and Bonham residents to the impoundment area or pipeline route is about five miles. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. Noise from the construction of the 35-mile pipeline to the Leonard WTP would not be fixed in one location but would progress along the pipeline as construction progresses; and the pipeline would not traverse any of the minority populations. Some nearby Honey Grove residents may experience annoying levels of noise; however, given the distance to the pipeline, impacts would be indirect. Such indirect impacts would be temporary and intermittent, and last for the duration of pipeline-related construction activities but not for the full duration of the three- to four-year construction phase. To minimize the effects of noise impacts, construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential and recreation areas; and construction equipment mufflers would be properly maintained and in good working order.

As discussed in Section 4.12 (Transportation), congestion would increase in the immediate project area due to additional vehicles and traffic delays. FM 1396 is an existing two-lane TXDOT asphalt road that runs from Ravenna; east across the county transecting the proposed reservoir; and south to Honey Grove and Ladonia. FM 1396 would not be available during construction of the dam and reservoir. Residents of Honey Grove and Ladonia routinely commuting west or north would be affected by increased traffic and time delays during the construction phase. Similarly, Bonham residents routinely commuting east or south would be affected by increased traffic and time delays. Community cohesion could be affected because travel time or miles traveled due to re-routing would increase during this time, potentially reducing access to community facilities such as parks, churches, or schools. That said, the existing transportation infrastructure in Fannin County would be sufficient to support the increase in vehicle traffic. Contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts.

Job opportunities would not create disproportionate beneficial impacts to minority populations within Fannin County. In other words, the potential benefit of job opportunities would not be a function of race, just as it would not be a function of location. Impacts would be felt most by those who might be in search of a short-term job. As discussed in Section 4.14 (Socioeconomics), construction of the proposed project would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers.

Operation Phase

The operation phase of Alternative 1 would not disproportionately impact minority populations adversely in the long-term. The proximity of Honey Grove, Ladonia, and/or Bonham to the reservoir might be advantageous for local recreationists and job-seekers. FM 1396 would be replaced with FM 897, located two to three miles to the west of FM 1396. The new FM 897 would be higher quality compared to the existing FM 1396, and as such could disproportionately benefit Honey Grove and Ladonia residents commuting into Bonham as it would be built to higher speed standards, and would be centrally located across the reservoir site. These effects would be beneficial when compared to existing conditions or the No Action Alternative. The proposed reservoir would introduce a recreational resource to the county, and represent a beneficial impact for all residents.

Low-Income Populations

As established in Section 3.13.1.2 (Low-Income Populations), Fannin County does not meet the regulatory definition of a low-income population. Census tract (CT) data show that between 21 and 25 percent of the population in Bonham is living below the poverty threshold, and therefore qualifies Bonham as an environmental justice population (See Figure 3.13-2: Distribution of Low-Income Populations in Fannin County).

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on low-income populations in Bonham. Some of the same types of impacts from the construction equipment, vehicles, and activities evaluated above for minority populations in Bonham were evaluated for low-income populations in Bonham and include:

1. Community Cohesion: An increase in travel time or miles traveled during the construction of the pipeline could reduce access to community centers, neighborhood parks, and recreation areas for Bonham residents commuting east or south.
2. Human Health and Safety: Construction workers are inherently exposed to safety risks such as injury by unguarded machinery and dust inhalation by operating heavy machinery and working on construction sites.
3. Job opportunities: Beneficial impacts could include the availability of short-term construction jobs.

Potential impacts to low-income populations in Bonham would essentially be the same as those to minority populations in Bonham. As discussed above in Section 4.15.2.1 (Minority Populations), potential impacts from noise disturbances would not affect Bonham residents given the distance from Bonham to the reservoir or pipeline route. Also discussed above in Section 4.15.2.1 (Minority Populations), potential impacts from congestion could affect minority populations and community cohesion in Ladonia and Honey Grove, or those commuting into Bonham to access community centers, neighborhood parks, and recreation areas; however, neither minority nor low-income populations living in Bonham would be affected. Low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia would be affected by increased traffic and time delays during construction of the 35-mile pipeline to the Leonard WTP. Increased traffic and delays would be temporary and intermittent, lasting for the duration of pipeline-related construction activities affecting access to Windom, Honey Grove, or Ladonia (respectively), but not for the entire duration of the construction phase.

If local construction workers are hired, job opportunities could result in beneficial impacts to Bonham residents in search of a job. As discussed in Section 4.14 (Socioeconomics), the construction phase would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers. However, the potential benefit of job opportunities would not be a function of location or income. Impacts would be felt by anybody who might be in search of a short-term job. All construction workers – low-income or otherwise – could inherently be exposed to safety and health risks due to operating heavy machinery and working on-site. Any health and safety risks associated with construction activities would not disproportionately affect low-income construction workers.

Operation Phase

The operation phase of Alternative 1 would not create disproportionate and adverse impacts on low-income populations in the long-term. The long-term impacts of Alternative 1 would be primarily beneficial due to a major new recreational facility, but these benefits would not disproportionately benefit low-income populations in Bonham. The replacement of FM 1396 with the new FM 897 would disproportionately benefit low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia.

Protection of Children

In compliance with EO 13045, *Protection of Children From Environmental Health Risks and Safety Risks*, this analysis examines local, regional, and national demographic data; evaluates the number and distribution of children in the area; and discerns whether these children could be exposed to environmental health and safety risks from Alternative 1 or 2. The analysis considers that physiological and social development of children makes them more sensitive to health and safety risks than adults. It also recognizes that children in minority and low-income populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population. Activities that result in air emissions, water discharges, and noise emissions are considered to have severe environmental health and safety risks if they were to generate disproportionately high environmental effects on youth populations within the ROI. Potential effects include health and safety concerns such as respiratory issues, hearing loss, and interruption of communication or attention in nearby residences and schools with children present.

Fannin County overall does not meet the regulatory definition of a minority or low-income population, or an environmental justice population. However, because the safety risks are higher in the vicinity of the proposed project, BGs identified high concentration "pockets" of minority populations in Ladonia, Bonham, and Honey Grove. CTs identified high concentration "pockets" of low-income populations in Bonham. As such, places where children "learn, live, and play" in Ladonia, Bonham, and Honey Grove are the focus of this analysis for disproportionate impacts as it relates to their health and safety.

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on children in the vicinities of Honey Grove, Ladonia, and Bonham. This analysis considers that the following types of adverse impacts on children from the construction equipment, vehicles, and activities could include:

4. Noise Disturbances: Increased level of noise created by construction equipment and vehicles could affect children's learning, especially near homes, schools, and recreational areas.
5. School Funding: Decreased tax revenue from a decrease in taxable land that would be impounded could affect funding for teachers, classroom materials, or maintenance and improvement projects in the Bonham Independent School District (ISD).
6. Mobile Source Air Pollutant Emissions (including traffic): Children living, learning, or playing along the eastern perimeter of the construction area and northern portion of the pipeline in close proximity to the project area could be impacted by construction activities and vehicles. Children are believed to be especially vulnerable due to higher relative doses of air pollution, smaller diameter airways, and more active time spent outdoors and closer to ground-level sources of vehicle exhaust.

7. Congestion and Obesity Factors: Increased congestion in the immediate area due to additional vehicles and traffic delays near the site could reduce opportunities for children to exercise outdoors and the accessibility of neighborhood parks, green spaces, and recreation areas. Children living in the east and northeast portion of Fannin County could be particularly affected.
8. Safety: Children living, learning, and playing in close proximity to the project area are inherently at a higher risk of accident or incident that could result in bodily harm.

Possible impacts under Alternative 1 to youth community and recreational facilities such as childcare centers, places of worship, schools, recreation facilities, hospitals, public health facilities, and social welfare facilities located in Fannin County would determine the characterization of impacts as posing a concern to the protection of children. Potential impacts to children at relevant youth community and recreational facilities in Fannin County are discussed below, and are included based on their location and proximity relative to the project area. The types of potential adverse impacts listed above in combination with impact factors (size, duration, likelihood, severity) are used to qualify the magnitude of impacts.

Youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during construction of the 35-mile pipeline to the Leonard WTP. As discussed above under 4.15.2.1 and Section 4.6 Acoustic Environment (Noise), increased noise levels and mobile source air pollutant emissions would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam and reservoir. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. Given that the shortest distance between Honey Grove and the pipeline is about five miles, impacts would be indirect.

The Head Start Program at Bailey Inglish Elementary School (BIES) in Bonham is part of the United States Department of Health and Human Services that provides comprehensive education, health, nutrition, and parent involvement services to low-income children aged three to four and their families. While BIES is part of the Bonham ISD and benefits from its facilities and eligibility for state funding, the program serves all of Fannin County. A total of 139 children aged three to four are currently enrolled in the Head Start Program at BIES (48 three-year olds and 91 four-year olds) (Hunt, 2012). Because students enrolled in the Head Start Program may reside and commute from anywhere in Fannin County (as opposed to within the Bonham ISD), traffic and time delays during the construction phase could adversely impact families commuting from the east and northeast. Given the distance of BIES to the project area, any increase in noise levels created by construction equipment and vehicles would not affect learning at BIES. Similarly, it is unlikely that increased congestion and mobile source air pollutant emissions from construction vehicles in the project area would reduce opportunities for children to exercise or play outdoors or increase the risk of dust inhalation or other pollutants at BIES.

As discussed in Section 4.14 (Socioeconomics) under Local Fiscal Impacts, tax revenues could initially decrease due to taxable land that would be impounded or allocated for mitigation. However, the NTMWD has committed to keeping tax agencies whole by making payments equal to any lost revenues (payments in lieu of taxes or PILT) until re-growth in the tax base compensates for initial lost tax revenues. As such, there would not be any impacts from lost tax revenues to the Bonham ISD in the short-term. Beneficial tax impacts from ancillary development (i.e., real estate and businesses) discussed in Section 4.14 (Socioeconomics) could occur during and extend the construction phase.

Bonham State Park is a 261-acre park located in South Bonham with prairies, woodlands, and a 65-acre man-made lake. Facilities including a playground, a launching ramp, a boat dock, picnic tables, and a lighted fishing pier are open and accessible to the public seven days a week, year-round (TPWD, 2012). Due to the distance to the project area (more than 10 miles), the likelihood that children recreating in

Bonham State Park would be at an increased risk of dust inhalation or other pollutants is low. Any increase in congestion would not likely reduce opportunities for children to exercise outdoors or access Bonham State Park. Construction would primarily occur during normal weekday business hours in areas adjacent recreation areas – as opposed to during weekends, which is presumably more popular.

Texoma Medical Clinic (TMC) Bonham Hospital, formerly known as the Red River Regional Hospital, is a Joint Commission accredited critical access hospital located in Bonham. This 25-bed hospital provides inpatient, outpatient and emergency services to Fannin County and surrounding communities, and is the only hospital in Fannin County (TMCBH, 2016). In the case of an accident, time delays due to traffic or congestion from the construction of Alternative 1 could hypothetically have serious consequences, although the likelihood of this occurrence is very low.

Operation Phase

The availability of water and recreational opportunities at the reservoir could potentially influence land uses in the greater vicinity to become more industrialized and/or developed, creating both adverse and beneficial impacts to children. Since children are at greater risk due to developing bodies and increased exposures, if herbicides are applied for the purpose of maintenance around the periphery of the reservoir and/or pipeline right-of-way, it could result in adverse health impacts to children. However, the likelihood of this occurring is considered low and would result in slight impacts.

As the population grows with economic development during the operation phase of the dam and reservoir, the tax base would also expand, eventually boosting property tax revenues in local taxing jurisdictions. This net increase in tax revenue would enable the cities and county to increase the number of schools and teachers and provide community services for the increased population. It should, however, be noted that it is unclear whether the increased revenue would be in fact used to address these needs. Those decisions are a function of the political process of local government and may also depend on other outstanding needs.

As discussed in Section 4.14 (Socioeconomics) under Local Fiscal Impacts, property taxes from new permanent and weekend residences at full development would generate $5.9 million in county and school district revenues, of which $3.9 million would be enjoyed by school districts in Fannin County (Clower, 2012). Much of this gain in school district revenues would not be accompanied by a proportionate increase in students because a large percentage of the potential property tax revenue would be from weekend or vacation properties.

Maintenance of the dam and reservoir would potentially create slight to moderate beneficial impacts due to the increased tax revenue without (necessarily) an increase in youth populations, because children of weekend residents are not expected to necessarily enroll in the Bonham, Trenton, or Leonard ISDs. The size or physical extent of impacts would be medium (localized), because long-term teaching jobs, materials, and facilities would be felt most by children attending schools in Fannin County. Based on the increased tax revenue from real estate and business development in other Texas counties that have constructed dams and reservoirs in the recent past, the likelihood of impacts would be high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years).

A major new recreational facility close to Bonham and Honey Grove offering boating, fishing, swimming, and other outdoor activities would represent a benefit for all area youth. The visual and aesthetic value of the reservoir and the green space around it would also be considered by many as beneficial in the long-term.

Conclusion

Alternative 1 would not result in environmental justice impacts in the overall ROI. Census BG data identified Honey Grove, Ladonia, and Bonham as "pockets" of minority populations and Bonham as a "pocket" low-income population. Alternative 1 could create indirect, slightly adverse impacts for at least a portion of the construction phase, though not during the operational phase. Low-income populations in Bonham commuting east or south and minority populations commuting to BIES could experience intermittent and temporary impacts from traffic or time delays. Youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during the construction of the 35-mile pipeline to the Leonard WTP. However, impacts would be temporary and intermittent and depend on the location and timing of specific construction activities. The size or physical extent of such impacts would be small (localized) and could affect the aforementioned "pockets" of environmental justice populations. The likelihood of all noise and air-quality related adverse impacts on environmental justice populations would be low given their distance(s) to the project area. The likelihood of adverse impacts on minority populations commuting to BIES would be medium: the unavailability of FM 1369 during construction of the dam and reservoir would indicate that the impacts have some chance of occurring, but the likelihood is below 50 percent.

Beneficial impacts in the form of jobs would not impact low-income or minority populations disproportionately in the short- or long-term. Long-term impacts of Alternative 1 on environmental justice populations would be moderately beneficial due to the replacement of FM 1396 with FM 897 and a major new recreational facility. Long-term impacts would last as long as the dam and reservoir's lifetime (50-100 years); impacts would occur throughout Fannin County and therefore the size or physical extent of impacts would be medium and localized; and the likelihood of beneficial impacts would be high.

4.15.3 Alternative 2

The reservoir under Alternative 2 would be roughly half the size of the reservoir footprint under Alternative 1. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. Alternative 2 would also include an eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County. As such, Fannin County still represents the focus and ROI for any direct and indirect impacts from these elements of Alternative 2. Many of the potential impacts on environmental justice populations would be similar to Alternative 1, and differences in impacts from the downsized reservoir or additional eight-mile pipeline are noted throughout the analysis. Impacts associated with the 35-mile pipeline are summarized throughout the section but the detailed analysis is not repeated.

Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe in Grayson County. For this portion of the project, Grayson County is also considered the ROI for any direct and indirect impacts. Additional impacts on environmental justice populations in Grayson County are analyzed below.

Minority Populations

As discussed under Alternative 1, Fannin County does not constitute an environmental justice population because the percentage of the minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in the five surrounding counties. Overall, there would be no disproportionate environmental justice impact to Fannin County. However, an analysis of BG data identified portions of Fannin County (Honey Grove, Ladonia, and Bonham) as minority populations.

Similar to Fannin County, Grayson County does not constitute an environmental justice population because the percentage of the minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in Fannin, Collin, Hunt, Cooke, and Denton counties (the counties in the ROI that surround Grayson County).

Construction Phase

Potential impacts on minority populations in Honey Grove, Ladonia, and Bonham from the construction of the dam and reservoir would be the same as those discussed under Alternative 1 in Section 4.15.2.1 (Minority Populations). The comparatively smaller reservoir that would be constructed under Alternative 2 would not change the types, duration, likelihood, size or physical extent, or severity of impacts from traffic and time delays. FM 1396 transects the reservoir under both Alternatives 1 and 2, and would not be functional during the construction phase of either alternative. The magnitude of impacts from the construction of the dam and reservoir under Alternative 2 would therefore be the same as those under Alternative 1.

The same 35-mile pipeline to the Leonard WTP that would be constructed under Alternative 1 would also be constructed under this alternative. As such, the disproportionate, slight, indirect impacts on minority populations in Ladonia, Honey Grove and Bonham discussed under Alternative 1 would occur under this alternative as well. The severity, duration, likelihood, and size or physical extent of impacts under Alternative 1 discussed in Section 4.15.2.1 (Minority Populations) would be the same for Alternative 2.

Additional infrastructure would be constructed for the blending portion of this alternative, including a new eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County. This pipeline segment is not located in Honey Grove, Ladonia, or Bonham; therefore, no additional impacts would occur to these locations with environmental justice populations.

Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Grayson County does not constitute an environmental justice population because the percentage of minority population neither exceeds 50 percent nor is it substantially higher than the percentage of minorities in the five surrounding counties. As such, no additional environmental justice impacts would occur due to this portion of Alternative 2.

Operation Phase

As under Alternative 1, operation of the dam and reservoir would not disproportionately impact minority populations adversely. Long-term benefits could disproportionately impact Honey Grove and Ladonia residents commuting to Bonham when FM 1396 is replaced with the new FM 897. Given that the additional eight-mile pipeline segment in southwestern Fannin County would be located at least 10 miles from minority populations in Honey Grove, Ladonia, or Bonham, operation of this pipeline segment would not affect the aforementioned environmental justice populations. Operation of the 25-mile pipeline would not result in additional beneficial or adverse impacts, as Grayson County does not constitute a minority or environmental justice population.

Low-Income Populations

As under Alternative 1, Fannin County does not meet the regulatory definition of a low-income population. The percentage of persons living below the poverty line does not exceed 50 percent, and the percentage is not meaningfully greater than the populations of Grayson, Collin, Hunt, Cooke, and Denton counties. However, CT data was used to identify Bonham as a low-income population.

Grayson County does not constitute an environmental justice population by either of the CEQ definitions provided in Section 3.13.1.2 (Low-Income Populations). The percentage of persons living below the poverty line does not exceed 50 percent, and the percentage is not meaningfully greater than the populations of Fannin, Collin, Hunt, Cooke, and Denton counties.

Construction Phase

As described for Alternative 1, given the distance of Bonham to the project area, potential impacts to community cohesion would not affect Bonham residents during the construction phase. Low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia would also be affected by increased traffic and time delays during construction of the 35-mile pipeline to the Leonard WTP.

Additionally, similar types of impacts from traffic and time delays would occur to low-income populations in Bonham traveling west or south due to construction of the 25-mile pipeline in Grayson County or the eight-mile pipeline segment in southwest Fannin County.

Operation Phase

As under Alternative 1, the operation phase would not create disproportionate and adverse impacts on low-income populations in Bonham. The replacement of FM 1396 with FM 897 would also disproportionately benefit low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia. The type, duration, likelihood, and size or physical extent of this benefit would not change with the comparatively smaller reservoir that would be constructed under Alternative 2. Primary benefits would also be related to a major new recreation facility, but impacts would not disproportionately benefit low-income populations in Bonham. No additional impacts would result from operation of the 25-mile pipeline segment from Texoma to the balancing reservoir near Howe.

Protection of Children

As under Alternative 1, places where children "learn, live, and play" in Ladonia, Bonham, and Honey Grove were analyzed for disproportionate impacts as it relates to health and safety. Grayson County overall does not meet the regulatory definition of a minority or low-income (environmental justice) population.

Construction Phase

As discussed under Alternative 1, youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during construction of the 35-mile pipeline to the Leonard WTP. Given that the shortest distance between Honey Grove and the pipeline is about five miles, impacts would be indirect.

The comparatively smaller reservoir that would be constructed under Alternative 2 would not change the types, duration, likelihood, size or physical extent, or severity of impacts from traffic and time delays. The same adverse impacts that could impact children of environmental justice populations commuting into Bonham from the east and northeast discussed under Alternative 1 would also occur under this alternative. Construction of the new eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County would not create additional impacts to children because this pipeline segment is not located in Honey Grove, Ladonia, or Bonham.

During at least a portion of the construction phase, the addition of the pipeline segment from Texoma to the balancing reservoir near Howe in Grayson County could create additional adverse impacts to children living in Grayson County. Children at learning centers, schools, and parks east of Highway 289 and west of Highway 75 – like those concentrated in Pottsboro, Denison, Sherman, Southmayd, and Howe – could experience adverse impacts from increased noise and mobile source air pollutant emissions. Both increases would be temporary and intermittent, and would move along the pipeline as construction progresses.

Operation Phase

The same impacts discussed under Alternative 1 would occur under this alternative. Operation of the dam and reservoir would potentially create moderate beneficial impacts due to the increased tax revenue. The size or physical extent of impacts would be medium (localized) and felt most by children attending schools in Fannin County. Based on the known benefits of increased tax revenue from development of dams and reservoirs in other Texan counties, the likelihood of impacts would be high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years). Existence of a major new recreational facility offering boating, fishing, swimming, and other outdoor activities would represent a benefit for all area youth. In the long-term, the visual and aesthetic value of the reservoir and the green space around it would also be considered beneficial by many.

The additional infrastructure needed for the blending portion of this alternative would not conflict with any existing infrastructure (i.e. no need to relocate any gas pipelines, transmission lines, roads, and cemeteries). Because children are at greater risk due to developing bodies and increased exposures, herbicides applied for the purpose of maintenance around the pipeline right-of-way in Grayson County could result in additional adverse health impacts to children. However, this pipeline segment would be constructed parallel an existing pipeline, and therefore it is assumed the right-of-way would be sprayed regardless of the implementation of this alternative. The likelihood that additional herbicide applied to this right-of-way would result in health impacts to children is considered low, and any such adverse impacts would be slight.

Conclusion

Impacts from Alternative 2 would be similar to those described under Alternative 1, and would not create environmental justice impacts in the overall ROI because neither Fannin nor Grayson counties meet the regulatory definition of minority or low-income populations. BG data identified Honey Grove, Ladonia, and Bonham as "pockets" of environmental justice populations. As with construction of the dam and reservoir under Alternative 1, low-income populations in Bonham commuting east or south and minority populations commuting to BIES could experience intermittent and temporary impacts from traffic or time delays. The likelihood of such impacts would be medium: the unavailability of FM 1369 would indicate that the impacts have some chance of occurring, but the likelihood is below 50 percent.

As under Alternative 1, construction of the 35-mile pipeline would create slightly adverse impacts on youth minority populations residing in Honey Grove as they relate to noise disturbances and mobile source air pollutant emissions. Under Alternative 2, additional adverse impacts could occur at learning centers, schools, and parks in Grayson County during construction of the 25-mile pipeline segment from Lake Texoma to the balancing reservoir near Howe. All pipeline-related construction impacts would be temporary and intermittent and would depend on the location and timing of specific construction activities. The size or physical extent under Alternative 2 would also be small (localized), and could also occur at youth community and recreational facilities in Grayson County – as with Honey Grove residents in close proximity to the 35-mile pipeline; those commuting to BIES; and low-income residents of Bonham commuting east or south to work. The likelihood of health and safety impacts to children at youth community and recreational facilities in Fannin and Grayson counties would be low given the distance to the project area.

Impacts from the operational phase would be the same as those discussed under Alternative 1, and would be moderately beneficial due to the replacement of FM 1396 with the new, higher-quality FM 897 and a major new recreational facility. Long-term impacts would last as long as the dam and reservoir's lifetime (50-100 years); the size or physical extent of impacts would be medium and localized; and the likelihood of beneficial impacts would be high.

4.16 CULTURAL RESOURCES

The Area of Potential Effects (APE) is defined in the PA as "the reservoir footprint itself to the planned top of flood pool (elevation 541 feet MSL at crest of spillway), the planned location of the dam and all associated construction and staging areas, the planned new water treatment facility in Leonard, Texas, the pipeline from the new water treatment facility to the discharge point into Pilot Grove Creek, all raw water pipelines between the reservoir and associated existing treatment facilities, lands manipulated for impact mitigation, plus the full horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project component boundaries and associated impact areas" (NTMWD et al., 2010).

Table 4.14-1. Summary of Impacts to Cultural Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Combined area of dam site disturbance, pipeline, WTP & TSR	Combined area of dam site disturbance, pipelines, WTP & TSR	Some sites already subjected to extensive testing
Duration	Permanent/Long-Term	Permanent/Long-Term	
Likelihood	High	High	
Severity	Severe	Severe	
Operation Phase			
Size	Combined area of dam site disturbance, pipeline, WTP & TSR	Combined area of dam site disturbance, pipelines, WTP & TSR	Unknown, but potentially severe
Duration	Permanent/Long-Term	Permanent/Long-Term	
Likelihood	High	High	
Severity	Severe	Severe	

4.16.1 No Action Alternative

Although the reservoir, raw water pipeline, new water treatment plant, and terminal storage facility would not be built under this alternative, there could be significant adverse impacts on cultural resources under the No Action Alternative. Since testing at sites has been completed, the No Action Alternative has already impacted sites by submitting them to extensive testing and by potentially revealing their location to the public due to visibility of work in some locations. In addition, because the sites have been revealed through testing, but eligible sites (aka Historic Properties) would not be mitigated if there was not an action, this could cause additional significant adverse impacts. Furthermore, because many of the sites are no longer on private property as they have been purchased by NTMWD (and have been surveyed and tested as necessary), the likelihood of additional adverse impacts on cultural resources is increased cumulatively and over the long term. Impacts to cultural resources from the No Action Alternative as a result of their location on non-private property are unknown.

4.16.2 Alternative 1

Impacts of Alternative 1 are discussed according to the category of cultural resource that may be affected by the undertaking (i.e., actions associated with this alternative).

National Register Properties

Alternative 1 would have no effect on properties currently listed on the NRHP because none are present on-site.

Historical Markers

Alternative 1 would have no effect on State of Texas historical markers because none are present on-site.

Historic Cemeteries

Within the Reservoir

One cemetery, the Wilks Cemetery (41FN96) is located within the proposed reservoir footprint. Based on a 2011 survey by ARC, the Wilks Cemetery was originally recommended as eligible for the NRHP and this recommendation was reviewed by the THC. The THC indicated that further testing is needed to evaluate the site's status and eligibility for the NRHP. Subsequently, the site will be relocated during the construction phase and would be evaluated during the mitigation phase.

Alternative 1 would have long-term and severe adverse effects to the Wilks Cemetery, hence the decision to relocate it if the project is implemented. Therefore, the site would have an undetermined status for RHP listing until the cemetery can be fully evaluated during the relocation phase. Regardless of its NRHP status, the Texas Health and Safety Code (Section 711) requires mitigation and re-interment of human remains that would be inundated or otherwise negatively impacted. Additionally, because the land is owned by NTMWD, a political entity of the State of Texas, it is subject to state burial laws, the Texas Health and Safety Code, and the Antiquities Code of Texas (Title 9, Chapter 191 of The Texas Natural Resources Code). Therefore, measures to mitigate the adverse impact on the Wilks Cemetery in accordance with these codes and regulations would consist of de-dedication of the cemetery by court order; removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery.

Outside of the Reservoir

Two cemeteries, Stancel Cemetery and White Family Cemetery, are located within the flowage easement to be acquired by NTMWD between the 541-foot contour and the 545-foot contour. Alternative 1 could result in temporary inundation and erosion of these cemeteries. Measures to mitigate such adverse impacts pursuant to the Texas Health and Safety Code could consist of construction of protective berms around the cemeteries to prevent temporary flooding or, alternatively, de-dedication of the cemeteries by court order; removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery. Therefore, Alternative 1 would have no impact on these cemeteries because they would be protected in place or relocated.

Historic Buildings and Structures

Within the Reservoir APE

Thirty-eight architectural resources are within the APE, none of which are recommended as eligible for the NRHP. Thus, Alternative 1 would have no impact on significant historic buildings or structures.

Outside of the APE

Alternative 1 would have no effect on architectural buildings or structures outside the APE and above the 541 foot MSL elevation.

Archeological Sites

Currently Known Sites Within and Close to the Reservoir APE

Within the proposed Lower Bois d'Arc Creek Reservoir, a total of 58 sites (28 prehistoric, 26 historic, and four prehistoric/historic multi-component) were recorded (41FN95-142 and 41FN147-159), yielding an average of one site per 86 acres. Seventeen sites are recommended for further testing and research to determine their eligibility: 41FN108, 109, 110, 113, 114, 118, 119, 120, 122, 136, 137, 138, 148, 151, 154, 156, and 159. Wilks Cemetery (41FN96) would be assessed for National Register of Historic Places eligibility during the relocation phase of the project. Impacts from Alternative 1 on these 17 sites would include loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, deterioration of organic remains, and impacts to sites that may be sacred and/or significant to the Caddo Nation. There would be no impacts to the remaining 41 prehistoric, historic, and multi-component sites identified during the reservoir APE survey because they were evaluated as not significant and were recommended as not eligible for listing on the NRHP.

Site 41FN96 is the Wilks Cemetery and would require mitigation of adverse impacts, as described above in Section 4.14.2.3. The other sites that have been recommended for further testing would require mitigation of adverse impacts if it is determined, after further testing and evaluation, that the site could be eligible for the NRHP. Individual mitigation plans and a Memorandum of Understanding would be developed between the project proponent (NTMWD) and the USACE, THC, and Caddo Nation for each eligible site. If bridges or other structures are determined eligible, different types of mitigation plans would need to be prepared. Mitigation measures for archeological sites could include additional testing and excavation conducted in accordance with the PA, along with archeological data recovery.

Raw Water Pipeline Route and Associated Facilities

The proposed Leonard WTP, the proposed TSR adjacent to the WTP, and a proposed rail spur that would transport materials to the new WTP both during construction and operation were found to contain seven historic archaeological sites and one prehistoric artifact (an interior chert flake). All of the sites have been heavily impacted by farming and can offer little or no information about the early history of Fannin County. None are eligible for listing on the NRHP. Thus, impacts on cultural resources from these connected actions are expected to be non-existent.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Alternative 1 would involve relocating FM 1396 and constructing a new bridge over the proposed reservoir. The results of the survey identified two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites described are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge was found to be eligible for listing on the NRHP or as a SAL. Because there are no NRHP-eligible resources in the survey area, impacts on significant cultural resources from this connected action are expected to be non-existent.

Riverby Ranch Mitigation Site

Protocols set forth in the PA will be implemented during the continuing investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. The PA guides the work and ensures compliance with Section 106 on a timeline separate from the EIS. A brief summary of the work plan and a description of the work that has been completed to date are outlined in the following section below.

Following the completion of the Phase I investigation which helped define the High Potential Areas (HPAs), the Phase 2 study was conducted between March and August of 2015 and consisted of an intensive pedestrian survey of 3,670 acres of HPAs for prehistoric and historic archaeological sites. The survey included collecting, washing, labeling, and analyzing artifacts, as well as preparing a written report. Overall, a total of 86 sites (20 prehistoric, 52 historic, and 14 multicomponent) are recorded on the property as a result of the Phase I and II surveys (Davis et. al., 2016). In addition, a total of 28 architectural resources were found to meet the historic-age guideline as established for this project and therefore were evaluated for their integrity and potential eligibility in the NRHP. Twenty five of these structures did not fulfill Criterion A, B, or C. In addition, none of these 25 structures maintained the level of integrity required to be considered for listing in the NRHP. Furthermore, none of the 28 structures were found to meet any of the special requirements under Criteria Considerations A-G. Three structures (structures 11, 21, and 25) met the historic age requirement and exhibited a potential for historical significance under Criteria A, B, and/or C. However, after careful evaluation and consideration, none of these structures were found to maintain the significant association and/or integrity required by the NRHP. As a result, Structures 11, 21, and 25 are recommended not eligible for listing in the NRHP. A summary of the 86 archaeological sites (both new and previously discovered) identified during the survey and the known interments for the Riverby Ranch mitigation area are provided in Appendix S.

Operation of the LBCR Dam and Reservoir

Impacts from construction of Alternative 1 to cultural resources or historic properties listed or eligible to be listed on the NRHP would be long-term/permanent and would continue through operations. Therefore, operation of the LBCR Dam and Reservoir under Alternative 1 would result in the same impacts to cultural resources and/or historic properties as construction.

4.16.3 Alternative 2

Under Alternative 2, there would be a small reduction in dam height and corresponding footprint, but the dam would still need to be able to pass the Probable Maximum Flood (PMF) without breaching. Based on engineering judgment, it is assumed that the dam footprint would be about 90 percent of Alternative 1. Alternative 2 would impact 9,305 acres (dam and reservoir) of waters, wetlands, and uplands, all within the footprint of Alternative 1 (Figures 4.14-1 and 4.14-2). Alternative 2 would also impact 3,800 acres of land around the perimeter of the proposed reservoir for the flood pool. The ROI for the cultural resources analysis under Alternative 2 is the same as the APE, which is defined in this alternative as the smaller reservoir footprint and including the dam and all associated construction and staging areas, planned new water treatment facility, raw water pipeline, terminal storage facility, and Riverby Ranch mitigation site. The smaller reservoir footprint would result in a surface area of approximately 8,600 acres, roughly half the acreage of Alternative 1. Impacts of the downsized alternative are discussed here by category of cultural resource that may be affected by the smaller version of the LBCR project.

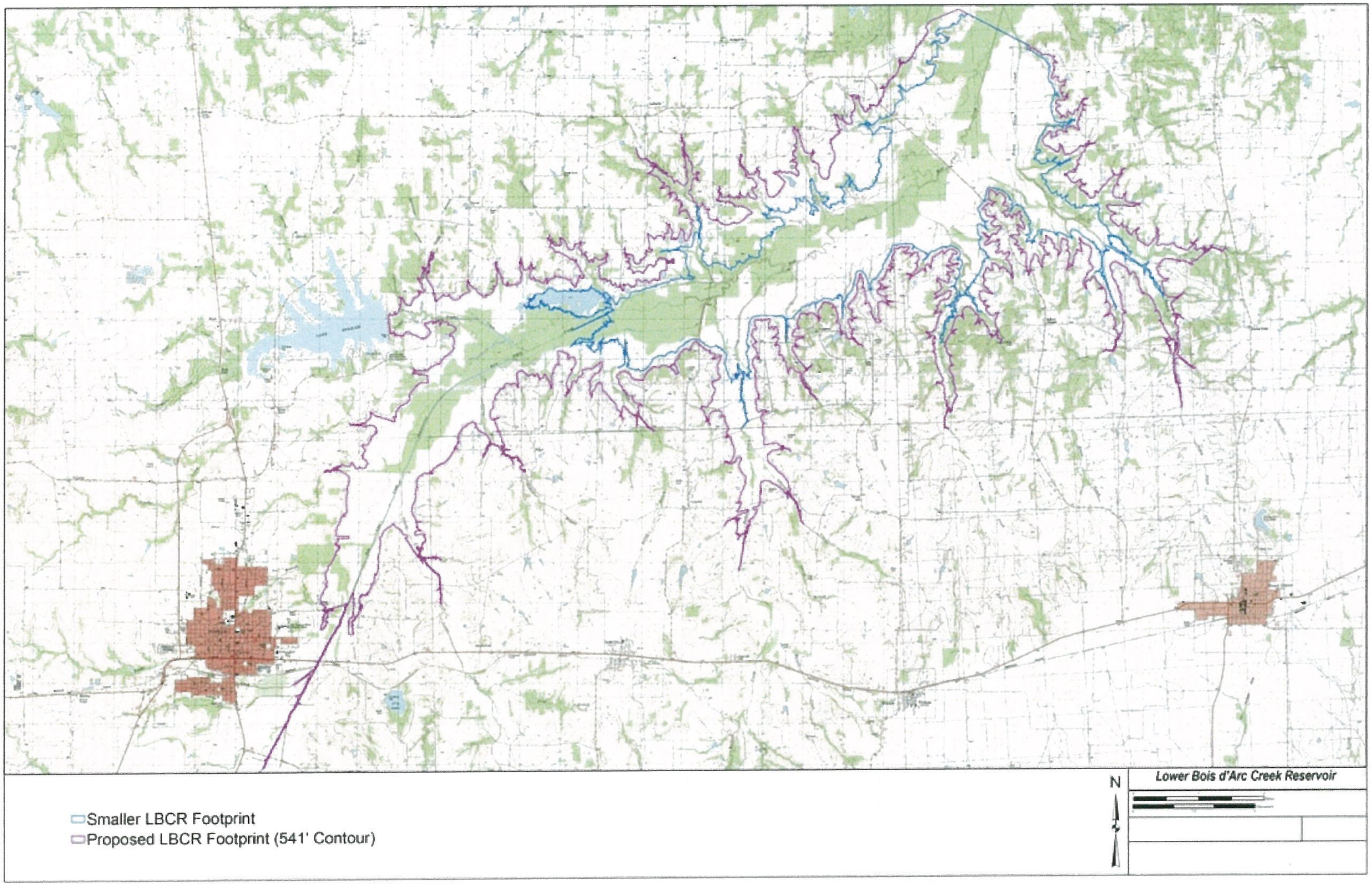


Figure 4.14-1. Downsized Alternative 2 APE with Associated Facilities

Source: Davis, 2016

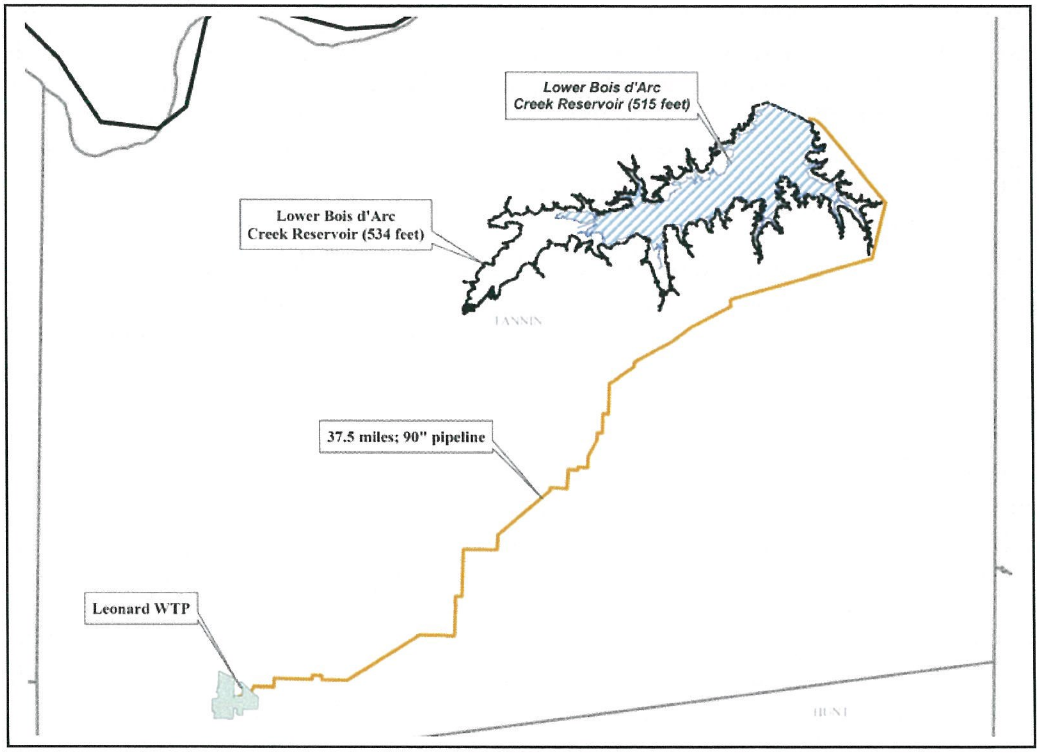


Figure 4.14-2. Sketch of Downsized LBCR and Raw Water Pipeline (Alternative 2)

National Register Properties

The downsized LBCR would have no impact on properties currently listed on the NRHP because none are present on-site.

Historical Markers

The downsized alternative would have no impact on State of Texas historical markers because none are present on-site.

Historic Cemeteries

Within the Reservoir

Alternative 2 would have an adverse impact on Wilks Cemetery (41FN96) because, while the site is located outside of the footprint under Alternative 2, temporary inundation and erosion are anticipated due to its location within the flowage easement to be acquired by NTMWD between the 541' contour and the 545' contour. Measures to mitigate this adverse impact (relocation and reinterment) would be the same as Alternative 1 pursuant to the Texas Health and Safety Code, thus impacts would be similar.

Outside of the Reservoir

The impacts to cemeteries outside of the downsized alternative footprint under Alternative 2 would be the same as described in Alternative 1.

Historic Buildings and Structures

Within the Reservoir APE

Thirty-eight architectural resources were identified during the archaeological field survey of the proposed action LBCR footprint under Alternative 1. Under the downsized footprint as part of Alternative 2, 11 buildings/structures would be located within the APE for the alternative reservoir footprint. As discussed in Chapter 3, none of the structures and/or buildings identified was found to meet any of the special requirements under NRHP Criteria Considerations A-G. Therefore, all historic-age resources evaluated are recommended ineligible for listing in the NRHP and subsequently, Alternative 2 would have no impact on significant historic buildings or structures.

Outside of the APE

The impacts to historic buildings and structures outside the APE would be the same under Alternative 2 as Alternative 1except that the 27 architectural resources (i.e. buildings and structures) would be located outside of the new APE. Because all of the buildings and structures are recommended ineligible for listing in the NRHP, there would be no impacts to significant historic buildings or structures under Alternative 2.

Archeological Sites

Currently Known Sites Within the Reservoir APE

Under Alternative 2, 31 archaeological sites (including 21 prehistoric, nine historic, and one prehistoric/historic multi-component site) would be located within the APE for the alternative reservoir footprint. Of these, eight were recommended for further testing and evaluation to determine NRHP eligibility and the remaining 23 were recommended as ineligible for listing in the NRHP. This alternative would be expected to have the same types of impacts to these 31 sites located within the reduced APE as Alternative 1 (e.g. the loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, deterioration of organic remains, and damage to sites sacred and/or significant to the Caddo Nation).

Because eight sites are being tested in the downsized alternative APE, and nine are being testing outside of the downsized alternative, there is no meaningful difference in probability of eligible sites being affected. Subsequently, it is not known at the present how many sites are eligible within the reduced or full APE, and the impacts from the downsized alternative could be exactly the same as Alternative 1. It may be that all sites tested in the downsized alternative are eligible and none in the proposed project outside the downsized alternative are eligible. In addition, because the magnitude of impacts for any eligible site (all sites eligible for the NRHP) would be severe, and because the extent would be reduced if there are fewer eligible sites, both magnitude and extent of impacts cannot be evaluated at present. Subsequently, as with Alternative 1, there is no difference between short-term and long-term impacts because cultural resources are non-renewable resources that would be irreparably altered (destroyed) by the project even if mitigated.

Table 4.14-2 below outlines and summarizes the archaeological sites that would be impacted under the downsized LBCR, Alternative 2 APE compared to Alternative 1 (full-scale dam and reservoir).

Table 4.14-2. Known Archeological Sites within the Downsized Alternative 2 APE as Compared to Alternative 1

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN95	No	X	
41FN96	Unknown – would be relocated during construction phase and would be evaluated during the mitigation phase.		X

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN97	No		X
41FN98	No	X	
41FN99	No	X	
41FN100	No		X
41FN101	No		X
41FN102	No		X
41FN103	No	X	
41FN104	No	X	
41FN105	No		X
41FN106	No		X
41FN107	No		X
41FN108	Further testing is needed to determine NRHP eligibility		X
41FN109	Further testing is needed to determine NRHP eligibility		X
41FN110	Further testing is needed to determine NRHP eligibility	X	
41FN111	No	X	
41FN112	No		X
41FN113	Further testing is needed to determine NRHP eligibility		X
41FN114	Further testing is needed to determine NRHP eligibility		X
41FN115	No	X	
41FN116	No	X	
41FN117	No	X	
41FN118	Further testing is needed to determine NRHP eligibility	X	
41FN119	Further testing is needed to determine NRHP eligibility	X	
41FN120	Further testing is needed to determine NRHP eligibility	X	
41FN121	No	X	
41FN122	Further testing is needed to determine NRHP eligibility	X	
41FN123	No	X	
41FN124	No	X	
41FN125	No	X	
41FN126	No	X	
41FN127	No	X	
41FN128	No		X
41FN129	No		X
41FN130	No	X	
41FN131	No	X	
41FN132	No	X	
41FN133	No	X	

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN134	No	X	
41FN135	No	X	
41FN136	Further testing is needed to determine NRHP eligibility	X	
41FN137	Further testing is needed to determine NRHP eligibility		X
41FN138	Further testing is needed to determine NRHP eligibility		X
41FN139	No longer considered a site		X
41FN14	No longer considered a site		X
41FN141	Further testing is needed to determine NRHP eligibility		X
41FN142	No longer considered a site		X
41FN147	No		X
41FN148	Further testing is needed to determine NRHP eligibility		X
41FN149	No	X	
41FN150	No		X
41FN151	Further testing is needed to determine NRHP eligibility	X	
41FN152	No		X
41FN153	No		X
41FN154	Further testing is needed to determine NRHP eligibility		X
41FN155	No	X	
41FN156	Further testing is needed to determine NRHP eligibility	X	
41FN157	No	X	
41FN158	No		X
41FN159	Further testing is needed to determine NRHP eligibility		X

Raw Water Pipeline Routes and Associated Facilities

Under the downsized alternative, impacts to cultural resources located within the APE for the proposed Leonard WTP, the TSR adjacent to the WTP and a proposed rail spur that would transport materials to the new WTP both during construction and operation would be the same in duration and extent as Alternative 1. Under the downsized alternative, a new raw water pipeline would also be built from Lake Texoma that would parallel and be directly adjacent to an existing raw water pipeline also from Lake Texoma. Although the new raw water pipeline would be located in very close proximity to the existing pipeline, the potential exists for previously unidentified cultural resources to be uncovered or impacted during the course of ground disturbance or construction activities. Subsequently, the new raw water pipeline would require a separate cultural resources survey, and appropriate Section 106 compliance under the PA would occur prior to any construction or ground disturbance. Based on the results of the cultural resources survey, measures to mitigate the adverse impacts to any eligible properties should be developed in a Memorandum of Understanding between the project proponent (NTMWD), the USACE, the Caddo

Nation, and the Texas Historical Commission in accordance with the PA. Mitigation measures could include archeological data recovery or other appropriate methods.

There are no currently known historic properties within the new raw water pipeline and associated facilities under the downsized alternative since a cultural resources survey has not been completed for the area. Therefore, potential adverse impacts to eligible historic properties remain unknown. Construction activities would be subject to the terms and stipulations of the PA, and protocols set forth in the PA would remain in place during the cultural resources investigations for the new pipeline. Although the investigations and identification of cultural resources remain unknown, because any ground disturbance resulting in modification to a historic property damages or destroys it permanently, impacts to cultural resources from construction of a new raw water pipeline (such as ground disturbance) would be comparable to those described for the treated water pipeline to be built from the new LBCR (whether full-scale or downsized).

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As with Alternative 1, Alternative 2 would also involve potential ground disturbance or inundation from construction and relocation of FM 1396 and construction of a new bridge over the proposed reservoir. The results of the survey identified two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge is eligible for listing on the NRHP or as a SAL. Since there are no NRHP eligible resources in the survey area, impacts on significant cultural resources from this connected action under Alternative 2 are expected to be non-existent.

Riverby Ranch Mitigation Site

Under the downsized alternative, impacts to cultural resources at the Riverby Ranch mitigation site would remain because the cultural resource investigations and archeological surveys at the site are ongoing and have not been complete. Protocols set forth in the PA would remain in place during the investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. Although the investigations and identification of cultural resources remain unknown, the impacts to identified cultural resources are anticipated to be less widespread and significant compared to Alternative 1 because the smaller reservoir footprint would require less area that would be mitigated. This would likely decrease both the potential to impact cultural resources and the extent of potential impacts, although it would not decrease the duration.

Operation of the LBCR Dam and Reservoir

Impacts from construction for Alternative 2 to cultural resources or historic properties listed or eligible to be listed on the NRHP would be long-term/permanent and would continue throughout operations. Therefore, operation of the LBCR Dam and Reservoir under Alternative 2 would result in the same impacts to cultural resources and/or historic properties as construction.

4.16.4 Conclusion

Because of the potential for disturbance of a site listed on or eligible for listing on the NRHP, the impacts from both Alternative 1 and Alternative 2 would be of severe magnitude. One site, the Wilks Cemetery located within the APE under Alternative 1, has been recommended as eligible for the NRHP, and this recommendation was reviewed by the THC. NRHP eligibility testing is ongoing at all sites for which an eligibility recommendation could not be made from survey data alone. Also, additional sites may be identified during the course of construction and ground disturbance activities, and these would be subject to the terms and stipulations of the PA, which requires that work cease in the vicinity and the signatories be contacted within 48 hours. A damage assessment would be performed and a defendable NRHP recommendation made at such sites. The PA guides this work.

The duration of impacts to each identified historic property (any site eligible for listing on or listed on the NRHP) would be long-term because cultural resources are non-renewable; any adverse effect is permanent/long-term. The likelihood of impact is high and the magnitude is severe. Given these ratings, the adverse impacts to historic properties under Alternatives 1 and the downsized Alternative 2 would be considered significant under NEPA. Should any of the sites recommended for further testing (eight of which are in the downsized APE) be determined to be historic properties, the impacts to each historic property would be adverse and significant under NEPA. Because it has not yet been determined if the eight sites recommended for further testing are determined to be historic properties, there is no known difference in the number of eligible sites between the two reservoir footprints under either Alternative 1 or 2. Once further testing has been completed and eligibility determinations have been made, then NTMWD would submit mitigation plans for each historic property to USACE, the Caddo Nation, and the THC for approval. Because impacts are significant and adverse to each historic property identified, mitigation measures must be applied to bring impacts below the level of significance.

As discussed above, impacts can be mitigated, including the use of archeological data recovery, exhumation of burials including repatriation and reburial of Native American burials discovered during excavation or construction, and/or site containment, stabilization, and/or capping of cultural deposits. Implementing these mitigation measures, as appropriate, would reduce the level of impact on cultural resources. The sites undergoing testing are being considered for NRHP eligibility under Criterion D, which states they have yielded or have the potential to yield information important in history or prehistory. The value of most historic properties is in the data they can provide regarding history or prehistory. Therefore, mitigation through data recovery would reduce the level of impacts below the threshold of significance. If prehistoric sites contain burials, the Caddo Nation would work with NTMWD, USACE, and THC to determine the most respectful manner for exhuming and relocating the individuals under the Texas Health and Safety Code. Historic burials would also be relocated using best practices. Sites that are not considered historic properties (those that are not eligible for the NRHP) are not evaluated for impacts due to their lack of significance.

4.17 UNAVOIDABLE ADVERSE IMPACTS

Sec. 102(C)(ii) of NEPA [42 USC § 4332] requires an EIS to list "any adverse environmental effects which cannot be avoided should the proposal be implemented." Table 4.17-1 lists, by resource topic, unavoidable adverse impacts that would result from Alternatives 1 and 2, i.e., construction and operation of the LBCR and related facilities. As noted throughout this chapter, many of these adverse effects could be mitigated to some extent, but in the instances below, some level of adverse impact remains even after mitigation.

Table 4.17-1. Unavoidable Adverse Impacts Associated with Alternative 1 and Alternative 2

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	Alternative 2
Land Use	• Long-term changes in land use toward higher-density development in the project vicinity induced by Alternative 1 itself and in Fannin County generally both from LBCR and growth of the DFW Metroplex. These changes may	• Long-term changes in land use toward higher-density development in the project vicinity induced by Alternative 1 itself and in Fannin County generally both from LBCR and growth of the DFW Metroplex. These changes may

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	Alternative 2
	be regarded by certain existing and future residents as adverse.	be regarded by certain existing and future residents as adverse.
Topography, Geology and Soils	• Topography would be permanently altered by dam construction and reservoir impoundment, though these impacts would be localized. • Surficial geology at the site of the 2-mile long dam itself would be permanently altered due to excavation of a slurry trench and placement of an impervious barrier along the length of dam foundation. • Soils on a total dam and reservoir "footprint" of 17,068 acres would be permanently altered through excavation, dam construction, and impoundment of water within the reservoir. • 13 soil types listed as "Prime Farmland Soils" would be permanently removed from potential agricultural production at the site of the dam and reservoir, WTP, and TSR.	• Topography would be permanently altered by dam construction and reservoir impoundment, though these impacts would be localized. • Surficial geology at the site of the nearly 2-mile long dam itself would be permanently altered due to excavation of a slurry trench and placement of an impervious barrier along the length of dam foundation. • Soils on a total dam and reservoir "footprint" of 9,305 acres would be permanently altered through excavation, dam construction, and impoundment of water within the reservoir. • Up to 13 soil types listed as "Prime Farmland Soils" would be permanently removed from potential agricultural production at the site of the dam and reservoir, WTP, and TSR.
Water Resources	• Dam and reservoir footprint of 17,068 acres would permanently inundate 123.3 miles of Bois d'Arc Creek (and tributaries) in Fannin County, converting the creek from a mostly channelized, free-flowing stream by impounding water behind a dam to form a reservoir. • 123.3 miles of intermittent/ephemeral streams would be permanently inundated. • Sedimentation rate of 0.94 AF/mi^2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) after 40 years; 7.5 percent loss of storage capacity after 100 years. • Minimum of 120,000 AFY (firm yield) of water would be diverted from Bois d'Arc Creek annual discharge into the Red River; cumulative but slight reduction of flows into Red River. • Downstream effects on geomorphology of Bois d'Arc Creek including reduction in volume of discharge during most storm events and corresponding reduction in erosion, scouring, and channel downcutting; in	• Dam and reservoir footprint of 9,305 acres would permanently inundate 66.1 miles of Bois d'Arc Creek (and tributaries) in Fannin County, converting the creek from a mostly channelized, free-flowing stream by impounding water behind a dam to form a reservoir. • 66.1 miles of intermittent/ephemeral streams would be permanently inundated. • Sedimentation rate of 0.94 AF/mi^2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) after 40 years; 21 percent loss of storage capacity after 100 years. • Minimum of 86,100 AFY (firm yield) of water would be diverted from Bois d'Arc Creek annual discharge into the Red River; cumulative but slight reduction of flows into Red River. • Downstream effects on geomorphology of Bois d'Arc Creek including reduction in volume of discharge during most storm events and corresponding reduction in erosion, scouring, and channel downcutting; in

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	**Alternative 2**
Water Resources (cont'd)	late summer, environmental flows would maintain flows when there is often no flow at present.	late summer, environmental flows would maintain flows when there is often no flow at present.
Biological Resources	• Construction of the dam and impoundment of water would impact 4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres (514 HUs) of emergent wetlands, and 49 acres (23 HUs) of scrub shrub wetlands. • Construction of the dam and impoundment of water would impact 78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (LF) (123.3 miles) of streams comprised of 286,139 LF (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams. • Change in aquatic biota abundance and species composition as a result of conversion from lotic to lentic conditions. • Approximately 11,440 acres loss of upland wildlife habitat (forests, woodlands, grasslands) from dam, reservoir, and WTP. • Probably contribute to spread of invasive species. • Adverse effects on state-listed species possible.	• Construction of the dam and impoundment of water would impact 2,909 acres (2,502 FCUs) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, and 27 acres (12 HUs) of scrub shrub wetlands. • Construction of the dam and impoundment of water would impact 78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of: 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ ephemeral streams. • Change in aquatic biota abundance and species composition as a result of conversion from lotic to lentic conditions. • Approximately 6,390 acres loss of upland wildlife habitat (forests, woodlands, grasslands) from dam, reservoir, and WTP. • Probably contribute to spread of invasive species. • Adverse effects on state-listed species possible.
Air Quality	• 3-4years of construction emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development. • Would have a relatively slight carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.	• 3-4 years of construction emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development. • Would have a relatively slight carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.
Acoustic Environment (Noise)	• During 3-4 year construction period, would have slight adverse effect on the noise environment. • Temporary minor increases in noise would result from the intermittent use of heavy equipment during land clearing and construction. • Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County.	• During 3-4 year construction period, would have slight adverse effect on the noise environment. • Temporary minor increases in noise would result from the intermittent use of heavy equipment during land clearing and construction. • Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County.

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	**Alternative 2**
Recreation	• Construction of the reservoir would have slight adverse impacts on local, small-scale recreation. • Infrequent minor to moderate adverse impacts may occur to the Legacy Ridge Country Club golf course from flooding due to severe storm events.	• Construction of the reservoir would have slight adverse impacts on local, small-scale recreation.
Visual Resources	• Due to its size and salience, the proposed dam and reservoir would have a major, long-term effect on visual resources locally; some observers may regard this change as adverse.	• Due to its size and salience, the proposed dam and reservoir would have a major, long-term effect on visual resources locally; some observers may regard this change as adverse.
Utilities	• Overhead power lines that run through the proposed reservoir site would have to be raised or removed and relocated before the reservoir can be filled. • Existing utilities would be impacted during construction of the pipeline.	• Existing utilities would be impacted during construction of the pipeline.
Transportation	• Impacts of moderate severity on roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint. • 5 roadways closed and 10 roadways rerouted and/or rebuilt due to proposed reservoir operation.	• Impacts of moderate severity on roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint. • 4 roadways closed and 7 roadways rerouted and/or rebuilt due to proposed reservoir operation.
Socioeconomics	• Construction and operation would entail both short-term and long-term severe adverse impacts, including economic, fiscal, and social effects, such as removal of agricultural land from production and removal of several long-term residents or landowners. • Would contribute cumulatively to increasing urbanization of Fannin County, which some residents would regard as an adverse effect.	• Construction and operation would entail both short-term and long-term severe adverse impacts, including economic, fiscal, and social effects, such as removal of agricultural land from production and removal of several long-term residents or landowners. • Would contribute cumulatively to increasing urbanization of Fannin County, which some residents would regard as an adverse effect.
Environmental Justice and Protection of Children	• None to slight impacts could occur during the construction and operation phases.	• None to slight impacts could occur during the construction and operation phases.
Cultural Resources	• Would adversely affect the Wilks Cemetery within the reservoir footprint. Therefore, the site would be relocated during the construction phase and evaluated during the mitigation phase. • Unavoidable adverse effects would occur to any historic property or NRHP eligible site located within the reservoir footprint. The adverse	• Would adversely impact Wilks Cemetery because, while the site is located outside of the footprint under Alternative 2, temporary inundation and erosion are anticipated due to its location within the flowage easement (between the 541' contour and the 545' contour). Measures to mitigate this adverse impact would be the same as under Alternative 1.

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	Alternative 2
Cultural Resources (cont'd)	effects can be mitigated, but even with data recovery, would permanently and unavoidably destroy eligible sites. • Excavation and data recovery destroys sites, even though data are salvaged. The integrity and context of the site would be forever altered under both alternatives. However, mitigation can reduce adverse impacts below the level of significance.	• Unavoidable adverse effects would occur to any historic property or NRHP eligible site located within the reservoir footprint. The adverse effects can be mitigated, but even with data recovery, would permanently and unavoidably destroy eligible sites. • Excavation and data recovery destroys sites, even though data are salvaged. The integrity and context of the site would be forever altered under both alternatives. However, mitigation can reduce adverse impacts below the level of significance.

4.18 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Sec. 102(C)(iv) of NEPA [42 USC § 4332] and 40 CFR 1502.16 require an EIS to address "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." This involves the consideration of whether a Proposed Action is sacrificing a resource value that might benefit the environment in the long term, for some short-term value to the project proponent or the public.

The purpose of Alternatives 1 and 2 – the Lower Bois d'Arc Creek Reservoir – is to capture, conserve, manage, and use a vital natural resource, water, in a manner that would benefit society. As disclosed in Chapter 4, after approximately 100 years of operation, the proposed reservoir under Alternative 1 would maintain approximately 92.5 percent of its capacity or storage volume; under Alternative 2 it would maintain approximately 79 percent of its storage volume. Thus, hypothetically, the LBCR project could help meet water needs for North Texas municipalities for a period of time measuring a century or more, which would qualify as long-term. Therefore, with regard to water, neither Alternative 1 nor Alternative 2 would be sacrificing long-term productivity for short-term use or gain.

The USACE acknowledges that there are tradeoffs inherent in any allocation of natural resources. In the present instance, implementation of the LBCR would necessitate the permanent loss of existing wetlands on site, including a regionally scarce type of wetlands – bottomland hardwood forest. Prime Farmland Soils in certain upland areas, some of which are currently used as agricultural land (cropland and pasture) and all of which could be used as such would also be permanently lost. Effects on wetlands, in any case, as mandated by Section 404 of the Clean Water Act, would require compensatory mitigation.

4.19 Irreversible and Irretrievable Commitments of Resources

Sec. 102(C)(v) of NEPA [42 USC § 4332] requires an EIS to address "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." Irreversible and irretrievable commitments of resources mean losses to or impacts on natural resources that cannot be recovered or reversed.

More specifically, "irreversible" implies the loss of future options. Irreversible commitments of resources are those that cannot be regained, such as permanent conversion of wetlands and loss of cultural resources, soils, wildlife, agricultural, and socioeconomic conditions. The losses are permanent, incapable of being reversed. "Irreversible" applies mainly to the effects from use or depletion of nonrenewable resources, such as fossil fuels or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time.

"Irretrievable" commitments are those that are lost for a period of time, such as the temporary loss of timber productivity in forested areas that are kept clear for use as a right-of-way, road, or winter sports site. The lost forest production is irretrievable, but the action is not irreversible. If the use changes back again, it is possible to resume timber production.

4.19.1 Irreversible Commitments of Resources

Under both Alternative 1 and Alternative 2 – construction and operation of the full-sized or downsized LBCR and construction and operation of related facilities and connected actions, the following irreversible commitments of resources would occur:

- Consumption of the fossil fuels (primarily diesel) and lubricants by the heavy construction equipment (bulldozers and Caterpillars, graders, scrapers, excavators, loaders, trucks, etc.) used to excavate and construct the dam and clear the reservoir footprint.
- Consumption of the fossil fuels (primarily diesel) and lubricants by the heavy construction equipment used to construct all related facilities and carry out connected actions, such as construction of the raw water pipeline and pump station/substation, water treatment plant, terminal storage reservoir, FM 1396 relocation and bridge construction, other road relocations, and the grading required at the Riverby Ranch and Upper BDC mitigation sites.
- Materials used to construct the dam and all other facilities such as the WTP, including cement/concrete, soil cement, slurry material, clay, sand, gravel, steel, iron, and other metallic alloys, copper wiring, PVC pipe, plastic, and so forth.
- Energy, supplied by fossil fuels or some other source of electricity, used over the operational life of the dam/reservoir to pump water from the intake/pump station at LBCR and possibly Lake Texoma to the North WTP near Leonard.
- Wetlands and linear feet of flowing stream permanently eliminated at the site of the reservoir footprint.
- Prime Farmland Soils inundated behind the dam within the reservoir footprint and therefore forever permanently removed from potential agricultural production. Also, Prime Farmland Soils converted to developed land at the WTP and TSR near Leonard.
- Existing and potential agricultural production on those Prime Farmland Soils and other soils within the footprint that could also be used for agriculture.
- Existing wildlife habitat within the reservoir footprint.
- Possible undiscovered archeological resources within the reservoir footprint, which would be permanently inundated by the reservoir and eventually buried under layers of sediments over the coming century and beyond, likely moving them beyond the reach of future investigations.
- Heritage and socioeconomic resources such as the homes, other structures, and multi-generational farmsteads that have to be purchased, demolished, and removed prior to impoundment.

4.19.2 Irretrievable Commitments of Resources

As noted above, "irretrievable" commitments of resources are those that are lost for a period of time, but not permanently. The Proposed Action would entail certain irretrievable commitments. The following two items represent such irretrievable commitments:

- Short-term loss of agricultural production during construction along the raw water pipeline right-of-way from the reservoir to the WTP near Leonard.
- Long-term loss of agricultural output and associated jobs, income, and tax revenue on lands (primarily pasture and ranch lands) at the Riverby Ranch mitigation site, which would be converted into wetlands, woodlands, and wildlife habitats to compensate for losses of these at the reservoir site.

5.0 CUMULATIVE IMPACTS

5.1 INTRODUCTION

Cumulative impacts are defined by the CEQ regulations in 40 Code of Federal Regulations (CFR) 1508.7 as "the impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time." Cumulative impacts include the direct and indirect impacts of a project together with the past, present, and reasonably foreseeable future actions of other projects. According to CEQ's cumulative impacts guidance, the cumulative impact analysis should be narrowed to focus on important issues at a national, regional, or local level. The analysis should look at other actions that could have similar effects and whether a particular resource has been historically affected by cumulative actions.

Several steps were taken to determine potential present and future actions to consider in the cumulative impacts analysis for the LBCR project. The first step involved coordinating with agencies to help identify other projects or actions in the area that could result in cumulative impacts when combined with the LBCR project. Agencies consulted included the U.S. Forest Service, U.S. Fish and Wildlife Service, Natural Resources Conservation Service, Texas Commission on Environmental Quality, Texas Water Development Board, Texas Parks and Wildlife Department, Texas Historical Commission, Upper Trinity Regional Water District, Fannin County government, and the Bonham Chamber of Commerce. This step included reviewing environmental documents that were recently completed or are in progress.

The study area ("area of cumulative effect") for cumulative impacts varies resource by resource. The study area for each resource is explained in the introduction to each resource topic in Section 5.6.

5.2 OVERVIEW OF EXISTING REGION C RESERVOIRS

NTMWD and Alternatives 1 and 2 are located in Region C of the Texas Water Development Board's designated planning areas. The various projects listed below, the various wholesale water providers and water user groups, are all connected by their relative proximity, transfers and sales of water among existing water sources and providers, cooperation in developing new water supplies and competition for some of those same prospective supplies. What happens to one water supply or provider can and does affect others in the region. This big picture provides perspective in considering cumulative impacts.

Region C includes all or portions of 16 northern Texas counties and contains approximately one quarter of the entire population of Texas. Region C's population grew seven-fold from just under one million in 1930 to 6.7 million in 2012 and continues to grow and develop rapidly. The two most populous counties in Region C, Dallas and Tarrant, contain 65 percent of its population. Region C includes most of the Dallas-Fort Worth-Arlington Metropolitan Statistical Area (MSA), in which the three largest employment sectors are trade, the service industry, and government, all of which depend heavily on water resources (Region C Water Planning Group, 2015).

Most of Region C is located in the headwaters of the Trinity River Basin, with smaller portions in the Brazos, Red, Sulphur, and Sabine Basins. Except for the Red River Basin, the predominant direction of stream flow in the region is from northwest to southeast, as is the case for most of Texas. In contrast, the Red River flows west to east, forming the northern border of Region C, as well as the border between Texas and Oklahoma. Its main tributaries within Region C, such as Bois d'Arc Creek, flow from southwest to northeast. The main streams in Region C include the Brazos River, Red River, Trinity

River, Clear Fork Trinity River, West Fork Trinity River, Elm Fork Trinity River, East Fork Trinity River, and many other Trinity River tributaries (Region C Water Planning Group, 2015).

As shown in Figure 5.2-1, at present, approximately 55 percent of the water available to Region C is supplied by approximately 30 reservoirs located within the region. A little less than half of that amount (25 percent) is supplied by imports of surface water from other Texas regions. Most of Region C's in-region reservoirs are located within the Trinity River Basin, but the region also depends on water supplies originating in the Neches, Red, Sabine, Brazos, and Sulphur River Basins (Region C Water Planning Group, 2015).

The following water-supply reservoirs are located within Region C:

- Cedar Creek – Impounded in 1965, Cedar Creek Reservoir is located in Henderson County, 15 miles west of Athens, and has a surface area of 32,623 acres.
- Richland-Chambers – Impounded in 1987, Richland-Chambers Reservoir is located in Navarro County, near Corsicana, and has a surface area of 41,356 acres.
- Hubert M. Moss – Impounded in 1960, Moss Lake is located in Cooke County, 10 miles west of Gainesville, and has a surface area of 1,140 acres.
- Texoma – Impounded in 1944, Lake Texoma is located on the Texas-Oklahoma border in Grayson County, northwest of Sherman-Denison, and has a surface area of 74,686 acres.
- Randell – Impounded in 1909, Lake Randell is located one mile south of Lake Texoma and three miles northwest of Denison in Grayson County, and has a surface area of 172 acres.
- Valley – Impounded in 1960, Valley Lake is located in Fannin County, three miles north of Savoy, and has a surface area of 1,080 acres.
- Bonham – Impounded in 1969, Bonham City Lake is located in Fannin County, three miles northeast of Bonham, and has a surface area of 1,020 acres.
- Ray Roberts – Impounded in 1987, Ray Roberts Lake is located in Cooke and Grayson counties, and has a surface area of 25,600 acres.
- Lewisville – Impounded in 1954, Lake Lewisville is located in Denton County, near Lewisville, and has a surface area of 29,592 acres.
- Benbrook – Impounded in 1952, Benbrook Lake is located in Tarrant County, 10 miles southwest of Fort Worth, and has a surface area of 3,635 acres.
- Weatherford – Impounded in 1957, Lake Weatherford is located 19 miles southwest of Fort Worth, and has a surface area of 1,158 acres.
- Grapevine – Impounded in 1952, Grapevine Lake is located in Tarrant and Denton counties, north of Grapevine, and has a surface area of 6,684 acres.

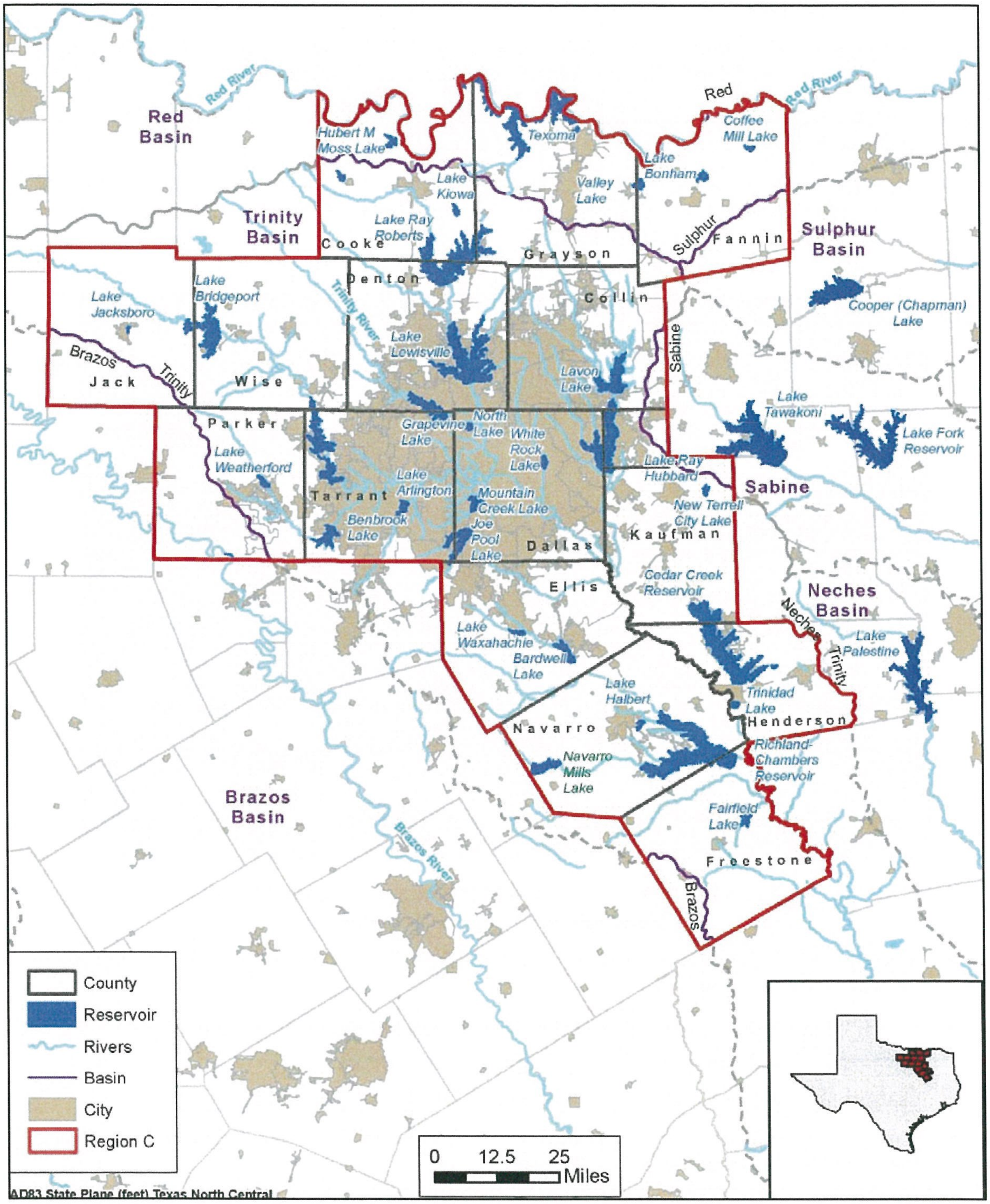


Figure 5.2-1. TWDB-Designated, 16-County Region C, Depicting Reservoirs Both Within and Outside of Regional Boundaries That Supply Water to Region C Users

- Arlington – Impounded in 1957, Lake Arlington is located in Arlington, Texas, and has a surface area of 1,939 acres.
- Joe Pool – Impounded in 1986, Joe Pool Lake is located in Tarrant, Ellis, and Dallas counties, four miles south of Grand Prairie, and has a surface area of 6,469 acres.
- Mountain Creek – Impounded in 1937, Mountain Creek Lake is located in Dallas County, four miles east of Grand Prairie, and has a surface area of 2,493 acres.
- Ray Hubbard – Impounded in 1968, Lake Ray Hubbard is located in Collin, Dallas, Rockwall, and Kaufman counties, one mile west of Rockwall, and has a surface area of 21,671 acres. A photo of Lake Ray Hubbard is shown in Figure 5.2-2.

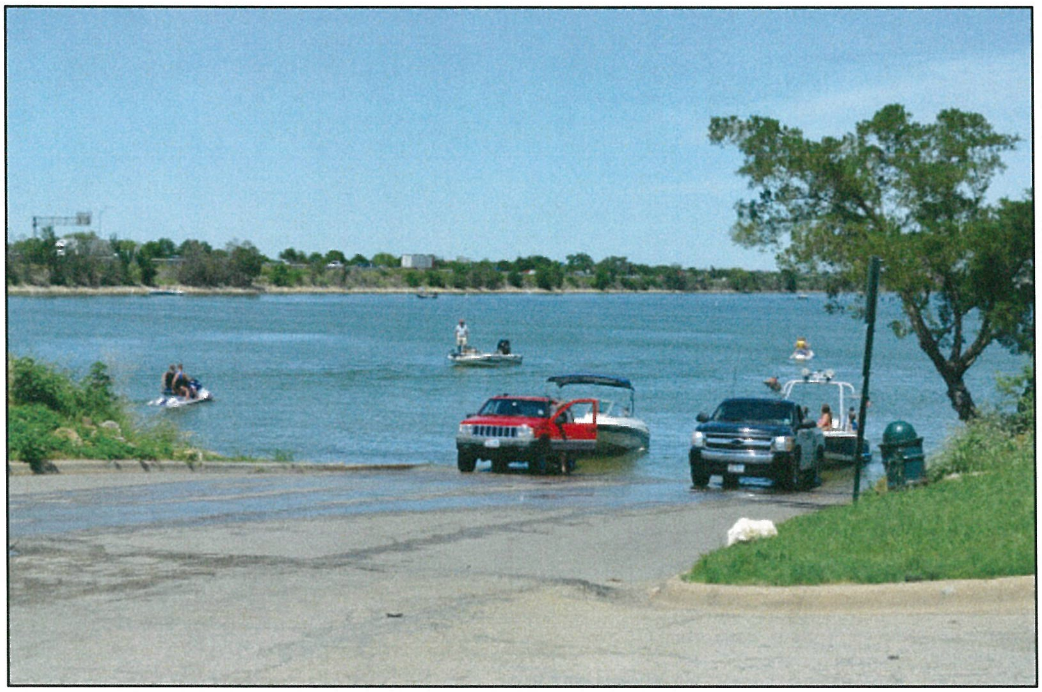


Figure 5.2-2. 21,671-acre Lake Ray Hubbard in Collin, Dallas, Rockwall and Kaufman Counties

- White Rock – Impounded in 1910, White Rock Lake is located in the City of Dallas, and has a surface area of 1,088 acres.
- Terrell – Impounded in 1955, Terrell City Lake is located in Kaufman County, five miles east of Terrell, and has a surface area of 1,150 acres.
- Clark –Lake Clark is a small reservoir located in Ellis County, two miles from Ennis.
- Bardwell – Impounded in 1965, Lake Bardwell is located in Ellis County, four miles southwest of Ennis, and has a surface area of 3,138 acres.
- Waxahachie – Impounded in 1956, Lake Waxahachie is located in Ellis County, two miles south of Waxahachie, and has a surface area of 656 acres.
- Forest Grove – Impounded in 1976, Forest Grove Reservoir is located in Henderson County, seven miles northwest of Athens, and has a surface area of 1,502 acres.

- Trinidad City – Impounded in 1925, Trinidad City Lake is located in Henderson County, two miles south of Trinidad, and has a surface area of 690 acres.
- Navarro Mills – Impounded in 1963, Navarro Mills Lake is located in Navarro County and has a surface area of 5,070 acres.
- Halbert – Impounded in 1921, Lake Halbert is located in Navarro County near Corsicana and has a surface area of 603 acres.
- Fairfield – Impounded in 1969, Fairfield Lake is located in Navarro County, five miles northeast of Fairfield, and has a surface area of 2,159 acres.
- Mineral Wells – Impounded in 1920, Lake Mineral Wells is located in Parker County, east of Mineral Wells, and has a surface area of 440 acres.
- Teague City – Teague City Lake is a small reservoir located in Freestone County near Teague, Texas.
- Lavon – Impounded in 1953 and doubled in size in 1974, Lake Lavon is located in Collin County, four miles northeast of Wylie, and has a surface area of 21,400 acres.
- Muenster –Muenster Lake is located in Cooke County and has a surface area of 309 acres.

The combined surface area of these existing water supply reservoirs impounded in Region C over the last century is approximately 289,523 acres (452 square miles). By comparison, the surface area of the proposed LBCR (Alternative 1) is 16,641 acres, or approximately six percent of the existing regional total; the downsized LBCR alternative (Alternative 2) would have a surface area of approximately 8,600 acres, or three percent of the existing impounded surface area in Region C.

Figure 5.2-3 shows the acreage of new impounded surface area (reservoirs) added per decade from 1900 to the present in Region C. More surface area was added in the 1940s than any other single decade, and the peak period extended from the 1940s to through the 1980s. No new reservoir surface area has been added in Region C for almost three decades.

Figure 5.2-4 shows the number of reservoir projects per decade adding impounded surface area in Region C from 1900 to the present, using available information on completion dates (all major reservoirs are included). The 1950s and 1960s were the two peak decades, with eight reservoir projects completed in each of those two decades. There have been no new reservoir projects that expanded total surface area of impoundments in Region C from the 1990s to the present.

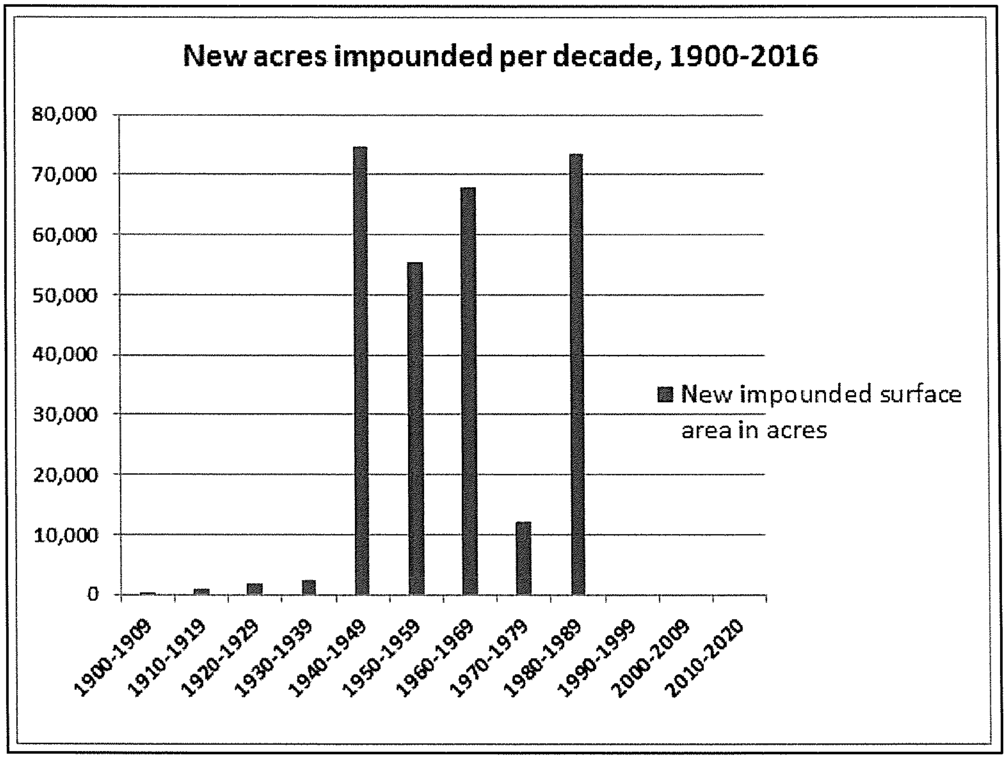


Figure 5.2-3. Increments of New Surface Area of Impoundments Added Per Decade in Region C from 1900 to Present

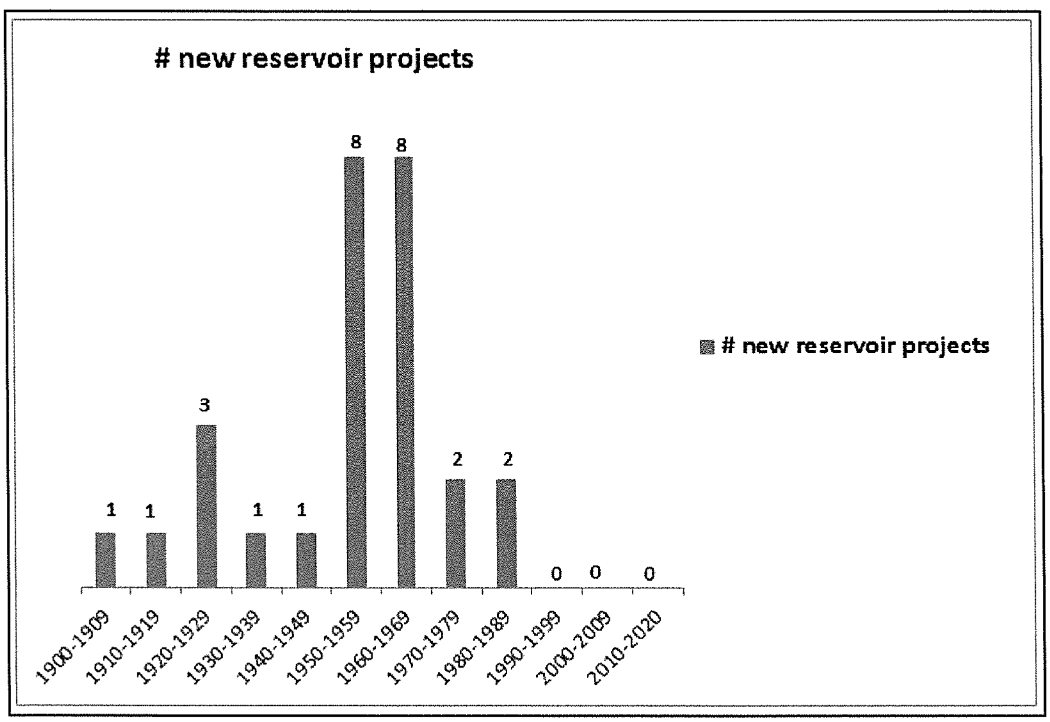


Figure 5.2-4. Number of New Reservoir Projects Completed Per Decade in Region C, from 1900 to the Present

There is no precise estimate of the length in linear feet of Region C water courses (streams and rivers) that have been impounded to date, i.e., converted from a lotic to a lentic condition. However, extrapolating from the ratio between the acreage of the proposed full-scale LBCR reservoir and the linear feet of stream length it would affect, an estimate of 11,149,407 linear feet (2,112 miles) of impounded streams and rivers is obtained.

While no hard data or studies are available, construction and operation of each of these reservoirs caused many of the same direct and indirect, short-term and long-term adverse environmental impacts that construction of the proposed LBCR (either Alternative 1 or Alternative 2) would cause, particularly on aquatic resources, including flowing waters of the United States, wetlands in general, and forested wetlands in particular. Cumulatively, the combined effects of constructing and operating these reservoirs within Region C have been important in a number of ways, from their hydrological and biological resource impacts to the population and economic growth and development they have induced, facilitated, or accommodated. In proceeding to the cumulative impact analysis for the present project, it is important to keep these pre-existing effects, the current baseline condition, in mind.

5.3 OVERVIEW OF PROPOSED NEW RESERVOIRS IN REGION AND STATE

A century ago, in 1913, just four major reservoirs with a total storage capacity of 277,600 AF had been constructed in all of Texas. In contrast, by January 2011, Texas had a total of 187 major reservoirs, defined as those with a normal capacity of 5,000 AF or larger. At present, there are approximately 6,740 reservoirs in the state with a normal storage capacity of at least 10 AF. Texas has about 5,607 square miles (3.6 million acres) of inland water, ranking it first among the 48 contiguous states in the U.S. (TSHA, no date-b). In Region C alone, as of 2016, there are approximately 30 existing major reservoirs with a total surface area of 289,523 acres (452 square miles).

In addition to the 187 existing major reservoirs in the state, both the *2012 State Water Plan* and the *2017 State Water Plan* recommend 26 new major reservoirs to meet water needs in several regions (see Figure 5.3-1), the majority located east of Interstate 35 where rainfall and runoff are more abundant. These new reservoirs would produce 1.1 million AFY of water in 2070 if all are built (TWDB, 2012; TWDB, 2016). As shown in Figure 5.3-1, many of these new reservoir sites are located off-channel, that is, they would not be constructed on the main stem of a river, although they may rely on flows from that main stem.

The five recommended new on-channel reservoirs in the Red River Basin (LBCR, Ralph Hall, Marvin Nichols, George Parkhouse North, and George Parkhouse South) would have a combined surface area of approximately 130,000 acres (more than 200 square miles), a 45 percent addition to the existing acreage of reservoirs in the region.

Overall, the construction of all existing reservoirs has had marked and significant cumulative effects – both beneficial and adverse – on the surface water hydrology of Texas and of Region C in particular. The LBCR would represent an incremental contribution to these already accumulated and reasonably foreseeable impacts on water resources in the region and state.

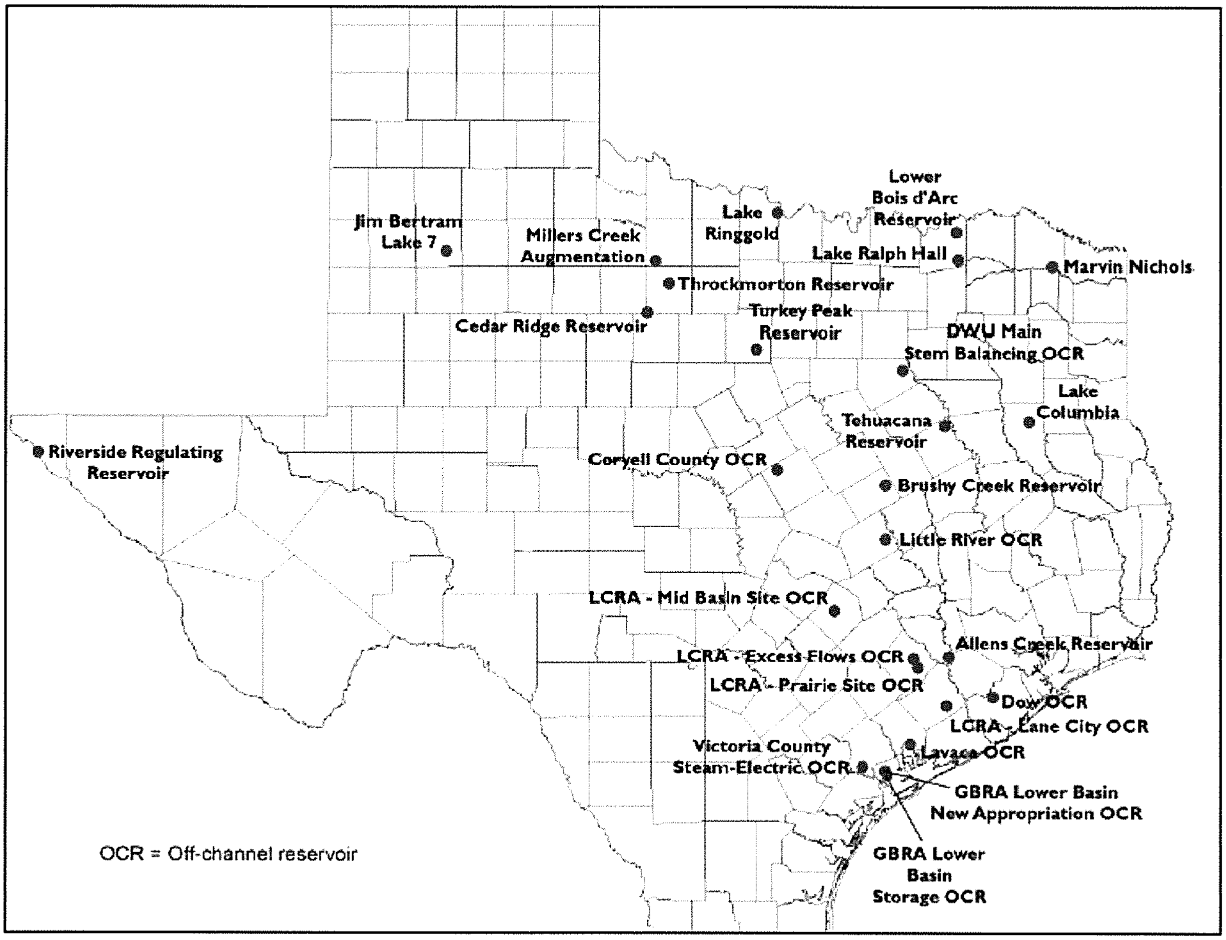


Figure 5.3-1. Recommended New Major Reservoirs in the *2017 Texas Water Plan*

5.4 ACTIONS CONSIDERED IN CUMULATIVE IMPACTS ANALYSIS

5.4.1 Past Actions

Fannin County's population peaked in 1900 at 51,793 and began a fluctuating decline that persisted through most of the 20th century (Pigott, 2012). By 1970, the county population had declined to below 23,000, less than half its size in 1900 and fewer than the number of residents in the 1880s. In the 2000 Census, the Fannin County population had increased to over 31,000, and this trend continued from 2000 to 2010, during which the number of residents grew by 9% to almost 34,000.

Throughout the 20th century, agriculture remained the principal source of economic activity and income, with cotton and corn as the main crops. More recently, beef cattle, wheat, milo, corn, pecans, and hay have become the chief agricultural and ranching products. Until the demographic and economic turnaround of the past few decades, Fannin County's economic activity was also at its highest early in the 20th century. Corn and hog production peaked in 1900 while cotton production peaked in 1920. The number of farms and businesses in the county also reached their zenith in 1900 (Pigott, 2012).

Channelization of Bois d'Arc Creek

As described in some detail in Chapter 3 (Section 3.3) of this EIS, modifications to the natural stream channel of Bois d'Arc Creek began prior to 1915. Over the past century, in order to control flooding, facilitate discharge, and expedite drainage in the area, substantial portions of the creek were channelized, including portions within the proposed reservoir footprint. These actions continued as recently as the 1970s. As documented in the 2010 Instream Flow Study (Appendix M), channelization and straightening have thoroughly modified the original hydrologic regime and geomorphology of Bois d'Arc Creek, resulting in channel downcutting and increased bank and bed erosion.

Bois d'Arc Creek flows are characterized as flashy, rising and falling rapidly in response to rainfall events, and with extended periods of little or no flow, especially in the late summer. The highly channelized and straightened nature of Bois d'Arc Creek plays an important role in determining the current behavior and geomorphological processes that prevail in this stream. It contributes to the flashy nature of the creek, considerable erosion of its bed and banks, limited habitat and biotic diversity in channelized sections, and minimal lateral migration (meandering).

The Bois d'Arc Creek channel has not yet re-established dynamic equilibrium since the time it was channelized and its riparian vegetation buffer changed. The creek's sediment supply and stream power are still out of balance and it continues to evolve through the same predictable sequence of channel stages that have been observed in many other modified stream systems.

Lake Bonham

Lake Bonham, shown in Figure 5.3-1, is located three miles northeast of the town of Bonham in Fannin County, immediately to the west of the upstream edge of the proposed LBCR. This reservoir was impounded in 1969 and has a surface area of 1,020 acres. It supports native emergent vegetation as well as a fishery, whose predominant fish species are largemouth bass, channel and blue catfish, sunfish, and crappie (TPWD, 2007b).

Figure 5.4-1. Lake Bonham

The Lake Bonham water right transferred to NTMWD in November 2010, and the lake is now used by NTMWD for water supply. Lake Bonham is used to meet the City of Bonham's demands, which were about 2,350 AFY in 2010. The reliable supply for NTMWD from Lake Bonham is about 5,340 AFY.

The impacts of Lake Bonham construction and operation that could contribute to cumulative impacts are shown in Table 5.6-1 at the end of the chapter.

Valley Lake (Brushy Creek Reservoir)

Valley Lake, also known as Brushy Creek Reservoir, is situated on Brushy Creek, a tributary of the Red River, about three miles north of the town of Savoy (about 10 miles west of Bonham) in Fannin County. The lake is owned and operated by Texas Power and Light Company for the purpose of condenser cooling and other power plant uses at its Valley Creek steam-electric generating station. Construction of Valley Dam began in April 1960 and finished in September 1961. Impoundment of water started in December 1960. The reservoir has a storage capacity of 16,400 acre-feet, encompassing a surface area of 1,080 acres, at the normal pool elevation of 611 feet MSL (TWDB, no date-b). The drainage area of Valley Lake is only eight square miles, but the water level in the reservoir is also maintained by the diversion of water from the Red River by two pumps installed in the power plant at the mouth of Sand Creek (TSHA, no date-a).

Coffee Mill Lake (Caddo National Grasslands)

Coffee Mill Lake is located approximately 15 miles northeast of Bonham in the Caddo National Grasslands. It is managed by the USFS. Coffee Mill Lake was impounded in 1939 on Coffee Mill Creek, a tributary of Bois d'Arc Creek with a confluence downstream of the proposed LBCR site. It has a drainage area of 39 square miles (TWDB, no date-c). It has a surface area of 650 acres and a maximum depth of 30 feet. Its normal pool elevation is 496 feet MSL. It is a popular, stocked fishing lake; largemouth bass, channel catfish, and crappie are the predominant species (TPWD, 2010e).

Lake Davey Crockett (Caddo National Grasslands)

Lake Davey Crockett is located in northeast Fannin County in the Caddo National Grasslands, approximately 20 miles east-northeast of Bonham. Like Coffee Mill Lake, it is managed by the USFS. Crockett Lake was impounded in 1938 on a tributary of Bois d'Arc Creek that has a confluence downstream of the proposed LBCR site. Its surface area is 355 acres and it has a maximum depth of 20 feet. Its normal (conservation) pool elevation is 487 feet MSL. Like Coffee Mill Lake, Lake Crockett is a popular, stocked fishing lake; largemouth bass, channel catfish, bluegill, and crappie are the predominant species (TPWD, 2007c).

Center for Workplace Learning – Grayson College

In 2003, the Center for Workplace Learning at Grayson College in Denison, TX was the recipient for a $1,700,000 public works investment. To date, this project has created 1,268 jobs and 1,175 existing jobs have been retained for a total of 2,443 jobs created and retained (TCOG, 2010). This action has improved the area's socioeconomic status and increased population. Increased population is associated with indirect and long-term, generally adverse cumulative effects on a number of environmental attributes. The impacts of Center for Workplace Learning construction and operation that likely contribute to cumulative impacts in the region are shown in Table 5.6-1.

North Texas Regional Airport

North Texas Regional Airport in Grayson County continues to enhance its facilities and site features with completion of the first phase of the $16.9 million Capital Improvement Program. In April 2009, the previously undersized water drainage system was updated and a $4.0 million taxiway rehabilitation project is still underway. This action affects regional transportation and general economic activity within the ROI.

TransCanada Gulf Coast Pipeline Project

Several pipelines cross the Riverby Ranch, including the Keystone Pipeline, an existing pipeline that transports oil from sand fields in Alberta, Canada into the U.S., terminating in Cushing, Oklahoma (KUT, 2015). The Keystone XL Pipeline is a proposed TransCanada Corporation project that would deliver crude oil from the Athabasca Oil Sands in northeastern Alberta, Canada to refineries in Illinois and Oklahoma before the pipeline heads south to the Gulf Coast at Port Arthur, Texas. The proposed pipeline would traverse Montana, South Dakota, Nebraska, Oklahoma, and Texas (NTEN, 2011).

The Keystone XL pipeline project includes 1,700 miles of pipeline in two sections. The southern section connects Cushing, OK, where there is a current bottleneck of oil, with the Gulf Coast of Texas, with its numerous oil refineries. That section, including the segment that passes through Fannin County and NTMWD's Riverby Ranch property, was constructed in 2013 and became operational in January 2014 (KUT, 2015). The other section of the Keystone XL pipeline project would include a new section from Alberta to Kansas. It would pass through the actively producing Bakken Shale region of eastern Montana and western North Dakota. This section is currently awaiting approval of a Presidential Permit from the U.S. State Department.

The southern leg of the pipeline, also known as the TransCanada Gulf Coast Pipeline Project, cuts through 16 counties in North and East Texas, including Fannin, Lamar, and Delta counties, on its way to the coast (Yeakley, 2012). While the length of the project in northeastern Fannin County is fairly short, it cuts through the Riverby Ranch property under an easement granted by the NTMWD.

According to the Final EIS conducted by the U.S. State Department on the Keystone XL Pipeline (U.S. Department of State, 2014), construction of the pipeline entails potential short-term impacts to surface water from sedimentation, changes in stream channel morphology and stability, temporary reduction in stream flow, and the potential for hazardous material spills. There would be other potential longer term effects during decades of operations, from potential releases of crude oil and other hazardous liquid spills. Other potential long-term impacts during operation include channel migration or streambed degradation that exposes the pipeline; channel incision that increases bank heights to the point where slopes are destabilized, eventually widening the stream; and sedimentation within a channel that could trigger lateral bank erosion. Mitigation measures would address these impacts (U.S. Department of State, 2014).

Other potential impacts of the pipeline identified in the EIS include those to floodplains, groundwater, wetlands, threatened and endangered species, geology and soils, wildlife, vegetation, fisheries, air quality and noise, land use, and cultural resources. Pipeline construction would also create temporary construction-related jobs.

TransCanada Corporation and the Gulf Coast pipeline are expected to contribute modestly to both the local economy and tax base for many years to come. The impacts of pipeline maintenance that potentially contribute to cumulative impacts in the region are shown in Table 5.6-1.

5.5 Reasonably Foreseeable Actions

The following reasonably foreseeable projects of all kinds in Fannin County and reservoir projects in Hydrologic Unit Code (HUC) 111401 that may take place in the future were identified as having potential cumulative effects when considered in conjunction with the proposed Lower Bois d'Arc Creek Reservoir.

Reasonably foreseeable Fannin County actions and trends include one large proposed reservoir project (Lake Ralph Hall), climate change, and general population growth and development in the county from expansion of the Dallas-Fort Worth (DFW) Metroplex. Each of these actions could contribute to a variety of cumulative environmental effects in the county.

5.5.1 Lake Ralph Hall

The Upper Trinity Regional Water District's (UTRWD) proposed Lake Ralph Hall (LRH) was initially identified as the main project affecting the assessment of cumulative impacts for the proposed LBCR. The proposed LRH would be located on the North Sulphur River approximately 4.8 miles northeast of the City of Ladonia and 22.5 miles southeast of the City of Bonham in Fannin County. Construction of the proposed 11,200-acre water supply reservoir would likely not take place during the same timeframe as the LBCR, but some years later. Figure 5.5-1 is a map displaying the two proposed reservoirs in relation to one another. This figure also depicts the location of the Riverby Ranch, the proposed mitigation site for the Lower Bois d'Arc Creek Reservoir. Figure 5.5-2 depicts a reach on the North Sulphur River in the vicinity of the proposed LRH dam site.

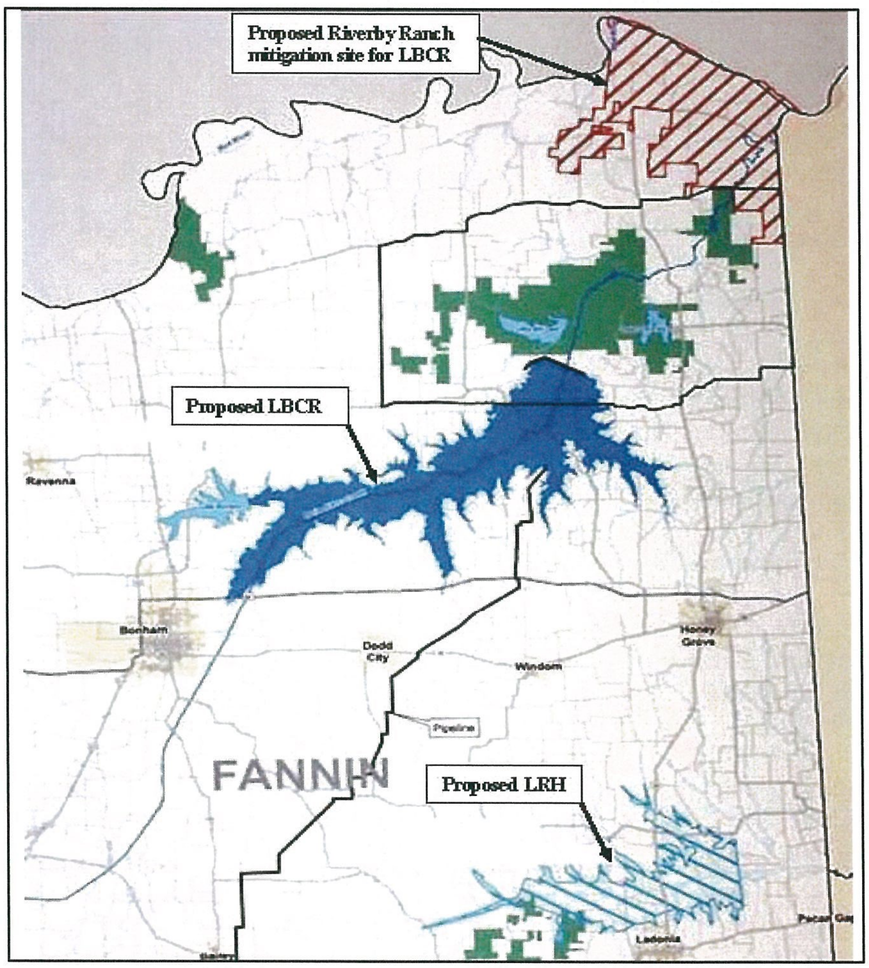


Figure 5.5-1. Relative Locations of LBCR, LRH and Riverby Ranch Mitigation Site in Fannin County

Figure 5.5-2. North Sulphur River Channel in the Vicinity of the Proposed Lake Ralph Hall

The purpose of the proposed Lake Ralph Hall is to provide water for approximately 33 towns, cities, and utility districts in portions of Collin, Cooke, Dallas, Denton, Fannin, Grayson, and Wise counties. Both the LBCR and Lake Ralph Hall Reservoir would serve portions of Collin, Fannin, and Denton counties. UTRWD could serve portions of NTMWD customer cities where it would be more feasible or cost efficient for them to provide water than it would be for NTMWD to extend lines to serve those areas. Generally, services from NTMWD and UTRWD would not overlap.

In March 2012, a meeting was held to consider possible cumulative interactions between the proposed LBCR project and the proposed LRH project. Attendees at this meeting included regulatory staff from the Tulsa and Fort Worth districts of the U.S. Army Corps of Engineers, representatives from the North Texas Municipal Water District and Upper Trinity Regional Water District, and EIS consultants and contractors. Both the LBCR and LRH EIS teams provided overviews of their projects (shown in Table 5.4-1) and summaries of preliminary key findings. To analyze socioeconomic impacts, both studies used the same IMPLAN model and data, and therefore the figures are comparable. A discussion of interacting direct and indirect consequences – both additive and subtractive – to tax revenue, jobs, recreational resources, residential and commercial development, real estate, agriculture, and ranching took place.

At the time the LBCR EIS began and even at the time of the March 2012 meeting to discuss cumulative impacts of LBCR and LRH, it appeared that their construction schedules could overlap, which would cause short-term cumulative impacts. However, this situation has changed and the current construction timeframe for LRH is estimated to occur between 2025 and 2030. This would be subsequent to the proposed construction of LBCR. It is thus likely that both projects would not be built concurrently. The impacts of Lake Ralph Hall that could contribute to cumulative impacts in the region are shown in Table 5.5-1.

Table 5.5-1. Comparison of Two Proposed Reservoirs in Fannin County

	Lower Bois d'Arc Creek	Lake Ralph Hall
Location	Fannin County	Fannin County
Service Area	Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall counties	Collin, Cooke, Dallas, Denton, Fannin, Grayson and Wise counties
Reservoir Surface Area	16,641 acres	11,200 acres
Impoundment	367,609 acre-feet of water	160,235 acre-feet of water
Construction Cost	$400,000,000	$187,164,295
Total Project Cost	$552,397,634	$198,478,359
Firm Yield/year	126,200 acre-feet	32,940 acre-feet

5.5.2 Climate Change

The climate of the Earth is warming as a result of the long-term buildup in the concentrations of greenhouse gases the atmosphere – primarily carbon dioxide (CO_2) and methane (CH_4) – as result of anthropogenic emissions of these gases (IPCC, 2013). According to the 2014 National Climate Assessment (Shafer et al., 2014), large areas of the Southern Plains, including Texas and Oklahoma, are expected to experience longer dry spells and periods of extreme heat (days above 100°F) over the coming decades. These changes in turn are likely to result in a number of effects on the project area, including upland and wetland vegetation communities, wildlife, hydrology, aquatic resources, water supplies, agriculture, and demand for electricity and water (See Table 5.6-1).

5.5.3 Growth of the Dallas – Fort Worth Metroplex

"Growth of the Metroplex" does not refer to one discrete project or action like the others listed above, but rather to the sum or aggregate of thousands of decisions and actions carried out over a period of decades by individual consumers and their families, companies (the private sector), and government (the public sector). Growth of the DFW Metroplex is more a trend than an action, but a trend with real physical implications for the landscape and the affected environment.

The demographic projections in Chapter 1 of this EIS indicate that Fannin County alone is expected to grow from a population of about 38,000 in 2010 to almost 87,000 in 2060, more than doubling in size. The population of Region C as a whole is projected to almost double over the same time period, increasing from approximately 6.7 million to more than 13 million. Accompanying this population growth will be development on a large scale to accommodate the needs and activities of 6.5 million new residents. Large areas of existing rural land or open space consisting of woodlands, cropland, pasture, or rangeland will be developed into residential, commercial, institutional, recreational, industrial, and transportation areas.

Based on extensive data collected and sampled for the National Resources Inventory (NRI) of USDA's Natural Resources Conservation Service (NRCS), the average Texas resident uses approximately 0.4 acre of land for all purposes (NRCS, 2013). Using these estimates and averages, approximately 2.6 million acres (4,063 square miles) of now-rural land would likely be developed to accommodate 6.5 million new residents in Region C by 2060. In Fannin County, at the state average of 0.4 acre per resident (population density of 1,600 per square mile), about 20,000 acres (31 square miles), would be developed to accommodate almost 50,000 new residents. This area is larger than the surface area of the proposed LBCR. Alternatively, assuming that new development in Fannin County over the coming decades took place at the more typical small town urban/suburban population density of 1,000 residents per square mile (Demographia, 2000), or 0.64 acre per resident, there would be approximately 31,000 acres (48 square miles) of additional development in the county, or about five percent of the total Fannin County area of 899 square miles. Depending on the density of development that actually does occur, the amount of new land developed in the county to accommodate projected population growth is likely to range between 31 and 48 square miles (about 20,000 to 31,000 acres), a substantial increase. While the county would still have more rural land than developed (urban or suburban) land, its character would change.

This process of development would have direct, indirect, and cumulative environmental impacts on virtually every topic covered in the Affected Environment and Environmental Consequences chapters of this EIS. For example, building a residential subdivision has direct, indirect, and cumulative, short-term and long-term impacts on soils, air quality, biological resources, surface water and groundwater (both in terms of effects on water quality and flows, that is, on hydrology, hydraulics, and flooding), vegetation, wildlife, noise, recreational opportunities, transportation, visual resources, socioeconomics, and cultural resources. The ongoing and projected future rapid population growth and attendant land development of the DFW Metroplex would affect the natural resources and environment not only in Fannin County, but most of the other counties in Region C. The population of the region as a whole is projected to increase from approximately 6.5 million in 2010 to 12.7 million by 2060 and 14.3 million by 2070 (Appendix N of this EIS and Table 2.1 in Region C Water Planning Group, 2015).

Potential cumulative impacts associated with growth of the DFW Metroplex are listed in Table 5.6-1.

5.5.4 Reasonably Foreseeable New, Nearby Reservoir Projects in Red River Basin

In their long-range water planning process, the Region C Water Planning Group and Texas Water Development Board foresee a number of potential reservoir projects in Region C. These projects are evaluated in Chapter 5 of the *2016 Region C Water Plan* as "Major Water Management Strategies" (Region C Water Planning Group, 2015). Some of these are already described in Chapter 2 of this EIS as a possible alternatives to LBCR – though none meet the specific purpose and need of this Proposed Action – or are mentioned as possible future options for NTMWD, in that implementation of even the full-scale LBCR would be insufficient to meet the long-term water demands of the NTMWD service area's projected population growth.

This section lists and briefly describes each of these reasonably foreseeable Region C reservoir projects, as well as their possible environmental consequences. Lake Ralph Hall is one of these reasonably foreseeable Region C reservoir projects; however, because it is located in Fannin County along with the proposed LBCR, it has already been described above. A number of other Major Water Management Strategies are also listed for Region C, which actually far exceed the number of potential new reservoir projects. These include: Gulf of Mexico desalination, new pipelines from existing reservoirs within Region C and outside of Region C, new reservoirs outside of Region C, water from Oklahoma, the Neches River Run-of-the-River Diversion, groundwater from several different counties, and a wetland and water reuse project involving return flows. None of these other alternative strategies would entail the magnitude of potential impacts on waters of the U.S. and wetlands that are associated with new reservoir projects, and therefore, only the potential new reservoir projects in Region C listed as Major Water Management Strategies in the 2016 plan are shown below.

Marvin Nichols Reservoir (elevation 328 feet MSL)

In the current *2016 Region C Water Plan*, developing the Marvin Nichols Reservoir site, located on the Sulphur River in Red River and Titus counties (Appendix O), has been downgraded from a recommended strategy to an alternative strategy for NTMWD, which means that it is considered a lower priority (Region C Water Planning Group, 2015). However, it is still listed in the 2016 plan as a Major Water Management Strategy for Region C as a whole, and it is considered a viable alternative strategy for TRWD, UTRWD, and Irving, in addition to NTMWD.

The Marvin Nichols Reservoir full configuration (328 feet MSL) would be a large new water source for the North Texas region. However, because of its size (more than 67,000 acres), the development of this reservoir site would likely entail extensive environmental impacts. The area that would be inundated is more than four times the footprint of the LBCR, with comparably greater impacts on natural habitats. The estimated acreage of impacted wetlands and bottomland hardwood forests (the two most high quality habitat types) for this alternative are considerably greater than the acreage determined for the Proposed Action (TWDB, 2008).

Estimates by TWDB (2008) are that total conversions of vegetated wetlands and associated habitats (bottomland hardwood forest, marsh, seasonally flooded shrubland, and swamp) due to this reservoir project would amount to 34,331 acres, in addition to 1,847 acres of open waters that would be affected (Appendix O).

Other possible direct and indirect adverse effects from the Marvin Nichols project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts could occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects. A project of this magnitude would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with Marvin Nichols Reservoir and related to this project are listed in Table 5.6-1.

George Parkhouse Lake (North)

George Parkhouse Lake (North), also known as Parkhouse II, is a potential reservoir site located on the North Sulphur River in Lamar and Delta Counties, about 15 miles southeast of Paris, TX (see Appendix O in this EIS). It is listed as an alternative strategy in the *2016 Region C Water Plan* for NTMWD and UTRWD. It would inundate an estimated 15,359 acres, a large portion of which is cropland or pasture. No designated priority bottomland hardwoods are present within or adjacent to the reservoir site (Region C Water Planning Group, 2015).

George Parkhouse North would affect an estimated 3,195 acres of vegetated wetlands and associated habitats (riparian woodland/bottomland hardwood, forested wetland, emergent/herbaceous wetland, and shrub wetland) in addition to 182 acres of open water/lacustrine habitat (see Appendix O in this EIS).

Other possible direct and indirect adverse effects from this project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would likely occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas probably outweighing adverse effects. The George Parkhouse Lake (North) project would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with George Parkhouse Lake (North) and related to this project are listed in Table 5.6-1.

George Parkhouse Lake (South)

George Parkhouse Lake South, also known as Parkhouse I, is a potential reservoir that would be located in Region D on the South Sulphur River in Hopkins and Delta counties, approximately 18 miles northeast of the city of Sulphur Springs. If constructed, it would be immediately downstream from Jim Chapman Lake. It is listed as an alternative strategy for NTMWD in the *2016 Region C Water Plan*, and would provide 108,480 AFY of water at a unit cost of $2.10 per thousand gallons (Region C Water Planning Group, 2015). With a conservation pool elevation of 401 feet MSL, Parkhouse I would inundate approximately 29,000 acres and store 652,000 acre-feet of water. The reservoir would have a total drainage area of 654 square miles (TWDB, 2008). It is estimated that it could not be built before 2035.

The yield of Parkhouse I would be reduced substantially by the development of Marvin Nichols Reservoir (Region C Water Planning Group, 2015). Yield studies conducted for TWDB as part of the Reservoir Site Protection Study indicate the yield of this lake would be reduced by 60 percent, to 48,400 acre-feet per year, if constructed after the Marvin Nichols Reservoir (TWDB, 2008).

George Parkhouse South would affect an estimated 10,379 acres of bottomland hardwood forest, 4,566 acres of marsh, 584 acres of seasonally flooded shrubland, 83 acres of swamp, 848 acres of open water, and various upland habitats (Appendix O).

Other possible direct and indirect adverse effects from this project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would likely occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects. The George Parkhouse Lake (South) project would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with George Parkhouse Lake (South) and related to this project are listed in Table 5.6-1.

5.6 Cumulative Effects of Alternative 1, Alternative Action 2, No Action Alternative, and Other Actions

This section discusses the potential for cumulative impacts of the Proposed Action (Alternative 1), downsized version of the LBCR (Alternative 2), and No Action Alternative in the context of the past, present, and reasonably foreseeable future actions within the area of cumulative effect, which varies by resource topic.

This section also includes a brief discussion of the area of cumulative effect identified for each resource. The area of effect considers past and reasonably foreseeable actions. Table 5.6-1 provides a summary of the actions considered in the cumulative analysis of each resource topic.

5.6.1 Land Use

The study area for assessing cumulative effects on land use consists of Fannin County. The analysis considers the footprint of the project alternatives in combination with other projects located in Fannin County (see Table 5.6-1). Fannin County was selected as the area of effect for the cumulative impact analysis because land use classifications are made at the county-level and the direct land use impacts attributable to the project alternatives are located almost entirely within Fannin County.

The county is relatively sparsely populated at present, with the majority of residents being spread out among the various agricultural lands that surround Bonham, which is the county seat. The county's land use is predominantly agricultural, including crop, hay, and pasture land. Row crops are found more in the eastern half of the county. Other land uses include forest land, residential, light industrial, and commercial.

The LBCR project would cover up to 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in Fannin County. This land is predominantly undeveloped with scattered rural residences. The sites proposed for the WTP, TSR, and related facilities near Leonard are also located on rural agricultural land.

From Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact land use within the ROI include Bois d'Arc Creek channelization, past county reservoir projects, the two proposed reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

In combination, the two reservoirs and their mitigation area(s) represent a substantial change in land use for Fannin County. Over time, as the population of the county grows, its rural, largely agrarian landscape would gradually decline as it becomes more developed and residential, commercial, and institutional land use increases. The two reservoirs and mitigation site(s) would permanently remain as open space and "parkland" as the county transitions away from agriculture and rural land uses.

Conclusion

If expected population growth and development occur, by 2060 there would be substantial cumulative changes in land use in Fannin County, with a smaller fraction of the county used for farmland and a growing percentage used for development of one type or another. In this context, the permanent nature of **Alternative 1** (full-scale LBCR) or **Alternative 2** (downsized LBCR) would generally maintain the open space character of the landscape. The **No Action Alternative** would not contribute to any cumulative changes in land use over the long term.

5.6.2 Topography, Geology, and Soils

The study area for cumulative effects on topography, geology and soils, including farmland classifications, consists of Fannin County. The analysis considers the footprint of the project alternatives in combination with other past and reasonably foreseeable actions in Fannin County (see Table 5.6-1). Fannin County was selected as the area of effect for the cumulative effects analysis because soils and geological characteristics are reported at the county-level (NRCS Fannin County soil survey) and the permanent impacts on soils and geology attributable to the project alternatives are located almost exclusively within the county.

Fannin County remains a largely rural, undeveloped county and most of its soils are used for agriculture, pasture, range, and woodland. The NRCS designates soil as "the most important natural resource in the county" (NRCS, 2001). Fannin County's soils produce forage for livestock, as well as food, fiber, and timber both for the market and for domestic consumption. These products are an important source of economic livelihood for many people in the county and agriculture is the main business on most lands in Fannin County. A number of soils, generally on milder slopes, are designated prime farmland soils. The major land uses supported by these soils are cropland and improved pasture. Nearly half of the agricultural income in the county is from the sale of livestock, primarily beef cattle; these livestock graze mainly on improved pastures (NRCS, 2001).

As shown in Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's soils include Bois d'Arc Creek channelization, all of the county's reservoir and pipeline projects (past and proposed), and the growth of Fannin County and the DFW Metroplex. In addition, as pointed in Section 4.3.1 (No Action Alternative for soils), past and future agricultural and grazing activities would be expected to continue to cause soil erosion in the county, especially on steeper slopes, gradually reducing soil depth.

Prime Farmland

Two large new reservoirs in Fannin County plus their mitigation site(s) would permanently inundate or change the vegetative cover on several thousand acres of prime farmland soils in the county. However, by 2060 another cause of conversion of prime farmland soils in the county is likely to be population growth and associated land development. TWDB's adopted demographic projections (Region C Water Planning Group, 2015) indicate that Fannin County's population is likely to grow by approximately 64,000 new residents, from an estimated 38,000 in 2020 to approximately 102,000 by 2060, an increase of about 170 percent. Road and parking lot pavement, subdivisions, building foundations, and other impervious surfaces which will cover up soils would be expected to increase more or less proportionately. Most of this projected growth and development would likely occur even in the absence of the Proposed Action, as the DFW Metroplex expands northward. However, the Proposed Action would contribute directly and indirectly to this adverse cumulative effect by stimulating new development.

Conclusion

Chapter 4 concluded that the effects on soils, including Prime Farmland soils, of constructing and operating the LBCR would be adverse. However, TWDB's adopted county population projections show Fannin County growing from approximately 38,000 residents in 2020 to almost 102,000 by 2060, an increase of about 64,000. Assuming a small town urban/suburban population density of 1,000 residents per square mile (Demographia, 2000), this would represent approximately 64 square miles of additional development (and associated conversion of agricultural soils to pavement, buildings, yards, and other built-up uses), compared to the combined 44 square miles that would be converted to reservoir by LBCR and LRH. Thus, if the Proposed Action were built, the sum total of all other development in Fannin County by 2060 would use an additional 145 percent of the amount of land that both proposed reservoirs would use. Given current land use in the county, much of it would likely be farmland, including prime farmland soils.

Under **Alternative 1**, the aggregate of all high-quality soil losses would constitute an adverse, long-term (permanent), moderate to severe impact covering a large area. Alternative 1 would contribute incrementally towards, and perhaps be partially responsible for some of this adverse cumulative effect, in the sense that without increased availability of municipal water, some share of the population growth and development might not materialize in this area.

Under **Alternative 2**, the aggregate of all high-quality soil losses would also constitute an adverse, long-term (permanent), moderate to severe impact covering a large area. Alternative 2 would contribute incrementally towards, and perhaps be partially responsible for some of this adverse cumulative effect, in the sense that without increased availability of municipal water, some share of the population growth and development might not materialize in this area.

Under the **No Action Alternative**, assuming that adequate water supplies were obtained from other sources – including enhanced conservation, water efficiency, recycling, reuse, and new water-saving technologies as well as the potential sources listed as "Major Water Management Strategies" in the *2016 Region C Water Plan* – to sustain population growth and continuing outward expansion of the DFW Metroplex toward the north, most of the same impacts on soils would occur as in the case of the Proposed Action. This would be due to the conversion of rural land soils to urbanized or developed lands. Impacts would thus be adverse, long-term, and moderate to severe.

5.6.3 Water Resources

This section consists of the assessment of cumulative effects on water resources including surface water hydrology, water quality, and groundwater.

The study area for cumulative effects on surface water hydrology and water quality includes the reach of Bois d'Arc Creek downstream of the project alternatives and the segment of the Red River at the confluence with Bois d'Arc Creek. The operation of the project alternatives in combination with the operation of the actions shown in Table 5.6-1 were selected for the cumulative effects assessment because the combined impact of these projects (changes in Red River flows and resulting impacts on surface water hydrology and water quality) may be measurable near the confluence of the Red River with Bois d'Arc Creek.

The Bois d' Arc Creek watershed, located over the Trinity Aquifer, was selected as the cumulative impact area of effect because the operation of the LBCR (either Alternative 1 or Alternative 2) in combination with the other actions occurring within the watershed (Table 5.6-1) could affect the aquifer.

Climate change is predicted to result in drier, hotter conditions in the region (Shafer et al., 2014) and drought conditions are likely to be more severe and longer-lasting. Paradoxically, there could be an increase in the intensity and frequency of storm events and corresponding high stream flows (discharges). In this context, expanding water storage capacity represents an important precautionary strategy for dealing with the likelihood of increasing water scarcity in the region.

Surface Water Hydrology

Streams

Bois d'Arc Creek, a tributary of the Red River, is the main watercourse traversing the heart of Fannin County from its headwaters in the southwest to its confluence with the Red River in the northeast. This creek has a number of tributary streams. To the north of the Bois d'Arc Creek watershed, other streams flow directly into the Red River, and to the south still others are tributary to the North Sulphur River, which discharges into the Red River downstream of its confluence with Bois d'Arc Creek.

The streams in Fannin County are impounded by four existing reservoirs: Lake Bonham, Lake Davy Crockett, Coffee Mill Lake, and Valley Lake. The first three are situated in the Bois d'Arc Creek watershed and the last is on Brushy Creek, a direct tributary of the Red River.

Most of the perennial and intermittent streams in Fannin County remain free-flowing, although it is expected that many would be in a somewhat degraded condition due to more than a century of erosion and sedimentation associated with agriculture and grazing. As mentioned earlier in this EIS, much of Bois d'Arc Creek itself has been channelized, which has affected the hydrology and geomorphology of this principal stream.

From Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact the study area's streams include Bois d'Arc Creek channelization, other reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

In Region C as a whole, approximately 30 existing major reservoirs have already had a significant impact on streams. The construction and operation of five additional major reservoirs within the region in the coming decades would further the extent of these modifications to stream hydrology and geomorphology.

Conclusion

The LBCR Proposed Action would directly impact 651,140 linear feet of stream on Bois d'Arc Creek and its tributaries; however, at Riverby Ranch and elsewhere, 392,265 linear feet of streams are proposed for mitigation. Therefore, there would be a net loss of 258,875 linear feet (46.6 miles) of streams. While net losses of stream length have not been quantified and evaluated for other proposed reservoirs flowing into the Red River, conversion of flowing streams to lentic reservoir conditions would still likely be substantial.

In addition to impacts on streams associated with the two proposed reservoirs, the increase in impervious surfaces associated with projected development and urbanization of an estimated 48 square miles of Fannin County to accommodate a projected 64,000 new residents by 2060 would also likely have adverse effects on streams. Flooding, erosion, and sedimentation would all increase, as would down-cutting of stream channels from larger pulses of runoff during storm events (USGS, 2014a; USGS, 2014b; Konrad, 2003). These impacts could be mitigated and reduced, but not eliminated altogether, by a variety of measures such as retention and detention basins to reduce storm runoff and peak flows.

In sum, under **Alternative 1**, by 2060 the cumulative effect of all reasonably foreseeable changes on streams in the study area would be moderately adverse. Cumulative effects on streams of **Alternative 2** would be somewhat less than those of the Proposed Action, but would also be moderately adverse.

Under the **No Action Alternative**, while the direct impacts to streams of the Proposed Action would be avoided, most of the impacts on streams associated with growth of the DFW Metroplex would likely still occur. These effects would be moderately adverse and long-term.

Water Supply Availability Downstream

The contribution of Bois d'Arc Creek to flows and discharges in the Red River downstream is relatively modest. In recent years, on average, approximately three to four percent of the total flow at the Red River's Arthur City gage originated from the Bois d'Arc Creek watershed above the proposed dam site.

The Red River flows through two Texas water planning regions between the Red River-Bois d'Arc Creek confluence and the Louisiana state line: Region C, which includes Cooke, Grayson, and Fannin Counties bordering the Red River and 13 other counties to the south and southwest; and Region D, which includes Lamar, Red River, and Bowie Counties bordering the Red River, and 16 other counties to the south.

Conclusion

By impounding and diverting water from the LBCR, **Alternative 1** and **Alternative 2** would reduce downstream flows in Bois d'Arc Creek, although no existing water rights would be affected. Minor reductions of flows and water supply in the Red River downstream of the Bois d'Arc Creek confluence would also occur, though this might amount to several percent at most and would not represent a major adverse impact. Cumulative impacts from all actions, including mining and hydraulic fracturing for shale-gas production, are not likely to cause water supply shortages.

Overall, construction of three additional Region C water supply reservoirs over the coming decades in the Red River Basin – LRH, Marvin Nichols and George Parkhouse North, all in the Sulphur River system (a watershed within the Red River Basin) – would divert more than seven times the proposed water diversions from the full-scale LBCR, removing this water from other potential future uses downstream in the Red River. The **No Action Alternative** would not contribute to cumulative downstream water supply impacts.

Water Quality

As related in Chapter 4 of this EIS (Section 4.4.2.4), high salinity, measured as TDS and specific conductance, is a major water quality issue in the headwaters of the Red River upstream of Lake Texoma, to the extent that it limits use of this water for municipal purposes. Because water in Lake Texoma is relatively salty, hydroelectric and other releases from Denison Dam largely determine salinity levels below Lake Texoma. As the Red River flows downstream from Lake Texoma, less salty water enters the river from various tributaries and dilutes Denison Dam hydropower releases, gradually reducing salinity in the river (Albright and Coffman, 2014).

From Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect water quality downstream in Bois d'Arc Creek and the Red River include stream channelization, the growth of Fannin County and the DFW Metroplex, and the past and proposed reservoir and pipeline projects.

Conclusion

Bois d'Arc Creek is one of the Red River tributaries whose flows dilute the salinity of the Red River; thus, by diverting most of the Bois d'Arc Creek flow from the proposed LBCR, the Proposed Action would inadvertently lead to higher salinity in the Red River than in the case of the No Action Alternative. However, as discussed in Chapter 4, analysis of specific conductance data show that with the reservoir present, TDS concentrations in the Red River downstream of the Bois d'Arc Creek confluence would likely increase by less than 2 percent. This is a slight cumulative, long-term impact.

Growth and development in Fannin County would increase stress on general water quality from non-point sources, including erosion, nutrients from fertilizer use, and runoff carrying contaminants from impervious surfaces. This is not expected to present serious problems for water quality in the LBCR. Natural gas development (hydrofracking for shale gas) in the Red River Basin is increasing in the Haynesville Shale, and can impact surface and groundwater water quality from soil erosion, turbidity, and sedimentation, as well as improper disposal of generated wastewater and methane contamination (McBroom et al., 2012; Nicot and Scanlon, 2012).

Alternative 1 and **Alternative 2** would result in at most minor adverse, long-term, cumulative impacts on water quality (salinity) in the Red River. The **No Action Alternative** would avoid cumulative impacts on salinity in the Red River altogether. Overall, growth and development of Fannin County, some of which would be induced by the Proposed Action but most of which would occur regardless from the northward expansion of the DFW Metroplex, would lead to increased stress on water quality in all watercourses of the watersheds within which development occurs, in some instances potentially leading to impairment.

Groundwater

The proposed LBCR is underlain by several aquifers, some of which – like the Northern Trinity Aquifer and Woodbine Aquifer – are significant regional aquifers recognized by the State of Texas as major or minor aquifers. Other aquifers in the area are less important regionally, although they may be drawn from locally to meet a variety of needs. In addition to the Northern Trinity and Woodbine aquifers, groundwater in Fannin County is also drawn from the Austin Chalk formation, the Blossom Aquifer, and the Red River alluvial aquifer, as well as an unnamed, shallow aquifer present beneath the proposed reservoir site.

As shown in Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's aquifers and groundwater resources include Bois d'Arc Creek channelization, reservoir and pipeline projects, and the growth of Fannin County and the DFW Metroplex.

Conclusion

The proposed LBCR project is not located directly above the recharge zone for any major or minor groundwater aquifer in Texas. The hydraulic head created by the impounded water in the reservoir could potentially serve as a source of recharge water for the subsurface aquifers due to water seepage, though this scenario is judged unlikely because the uppermost zone of the Woodbine aquifer is located between 500 and 1,000 feet below ground surface in the area of the proposed Lower Bois d'Arc Creek Reservoir.

Other minor aquifers located above the Woodbine aquifer in the study area are all considered to be insignificant aquifers in Fannin County. Groundwater wells in the undefined alluvium aquifer are presumably drawing water from the Red River alluvium, which is located in the northern portion of the county adjacent to the Red River.

The increase in surface water supply to the county and wider region as a result of both proposed reservoirs (LBCR and LRH) could potentially reduce the amount of groundwater pumping in the area and reduce declining groundwater levels, thereby allowing for increased aquifer recharge, storage and production. All of the other actions listed in Table 5.6-1 would have at most localized effects on groundwater.

Therefore, neither **Alternative 1** nor **Alternative 2** are expected to result in adverse cumulative impacts on local groundwater resources and may even have a beneficial impact. The **No Action Alternative**, by not meeting projected water needs, could possibly lead to an increase in well drilling, groundwater withdrawal, and pressure on already stressed groundwater resources within the study area.

5.6.4 Biological Resources

This section consists of the assessment of cumulative effects on wetlands, vegetation and terrestrial wildlife (upland habitats), aquatic resources, and state-threatened species.

Overview of Cumulative Effects

The study area for the cumulative effects on wetlands and waters is the USGS-designated Red-Little Watershed, Hydrologic Unit Code (HUC) 111401 (see Figure 5.6-1). This HUC, which straddles the border of Texas and Oklahoma, was selected as the cumulative area of effects because the HUC represents wetlands and other related resources that share common attributes at a watershed level and is a reasonable scale for being able to disclose cumulative effects. Table 5.6-1 shows the past and reasonable foreseeable actions that when combined with the project alternatives may result in cumulative effects on water-related resources occurring within the HUC. Construction or operation of these projects could result in either direct or indirect effects on the water-related resources located in HUC 111401.

The study area for the cumulative effects on vegetation and terrestrial wildlife consists of the upland areas within the Bois d' Arc Creek watershed. The watershed was selected as the cumulative study area because the vegetation and terrestrial wildlife habitats within the study area share common attributes. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

The study area for the cumulative effects on aquatic resources consists of Bois d' Arc Creek and tributaries. These watercourses were selected as the study area because the aquatic resources share common attributes and changes in the environmental conditions within the watershed attributable to the project alternatives and past and reasonably foreseeable actions can be more accurately determined. As indicated in the discussion of water resources above, impacts on water flow or quality below the confluence of the Bois d'Arc Creek with the Red River are not expected. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

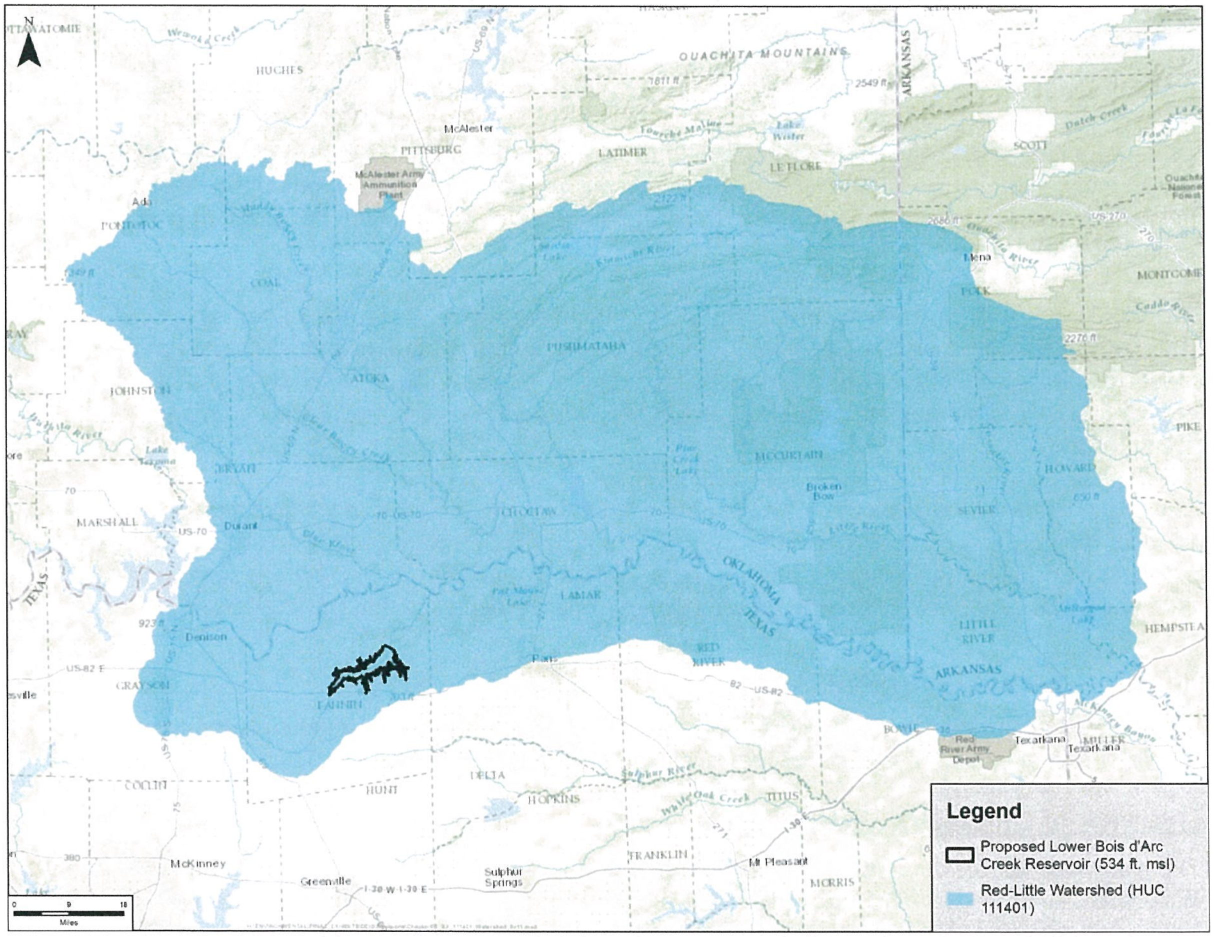


Figure 5.6-1. HUC 111401, Study Area for Cumulative Effects on Wetlands and Waters

The study area for the cumulative effects on state-listed species consists of the Bois d' Arc Creek watershed. This area was selected as the study area because the type, status, and suitable habitat of these species within the watershed can be readily identified and the changes in the environmental conditions within the watershed attributable to the project alternatives and past and reasonably foreseeable actions can be more accurately determined. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

If either Alternative 1 or Alternative 2 is implemented, there would be a short-term net loss in species abundance and biodiversity within the Bois d'Arc Creek watershed and Fannin County as a result of conversion of bottomland hardwood forest, streams, and riparian habitats and wildlife dependent on these habitats relocating.

In several decades however, after mitigation, no net long-term, adverse cumulative impacts on biological resources are anticipated under Alternative 1 or Alternative 2. The landscape in Fannin County has been heavily altered over more than a century of agricultural and residential development, so natural plant and animal communities that are left tend to be fragmented and heavily modified from those of the pre-settlement era. Flora and fauna that persist even in the face of growing residential and other development from projected population growth are those species and associations that are the most adaptable. Overall, in several decades, the presence of a large corridor of protected, largely connected open space and wildlife habitat would be highly beneficial for Fannin County's enduring biological resources. This corridor would start from the Red River/Bois d'Arc Creek confluence and proceed upstream for many miles; it would include Riverby Ranch, Caddo Grasslands, protected zones around LBCR, and habitats that have been protected and restored upstream for mitigation purposes (Figure 5.6-2).

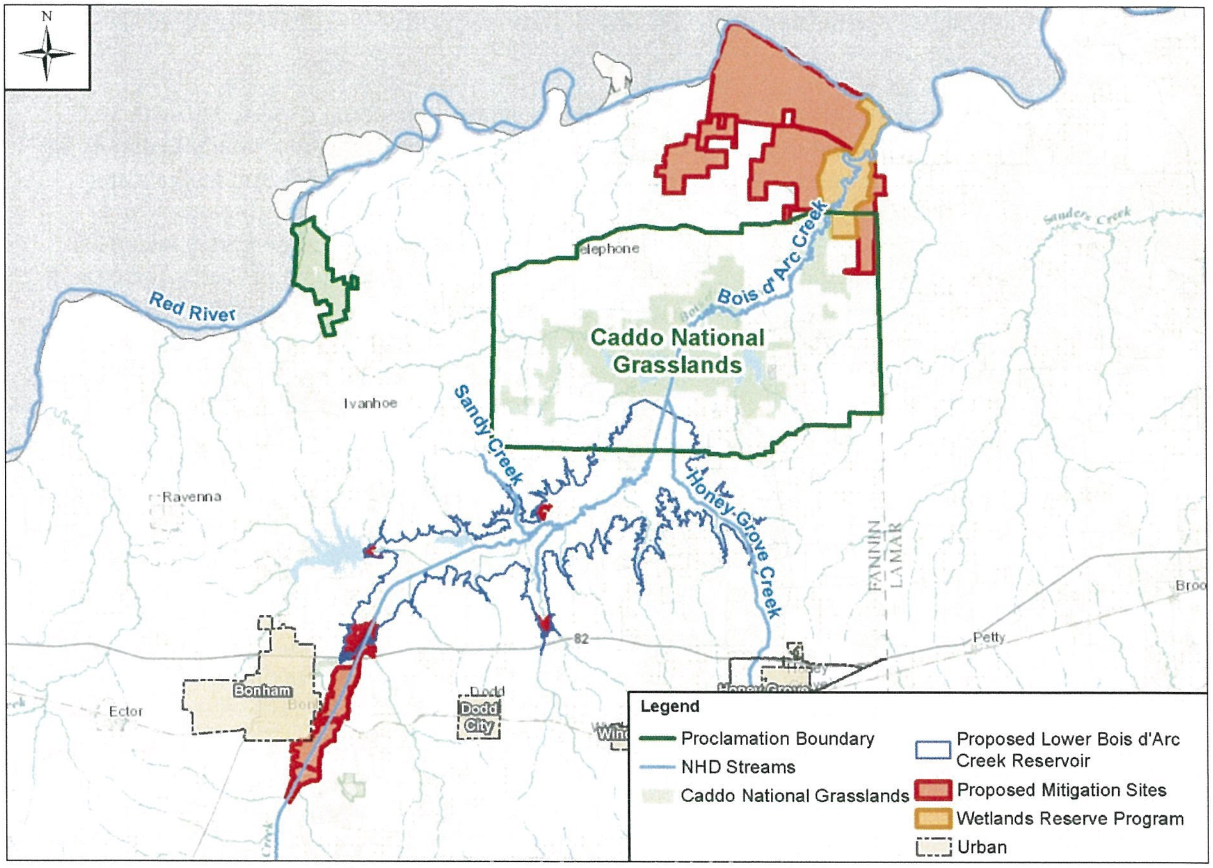


Figure 5.6-2. Potential Future Corridor of Protected and Connected Wildlife and Aquatic Habitats Along Bois d'Arc Creek

Statewide, the area of forested river and creek floodplain vegetation (i.e., bottomland hardwood forests and riparian vegetation) is estimated to have decreased from an original 16 million acres to 6 million acres at present (Texas Water Matters, 2012) as a result of dams/reservoirs and all other causes (e.g., clearing for agricultural purposes, channelization, urbanization, etc.). However, following the successful implementation of mitigation at the Riverby Ranch and other compensatory mitigation sites, neither Alternative 1 nor Alternative 2 would contribute to further net loss in the region or the state.

Impacts of Alternatives 1 and 2 on aquatic wildlife within the reservoir footprint would be adverse and beneficial, short-term and long-term, and of moderate severity. Within Bois d'Arc Creek downstream of the reservoir, long-term effects of the LBCR on aquatic wildlife are expected to be largely beneficial, due to the ability of water managers to control flows throughout the year and provide for continuous flow in the late summer months when (presently) there is often none.

Conclusion

Chapter 4 concluded that, overall, the impacts of Alternatives 1 and 2 on upland or terrestrial vegetation would be slightly adverse over the long term. However, with mitigation measures implemented, these impacts would be reduced. Once the reservoir habitats are established and stabilized, and Riverby Ranch and other mitigation site habitats have been fully developed, benefits for terrestrial and aquatic wildlife overall would likely have increased sufficiently as to offset and likely surpass the initial adverse effects, provided the mitigation goals and objectives set forth in the Revised Mitigation Plan (Appendix C) are achieved. Once proposed mitigation is taken into account, overall impacts to wildlife from Alternatives 1 and 2 would be both adverse and beneficial, and slight. No adverse effects to federally listed species are anticipated.

The cumulative impacts of all other reasonably foreseeable actions, including expected growth and development in the watershed and in Fannin County over the coming half century, would generally be negative for native vegetation and wildlife, as roughly 20,000 acres of rural lands and habitats are converted into developed areas. Certain species of vertebrates that are well-adapted to urban and suburban habitat settings – such as crows, robins, mockingbirds, cardinals, Canada geese, raccoons, squirrels, red foxes, and certain rodent and bat species – will not only survive but probably increase in number as human population density increases in the county. However, most species that are now common in the mix of farmland and woodlands that prevail across most of the county will probably experience population decreases or extirpation in the future. Thus, a net decrease in biodiversity is anticipated. An overall increase in the cumulative number of **invasive species** of both plants and animals is expected, as well as an increase in challenges and costs they impose.

Overall net cumulative effects on all biological resources from all reasonably foreseeable actions, including the Proposed Action, are expected to be adverse.

Wetlands and Waters

For analysis of cumulative impacts on waters of the United States, including wetlands, the study area is HUC 111401. However, it is worth starting with the State of Texas because data on wetlands are often compiled and aggregated state by state, but also because the values and functions of wetlands, especially as habitat for wildlife and migratory birds, are best considered on more extensive and ecosystem scales than the smaller scales of single watersheds or counties.

The USGS estimates that from the time of settlement through the 1980s, Texas lost approximately 52 percent of its original wetlands acreage. Wetlands comprise about 7.6 million acres of the state, or 4.4 percent of its area. The most widespread wetlands in the state are the bottomland hardwood forests and swamps of East Texas; the marshes, swamps, and tidal flats of the coast; and the playa lakes of the High Plains. The main causes of wetland losses are agricultural conversions, overgrazing, urbanization, channelization, water-table declines, and construction of navigation canals (Yuhas, 2013).

Statewide, as a result of dams/reservoirs and all other causes such as clearing for agricultural purposes, channelization, and urbanization, the area of forested river and creek floodplain vegetation (i.e., bottomland hardwood forests, forested wetlands, and riparian vegetation) in Texas is estimated to have decreased from an original 16 million acres to six million acres at present (Texas Water Matters, 2012). There are no comparable estimates for HUC 111401 in particular; however, the reduction in wetland area from pre-settlement times is likely to be considerable. This is due to the widespread presence within the HUC of hundreds of farms and ranches, many towns and roads, as well as several other large USACE reservoirs in Texas and Oklahoma, including the 5,940-acre Pat Mayse Lake (12 miles north of Paris, TX in Lamar County); 13,250-acre Hugo Lake (Choctaw County, OK); 3,750-acre Pine Creek Lake (McCurtain and Pushmataha counties, OK); 14,000-acre Broken Bow Lake (McCurtain County, OK) (Figure 5.6-3); and 14,360-acre Sardis Lake (Pushmataha and Latimer counties, OK).

Figure 5.6-3. Broken Bow Dam on the Broken Bow Reservoir on the Mountain Fork River in McCurtain County, Oklahoma, Built by the USACE in the 1960s

From Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact the study area's waters and wetlands include Bois d'Arc Creek channelization, other reservoir and pipeline projects, climate change, and the growth of Fannin and other counties and the DFW Metroplex. Specific projects and actions in the Oklahoma portion of the HUC (the majority of it) would be far too many to enumerate; however, population growth and associated development, agriculture, forestry, and other urban and rural activities could potentially affect wetlands generally and bottomland hardwoods in particular over the coming decades.

Conclusion

Total direct impacts to wetlands (forested, emergent, and scrub-shrub) and waters of the U.S. (streams and open waters) from the dam and reservoir would be 5,952 acres and 3,755 acres for **Alternatives 1 and 2**, respectively. The compensatory mitigation plan (see Appendix C) for Alternative 1 or Alternative 2 should result in no net loss of wetlands and should compensate for the loss of other waters of the United States. There are no other foreseeable reservoir projects within the HUC at this time.

Under both **Alternatives 1 and 2** – with mitigation – and the **No Action Alternative**, little or no contribution to cumulative adverse impacts on waters and wetlands in the HUC as a whole is anticipated. There would be no net loss, in keeping with national policy.

Aquatic Biota

The study area for the analysis of cumulative impacts on aquatic life in this EIS is Bois d'Arc Creek and its tributaries, from the upper end of the proposed reservoir site to its confluence with the Red River. The Index of Biological Integrity (IBI) is a measure of fish communities that includes components of species and trophic composition, abundance and condition. In surveys (Appendix M), IBI scores for fish community structure in Bois d'Arc Creek were Intermediate to High, with scores that increased longitudinally within the mainstem from upstream to downstream. Most fish species were generalists rather than fluvial specialists. The overall biological integrity of Bois d'Arc Creek's macroinvertebrate community was at the higher end of the intermediate range.

The effects of dam and reservoir construction on aquatic life in the reservoir itself and downstream would be both adverse and beneficial. Within the reservoir footprint, stream habitat would be inundated by the proposed reservoir and converted to lacustrine (lake-like) habitat. Diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently flooded are expected to change as a result of the reservoir, which would provide a permanent water source of variable depth in place of what is now a permanent, relatively shallow stream with little or no flow during later summer months and with intermittent tributaries. The reservoir would create both shallow and deep water lentic (still water) habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream (lotic or flowing water) habitats would be disadvantaged. The abundance of other species that are more generalist or versatile may be little changed.

The fish species composition after inundation is expected to shift towards more pool-associated species, largely composed of sunfish (Centrarchids), temperate bass (Moronidae), catfish (Ictalurids), and suckers (Catostomids). Fish species that are found only in rivers and streams would disappear from the reaches of Bois d'Arc Creek and its tributaries that were impounded. Adverse effects to the existing benthic macroinvertebrate community would also occur due to construction and inundation of the proposed dam and reservoir.

Both adverse and beneficial effects would be anticipated for aquatic life downstream of the proposed dam. The flow regime downstream of a reservoir can be substantially different than before the reservoir was built. The flow regime in the draft water right permit would maintain flowing water in the creek channel, provide for connectivity between pools, maintain existing aquatic habitat and communities, and protect water quality downstream.

Over the long term, the change in flow regime downstream from the proposed dam could negatively affect those fish species with narrower habitat requirements. These species use temperature or flow for reproductive cues, are substrate-specific spawners, and depend on higher flows for egg dispersal. However, because most fish species collected from Bois d'Arc Creek during the Instream Flow Study are habitat generalists, no adverse effects are expected on downstream fish communities and biodiversity as long as there is water flowing in the creek. The proposed flow regime for Bois d'Arc Creek downstream of the proposed dam would provide a sound ecological environment that would support the existing and future aquatic ecosystem environment. The macroinvertebrate communities downstream of the impoundment should not change greatly, as long as adequate flows are maintained.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact aquatic life in Bois d'Arc Creek and tributaries include channelization, reservoir and pipeline projects within the Bois d'Arc Creek watershed, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would contribute both adverse and beneficial cumulative impacts to the aquatic life of Bois d'Arc Creek, both within the segment that would be impounded (reservoir footprint) and within the segment downstream of the proposed dam. Overall, these net, long-term changes downstream would probably be more beneficial than adverse due to the ecological conditions that would likely result from the flow regime and releases outlined in the water right permit (included as Appendix F). Other actions within the Bois d'Arc Creek watershed in Fannin County, primarily the increase in non-point sources of pollutants and impervious surfaces associated with the development necessary to accommodate 64,000 new residents by 2060, would tend to have negative or adverse implications cumulatively for the diversity and abundance of aquatic life, both fish and benthic macroinvertebrates in Bois d'Arc Creek. While the **No Action Alternative** would avoid direct adverse and beneficial cumulative impacts resulting from the Proposed Action, it would not avoid adverse impacts from the anticipated increase in development within the watershed.

Upland Vegetation

The primary study area for the analysis of cumulative impacts on vegetation is Fannin County and all of Region C. The county is located in the Northern Post Oak Savannah Ecoregion, characterized by native bunch grasses and forbs with scattered clumps of trees, primarily post oak. At present, improved pastures, rangelands, and croplands make up the majority of this Ecoregion. Historically, fires and burns in the northern part of the East Central Texas Plains maintained grassy openings, but with the absence of fires, woody plants have taken over many of these grassy openings. Mixed native and introduced grasses and forbs on grassland sites or mixed herbaceous communities have resulted from the recent clearing of woody vegetation.

The proposed LBCR site is located on 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek. The vegetation and habitats on this site are described in detail in Section 3.4. The two most abundant vegetation communities occurring on the project site are bottomland hardwoods/forested wetlands and grasslands/old fields. If construction of the LBCR were to proceed, the entire acreage within the project site would be converted to open water, fringe wetlands, mudflats, and the dam and appurtenant facilities, as described in Section 4.6. Additional minor effects on vegetation would be associated with connected actions.

Unavoidable impacts to both bottomlands/wetland and upland vegetation from the LBCR would be mitigated at the Riverby Ranch mitigation site as well as around the perimeter of the completed reservoir. Impacts and mitigation are quantified in a series of studies, the results of which are shown in Section 4-6. Once compensatory mitigation has been carried out, most but not all net impacts would be eliminated. There would still be a net deficit of Habitat Units for upland deciduous forest, grassland/old field, and shrubland; however, these are not considered sensitive or rare habitats in Texas. There would be a surplus of riparian woodland /bottomland hardwood, emergent wetland, and shrub wetland (as measured by net change in Habitat Units).

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact Fannin County and Region C vegetation include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would have a long-term beneficial effect on some types of vegetation, particularly those associated with wetlands and waters of the U.S., and a minor, long-term, adverse effect on upland vegetation types. Cumulatively, as Fannin County's developed surface area expands to accommodate a population expected to more than double by the year 2060, all vegetation communities, particularly upland sites more amenable to building and not protected by regulations to conserve wetlands, are likely to decline. Similar trends would be expected in Region C as a whole. The proposed LBCR would not contribute to the growing cumulative pressure on wetlands-associated vegetation; however, it would contribute to a minor extent to the cumulative decline in upland vegetation associated with woodlands, ranching, and agriculture. The **No Action Alternative** would not contribute to any cumulative change in either wetland or upland vegetation; however, under this scenario there would still be a net decrease in natural vegetation in Fannin County and Region C, especially upland vegetation, associated with anticipated population growth and development.

Upland Wildlife

The primary study area for the analysis of cumulative impacts on terrestrial wildlife is upland areas within Bois d'Arc Creek watershed. Fannin County is located within the Texan Biotic Province. While several larger vertebrate species that once would have occurred here were extirpated long ago, upland and wetland habitats in this province, Fannin County, and the wider region as a whole, still support a wide variety of terrestrial vertebrates (mammals, birds, amphibians, reptiles) and invertebrates. Included are herbivores, omnivores, carnivores, insectivores. The reservoir site and surrounding habitats are characterized by wildlife typical to this part of Texas, including white-tailed deer, squirrels, raccoons, wild turkey, raptors, colonial waterbirds, songbirds, and other migratory birds. Common reptiles and amphibians are especially abundant in wetland habitats.

Adverse effects from the proposed LBCR on wildlife would be expected to be moderate in severity and long-term. During construction, terrestrial habitats at the dam site and within the cleared areas would be removed. Eventually the areas within the footprint of the reservoir would be converted to open water aquatic habitats.

Taking into account the proposed mitigation plan, overall impacts to wildlife from the Proposed Action would be adverse and beneficial as well as short-term and long-term. Over the long run, once the reservoir habitats are established and stabilized, and once Riverby Ranch mitigation site habitats have been fully developed, the benefits for wildlife overall would likely have developed sufficiently as to offset and perhaps surpass the initial adverse effects, provided that planned mitigation goals and objectives come to fruition.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact terrestrial wildlife include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would have medium-term adverse effects on existing wildlife and wildlife habitat by converting those existing habitats into another habitat type altogether (mostly open water). However, over the long term, the immediate adverse effects of the LBCR on wildlife in upland areas of the watershed would be offset by wildlife habitat restoration and improvement at the Riverby Ranch and other mitigation sites. Thus, the long-term net cumulative effect of the LBCR may be beneficial. In spite of these positive gains however, by 2060 there would likely be less terrestrial wildlife overall (both less abundance and less species diversity) within upland areas of the watershed than at present due to the need to develop existing wildlife-supporting habitats to support the expected addition of 64,000 more residents within Fannin County. The **No Action Alternative** would not contribute to adverse cumulative impacts on wildlife associated with growth and development; however, it would not prevent this growth and development from occurring.

State Threatened Species

The study area for the analysis of cumulative impacts on threatened and endangered species in this EIS is the Bois d'Arc Creek watershed (no federally-listed species are present). In terms of state-listed species, the Texas state-threatened blackside darter, blue sucker, creek chubsucker, and timber/canebrake rattlesnake may occur in the vicinity of the project and its connected actions. Several state-listed species of mussels may also be present. Long-term adverse impacts to the Texas state threatened blackside darter, blue sucker, creek chubsucker, timber/canebrake rattlesnake and one or more listed mussel species are possible due to the construction and inundation of the proposed dam and reservoir. Overall, potential adverse effects to all these species would be moderate in severity.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact threatened and endangered species include Bois d'Arc Creek channelization, the reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would not contribute to cumulative adverse impacts on federally threatened and endangered species in Fannin County. However, the dam, reservoir, and connected actions might adversely affect four state-listed species that could be present in the project vicinity. Other projects and general development expected within the county to accommodate the needs of 64,000 projected new residents by 2060 would also directly or indirectly cause adverse effects on these state-threatened species. Thus, overall expected cumulative impacts on state-listed species documented within Fannin County would be adverse and long-term. The **No Action Alternative** would not contribute to cumulative adverse impacts on state threatened and endangered species in Fannin County. However, cumulative adverse impacts could occur on these species due to expected growth and development of Fannin County.

Invasive Species

Ground disturbance and vegetation removal associated with the construction work of both **Alternative 1** and **Alternative 2** would increase opportunities for the spread of invasive species in the Bois d'Arc Creek watershed. Lake-based recreation in a new reservoir on Bois d'Arc Creek would facilitate and be adversely affected by the spread of aquatic invasive species. As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively affect invasive species include Bois d'Arc Creek channelization, reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex. The **No Action Alternative** would neither contribute to nor impede the spread of invasive species within the study area.

5.6.5 Air Quality

The study area for cumulative effects on air quality and climate change is the 19-county Air Quality Control Region (AQRC) 215. The cumulative assessment considers the construction and operation-related emission generated by the project alternatives in combination with the other actions identified in Table 5.6-1. AQCR 215 was selected as the area of effect for the cumulative impact analysis as the project alternatives are located within the AQCR and because air quality constituents and emissions sources are monitored, reported, and managed at the AQCR level.

According to EPA, Fannin County air quality is in attainment for all criteria pollutants. However, portions of the region are not in attainment for ozone (O_3).

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect air quality within the ROI include reservoir and pipeline projects, the

Center for Workplace Learning, North Texas Regional Airport, climate change, and the growth of Fannin County and the DFW Metroplex.

Dam/reservoir projects and pipeline construction and maintenance work would entail short-term, localized impacts to air quality during construction from tailpipe emissions of construction equipment, workers' vehicles, and fugitive dust. There would be short-term increases in criteria pollutants such as particulate matter, VOCs, NOx, and perhaps ozone. Other reasonably foreseeable projects would also result in similar types of emissions during construction. None of these projects, individually or in conjunction with each other, are likely to shift Fannin County or the ROI from attainment to non-attainment status even if occurring simultaneously.

Over the long term, both **Alternative 1** and **Alternative 2** would contribute small incremental amounts of air pollution if they become popular recreation destinations, both from tailpipe emissions of vehicles used by visitors to access these attractions, as well as from the use of outboard motors on boats. However, these would likely be negligible in a regional context. As the DFW Metroplex grows towards the north, this will have a much stronger influence on air quality trends. It will tend to degrade air quality, especially by increasing ozone concentrations, within Fannin County and the ROI as a whole. This would occur as a result of increasing vehicular traffic associated with a projected 64,000 new residents by 2060, and other emissions sources, such as fossil fuel fired power plants and industrial and manufacturing facilities. There would also be a large increase in the sources of VOCs, NOx, particulates emissions, and perhaps HAPs. However, at the same time, ongoing improvements in air pollution control technology both with regard to vehicular and power plant emissions could offset or even slightly reverse this trend, in spite of the increasing number of pollutant sources.

Conclusion

Chapter 4 concluded that overall, the impacts on air quality from **Alternative 1** and **Alternative 2** would be adverse and generally of slight severity, and of both short-term (construction) and long-term (operation) duration.

As the DFW Metroplex expands into Fannin County over the next 50 years, the increase in the number of vehicles and vehicle-miles-traveled (VMT) will increase emissions of criteria air pollutants, in particular VOCs and NOx, which would tend to degrade air quality within the county. However, continuing improvements in fuel efficiency (CAFE) standards and ever more stringent tailpipe emissions requirements would likely offset or even slightly reverse this trend. Overall, while there would likely be adverse effects on air quality, that is, lower average air quality in the future, the effects would likely not be significant, and the area is likely to stay in attainment for all criteria air pollutants.

Alternative 1 and **Alternative 2** would both contribute directly to these cumulative impacts only to a negligible or minor degree. The recreational features of the LBCR and the water supply it would provide could be an indirect cause of some of these cumulative impacts on air quality. The **No Action Alternative** would not directly contribute to any cumulative impacts on air quality in the ROI, but many of these same impacts would probably still occur due to regional growth.

5.6.6 Acoustic Environment (Noise)

The study area for cumulative effects on the acoustic environment was determined to be the area at and within the vicinity of noise generated by the alternatives in combination with noise generated by the other actions shown in Table 5.6-1. Because of the rural nature of the site under Alternatives 1 and 2, the assessment of cumulative effects included growth in Fannin County and the DFW Metroplex Area.

Neither Fannin County nor the State of Texas have noise ordinances. The City of Bonham has a nuisance noise ordinance that addresses common noises such as car radios, but not construction noise. According to Section 3.6.3, existing sources of noise near the proposed sites include typical noise sources associated with ranching and activities associated with Caddo National Grasslands and surrounding recreation areas including: rural roadway traffic, high-altitude aircraft overflights, farm equipment, and natural noises such as the rustling of leaves and bird vocalizations. In general, noise levels are typical of a rural setting, and existing noise is predominantly due to secondary roadways. In small towns such as Bonham and Honey Grove, as would be expected, higher existing ambient noise levels prevail.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect noise levels within Fannin County include the growth of Fannin County and the DFW Metroplex. Fannin County and the study area will become a noisier place in the future primarily as a result of projected growth and development and the associated increased presence and use of noise-generating machinery, from autos and light trucks to air conditioners, lawn mowers, and generators.

Conclusion

Chapter 4 concluded that Alternative 1 and Alternative 2 would have short-term and long-term slight effects on the acoustic environment. While most existing sources of noise within the reservoir footprint such as agricultural activities, automobile traffic, and lawn maintenance equipment would be eliminated, there is likely to be noise associated with long-term recreational and real estate development at and in the vicinity of the reservoir. However, these predicted increases in noise would not create areas of incompatible land use or violate any Federal, state, or local noise ordinance.

Overall, because of a substantial increase in the number of noise sources associated with projected population growth and development, Fannin County will likely be a noisier place in 50 years. **Alternative 1** and **Alternative 2** would contribute both directly and indirectly to this cumulative increase in noise levels; however, these impacts and noise levels would not be significantly adverse. The **No Action Alternative** would not contribute to the expected cumulative increase in future ambient noise levels in Fannin County.

5.6.7 Recreation

The study area for cumulative effects on recreation includes other recreation sites within Fannin, Collin, Hunt, Lamar, Grayson, and Delta Counties. This study area was based on the willingness of recreationists to travel to similar reservoirs as well as actions within the region that could result in loss of recreation opportunities similar to those that currently occur within the footprint of the reservoir site. The actions considered in cumulative assessment of effects on recreation resources are shown in Table 5.6-1.

The area of cumulative effect for recreation is Fannin County and the surrounding counties (Collin, Hunt, Lamar, Grayson, and Delta). This is considered the distance over which daily users of any recreation facilities developed at a future lake under Alternatives 1 and 2 would be willing to travel.

Recreation land within the reservoir footprint and pipeline route(s) provides non-commercial opportunities for recreation on individual private lands. Private landowners and their guests access the Bois d'Arc Creek for recreation activities such as boating, wildlife observation including bird watching, fishing, hunting (for deer, feral hogs, waterfowl, and dove), trapping, and enjoyment of scenic natural beauty. Another private recreation area in the immediate vicinity of the proposed reservoir is the Legacy Ridge Country Club which includes a clubhouse, residences and developments under construction and a 72-par golf course which winds into the wetlands of the Bois d'Arc Creek.

The six-county ROI contains a number of lakes and parks that provide outdoor recreation experiences including the Caddo National Grasslands, managed by the U.S. Forest Service.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact recreation within the ROI include Bois d'Arc Creek channelization, existing reservoirs, the two proposed Fannin County reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

Long-term cumulative impacts would likely occur because of the LBCR and LRH reservoirs operating in relatively close proximity, with both providing recreational opportunities such as fishing and boating. At this juncture it is impossible to predict whether they are likely to compete with or complement one another. In general, even if the two lakes compete with each other for recreational users at first, subsequent increases in demand for lake-based outdoor recreation that occurs as population in the region grows over time could eventually reduce or eliminate any competition. At some point, the proximity of the two facilities could become advantageous as a draw to visitors.

Conclusion

Chapter 4 concluded that recreational opportunities from **Alternative 1** and **Alternative 2** are likely to be moderately beneficial and long term. As the population and level of development in Fannin County increase, demand for recreational opportunities would be expected to increase. While the county's fishing and boating and other water recreation-related opportunities would be increased by the presence of two new lakes (LBCR and LRH), it is likely that hunting opportunities in Fannin County would decrease, because hunting is not generally compatible with higher human population densities due to safety concerns, and possibly, less game. Overall cumulative impacts on recreation from all actions would be generally beneficial, and the LBCR would contribute to these. A potential downside is that with 64,000 projected additional residents in Fannin County, and similar demographic trends in some of the other surrounding counties within the ROI (population increases from one million to 1.9 million in Collin County [2020 to 2060]; from 135,000 to 251,000 in Grayson County, etc.), some outdoor recreation sites and facilities could potentially face overcrowding, which would diminish the visitor experience. The **No Action Alternative** would contribute neither the adverse nor the beneficial, long-term and cumulative effects described above.

5.6.8 Visual Resources

The area of cumulative effect for visual resources is the viewshed at and in the vicinity of the project alternatives. The focus of this assessment is to identify the combined effects on the viewshed as a result of constructing the project alternatives in combination with projects constructed or planned in the vicinity. The other projects considered in this analysis are shown in Table 5.6-1.

Visual resource ratings for the entire proposed reservoir location range from moderate to least visual quality. The higher values are due to the presence of water at the creek site, as the scenic quality inventory ranks areas with water as visually more appealing.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact visual resources within the ROI include Bois d'Arc Creek channelization, the proposed LBCR, and the growth of Fannin County and the DFW Metroplex.

LBCR would cause a large change to the existing visual appearance of a part of Fannin County, which is now largely rural and agricultural. Over time, as the population of the county increases, its rural appearance would gradually fade as it becomes more developed and populous. In this scenario, the open space and "natural areas" represented by both lakes and their adjacent areas could become a valued asset of the county.

Conclusion

Chapter 4 concluded that, due to their size and salience, **Alternative 1** and **Alternative 2** (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources; however, whether this impact would be regarded as positive or negative, that is, whether it is a beneficial or adverse impact, would depend on the observer. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Bois d'Arc Creek as a loss outweighing any gain provided by a lake setting. Other individuals would regard the permanent addition of a lake to the landscape as an aesthetic asset to the community. Many members of the public are expected to appreciate both the aesthetic loss and the aesthetic gain.

As Fannin County's population grows and its developed land increases at the expense of rural countryside, cumulative effects on visual resources would be expected to be generally negative for most observers. However, in the more developed setting in the future, the LBCR and the open space surrounding it would represent a positive visual element, counteracting the overall degradation of visual resources that is typically associated with urbanization and loss of open space.

The **No Action Alternative** would not change the appearance of Bois d'Arc Creek or the surrounding area. Cumulatively, over the long run, by not developing a lake with a protected green perimeter, this alternative may deny future residents a positive visual element in a county that would be both more populous and more developed.

5.6.9 Utilities

The study area for the cumulative effects of utilities consists of Fannin County. The county was selected as the study area because the utility services affected by the project alternatives are local in nature and not part of a broader regional utility infrastructure. Utility services could be further adversely affected by the actions shown in Table 5.6-1.

Overhead power lines run within the vicinity of the proposed Lower Bois d'Arc Creek reservoir footprint. Utility corridors crisscross Fannin County in a number of locations in a manner reminiscent of most other counties in the United States.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively affect utilities within the ROI include the two proposed reservoir projects (LBCR and LRH), the Center for Workplace Learning, pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex. As Fannin County grows considerably more populous in the coming decades, the requisite utilities needed to accommodate this grow will proceed apace. A warmer climate may increase consumer demand for water and electricity (for air conditioning) over and above anticipated population growth.

Conclusion

No cumulative adverse impacts are expected from **Alternative 1, Alternative 2,** or the **No Action Alternative** because, as the county population grows, there will be more utilities and utility corridors of all types.

5.6.10 Transportation

The study area for the cumulative transportation effects assessment consists of Fannin County. The county was selected as the study area because the roadways affected by the project are local transportation routes and not part of a broader region or statewide transportation network. The capacity and condition of the local roadways could be further adversely affected by the actions shown in Table 5.6-1.

The proposed reservoir footprint is traversed by a number of roads and bridges and many of these would be impacted by the LBCR, especially FM 1396. As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact transportation within the study area include Bois d'Arc Creek channelization, past reservoir projects in the county, the two proposed reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

If the LBCR and LRH dam/reservoir construction projects were to occur simultaneously, which appears increasingly unlikely, there would be an additive, short-term adverse effect on transportation facilities and traffic. These are unlikely to be considered significant. With population growth and correspondingly increased vehicle miles traveled in the future, Fannin County will need to add capacity to its ground transportation network as do all areas in the process of growth and development.

Conclusion

Chapter 4 concluded that **Alternative 1** and **Alternative 2** would have short-term, moderate adverse effects on transportation and traffic, due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be mixed. After completing the proposed dam, the reservoir would close some secondary roadways, and motorists would be rerouted in some fashion. If construction of LBCR and LRH overlapped, short-term effects on traffic and transportation corridors could be exacerbated.

Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for roads not closed by the LBCR, such as a new highway and bridge (rerouting of FM 1396 and extension of FM 897) over the new reservoir. Effects would be of slight severity and last for many decades. Given the mitigation measures proposed to ameliorate these impacts, the long-term effects of the LBCR on transportation would be moderate.

Anticipated growth and development in Fannin County in the coming decades would bring about substantial cumulative effects in the county's road transportation network and traffic situation. Whether traffic congestion will be a significant problem in the future is impossible to predict due to the number of variables. What is certain is that there will be much more traffic than at present. The contribution of the proposed reservoirs to these cumulative effects related to transportation would be minimal.

The **No Action Alternative** would have no direct or indirect effects on transportation in Fannin County; however, many of the predicted cumulative effects related to increase traffic and a need for greater transportation infrastructure able to accommodate much larger traffic volumes will occur regardless.

5.6.11 Socioeconomics

The study area or region of influence for the cumulative socioeconomic effects assessment consists of Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties. This six-county study area was selected because the social and economic effects of constructing and operating the project alternatives are expected to occur outside of the immediate vicinity of the project as well as outside of Fannin County alone. In addition, the county-level assessment method was selected as socioeconomic data is typically reported at that level. The other actions occurring within the study area that may contribute to social and economic effects are shown in Table 5.6-1.

Construction Phase

If both the LBCR and LRH reservoirs are permitted, the construction timeframe of both reservoirs could overlap, although this appears less and less likely. In the case of simultaneous construction, the cost of materials, especially fuel and cement, could increase. However, this is considered unlikely because the amount of fuel and cement expected for both projects would not be considered very large relative to overall consumption in the region (LBCR would be an earthen dam with cement used primarily for the spillway). Future purchase agreements with construction contractors would lock the price of materials into place. A single contractor bidding on both projects, or two contractors bidding together on both projects, could drive down costs and increase efficiency. In this latter scenario, cost synergy – the opportunity of a combined corporate entity to reduce or eliminate expenses associated with running a business – would likely occur. Cost synergies are generally realized through economies of scale, whereby duplicate costs are eliminated.

The simultaneous construction projects would likely have subtractive effects to the overall economic activity figures of each project; and could simultaneously indicate a bigger indirect and induced impact. Water from LRH is estimated to generate more than $18 billion in economic benefits to Denton, Collin, and Dallas counties. The lake would also generate $148 million in economic benefits for the Fannin County area (UTRWD, 2005b). These figures (as well as the LBCR figures) likely double-count job creation and/or overstate potential economic impacts.

Property Taxes

Both NTMWD and UTRWD would make payments to Fannin County by agreement and in lieu of taxes. These payments would begin during the pre-construction period to offset the reduced tax rolls (and therefore tax revenue) that would be associated with the two proposed reservoirs. Payments would not cease until tax rolls returned to their pre-project level(s). The large amount of land that would be acquired for the two impoundment areas would otherwise create a significant loss in property tax revenue. With payments extending beyond both construction periods, no such losses would occur (McCarthy, 2017).

Operation Phase

Recreational Users and Revenue

Both proposed reservoirs are planned to provide recreational opportunities such as boating and fishing.

The Texoma Council of Government (TCOG) 2012 *Texoma Comprehensive Economic Development Strategy* affirmed the goal of promoting Lake Texoma as a tourism destination as well as supporting the region's associated tourist destinations such as historic and heritage sites, state parks, and refuges. According to the USACE, Lake Texoma attracts more than six million visitors per year and generates millions of dollars in tax revenue through associated spending in recreation activities, retail purchases, accommodations, and food service (TCOG, 2012). In light of the TCOG's goal, it can be assumed that the lakes created by the LBCR and LRH projects would be marketed in such a way as to capitalize on recreational revenues. However, it is unclear if an equal amount of marketing for the two proposed lakes would take place; and consequently if one would create disproportionately more revenue than the other (possibly at the expense of the other).

Because LRH is roughly 30 miles closer to Dallas than LBCR, visitors from the DFW Metroplex might be more attracted to LRH. However, the LBCR would be roughly three times the size of LRH so it might attract more recreationalists from further away. Both are adjacent to the Caddo National Grasslands; in fact, LRH would inundate approximately 250 acres within the 2,780-acre Ladonia Unit. The majority of the nearly 18,000-acre Caddo National Grasslands recreational area occurs within the Bois d'Arc Unit which is adjacent to – but would not overlap with – the proposed LBCR. One designated campground exists in the Ladonia Unit, compared to several in the Bois d'Arc Unit. The Bois d'Arc unit also includes campgrounds, multi-purpose trails, and boating on Coffee Mill Lake and Lake Crockett (see Figure 5.6-4). Therefore, the area near the Lower Bois d'Arc Creek Reservoir would offer more activities than the area near LRH, and thus could be more appealing to prospective anglers and boaters.

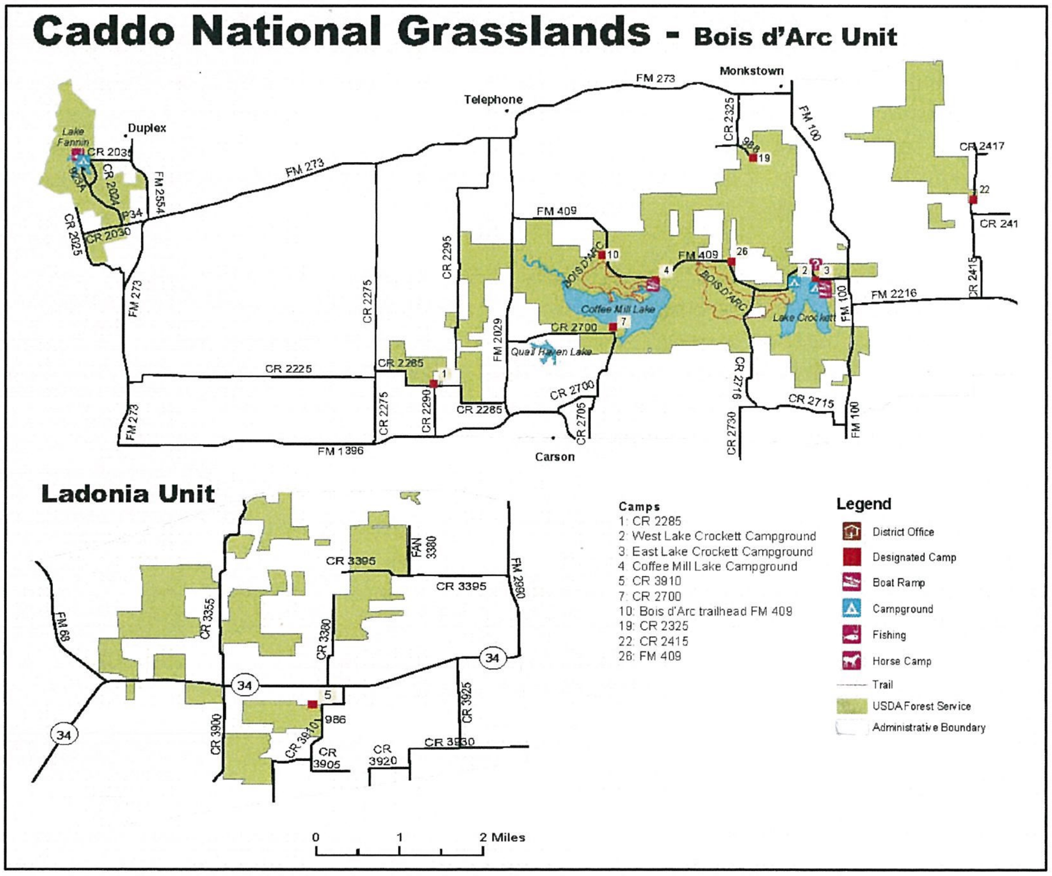


Figure 5.6-4. Caddo National Grasslands – Ladonia and Bois d'Arc Units

Source: USFS, no date

Regardless, the potential impacts from both reservoirs would likely be additive. That is, the increase in demand for certain goods and services would justify even more development in the form of commercial and residential real estate, sporting/boat/bait shops, restaurants, etc. There exists the risk of saturating the market to the point it no longer generates new demand for a set of products. This could occur due to competition, decreased need, or obsolescence; however, the aforementioned factors are unlikely to occur in the foreseeable future.

Tax Revenue

Real estate taxes from commercial and residential development around both reservoirs would increase the county's tax roll. Future tax receipts from oil and gas pipeline projects would also contribute to the increased tax revenues in Fannin, Lamar, and Grayson counties.

Social Impacts

Potential impacts from both reservoir projects to community cohesion and the quality of life in Fannin County could be adverse. Some of the opposition and controversy surrounding the two projects, as manifested in their planning and EIS scoping stages, is rooted in the belief that socially cohesive areas of small towns and rural lifestyles, which have experienced little change over the decades, would be subjected to social and cultural changes that would erode this cohesion over time. However, the population of Fannin County and surrounding counties in the study area are projected to grow enormously regardless of whether or not LRH or LBCR are built, due to the large-scale, long-term growth of the DFW Metroplex.

Lake Ralph Hall has drawn opposition from environmentalists, landowners, businesses, and some of the UTRWD's own members, including Flower Mound. In 2004, Flower Mound filed a lawsuit against the UTRWD over plans for a new treatment plant the town claimed was unnecessary. That suit was dismissed; however, the town kept fighting the project. It claimed that the UTRWD overbuilt infrastructure based on inflated population estimates. It has also raised questions about the district's financial condition (Hundley, 2012).

Conclusion

If the LBCR (either **Alternative 1** or **Alternative 2**) and LRH dam and reservoir construction projects were to occur simultaneously, a scenario that seems increasingly unlikely, there could be additive, short-term effects, both beneficial (from job and income creation) and adverse (from an influx of outside workers). Whether or not these effects would be synergistic is uncertain. If cost synergy occurs, the cost of materials, number of jobs, and overall potential economic activity would be reduced. However, lower costs for both projects could reduce the cost of water to customers as the annual amortization rate could diminish marginally. If other construction projects occurred simultaneously with either of the proposed dam and reservoir projects, these could further drive up the costs of labor and materials and reduce economic activity overall.

However, as noted in at the beginning of this chapter, it appears more and more likely that the two reservoir projects would occur sequentially rather than simultaneously, which would dampen and draw out socioeconomic effects, both beneficial and adverse.

Financing costs would potentially create cumulative impacts of moderate magnitude if job creation is double-counted and economic activity is overstated for each project. This cost-synergy scenario would also create beneficial impacts to NTMWD and UTRWD customers, as project costs would have been overstated and therefore projected water price increases as well. Decreased tax rolls in the short-term from property acquisition would be offset by both water districts making payments until the tax base has reached its pre-project level(s); in the long-term, both reservoirs would create additive, cumulative impacts. Additionally, tax receipts from various pipeline projects would add tens of thousands of dollars of annual revenue to Fannin, Lamar, and Grayson counties.

In the long-term, beneficial impacts from recreational revenue, and commercial and real estate development property tax revenue for both dam projects would be additive and significant. The two reservoirs would contribute to the stable economic development of Fannin and surrounding counties. Population growth and economic activity would be expected to be greater in the presence of the two projects than in their absence. Under the **No Action Alternative**, much population growth, change and development would still occur in Fannin County and the rest of the cumulative effects study area.

5.6.12 Environmental Justice

The study area for the cumulative effects on low-income or minority communities or populations is the same six-county region as for socioeconomic effects (Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties). Environmental justice populations on the basis of ethnicity are present in Honey Grove, Ladonia, and Bonham. In addition, Bonham constitutes an environmental justice population on the basis of low-income status. Chapter 4 (Section 4.15) showed that disproportionate EJ impacts would be negligible to minor for both minority and low-income populations. The other actions occurring within the study area that may also contribute to cumulative effects are shown in Table 5.6-1.

Conclusion

Any long-term cumulative effects from **Alternative 1**, **Alternative 2**, and LRH on environmental justice would be slight but likely beneficial (from increased economic and recreational opportunities). No cumulative effects on environmental justice are expected from the other reasonably foreseeable actions. The **No Action Alternative** would not result in any cumulative impacts on environmental justice.

5.6.13 Cultural Resources

The study area for the cumulative cultural resource effects assessment consists of Fannin County. The county was selected as the study area because the location and type of cultural resources similar to those within the project's Area of Potential Effect (APE) can be more accurately determined. The other actions occurring within the study area that may contribute to social and economic effects area shown in Table 5.6-1.

A 2010 Programmatic Agreement (PA) signed by four parties (NTMWD, USACE, SHPO, and the Caddo Nation of Oklahoma) governs all cultural resources investigations and analysis related to this project. The PA serves as a guidance document that will be relied upon by all parties to ensure that Section 106 requirements are met throughout the life of the project. It will ensure Section 106 compliance on a timeline independent of the EIS. The PA will be in place for a period of ten years from signing, and is renewable. An additional agreement document will be drafted and signed by the PA signatories that will outline mitigation or avoidance measures for all identified adverse effects.

In 2011 and 2013 surveys, a total of 61 archaeological sites (31 prehistoric, 26 historic, and four prehistoric/historic multi-component) and 26 isolated objects (IOs) were recorded in the APE of the Alternative 1 reservoir footprint. Most of the prehistoric and historic sites were not eligible for listing on the National Register of Historic Places (NRHP) or as State Antiquities Landmarks (SALs). However, 17 archaeological sites (both historic and prehistoric) were recommended for further testing and research to determine their eligibility. The Wilks Cemetery has an undetermined eligibility for listing on the NRHP, but would be relocated prior to the construction of the reservoir and would be evaluated for eligibility during that phase of the project. A total of 38 architectural resources were identified within the proposed LBCR boundaries. In addition, seven historic archaeological sites and one prehistoric artifact were documented during a pedestrian survey and intensive investigation of the LBCR pipeline (Davis et al., 2014).

Regardless of its NRHP status, measures to mitigate the adverse effect on Wilks Cemetery would consist of de-dedication of the cemetery by court order, removal of all human remains, markers, and any grave goods from the current location, and re-interment of these remains at a new perpetual care cemetery.

Two other cemeteries outside the reservoir footprint, but within the flowage easement, could also be affected. Measures to protect them could consist of construction of protective berms around the cemeteries to prevent temporary flooding or, alternatively, de-dedication of the cemetery by court order;

removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery.

Impacts to archeological sites of undetermined eligibility possibly requiring additional archeological testing to clarify their eligibility would include loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, and deterioration of organic remains.

In sum, without mitigation, both **Alternative 1** and **Alternative 2's** impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA. Impacts could be mitigated by such measures as archeological data recovery, exhumation of burials including possible repatriation of Native American burials, and/or site containment, stabilization, and/or capping of cultural deposits. Implementing mitigation measures, as appropriate, would reduce the level of impact on cultural resources in general to below the threshold of significance.

Both large reservoir projects (LBCR and LRH) and other construction projects in Fannin County would impact cultural resources, although both would need to reduce those impacts to below the threshold of significance in order to comply with federal and state laws. There is a continuing, cumulative loss of heritage resources in the area and elsewhere as a result of development, destruction, neglect, and natural processes such as weathering, erosion, and decay.

On the other hand, both Alternative 1 and Alternative 2 would also cause beneficial effects related to cultural resources. The LBCR project has triggered intensive research leading to the discovery of previously unknown cultural information that otherwise might have remained unknown and ultimately lost due to the natural processes associated with weathering and decay. Cultural resources investigations are continuing at the Riverby Ranch mitigation site. A vast amount of data, information, and artifacts will be collected, studied, and preserved. Future generations could possibly benefit from the information garnered from the cultural resource studies associated with the LBCR and its analysis.

Conclusion

Chapter 4 concluded that the impacts from **Alternative 1** and **Alternative 2** on cultural resources would be severe. There would be no direct or indirect impacts to cultural resources from the **No Action Alternative**. However, over the long term, any cultural resources within the reservoir footprint and mitigation sites would be largely unprotected by federal law because they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action Alternative are unknown.

There is an ongoing, cumulative loss of heritage resources in the county and elsewhere as a result of development, destruction, neglect, and natural processes such as weathering, erosion, and decay. With expected growth and development over the coming 50 years, these processes would be accelerated and the losses to cultural resources would be exacerbated. Thus, cumulative adverse impacts to cultural resources would be considered major, and the proposed LBCR would contribute to these major adverse impacts. However, the proposed LBCR has already, and will continue to, trigger the collection of a large amount of information and knowledge about Fannin County's cultural resource legacy. Cumulatively, in the coming decades, the opposite and contradictory trends of ongoing or accelerating cultural resource degradation and destruction, on the one hand, and increasing discovery, mitigation, protection, and knowledge, on the other, are both expected to continue.

Table 5.6-1. Cumulative Impacts Associated with Lower Bois d'Arc Creek Reservoir

		Past Actions								Reasonably Foreseeable Future Actions						
Resource	Area of Cumulative Effect	Bois d'Arc Creek Channelization	Lake Bonham	Valley Lake	Coffee Mill Lake	Lake Davy Crockett	Center for Workplace Learning	North Texas Regional Airport	Pipeline Maintenance	Lake Ralph Hall	Climate Change	Growth of Fannin County	Growth of DFW Metroplex	Marvin Nichols Reservoir	George Parkhouse Lake (North)	George Parkhouse Lake (South)
SOILS																
Soils and Geology	Fannin County	X							X							
Prime Farmland	Fannin County	X										X	X			
WATER RESOURCES																
Surface Water Hydrology	Bois d'Arc Creek and portions of Red River Basin[a]	X	X	X	X	X			X	X	X	X	X			
Water Quality	Bois d'Arc Creek and portions of Red River[a]	X			X	X			X	X	X					
Groundwater	Bois d'Arc watershed	X			X	X			X		X	X	X			
BIOLOGICAL RESOURCES																
Wetlands and Waters	HUC 111401	X	X	X	X	X			X		X	X	X			
Aquatic Biota	Bois d'Arc Creek and tributaries	X	X		X	X			X		X	X	X			
Upland Biota (Vegetation and Wildlife)	Upland areas within Bois d'Arc Creek watershed		X		X	X			X		X	X	X			
State-threatened Species	Bois d'Arc Creek watershed	X	X		X	X			X		X	X	X			
Invasive Species	Bois d'Arc Creek watershed	X	X		X	X			X		X	X	X			
AIR QUALITY AND CLIMATE																
Air Quality	AQCR 215[b]							X	X	X	X	X	X			
Climate			X	X	X	X				X		X	X	X	X	X

		Past Actions								Reasonably Foreseeable Future Actions						
Resource	Area of Cumulative Effect	Bois d'Arc Creek Channelization	Lake Bonham	Valley Lake	Coffee Mill Lake	Lake Davy Crockett	Center for Workplace Learning	North Texas Regional Airport	Pipeline Maintenance	Lake Ralph Hall	Climate Change	Growth of Fannin County	Growth of DFW Metroplex	Marvin Nichols Reservoir	George Parkhouse Lake (North)	George Parkhouse Lake (South)
ACOUSTIC ENVIRONMENT (NOISE)	Areas of elevated noise during construction and operation											X	X			
RECREATION	6-county ROI[c]	X	X		X	X				X		X	X		X	X
VISUAL RESOURCES	Viewshed of Alternatives 1 and 2		X		X	X						X	X			
LAND USE	Fannin County	X	X	X	X	X			X	X		X	X			
UTILITIES	Fannin County						X	X		X	X	X	X			
TRANSPORTATION	Fannin County						X	X		X		X	X			
SOCIOECONOMIC IMPACTS	6-county region[c]	X	X	X	X	X	X	X		X		X	X		X	X
ENVIRONMENTAL JUSTICE	6-county region[c]						X			X		X	X		X	X
CULTURAL RESOURCES	Fannin County	X	X	X	X	X			X	X		X	X			

[a] Bois d'Arc Creek and portion of Red River downstream of confluence.

[b] 19-countyAir Quality Control Region.

[c] Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties.

BDC = Bois d'Arc Creek

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8.0 INDEX

I

J

L

M

N

O

P

R

S

T

APPENDIX A: PERSONS AND AGENCIES CONSULTED

APPENDIX A – LIST OF PERSONS AND AGENCIES CONSULTED

Person	Affiliation
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APPENDIX B: SCOPING REPORT

Lower Bois d'Arc Reservoir EIS
Scoping Report

May 2010

Prepared by the Mangi Environmental Group

for the

U.S. Army Corps of Engineers
Tulsa District

Table of Contents

1. Introduction

On Friday, 13 November 2009, in the *Federal Register* (Vol. 74, No. 218, pp. 58616-58617), the U.S. Army Corps of Engineers, Tulsa District (USACE) published a Notice of Intent (NOI) to prepare an EIS for the proposed construction of Lower Bois d'Arc Creek Reservoir in Fannin County, Texas. This NOI (Attachment A) was published subsequent to the USACE receiving an application for a Department of the Army Permit under Section 404 of the Clean Water Act (CWA) from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir.

In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.), the USACE determined that issuance of such a permit may have a significant impact on the quality of the human environment. Therefore, the USACE decided to require the preparation of an Environmental Impact Statement (EIS).

Within NEPA, scoping is the process by which a lead agency charged with carrying out a NEPA analysis and preparing an EIS or an Environmental Assessment (EA) determines the scope of the document, that is, which topics, issues, alternatives, and potential impacts it will address. During the scoping period, all interested public agencies and citizens are encouraged to let the lead agency know what they think the EIS should cover.

On the afternoon and evening of 8 December 2009, the USACE conducted a public scoping meeting in the Fannin County Multi-Purpose Complex in Bonham, Texas. This meeting was advertised beforehand in the online and print editions of a local newspaper (*Bonham Journal*), local radio stations, and by means of a public notice issued by the USACE (Attachments B and C). The format of the meeting was that of an "open house." At their leisure, attendees could pass through the large facility looking at exhibits, maps, reports, and information arranged on tables. They could also speak informally and at length with representatives of the USACE, the Texas Commission on Environmental Quality (concurrently conducting a public meeting on the 401 water quality certification associated with the 404 permit application), NTMWD, and contractors/consultants working for the USACE and the NTWMD. In addition, they could submit written comments on a comment form as well as on a diagram depicting phases and elements of the proposed action. Approximately 100 people participated in this event (Attachment D).

On the next day, 9 December 2009, the USACE held an inter-agency scoping meeting in Wylie, TX. Representatives of a number of federal and state agencies were in attendance. Attachment E is the attendee list for this meeting. Attachment F is notes from this agency meeting. Several concerns and issues were mentioned verbally by agencies in this meeting that do not appear in Table 2 on the following pages, among them the following:

- cumulative impacts from concurrent construction of Lake Ralph Hall (also in Fannin County)
- cumulative impacts on water flows in the Red River downstream of the proposed Lower Bois d'Arc reservoir project when considered in conjunction with consumptive water use

in "hydrofracking" [hydraulic fracturing] for natural gas extraction from the Haynesville Shale formation

- effects of the proposed action on the spread of terrestrial invasive species, particularly Chinese tallow, salt cedar, and tree-of-heaven.
- the need for a lakeshore management plan to protect water quality in the lake, and
- possible impacts on U.S. Forest Service plans to restore Lower Bois d'Arc Creek in its original channel at the Caddo National Grasslands downstream of the project site.

2. Issues Raised in Scoping

During scoping, members of the public and public agencies broached a wide variety of issues and topics related to the proposed action – reservoir construction and operation. Tables 1 and 2 show this diversity of opinions and topics. Table 1 lists comments that members of the public were invited to write with magic markers onto several large posters depicting flow diagrams, or more properly, C-E-Q (Cause-Effects-Questions) diagrams, which were prominently displayed on tables at the public scoping meeting in Bonham on December 8, 2009.

Table 1 – Comments/questions written onto C-E-Q Diagram* at public scoping meeting

SHEET #1 OVERVIEW – LOWER BOIS D'ARC CREEK DAM AND RESERVOIR	
Box(es) in C-E-Q Diagram	**Comment or Question**
Dam and Reservoir	What are the local economic implications?
Clearing trees	How many trees?
Facility Construction	Who?
Recreational facilities	What kind?
Facility Operation	Who?
Water supply	Needed. 2060 is around the corner
Recreation	What kind? How much $?
Plugging water wells	Oil and gas wells?
[New box added by commenter]	Wastewater treatment
Raw Water Transmission Line	Who does this effect? [sic]
New Water Treatment Plant	Cost?
Alternatives to Proposed Action	Recycle/Reuse? [New box added by commenter]
Ogallala Aquifer Alternative	Won't have for too much longer!
Water conservation alternative	[Commenter changed to: Water conservation alternatives] Why not?
SHEET #2 SITE PREPARATION	
Box(es) in C-E-Q Diagram	**Comment or Question**
Equipment and Workers	Will local contractors and people be first in line for contracts?
Increasing housing needs?	Exceed school capacities Increase Fannin County land taxes
Disposal of construction waste	Where?
Burning of waste	What?
Exceed landfill capacity	What?

Harm wildlife/vegetation?	What happens to the endangered wildlife?
Construction of access roads	Where? Impact?
SHEET #3 SITE PREPARATION	
Box(es) in C-E-Q Diagram	**Comment or Question**
Clearing and grading	Local contractors given contracts first?
Loss of prime farmland?	*First commenter*: We still have lots left! *Second commenter*: I disagree
Loss of tax revenue?	To Fannin, Lamar, Collin, Grayson, Bryan counties
SHEET #4 FACILITY AND DAM CONSTRUCTION	
Box(es) in C-E-Q Diagram	**Comment or Question**
Equipment layout site – Harm wildlife/vegetation?	Bears, eagles, timber rattlers, American burying beetle
SHEET #5 FACILITY CONSTRUCTION – RESERVOIR IMPOUNDMENT	
General comments on this sheet: *First commenter*: Most people I know are 100% for the lake. *Second commenter*: You do not know very many people.	
Box(es) in C-E-Q Diagram	**Comment or Question**
Downstream – Decrease water flow?	Big Time Compromise existing irrigation systems
Decrease stream level?	Especially during drought
Change water chemistry?	Decreased water flow in Bois d'Arc will eventually change chemistry especially salinity
Change groundwater hydrology?	Will it?
Impoundment area	Evaporation? [New box added by commenter]
Sediment loading from upstream?	How much?
Block migration of terrestrial wildlife?	Where will they go?
Isolate populations?	Decrease areas for beef production Farm production? DFW FOODSHED?
Impact fisheries?	Due to increased salinity from Red River backflow Mussels
Upstream	Flooding of creek bottoms & farms? Will this lead to construction of Upper Bois d'Arc Reservoir?
Leaching of metals and minerals?	Residual pesticides from agricultural use of land?
Degrade water quality?	Inflows from sewer treatment and plants City of Bonham landfill (currently closed) County Road 2935.

*A C-E-Q (Cause-Effects-Questions) Diagram is like a flow chart with boxes and arrows connecting these boxes, which together depict elements of the proposed project and possible impacts of those elements.

Table 2 summarizes all written comments received by the USACE from both the public and agencies during the scoping comment period. These comments were furnished in several different modes: 1) on comment forms available at the public scoping meeting; these forms could be filled out and dropped into a box or mailed later; 2) emails sent to the USACE; and 3) hard copy letters mailed to the USACE.

The USACE received a total of 84 comment forms, emails, and letters submitted by more than 100 individual citizens and agencies. Several individuals sent more than one comment form, email or letter. Each form, email or letter contained multiple comments on different issues, sometimes many dozens of issues. Each of these was tallied as a separate "comment" on that given issue or topic. For example, Table 2 indicates that 33 separate commenters covered the topic "Impacts on native wildlife species and habitat." Even if a given commenter made more than one remark or observation concerning wildlife species and habitat, this was still tallied just one time for that commenter.

Table 2 needs the following disclaimer: During the review of submitted comments, attempts have been made to identify distinct topics and associate similar comments. While we are confident that all issues raised during the scoping process appear within the following table, the tabulation of numbers of commenters raising a particular issue implies precision that does not truly exist, as comments were expressed in similar form but may have emphasized different aspects of a particular issue.

By way of example, two commentors may have raised concerns for impacts to existing cemeteries or burials. In one instance, the emphasis may have been on potential flooding risks whereas in another comment, emphasis may have been on the unknown historical values at risk. Consequently, the numbers in the following table should be considered approximate and reflect a proportional level at which the issue was shared by other commentors. The numbers should be considered a rough gauge of how widely a listed concern is shared by the public.

Table 2 – Issues Raised in Written Scoping Comments

Topics and related comments	**Number of commenters who cited**
Air Resources	
• Increased water surface & subsequent evaporation from all existing and planned reservoirs may increase humidity in region	3
• Effects on air quality and greenhouse gas emissions	1
Alternatives	
• Reservoir is unnecessary and better alternatives are available	10
• Each alternative needs to include water conservation	3
• Pipeline(s) from existing reservoirs would be cheaper & better option	3
• Water conservation and reuse is better alternative	2
• Mitigation needs and costs for each alternative should be identified	2
• Desalination plant at Gulf to tap into inexhaustible water of ocean	2
• Identify the least environmentally damaging alternative (LEDPA)	1

Topics and related comments	Number of commenters who cited
Alternatives (cont.)	
• Consider combinations of alternatives	1
• Groundwater alternative – Carrizo-Wilcox formation is renewable	1
• Oklahoma has "vast water resources"	1
• Obtain water from Red River itself	1
• Dam the Trinity; it's closer to Dallas and would provide more recreation	1
• Higher water pricing will curtail water use	1
• More water could be desalinated from Lake Texoma	1
• NTMWD doesn't actively encourage water conservation because it would lose money	1
• Is there a practicable alternative with less adverse impact to jurisdictional waters?	1
• Why are other existing reservoirs rejected solely on basis of cost?	1
• Need for reservoir not established	1
Biological Resources	
• Impacts on native wildlife species and habitat	33
• Spread of invasive species, e.g. zebra mussel, hydrilla, feral hogs	9
• Endangered, threatened, rare species and habitats	8
• Impacts on trees and bottomland/riparian forests	7
• Impacts to Louisiana black bear	3
• Impacts to American burying beetle	3
• Removal of timber from areas being purchased for reservoir	3
• Effect on Caddo Grasslands and its wildlife	2
• Displaced wildlife will compete with existing wildlife on other sites	2
• Impacts to timber rattlesnake	2
• Importance of ensuring that mitigation areas adequately replace lost area	2
• Impacts to rare plants	1
• Impacts to bald eagle	1
• Impacts to wild turkey & habitat	1
• Impacts to migratory birds	1
• Impacts to fisheries	1
• Impacts to cougars	1
• Impacts to state-listed freshwater mussels	1
• Proposed mitigation site does not have same habitat as Lower Bois d'Arc Creek	1
• State-listed species	1
• Wildlife will get mired in mudflats	1
• Aquatic life below the reservoir and means of minimizing adverse impacts	1
• TPWD has creek as an Ecologically Significant Stream Segment	1
• Need to develop a mitigation plan to offset unavoidable impacts	1
• Mitigation ratio	1

Topics and related comments	Number of commenters who cited
Cultural Resources	
• Impacts to Indian artifacts or burial sites	11
• Impacts to unmarked slave and pioneer cemeteries	9
• Damage to historic/cultural/archeological properties	7
• Camp Benjamin Confederate Soldiers near former Onstatt Lake	4
• Need for surveys given high cultural resource potential of area	1
• Paleontological resources (e.g. sharks teeth)	1
• Historic farmhouses	1
Geology and Soils	
• Possible oil and gas resources beneath reservoir footprint	5
• Permanent loss of fertile, productive soils	2
Human Health and Safety	
• Increase in disease vectors, e.g. mosquitoes	7
• Health in jeopardy	1
• Traffic control, police coverage, emergency access	1
• Health risks from chemicals used to control mosquitoes and aquatic weeds	1
• Emotional stresses on the local population	1
Land Use	
• Zoning effects on property rights and lakefront development	8
• Fate of mitigation land (Riverby property)	6
• Adverse impact to Legacy Ridge golf course and Country Club	4
• County's best farmland is in reservoir footprint	3
• Loss of acreage for beef production	2
• Public infrastructure and utilities	1
• Areas will be made inaccessible	1
• Who enforces Rural Property Protection Act?	1
• Purpose of land purchase near Leonard	1
Recreation	
• Shallow &fluctuating lake will not be conducive to aquatic recreation opportunities	10
• Impact on existing hunting opportunities	5
• Added recreational opportunities in county	1
• Encourage development of scuba park/training area in reservoir	1
• Impact on existing recreation opportunities and potential for future ones	1
Socioeconomics	
• Adverse impact to agricultural economy & livelihoods in county	29
• Less tax revenue to county and heavier tax burden on remaining residents	23

Topics and related comments	Number of commenters who cited
Socioeconomics (cont.)	
• Displacement of multi-generational residents, farmers and ranchers; loss of farming/ranching/rural heritage	20
• Reputed recreational & related economic benefits are questionable because of fluctuating lake level and shoreline, mudflats, etc. – look at other reservoirs in area where claimed benefits have not been realized	17
• Losing own home, land, and/or job	9
• Lost food production and its economic value	8
• Will benefit Lake Lavon (by maintaining water level) and its residents at expense of Fannin County residents	8
• Project will encourage beneficial local economic development	7
• New reservoir won't be able to compete with established lakes that already offer high-quality recreational experience & real estate properties	7
• Eliminating family businesses	4
• Culture of area will change against wishes of longtime residents due to influx of outsiders who don't share values; social cohesion eroded	4
• Landowner compensation needs to be fair, by purchasing entire, not partial, properties	4
• Cost of relocation	2
• Direct, indirect and cumulative impacts of economic development stimulated by the lake	2
• Lakefront zoning effects on property rights and quality of development	2
• Project will undermine economic prospects of Fannin County	2
• This project will be detrimental to cattle production	2
• Tax revenues will increase because of project	1
• A few people will make a lot of money	1
• Crime will worsen	1
• Reservoir will provide for increased population in service area	1
• Water from reservoir will be used to hold cost down	1
• Life of Woodbine Aquifer will be extended due to reservoir	1
• NTMWD's acquisition of all water rights in basin will prevent cattle production, which needs irrigation, from expanding	1
• Loss of revenue stream from timber harvest over time	1
• Loss of revenue from hunting and fishing	1
• Impacts on Sam Rayburn ISD	1
Transportation	
• Potential for adverse effects on existing roads and bridges	3
• Effects on private roads	1
• Traffic and control	1
• Opening Red River to barges and freight traffic	1
• Navigation potential of Red River may be compromised from lower flow	1

Topics and related comments	Number of commenters who cited
Utilities	
• Who is responsible for rerouting infrastructure during construction?	2
• Issues arising from NTMWD's demand for electricity to pump water	1
Water Resources	
• Water is being wasted and needs to be conserved	23
• Concerned that reservoir may cause flooding in Bonham, along tributaries, and upstream areas	19
• Fluctuating lakeshore and resultant unattractive mudflats	12
• Limited viable lifetime of reservoir (storage capacity loss over time from siltation)	11
• Shallow depth of reservoir/reservoir only partially full much of year	7
• Benefit of adding more water supply/additional water will be needed	7
• Impacts on wetlands and their values and functions	5
• What is the scope and purpose of the reservoir?	5
• Taking Fannin County's water	3
• Hydrological and ecological effects upstream and downstream	3
• Ill-suited site for reservoir because of low gradient	3
• Will deep water well systems have to move to this surface supply?	3
• Lake evaporation rate and losses	2
• Reducing availability of water for neighbors downstream	2
• Cumulative impacts on aquatic resources over time, including Red River	2
• Impacts of the pipeline on water resources at stream crossings	2
• Continuation of existing irrigation rights	2
• How much water will Fannin County have access to?	2
• Impact on farmers downstream on Bois d'Arc who use it for irrigation	2
• How realistic are yield projections?	1
• Is it necessary for each house to have a swimming pool?	1
• Reservoir will reduce flooding	1
• Inter-basin transfer of water is good	1
• Backflow from Red River will increase Lower Bois d'Arc salinity	1
• Do groundwater rights go with surface water rights or are they separable?	1
• Does water right condemnation to build lake require taking flood easement and/or groundwater?	1
• Potential for shoreline erosion due to alignment of lake with SW winds	1
• Impacts of pipeline at stream crossings and wetlands	1
• Impacts of reservoir itself on wetlands and waters of the U.S.	1
• Existing condition of Pilot Grove Creek and impacts of inter-basin transfer	1
• Will citizens be allowed to use their own groundwater?	1
• Impacts of project on flood attenuation and nutrient storage services provided by existing wetlands	1
• Changes in volume and frequency of upstream and downstream flows	1
• Mitigation Plan for biological and wetlands resources using HEP	1

Topics and related comments	Number of commenters who cited
Water Quality	
• Poor water quality in reservoir from upstream pollutants	17
• Upstream wastewater treatment plant discharges (treated & raw sewage)	10
• Effects of chemical (arsenic) residues from cotton farming	9
• Impact of reservoir on water quality of private wells nearby	6
• Old VPG plant contaminants	5
• Impact on underground sewer and septic systems	4
• Effects on Woodbine, and by extension, Whiteshed Water and Bois d'Arc Mud water systems	3
• Water from lake will be unreliable, of lower quality and cost more	2
• Lake likely to become hog wallow; effects on WQ?	1
• Effects of trihalomethanes from decomposing tree tops	1
• Threat of water contamination from MTBE (gasoline additive)	1
• Unacceptable odors in water	1
• Will ranchers be allowed to water their cattle in the lake?	1
• Releases from dam to downstream creek will be lower temp. & oxygen	1
• Maintenance of water quality during and after construction	1
• Existing water quality in Pilot Grove Creek and effects of adding water transferred from Lower Bois d'Arc Creek	1
• Stagnant, shallow water in reservoir	1
Miscellaneous comments on process and preferred outcome*	
• Project and lake will be negative for county	8
• Project and lake will be positive for county	7
• USACE previously denied this project, proving it does not make sense; why is USACE reconsidering it?	6
• NTMWD is treating landowners fairly in purchasing their properties	4
• Need 3rd party study of who really gains and loses from reservoir	4
• NTMWD is treating landowners unfairly	3
• NTMWD purchasing land without approved permit	2
• Unduly lengthy approval and permitting process	1
• Reservoir opponents are stubborn and resist change	1
• Local residents believe project is being pushed on them	1
• Stop this atrocious infringement upon the rights and liberties of county citizens	1
• Wants to delay or prevent project	1
• Majority of county residents opposed to project	1
• Majority of county residents support project	1
• Lack of communication with NTMWD	1
• If homes are flooded many lawsuits will be filed	1
• Lower Bois d'Arc Creek should be preserved as a wilderness area	1
• Rights are being trampled and due process is just a formality	1

*These miscellaneous comments were received by the USACE and are here documented in this scoping report, but are not necessarily within the scope of topics to be covered in the EIS, which by the NEPA statue and CEQ regulations considers potential environmental consequences.

3. Main Issues and Topics Raised in Scoping

Table 3 lists the top issues/topics from Table 2, as cited by the members of the public and governmental agencies. These are a gauge of the highest priority concerns that agencies and the public feel need to be addressed in the EIS.

Table 3 – Top Issues Raised by Proposed Lower Bois d'Arc Reservoir

Place	Issue/Topic	Number of commenters who cited
1	Impacts on native wildlife species and habitat	33
2	Adverse impact to agricultural economy & livelihoods in county	29
3	Reduced tax revenues to county and heavier tax burden for remaining residents	23
3	Water is being wasted and needs to be conserved	23
5	Displacement of multi-generational residents, farmers and ranchers; loss of farming/ranching/rural heritage	20
6	Concerned that reservoir may cause flooding in Bonham, along tributaries, and upstream areas	19
7	Reputed recreational & related economic benefits are questionable because of fluctuating lake level and shoreline, mudflats, etc. – look at other reservoirs in area where claimed benefits have not been realized	17
7	Poor water quality in reservoir from upstream pollutants	17
9	Fluctuating lakeshore and resultant unattractive mudflats	12
10	Impacts to Indian artifacts or burial sites	11
10	Limited viable lifetime of reservoir (storage capacity loss over time from siltation)	11
12	Shallow &fluctuating lake will not be conducive to aquatic recreation opportunities	10
12	Upstream wastewater treatment plant discharges (treated & raw sewage)	10
14	Effects of chemical (arsenic) residues from cotton farming	9
14	Spread of invasive species, e.g. zebra mussel, hydrilla, feral hogs	9
14	Impacts to unmarked slave and pioneer cemeteries	9
14	Losing own home, land, and/or job	9
18	Endangered, threatened, rare species and habitats	8
18	Zoning effects on property rights and lakefront development	8
18	Lost food production and its economic value	8
18	Will benefit Lake Lavon (by maintaining water level) and its residents at expense of Fannin County residents	8
22	Impacts on trees and bottomland/riparian forests	7
22	Increase in disease vectors, e.g. mosquitoes	7
22	Damage to historic/cultural/archeological properties	7

22	Project will encourage beneficial local economic development	7
22	New reservoir won't be able to compete with established lakes that already offer high-quality recreational experience & real estate properties	7
22	Shallow depth of reservoir/reservoir only partially full much of year	7
22	Benefit of adding more water supply/additional water will be needed	7

It should be emphasized that this particular delineation/breakdown of issue topics is somewhat arbitrary. Thus, this particular ordering of priority issues is also somewhat arbitrary. Nevertheless, from a close examination of the wide diversity of hundreds of comments received by citizens and public agencies during the Lower Bois d'Arc Reservoir scoping process it is clear that the main concerns relate to: 1) possible impacts on wildlife and habitat; 2) socioeconomic impacts on the area's residents and agricultural economy and fiscal impacts on county government and services; 3) water conservation and quality; 4) flooding; 5) the possibility of overstated economic and recreational benefits due to the proposed lake's shallow depth, allegedly fluctuating shoreline, and limited useful life; and 6) possible impacts to cultural resources. The EIS will address these issues and concerns.

The EIS will also address the significant issues raised by written comments the USACE received in response to the Public Notice on the original 404 permit application. As noted in the attached NOI (Attachment A to this Scoping Report):

> Issues to be given analysis in the EIS are likely to include, but will not be limited to: The effects of the lake on the immediate and adjacent property owners, nearby communities, downstream hydraulics and hydrology, wetlands, surface water quality and quantity, groundwater quality and quantity, geological resources, vegetation, fish and wildlife, federally-listed threatened and endangered species, soils, prime farmland, noise, light, aesthetics, historic and pre-historic cultural resources, socioeconomics, land use, public lands, public roads, air quality, and the effects of construction of related facilities.

The USACE verbally reiterated these issues at the outset of the 9 December 2009 agency scoping meeting in Wylie, TX, stating:

> Things the USACE sees [being covered in the EIS] include, but are not necessarily limited to: the magnitude of the project; its impacts on landowners and livelihoods; impacts on forested wetlands and other wetland habitats and other aquatic resources; mitigation of projected wetland losses; impacts on downstream lands including riparian forest lands, U.S. Forest Service (USFS) Caddo National Grasslands, social and economic impacts (e.g., roads); changes to downstream flow regime; conversion of agricultural lands to lakebed or mitigation lands (loss of agricultural production on local economy); changes (loss to quasi-public purposes) to the tax base in Fannin County; impacts to the school district (quality and funding); project alternatives (alternative lake sites or water sources); environmental and social costs incurred by Fannin County when other counties benefit from the water; whether adequate conservation measures are in place; potential archeological/ cultural resources. This is not an exhaustive list.

electronic means," or "reasonable means." What changes, if any, are needed to the rule regarding electronic certificates? Should foreign manufacturers be required to issue a certificate?

IV. Details Regarding the Workshop

The workshop will be held from 9:30 a.m. to 4 p.m. on Thursday, December 10, 2009, and Friday, December 11, 2009 at the CPSC's headquarters building at 4330 East West Highway, Bethesda, Maryland 20814, in the 4th Floor Hearing Room.

The workshop will open with a review of CPSC staff's current work on sections 14(a) and 14(d)(2) of the CPSA, including a discussion of the factors involved in sampling and an overview of the economic issues, followed by break-out sessions on the following subjects:

- The Consumer Product Labeling Program;
- Reasonable Testing Programs;
- Sampling Plans;
- Safeguarding Against Undue Influence on Product Testing;
- Additional Third-Party Testing Requirements for Children's Products; and
- Verification of Children's Product Testing Results.

The panels at the break-out sessions will consist of Commission staff and invited members from the public. If you would like to make a presentation at the workshop or be considered as a panel member for a specific break-out session, please send, via electronic mail (e-mail), a note indicating your desire to participate and/or indicating which of the break-out sessions you wish to join. We ask that you limit the number of break-out sessions to no more than three. We will select panelists and persons who will make presentations at the workshop, based on considerations such as: The individual's familiarity or expertise with the topic to be discussed; the practical utility of the information to be presented (such as a discussion of specific standards, methods, or other regulatory approaches), and the individual's viewpoint or ability to represent certain interests (such as large manufacturers, small manufacturers, consumer organizations, *etc.*). The e-mail should be sent to Robert Howell at *rhowell@cpsc.gov* no later than November 20, 2009. In addition, please inform Mr. Howell of any special equipment needs required to make a presentation. While an effort will be made to accommodate all persons who wish to make a presentation, the time allotted for presentations will depend on the number of persons who wish to speak on a given topic and the workshop schedule. We recommend that individuals and organizations with common interests consolidate or coordinate their presentations and request time for a joint presentation. If you wish to make a presentation and want to make copies of your presentation or other handouts available, you should bring copies to the workshop. We will notify those who are selected to make a presentation or participate in a break-out session panel at least 3 weeks before the workshop. Selections will be made in attempt to ensure that a wide variety of interests are represented.

If you do not wish to make a presentation, you do not need to notify the CPSC, but please be aware that seating will be on a first-come, first-served basis.

If you need special accommodations because of disability, please contact Mr. Howell at least 7 days before the workshop.

In addition, we encourage written or electronic comments to the docket. Written or electronic comments will be accepted until January 11, 2010. Please note that all comments should be restricted to how the CPSC should interpret and implement the requirements found in sections 14(a) and 14(d)(2) of the CPSA so as to promote increased product safety while minimizing possible adverse impacts or unintentional consequences of the implementing regulations to be developed.

Dated: November 9, 2009.

Todd A. Stevenson,

Secretary, Consumer Product Safety Commission.

[FR Doc. E9–27328 Filed 11–12–09; 8:45 am]

BILLING CODE 6355–01–P

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Intent To Prepare an Environmental Impact Statement for the Proposed Construction of Lower Bois d'Arc Creek Reservoir in Fannin County, TX

AGENCY: Department of the Army, U.S. Corps of Engineers, DoD.

ACTION: Notice of Intent.

SUMMARY: The U.S. Army Corps of Engineers, Tulsa District (USACE) has received an application for a Department of the Army Permit under Section 404 of the Clean Water Act (CWA) from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir. In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 1321 *et seq.*), the USACE has determined that issuance of such a permit may have a significant impact on the quality of the human environment and, therefore, requires the preparation of an Environmental Impact Statement (EIS).

The USACE intends to prepare an EIS to assess the direct, indirect, and cumulative environmental, social, and economic effects of issuance of a Department of the Army permit under Section 404 of the CWA for discharges of dredged and fill material into waters of the United States (U.S.) associated with the construction of the proposed water supply reservoir. In the EIS, the USACE will assess potential impacts associated with a range of alternatives. The preparation of an EIS begins with a scoping process to determine the issues to be addressed in the EIS.

The NTMWD provides wholesale treated water supply, wastewater treatment, and regional solid waste services to 45 member cities and customers in a service area covering all or parts of Collin, Dallas, Denton, Fannin, Hunt, Kaufman, Rains, and Rockwall Counties in north central Texas. The Lower Bois d'Arc Creek Reservoir, if constructed, would be a non-federal project constructed, owned and operated by NTMWD.

DATES: A Public Scoping Meeting will be held December 8, 2009, from 3 p.m. to 8 p.m.

ADDRESSES: The Public Scoping Meeting location is Fannin County Multi-Purpose Complex, 700 FM 87, Bonham, Texas 75418, approximately 1.5 miles west of Bonham off Highway 56.

FOR FURTHER INFORMATION CONTACT: For further information or questions about the proposed action and EIS, please contact Mr. Andrew R. Commer, Supervisory Regulatory Project Manager, by letter at Regulatory Office, CESWT–RO, U.S. Army Corps of Engineers, 1645 South 101st East Avenue, Tulsa, Oklahoma 74128–4609; by telephone at 918–669–7400; by electronic mail *Andrew.Commer@usace.army.mil*. For special needs (visual or hearing impaired, Spanish translator, etc.) requests during scoping meetings, please contact Andrew Commer by November 24, 2009.

SUPPLEMENTARY INFORMATION:

1. *Description of Proposed Project:* The proposed reservoir dam would be located in Bois d'Arc Creek, in the Red River watershed, approximately 15 miles northeast of the town of Bonham,

between Farm-to-Market (FM) Road 1396 and FM Road 409, in Fannin County, TX. The proposed project site consists of 17,068 acres. Approximately 38 percent of the project site is cropland, 37 percent is bottomland hardwoods and riparian woodlands. The remaining 25 percent is mostly upland deciduous forest.

The purpose of the proposed project is to impound the waters of Bois d'Arc Creek and its tributaries to create a new 16,641 acre water supply reservoir for NTMWD. Approximately 427 acres would be required for the construction of the dam and spillways. NTMWD has requested the right to impound up to 367,609 acre-feet of water, to produce an estimated firm yield of 126,200 acre-feet of water per year. State population projections show the NTMWD service population to increase from 1.6 million to 3.3 million by 2060. The Lower Bois d'Arc Creek Reservoir would provide a new water supply to help meet this increasing demand.

Lower Bois d'Arc Creek Reservoir Dam would be about 10,400 feet in length and would have a maximum height of about 90 feet. The design top elevation of the embankment would be 553.5′ msl with a conservation pool elevation of 534.0′ msl controlled by a service spillway at elevation 534.0′ msl with a crest length of 150 feet. The service spillway would be located at the right (east) abutment of the dam. Required low-flow releases would be made through a 36-inch diameter low-flow outlet. An emergency spillway would also be located in the right abutment of the dam. The emergency spillway would be a 1,400-foot wide uncontrolled broad crested weir structure with a crest elevation of 541′ msl. This elevation was selected to contain the 100-year storm such that no flow passes through the emergency spillway during this event.

Raw water from the reservoir would be transported by 29 miles of 90-inch pipeline to a proposed water treatment plant near the City of Leonard in southwest Fannin County. To allow the NTMWD the ability to treat water from Lower Bois d'Arc Creek Reservoir at its existing facilities in Wylie, TX, 14 miles of 66-inch pipeline would also extend from the water treatment plant to an outfall on Pilot Grove Creek, a tributary of the East Fork of the Trinity River, to deliver raw water to Lake Lavon, in the Trinity River basin.

Construction of the dam and impoundment of the water within the normal pool elevation of 534′ msl would result in direct fill impact or inundation of approximately 120 acres of perennial streams, 99 acres of intermittent streams, 87 acres of open water, 4,602 acres of forested wetlands, 1,223 acres of herbaceous wetlands, and 49 acres of shrub wetlands.

2. *Alternatives:* Alternatives available to the USACE are to: (1) Issue the Department of the Army permit; (2) issue the Department of the Army permit with special conditions; or (3) deny the Department of the Army permit. Alternatives available to NTMWD include: (1) Construct Lower Bios d'Arc Creek Reservoir as proposed; (2) construct Lower Bois d'Arc Creek Reservoir as proposed by NTMWD, with modifications; (3) developing or acquiring other water supply sources; or (4) no action. As part of the EIS process, a full range of reasonable alternatives, including the applicant's preferred alternative, will be evaluated.

3. *Scoping and Public Involvement:* A public notice for the Section 404 CWA permit application was issued on the proposal on October 14, 2008 soliciting comments from federal, state, and local agencies and officials, interested individuals and the general public. The 30-day comment period was extended by 30 days until December 12, 2008 to afford ample opportunity for public and agency comment on this project. A public Scoping Meeting will be held regarding the proposed action to seek public comments on the proposed project and its potential effects to the human environment (*See* **DATES AND ADDRESSES**). The USACE will be conducting the public scoping meeting to describe the project, preliminary alternatives, the NEPA compliance process, and to solicit input on the issues and alternatives to be evaluated and other related matters. Written comments for scoping will be accepted until January 9, 2010.

4. *Significant Issues:* Issues to be given analysis in the EIS are likely to include, but will not be limited to: The effects of the lake on the immediate and adjacent property owners, nearby communities, downstream hydraulics and hydrology, wetlands, surface water quality and quantity, groundwater quality and quantity, geological resources, vegetation, fish and wildlife, federally-listed threatened and endangered species, soils, prime farmland, noise, light, aesthetics, historic and pre-historic cultural resources, socioeconomics, land use, public lands, public roads, air quality, and the effects of construction of related facilities.

5. *Cooperating Agencies:* The USACE has invited the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Forest Service, Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, Texas Historical Commission, and Texas Water Development Board to be Cooperating Agencies (CA) in the formulation of the EIS. No decisions have been made on CA status at this time. Regardless of final CA status decisions, these agencies, as well as other federal, tribal, state, and local governmental entities are expected to be involved in the review and comment of the Draft EIS.

6. *Additional Review and Consultation:* Compliance with other Federal and State requirements that will be addressed in the EIS include, but are not limited to, state water quality certification under Section 401 of the CWA, protection of water quality under the Texas Pollutant Discharge Elimination System, protection of air quality under the Texas Air Quality Act, protection of endangered and threatened species under Section 7 of the Endangered Species Act, and protection of cultural resources under Section 106 of the National Historic Preservation Act.

7. *Availability of Draft EIS:* The Draft EIS is projected to be available by September 2010. There will be a public comment cycle (a public meeting(s) and opportunity for public hearing) following the release of the Draft EIS.

David A. Manning,

Chief, Regulatory Office.

[FR Doc. E9–27262 Filed 11–12–09; 8:45 am]

BILLING CODE 3720–58–P

DEPARTMENT OF DEFENSE

Department of the Army

Record of Decision for Stationing and Training of Increased Aviation Assets Within U.S. Army Alaska

AGENCY: Department of the Army, DoD.

ACTION: Notice of Availability (NOA).

SUMMARY: The Department of the Army announces the availability of its Record of Decision (ROD) that documents and summarizes the decision for implementing actions to increase numbers and types of aviation assets and training within U.S. Army Alaska (USARAK). The decision is based on the analysis described in the Final Environmental Impact Statement (FEIS) for Stationing and Training of Increased Aviation Assets within U.S. Army Alaska (August 2009), supporting studies, and comments provided during formal comment and review periods.

ADDRESSES: Requests for copies of the Army's ROD may be made to Ms. Carrie McEnteer, Directorate of Public Works,

Attachment B – Display Ad/Public Notice in *Bonham Journal*

PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR

Published: Monday, November 30, 2009 10:11 AM CST

Public Meeting in Bonham

Tuesday, December 8, 2009 (3 to 8 p.m.)

Fannin County Multi-Purpose Complex

The U.S. Army Corps of Engineers, Tulsa District (USACE) has received an application for a Permit under Section 404 of the Clean Water Act from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir. The USACE has determined that issuing this permit may have a significant impact on the quality of the human environment and, therefore, requires the preparation of an Environmental Impact Statement (EIS).

The USACE intends to prepare an EIS to assess the environmental, social, and economic effects of issuing a Section 404 permit for discharges of dredged and fill material into waters of the U.S. associated with the construction of the proposed water supply reservoir. In the EIS, the USACE will assess potential impacts from a range of alternatives. EIS preparation begins with a scoping process to determine the issues to be addressed in the EIS and the public helps to determine what issues are important.

The NTMWD provides wholesale treated water supply, wastewater treatment, and regional solid waste services to 45 member cities and customers in a service area covering all or parts of eight counties in north-central Texas. The Lower Bois d'Arc Creek Reservoir, if constructed, would be a non-federal project constructed, owned and operated by NTMWD.

The USACE will be conducting a public scoping meeting to describe the project, preliminary alternatives, the NEPA compliance process, and to solicit input on the issues and alternatives to be evaluated and other related matters. Written comments for scoping will be accepted until January 9, 2010.

A Public Scoping Meeting will be held on Tuesday, December 8, 2009, from 3 to 8 p.m., at the Fannin County Multi-Purpose Complex, 700 FM 87, Bonham, Texas 75418. The Complex is about 1.5 miles west of Bonham, north of Hwy 56.

For further information or questions about the proposed action and EIS, please contact Mr. Andrew R. Commer, Supervisory Regulatory Project Manager, by letter at Regulatory Office, CESWT-RO, U.S. Army Corps of Engineers, 1645 South 101st East Avenue, Tusla, Oklahoma, 74128-4609; by telephone at 918-669-7400; by electronic mail

Andrew.Commer@usace.army.mil. For special needs (visual or hearing impaired, Spanish translator, etc.) request during scoping meetings, please call Mr. Commer.

Attachment C – USACE public notice for scoping meeting

Public Notice

U.S. Army Corps of Engineers
Tulsa District

Reply To:

U.S. Army Corps of Engineers
ATTN: Regulatory Office
1645 South 101st East Avenue
Tulsa, OK 74128-4609

SWT-0-14659
EIS Scoping Meeting
Public Notice No.

November 6, 2009
Public Notice Date

January 9, 2010
Expiration Date

PURPOSE
The purpose of this public notice is to inform you of a proposal for work in which you might be interested and to solicit your comments and information to better enable us to make a reasonable decision on factors affecting the public interest.

SECTION 10
The U.S. Army Corps of Engineers is directed by Congress through Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) to regulate all work or structures in or affecting the course, condition, or capacity of navigable waters of the United States. The intent of this law is to protect the navigable capacity of waters important to interstate commerce.

SECTION 404
The U.S. Army Corps of Engineers is directed by Congress through Section 404 of the Clean Water Act (33 USC 1344) to regulate the discharges of dredged and fill material into all waters of the United States. These waters include lakes, rivers, streams, mudflats, sandflats, sloughs, wet meadows, natural ponds, and wetlands adjacent to other waters. The intent of the law is to protect these waters from the indiscriminate discharge of material capable of causing pollution and to restore and maintain their chemical, physical, and biological integrity.

NOTICE TO PUBLISHERS
This public notice has been provided as a public service and may be reprinted at your discretion. However, any cost incurred as a result of reprinting or further distribution shall not be a basis for claim against the Government.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, TULSA DISTRICT
1645 SOUTH 101ST EAST AVENUE
TULSA, OKLAHOMA 74128-4609

November 6, 2009

Application No. SWT-0-14659

PUBLIC NOTICE

U.S. Army Corps of Engineers (Corps), Tulsa District

Announcement of Public Scoping Meeting

Proposed Lower Bois d'Arc Creek Reservoir
Environmental Impact Statement (EIS) Process

Interested parties are hereby notified that the District Engineer has scheduled a Public Scoping Meeting related to the Clean Water Act (CWA) Section 404 permit application by North Texas Municipal Water District (NTMWD) for the proposed construction of Lower Bois d'Arc Creek.

The application is to construct a dam on Bois d'Arc Creek to impound a water supply reservoir, Lower Bois d'Arc Creek Reservoir. The purpose of the work is to expand water supply resources of the North Texas Municipal Water District.

The Corps intends to prepare an EIS to assess the direct, indirect, and cumulative environmental, social, and economic effects of issuance of a Department of the Army permit under Section 404 of the CWA for discharges of dredged and fill material into waters of the United States associated with the construction of the proposed water supply reservoir. In the EIS, the Corps will assess potential impacts associated with a range of alternatives. The preparation of an EIS begins with a scoping process to determine the issues to be addressed in the EIS.

Date and Location of Meeting: **December 8, 2009**
3:00pm to 8:00pm
Fannin County Multi-Purpose Complex
700 FM 87
Bonham, Texas
(Complex is about 1.5 miles west of Bonham, north of Hwy 56)

A public notice for the Section 404 CWA permit application was issued on the proposal on October 14, 2008 soliciting comments from Federal, State, and local agencies and officials, interested individuals and the general public. The 30-day comment period was extended by 30 days until December 12, 2008, to afford ample opportunity for public and agency comment on this project. A public Scoping Meeting is being held regarding the proposed action to seek public comments on the proposed project and its potential effects to the human environment. The Corps will be conducting the public scoping meeting, assisted by its Third Party EIS Contractor (Mangi Environmental Group), to describe the project, preliminary alternatives, the National Environmental Policy Act compliance process, and to solicit input on the issues and alternatives to be evaluated and other related matters. Written comments for scoping will be accepted **until January 9, 2010.**

Project Description: The proposed reservoir dam would be located in Bois d'Arc Creek, in the Red River watershed, approximately 15 miles northeast of the town of Bonham, between Farm-to-Market (FM) Road 1396 and FM Road 409, in Fannin County, Texas. The proposed project site consists of 17,068 acres. The purpose of the proposed project is to impound the waters of Bois d'Arc Creek and its tributaries to create a new 16,641-acre water supply reservoir for NTMWD. Lower Bois d'Arc Creek Reservoir Dam would be about 10,400 feet in length and would have a maximum height of about 90 feet. The design top elevation of the embankment would be 553.5 feet mean sea level (' msl) with a conservation pool elevation of 534.0' msl controlled by a service spillway at elevation 534.0' msl with a crest length of 150 feet. Raw water from the reservoir would be transported by 29 miles of 90-inch pipeline to a proposed water treatment plant near the City of Leonard in southwest Fannin County. To allow the NTMWD the ability to treat water from Lower Bois d'Arc Creek Reservoir at its existing facilities in Wylie, Texas, 14 miles of 66-inch pipeline would also extend from the water treatment plant to an outfall on Pilot Grove Creek, a tributary of the East Fork of the Trinity River, to deliver raw water to Lake Lavon, in the Trinity River basin.

Texas Commission on Environmental Quality (TCEQ): Permitting under the CWA Sections 401 and 404 is conducted jointly between the Corps and the TCEQ, with the TCEQ making a State water quality certification decision concurrent with the Corps permit application decision. For the purposes of conducting a TCEQ public meeting, the TCEQ will participate in this EIS Scoping Meeting and will be available for questions and comments regarding the TCEQ's role in reviewing the 404/401 permit application submitted by the NTMWD for the proposed Lower Bois d'Arc Creek Reservoir.

For Additional Information: For further information or questions about the proposed action and EIS, please contact Mr. Andrew Commer, Supervisory Regulatory Project Manager, by letter at Regulatory Office, CESWT-RO, U.S. Army Corps of Engineers, 1645 South 101st East Avenue, Tulsa, Oklahoma, 74128-4609; by telephone at 918-669-7400; by electronic mail *Andrew.Commer@usace.army.mil*. For special needs (visual or hearing impaired, Spanish translator, etc.) requests during scoping meetings, please contact Andrew Commer by November 24, 2009.

David A. Manning
Chief, Regulatory Office

Attachment D – Attendee List for Public Scoping Meeting

Proposed Lower Bois d'Arc Creek Reservoir, Fannin County
Texas Environmental Impact Statement
December 8, 2009 Public Scoping Meeting – Bonham, TX
Sign-In Sheet

Name	Address	Affiliation
Jim Crooks	PO Box 507 Decatur, TX 76234	USFS
Jackie Lackey	PO Box 225 Dodd City, TX 75438	Landowner
Kenneth Tredway	PO Box 92 Dodd City, TX 75438	Landowner
Carl Bysen	13508 E. FM 1396 Windom, TX 75492	Landowner
Tom & Tommie Sue Turner	300 E. Russell Bonham, TX 75418	Commercial Office Rental
Maeta Lee	703 W Market Honey Grove, TXX 75446	Landowner
Glenn Lee	703 W Market St Honey Grove 75446	Landowner
Craig Richards	908 E. 10th St Bonham, TX 75418	Landowner
Gloria Walker	340 Boyd Loop Bonham, TX 75418	Landowner
Harry Allen	14891 FM 1396 Windom, TX 75492	
Dick & Eleanna Crawford	690 CR 37500 Summer, TX 75486	
Diane Payne	1775 CR 2655 Telephone, TX 75488	
Chad Clour	2996 CR 2655 Telephone, TX 75488	
Thomas R. Brewer	126 Carpenter loop Bonham, TX 75418	
RET. US Navy Chief George Sutterfield	283 CR 2273 Telephone, TX 75488-6216	
Tami Sundquist	1445 Ross Ave Dallas, Tx 75202	
Harry Hammett	1494 CR 2917 Dodd City, TX 75438	

Mike Scheiler	2628 S. Hwy. 121 Bonham, TX 75418	
Carlos A. Pardo	2653 C.D. 2900 Bonham, TX 75248	
Michael Yarbrough	2325 CR 2765 Honey Grover, TX 75446	Rancher
Troy & Carol Boreham	2160 CR 2950 D. Dodd City, TX 75438	Rancher
Ronnie Knight	317 CR 2950 Dodd City, TX	Cattle
Randy Moore	200 E. 1st st. Bonham, TX 75418	USDA-NRCS
Wes Reed	4519 W. Lovers Lane Dallas, TX 75209	Rancher
Dustin Knight	1037 CR 2950 Dodd City, TX 75438	Cattle
Ken Jones	3054 CR 2730 Honey Grove, TX 75446	Rancher
Sandra Loschke	874 CR 2750 Honey Grove, TX 75446	Rancher/ farmer
Don Belk	205 CR 2650 Telephone, TX 75488	Rancher Live on Boisedearc
Nathan Ryser	602 Oak St. Honey Grove, TX 75446	Farmer
Harold & Jean Gillineath	1283 CR 2960 Dodd City, TX 75438	
John Yarbrough	3576 CR 2765 Honey Grove, TX 75446	
Charles Yarbrough	404 Pecan St Honey Grove, TX 75446	
Stewart Richardson	9086 FM 100 Honey Grove, TX 75446	
Beth R. Porter	418 Jo Aynn Circle Bonham, TX 75418	
Ralph W. Thomas, Jr.	614 Chestnut St. Bonham, TX 75418	
Mary & Kyle Payne	626 CR 2615 Telephone, TX 75488	
Bob Payne	1775 CR 2655 Telephone, TX 75488	
John Loschke	874 CR 2750 Honey Grove, TX 75446	Farmer
Nathan & Ellen Nelson	3385 E. State Hwy 56 Dodd City, TX 75438	Farmer/ Landowner
Gregory Hall	328 CR 1035 Ravenna, TX 75476	

Julia Russell	790 CR 2900 Dodd City, TX 75438	
Michele Holmes	15924 E FM 1396 Windom, TX 75492	
Chad Knight	489 CR 2950 Dodd City, TX 75438	
Sam Bullock	785 CR 2620 Telephone, TX 75488	
Jarett & Rachael Tucker	4484 CR 2610 Bonham, TX 75418	
Doug Kopf	2713 CR 2998 Windom, TX 75418	Landowner
Rebecca Knight	317 CR 2950 Dodd City, TX 75438	Landowner
Dennis Troutz	PO Box 996 Windom, TX 75492	Landowner
John & Kay Burnett	402 Mockingbird Bonham 75418	Bonham City Council
Larry N. Patterson	PO Drawer 305 Lewisville, TX 75067	UTRWD
Sue Carpenter	2177 CR 2945 Dodd City, TX 75438	
Joe Carpenter	2177 CR 2945 Dodd City, TX 75438	
Justin Staton	281 CR 265 Telephone, TX 75488	
Leroy Tarpley	295 S. St. Hwy 78 Bonham, TX 75418	
Jimmy Newhouse	2438 CR 2730 Honey Grove, TX 75446	
Larry Franklin	15387 E FM 1396 Windom, TX 75492	
Patti Chun	6232 South FM 1743 Windom, TX	
Tony Brawner	9898 E FM 273 Ivanhoe, TX 75447	
Ross Griffith	PO Box 28 Bonham, TX 75418	
Millard D. Brant	PO Box 46 Dodd City, TX 75438	
Danny R. Gilbreath	3315 Oliver Dallas, TX 75202	
Pat Hilliard	32015 FM 2099 Bonham, TX 75418	FanninCo.
Dale McQueen	1352 E FM 1396 Ivanhoe, TX 75447	
Denise Hickey	505 E. Brown Wylie, TX 75098	

Wayne & Betty Burk	2000 CR 2950 Dodd City, TX 75438	
Ronnie & Ronda Fitzwater	Bonham, TX 75418	
Joe L. Ward	1626 CR 2315 Telephone, TX 75488	
Roger Skipper	3243 CR 2955 Dodd City, TX 75438	Texas AgriLife Extension
Joan Snider	615 Willow Bonham, TX 75418	Fannin Co.
Ray Floyd	408 Rainey Bonham, TX 75418	City of Bonham
Lynda Floyd	408 Rainey Bonham, TX 75418	
Curtis E. Carlson Jr.	PO Box 292 364 Lewisville, TX 75029	Landowner
Jack Black	13759 Bandera Ranch CR Roanoke, TX 76262-5866	Landowner
Glenn Estes	232 CR 2650 Telephone, TX 75488	Telephone
Corby Alexander	301 E 5th Bonham, TX 75418	City of Bonham
Ronny & Marilyn Hart	1782 CR 2925 Dodd City, TX 75438	
Richard Danner	321 CR 2040 Ravenna, TX 75476	Solid Ground Realtors
Jessica Kirkpatrick	2501 N Center Bonham, TX 75418	Fannin Newspapers
Galen L. Raper	767 CR 4779 Winnsboro, TX 75494	Six Pines Natural Resources
W.A. Harcues Jr.	5782 CR 2610 Bonham, TX 75418	
Joyce Hassell	14562 CR 565 Farmersville, TX 75442	
Kenneth Hassell	14262 CR 565 Farmersville, TX 75442	
Joseph Y. Reed	116 Hilltop Pottsboro, TX 75076	Landowner
J. D. Moore	10165 W Hwy 82 Savoy, TX 75479	
Dennis Holman	989 CR 2650 Telephone, TX 75488	Landowner
Allen Rich	425 CR 2601 Bonham, TX 75418	
Wilma Arnold	2203 Pecan St. Bonham, TX 75418	

Ronald Ford	PO Box 103 Bonham, TX 75418	City of Bonham
Joe Hafertepe	5331 Yolanda Dallas, TX 75229	Landowner
Joel Shepard	1112 CR 2145 Telephone, TX 75488	USPA Forest Service
Gordon Locke	2601 N SH 121 Bonham, TX 75418	Landowner
Cathy Melson	3385 E. HWY 56 Dodd City, TX 75438	Landowner

Attachment E – Attendee List/Sign-in Sheet for Agency Scoping Meeting December 9, 2009 – Wylie, Texas

Name	Agency	Address
Robert McCarthy	NTMWD	505 E. Brown Wylie, TX 75087
Mike Rickman	NTMWD	505 E. Brown Wylie, TX 75087
Ashley Burt	NTMWD	505 E. Brown Wylie, TX 75087
Tami Sundquist	US EPA, Region 6	1445 Ross Ave. Dallas, TX 75202
Lynn Jackson	U.S. Forest Service	415 S. First Street Ste.110 Lufkin, TX 75901
Chalonda Jasper	U.S. Forest Service	415 S. 1st St. Ste.110 Lufkin, TX 75901
Dave Peterson	USFS	415 S. 1st St. Ste.110 Lufkin, TX 75901
Mark Fisher	TCEQ	MC-150 P.O. Box 13087 Austin, TX 78711-3087
Jeanene Peckham	EPA	1445 Ross Ave. Dallas, TX 75202
Andrew Commer	U.S. Army Corps of Engineers	1645 S. 101st E. Ave. Tulsa, OK 74128
Randall Howard	Freese & Nichols, Inc.	10814 Jollyville Blvd. 4 Ste. 100 Austin, TX 78759
Steve Watters	Freese & Nichols, Inc.	4055 International Plaza Fort Worth, TX 76109
Alan Skinner	AR Consultants, Inc.	11020 Audelia Rd. Ste. C105 Dallas, TX 75243
Gordon M. Wells	Freese & Nichols, Inc.	4055 International Plaza Fort Worth, TX 76109
Shane Charlson	U.S. Army Corps of Engineers	1645 S. 101st E. Ave. Tulsa, OK 74128
David Galindo	TCEQ	12100 Park 35 Cin. Austin, TX 78711
Peter Schaefer	TCEQ	12100 Park 35 Cin. Austin, TX 78711
Clint Robertson	TPWD	P.O. Box 1685 San Marcus, TX 78667
Ryan McGillicuddy	TPWD	4200 Smith School Rd Austin, TX 78744
Leon Kolankiewicz	Mangi Environmental	7927 Jones Branch Dr. #150 McLean, VA 22102
Tom Cloud	U.S. F.W.S	711 Stadium Dr., #252 Arlington, TX 76011
Sid Puder	U.S. F.W.S	711 Stadium Dr. Arlington, TX 76011
Jim Crooks	U.S.F.S	PO Box 507 Decatur, TX 76234

Thomas Philipps	U.S.F.S	415 South First St Lufkin, TX 75901
Anna Lundin	Mangi Environmental	24858 Richmond Hill Rd. Conifer, CO 80433
Joel Stone	Daniel B. Stephens & Associates, Inc.	4030 W. Braker Ln. Ste.325 Austin, TX 78759
Nick Trierweiler	Ecological Communications Corp.	4009 Banister Ln. Ste. 300 Austin, TX 78704
Tom Gooch	Freese and Nichols	4055 International Plaza Ste.200 Fort Worth, TX 76132
Michael Votaw	Freese & Nichols	4055 International Plaza Ste.200 Fort Worth, TX 76132
Karen Hardin	TPWD	4200 Smith School Rd Austin, TX 78744

Attachment F – Agency Scoping Meeting Notes

Proposed Lower Bois d'Arc Reservoir EIS
Agency Scoping Meeting, Wylie, TX
December 9, 2009

AGENCY SCOPING MEETING NOTES

USACE (Andy Commer) opened the meeting with introductory remarks on the purpose of the scoping meeting. It helps the USACE focus its vision on what needs to be covered in EIS in order to inform decision-making on the 404 permit application. Environmental, social, and economic impacts will all get covered in the EIS. The internal Preliminary Draft EIS is the next step. The next opportunity for agencies to engage is at publication of the DEIS.

The proposed project is being handled by the USACE, which is the decision-maker and lead federal agency. The USACE has invited cooperating agency status from other federal and state agencies, not all of which have yet responded. Texas Parks and Wildlife and the US Fish and Wildlife Service have both accepted while the Texas Water Development Board has declined. The USACE is still awaiting replies from the U.S. Forest Service and Environmental Protection Agency.

Since there is no funding for internal EIS preparation by the USACE, costs are borne by 404 permit applicants. A third party contractor prepares the EIS, in this case the Mangi Environmental Group.

Mangi (Leon): EIS project manager from Mangi, made brief remarks about Mangi's and his own role and experience.

USACE (Andy) then had everyone introduce themselves and state their agency affiliation.

See Attachment A for the full list of attendees along with their affiliations and contact info.

NTMWD (Mike) gave an overview for the North Texas Municipal Water District. The population will more than double within its service area. They need to find additional water supplies. NTMWD has to bring online the equivalent of one Lake Lavon every decade for the next five decades in order to meet the water needs of people coming here. The City of Bonham can't meet its own needs past 2020. The Lower Bois d'Arc Creek Project will also meet needs in the immediate vicinity of the lake in Fannin County. Lake Bonham cannot alone supply all of Fannin County's water supply needs with its projected future growth.

Since the last meeting, NTMWD has opened an office in Bonham and begun acquisition of lands. So far, land purchase in the basin has been done on a willing seller basis only. NTMWD has acquired almost 10,000 acres of the reservoir footprint already. Recently, they became aware of the Riverby Ranch for sale along the Red River and recognized its potential as a mitigation site. They entered into contract to purchase this ranch, about 14,700 acres in size and with seven miles of Red River frontage. NTMWD is scheduled to close on the deal in mid-February; they are well aware that they are taking a risk in having purchased this, if the 404 permit is not approved, but they would be able to re-sell it.

USACE (Andy) then opened the meeting to the agencies present, in order to provide a forum for the agencies to ask questions and raise issues. What issues need to be addressed in the EIS? Some of those present have already been involved in the Habitat Evaluation Procedures (HEP) and instream flow studies. This meeting is for the USACE to listen to agency concerns.

EPA (Jeanene): What issues are in the USACE's focus, that is, what does the USACE see as being within the scope of the EIS now?

USACE (Andy): Things the USACE sees include, but are not necessarily limited to: the magnitude of the project; its impacts on landowners and livelihoods; impacts on forested wetlands and other wetland habitats and other aquatic resources; mitigation of projected wetland losses; impacts on downstream lands including riparian forest lands, U.S. Forest Service (USFS) Caddo National Grasslands, social and economic impacts (e.g., roads); changes to downstream flow regime; conversion of agricultural lands to lakebed or mitigation lands (loss of agricultural production on local economy); changes (loss to quasi-public purposes) to the tax base in Fannin County; impacts to the school district (quality and funding); project alternatives (alternative lake sites or water sources); environmental and social costs incurred by Fannin County when other counties benefit from the water; whether adequate conservation measures are in place; potential archeological/ cultural resources. This is not an exhaustive list. All comments received by the USACE as a result of the Public Notice are part of the EIS scoping.

EPA (Jeanene): Last night at the public scoping meeting I heard someone say that this project had been proposed and rejected twice by the USACE in the past.

USACE (Andy): Those earlier projects were different (multi-purpose), and the USACE's conclusions are being inappropriately transferred by opponents to the current project. The earlier USACE proposals were rejected by the USACE itself in the past due to cost/benefit analyses and multi-purpose needs stipulations. The USACE determined that the lakes weren't feasible. However, we cannot extrapolate the findings of those projects onto this proposal. Also, the USACE needed a local sponsor and may not have been able to find one. Both Upper and Lower Bois d'Arc Creek locations were determined not to be feasible for further investigation. The differences between the present project and past proposals evaluated and rejected previously are that 1) this is not a USACE project, and 2) this is a water supply lake, not a multi-purpose proposal. That is, the water supply purpose stands on its own. While there may be recreation added, recreation is not a primary purpose. Thus, some of the comparisons between the present proposal under consideration, and for which a 404 permit is being sought, and past discarded proposals, are not appropriate.

TCEQ (Mark Fisher): Regarding that earlier USACE proposal, what phase of analysis/ investigation did it reach?

USACE (Andy): The earlier proposal never got to the point of discussing a permit.

NTMWD (Mike): The USACE could not find a local sponsor. Having a local sponsor is a funding requirement.

USACE (Andy): I think now that joint projects need 35% local funding, but don't quote me.

TCEQ (Mark): Should this history be included in the EIS?

USACE (Andy): The EIS will provide clarifying information on why the USACE is considering once more what it rejected earlier.

TCEQ (Mark): What is the timeframe of the EIS?

Mangi (Leon): We're shooting for the latter part of 2010 for the draft EIS.

EPA (Jeanene): What about Mangi review of work that has been done to date?

Mangi (Leon): Mangi will provide an independent review of all prior work, neither accepting it nor dismissing it out of hand, nor repeating what has already been done, if it's adequate. Everything that has been done to date appears to be kosher – although that doesn't mean it's complete.

EPA (Jeanene): All roads that are impacted need to be evaluated, not just public roads.

EPA (Jeanene): One of my comments [in EPA's letter on the 404 permit application] is that the EPA wants to include a plan to reduce water use in the EIS – a conservation plan – will Mangi be looking at such a plan?

Mangi (Leon): Conservation has to be part of at least one alternative; however, even with conservation measures, there is not currently adequate water supply to meet projected demands.

EPA (Jeanene): We are asking for a plan to reduce water use. Also, as a cumulative impact, we want the impacts of all water impounded to date in the State of Texas included and considered in the EIS. Data on this topic (total impoundment acreage) were in EPA's comment letter and date to 2006. For cumulative impacts, the EIS should also consider reasonably foreseeable impoundment proposals in its cumulative analysis. Would the most current estimates of the amount of impounded water in the State be updated and included in the EIS?

Mangi (Leon): You want both existing and planned impoundments in the state to be included in the cumulative analysis of the EIS? OK.

USFS (Tom): Does the water district have legislative authority to mandate conservation measures?

NTMWD: No

Mangi (Leon): The EIS will look at legislative options, e.g. what it would take to mandate conservation.

EPA (Jeanene): What about funding?

NTMWD (Mike): NTMWD would fund the Lower Bois d'Arc Creek Reservoir 100% through bonds.

EPA (Jeanene): Is NTWD seeking funds from TWDB?

NTWMD (Mike): It's a possibility.

EPA (Jeanene): How would rates be affected by the project?

NTMWD (Mike): The proposed project will impact (increase) consumer rates.

USFS (Tom): How about the impact on USFS lands (Caddo National Grasslands)? Would there be a land exchange? There is no congressional authority needed to designate the donated land (e.g., the mitigation bank) as part of the National Grasslands as per the Bankhead-Jones Act. This 1930's era statute gives the USFS authority to accept that land; only administrative activity will be needed. (The Grasslands boundary is an "Administrative Boundary" and not a "Proclamation Boundary" under Bankhead Jones. This allows the USFS to include, acquire, or receive lands that are outside of the administrative boundary. A proclamation boundary would not allow such.)

EComm (Nick) : The Texas Historical Commission (THC) is not here. Has anything been initiated with them?

USACE (Andy): Yes, a programmatic agreement (PA) is all but signed with THC. It lays down the rules of engagement and will contain methodology on how to evaluate cultural resources in the EIS. The PA will include a research design for cultural resource investigations, and once the PA is signed and executed, the research design will be implemented and the field sampling will begin. Work on a research design has begun. The next step is fulfilling the research design and doing stratified, random samples in select areas of the basin. There will be surface searches, and probably backhoe trenching, to explore the need for further research and/or recovery. Alan Skinner will probably be involved in this fieldwork.

EPA (Jeanene): With respect to the instream flow study, how far downstream does the USACE intend to look at downstream impacts? A TPWD report shows that Lower Bois d'Arc Creek is an important tributary/discharge to the Red River. The Red River is now being used for "hydrofracking" [hydraulic fracturing] for natural gas extraction from Haynesville Shale in LA and TX. Haynesville Shale exploration has mushroomed recently, and drilling as well. The EIS needs to look at cumulative impacts on the flow of the Red River.

USACE (Andy): We will be looking at the downstream impacts in the EIS. We don't know where the downstream impacts analysis will be limited to yet. Is there a lot of water use associated with the natural gas/shale activity in LA?

EPA (Jeanene): Yes, 5 MGD is needed for hydraulic fracturing of each well.

Mangi (Leon): We haven't brought up how cultural resource studies fit into the EIS; the idea is to have the results of the studies included in the EIS.

USACE (Andy): Work on the EIS is to inform the permit application. Cultural fieldwork will be concurrent; it may not be complete for the draft, but will be complete by the Final EIS. The USACE will then make its decision based on the best available information. We won't issue a 404 permit that says we'll look into impacts later; on the other hand, we may still issue a permit that calls for ongoing or future monitoring.

TPWD (Karen): Is recreation an identified purpose of the proposed project?

NTMWD: Recreation is a secondary purpose of the reservoir. Water supply is the primary purpose.

TPWD (Karen): How fully will recreation effects be evaluated in the EIS?

USACE (Andy): The current forecast of recreation projections may not be fully accurate (it may assume there would be more recreation than what would actually occur); we will make sure the projections are accurate. It is an indirect impact which will be considered in the EIS.

TPW (Karen): Why would recreation impacts be considered secondary and indirect?

USACE (Andy): The impacts to current recreation use within the actual reservoir footprint are a direct impact and will be analyzed as such.

TPWD (Karen): I don't understand why recreation is considered a purpose of this project at all. Isn't recreation more appropriately identified as a benefit of the project?

NTMWD: We're building the reservoir as a water supply lake. Recreation will be a secondary benefit.

TCEQ: If Lower Bois d'Arc is operated primarily as a water supply lake, a fluctuating water level, and lakeshore, will occur. Will water levels fluctuate and be varied according to the water supply?

NTMWD: Water levels will not be kept constant for recreation. The miles of shoreline have not been measured; the use of the shoreline is a concern to the water quality of the reservoir.

TCEQ: Wastewater treatment plants (WWTPs) discharge effluent upstream.

NTMWD: Existing effluent discharge standards for these WWTPs are based on downstream water uses. A downstream water supply reservoir such as the proposed Lower Bois d'Arc may change the standards to be achieved and may result in upgrade costs for local municipalities. (Discharge permits and effluent quality may need to be upgraded up and downstream of the project in order to protect water quality in the reservoir.) NTMWD is committing to not place financial burden on cities – if upgrades to WWTPs are required by the State, NTMWD would pay the costs of these upgrades to meet higher standards.

EPA (Jeanene): Is all of this included in the cost of the project?

NTMWD: Yes.

Ryan: How fully will recreational impacts be addressed in the EIS?

USACE (Andy): Local opposition to the lake is concerned that economic projections overstate claimed benefits. They point to other lakes where recreation hasn't really developed, or at least not developed as quickly as hoped, such as Lake Chapman. New recreation would be an indirect impact and may be hard to predict. The USACE can't take control over this with its permit decision and EIS.

USFS (Tom): Another issue that needs to be addressed is invasive species, especially giant salvinia. There needs to be a sound weed management plan and weed prevention measures in place. The new lake will need signs and wash stations.

USACE (Andy): We know aquatic invasives are an issue. The EIS also needs to look at the zebra mussel.

USFS (Dave): Zebra mussels are already in Lake Texoma. Aquatic weeds are a major problem. Another problem is that reservoirs become a sink for pollutants, primarily mercury. There are health advisories on many local lakes for fish consumption because of high mercury levels. Anytime you create a large outfall area, you have mercury and other pollutants.

Bois d'Arc Creek was channelized back in the 1940s; we want to restore the Creek back to its natural flow. This is difficult since the original channel is elevated in the flood plain above the flow line of the current channel

We are concerned with invasives and concerned with the reservoir becoming a sink for fallout from atmospheric pollution (mercury etc.). All these issues are concerns for us because the reservoir is upstream of where we want to restore the Creek. Shoreline development of the new lake is also a concern to us which hasn't really been addressed yet.

Also, the EIS should address how outflows from the reservoir would be prevented from causing downstream erosion and storm water damage. What are the potential effects on Caddo NG from the expected downcutting within the channel downstream of the dam? How does this project affect the goal that Fisheries has of restoring downstream flows in the original channel? It is proven that there is lower fisheries diversity in reservoirs; the species diversity in the Creek will drop as a result of this project. We will lose native bass in this reach; the Florida hybrid will be put in. Native northern largemouth bass have disappeared from habitats. Non-native fish will likely benefit at the expense of native species because of the project.

Don't forget about terrestrial invasives; water acts as a vector for the spread of these invasives. Chinese tallow, salt cedar, and tree of heaven are terrestrial invasives that may be affected by the project and should be considered in the EIS.

The proposed mitigation bank may have suitable habitat for sensitive species. Among possible rare plants in the mitigation tract is the globally threatened Arkansas meadow rue. The reach of the Red River that might be protected by the proposed mitigation area could possibly benefit the federally endangered Ouachita rock pocketbook mussel.

The EIS needs to have a clear explanation of how the mitigation area compensates for habitat loss – and you need to make sure the mitigation bank adequately compensates for the habitat loss.

USFWS (Tom Cloud): How does the mitigation area compensate for the loss of jurisdictional areas? The EIS needs to do a comparison of whether the mitigation site adequately addresses the loss of quality and quantity in the affected areas.

TCEQ (Mark): Is a functional assessment required?

USACE (Andy): The HEP baseline is available. HEP analysis on the lake basin is the baseline for impacts. HEP analysis will have to be done on the baseline condition of the mitigation tract. Mitigation boost will be predicted on basis of same HEP process.

TCEQ (Mark): How will the ongoing instream flow study be integrated into the EIS?

USACE (Andy): There have been difficulties scheduling field data collection because of rainfall and high water. F&N says they can finish report in March 2010.

F&N (Michael): We'll be getting back into the field ASAP, once water levels retreat. We are compiling already collected field data right now.

F&N (Steve): Conditions can be difficult and dangerous if the creek's flow is over 30-40 cfs.

TCEQ (Mark): Will the water rights permit be integrated into the EIS?

USACE (Andy): There is no linkage at all; the water rights permit is an independent process from the 404 permit.

TCEQ: If water right changes, would that require a supplement to the EIS?

USACE (Andy): Possibly.

TCEQ (Mark): I think the water right is controlling in terms of the amount of water that can be stored and used in the reservoir. The instream flow study is a coordinated effort. Ultimately, decision-making authority is vested in two separate bodies.

EPA (Jeanene): Will the local government get involved at some point (e.g., for zoning and shoreline development issues)? A Lakeshore Management Plan is needed to protect water quality

NTMWD (Mike): The local governments are already involved; the NTMWD meets regularly with County commissioners regarding zoning and the 13 cities that are incorporated in Fannin County.

EPA (Tami): Who has zoning authority in Texas?

NTMWD (Mike): Cities typically have zoning authority in Texas. Fannin County requested development authority (zoning responsibility) from the State Legislature.

Mangi (Leon): Land use will be a section in the EIS.

TCEQ: How will mitigation be considered? Land has already been acquired, but we don't want to be locked into this particular property. What will be done to be sure we're not locked in?

USACE (Andy): The District contacted the USACE about the possible mitigation site and a meeting was held. NTMWD wanted feedback from the USACE as to whether this was a viable option, not a be-all-and-end-all. Was it a good option in the USACE's opinion? I haven't visited the site, but the District presented good info on what is there, what natural features persist, for floodplain, restoration, bottomland wetlands, etc. In short, the USACE sees this as a good opportunity. The USACE told the District that if they have the opportunity, they should pursue it. Opportunities like this are unusual. No promises were made to NTMWD that this is all the mitigation that would be required. The USACE and NTMWD have had no discussion as to whether the District would receive mitigation credit for this site, or how the site would have to be developed for mitigation. Mitigation is not the only issue on the 404 permit application, but having this single large tract in close proximity to the project is something that the USACE rarely sees.

USFS (Tom): I concur with Andy that this property has real potential; its location in proximity to the proposed reservoir and on the Red River are advantages.

USFWS (Syd): I second what Tom says.

NTMWD (Mike): The NTMWD fully recognizes the risk of purchasing the land at this point.

USACE (Andy): The District is indeed taking some risk.

F&N (Steve): This is a rare opportunity for mitigation that almost never occurs. F&N will examine the potential of the site. The District will not take a risk at this point by making an irretrievable commitment. If necessary, they want to be able to turn around and sell the property.

NTMWD (Mike): The cost of the property is $34.5 million.

TCEQ (Mark): What is the baseline in terms of the functional assessment? When does formal compensatory mitigation come into place? What is the environmental baseline against which to calculate mitigation?

USACE (Andy): The HEP was conducted last summer (2008) and this is the baseline. In the last two years however, some timber cutting has been occurring on land within the reservoir footprint that has been purchased by the NTMWD as part of the NTMWD negotiations. As soon as the USACE was made aware of this, I sent a letter to the NTMWD stating that all timber cutting (irretrievable commitment of resources) must stop as part of negotiations. It has stopped.

Some cutting is still occurring but these are private actions by individual land owners, not NTMWD. From what I have seen, there haven't been violations of 404; what has gone on are private actions over which the USACE has no control. Still, we will go by the habitat conditions documented in the HEP.

NTMWD (Mike): The District is now buying timber in place.

USFWS (Syd): We have to use the date in which the HEP was done.

F&N (Steve): The area was flown just months before the HEP.

USACE (Andy): We have asked for a clearing plan in which some areas would be left in standing timber. The USACE wants to preserve some timber stands as part of this project to eventually provide structure in aquatic habitat. The only change in the scope of the project since the Public Notice is the location of the water treatment plant and its pipeline. All pipelines/roads etc. directly impacted by this proposal will be part of the EIS.

NTMWD: The NTMWD has purchased the land that the water treatment plant will be located on.

Ryan: I have a question on the geographic scope. What elements of the project will be included in EIS?

USACE (Andy): All connected actions will be covered, including water treatment plant, pipelines, and outfall on Pilot Grove Creek.

TCEQ: All infrastructure that has to be removed will be covered?

USACE (Andy): Yes, all existing facilities.

TCEQ: Potential impacts to Pilot Grove Creek are to be included?

USACE (Andy): Yes. The change in water flow due to the outflow pipe in Pilot Grove Creek will be evaluated in the EIS. The Creek flow may be monitored pre- and post- reservoir construction.

EPA (Jeanene): We are very interested in a strong look at alternatives to the proposal, possibly combinations of projects.

EPA (Tami): What is the baseline measure for the possible mitigation site?

USACE (Andy): We need to establish the baseline conditions for the mitigation site. The District will begin to work on this. We will use the same HEP tools that were used to evaluate the reservoir footprint area. We will establish existing conditions and see what might be developed and look at how credit could be built up over time.

USFS: As far as cumulative impacts, how will Lake Ralph Hall be considered?

USACE (Andy): The Lake Ralph Hall project is in the same county as this proposal and is slightly ahead of this project with respect to the EIS and permit application. The USACE is fully aware of the need to assess the cumulative impacts of both reservoirs constructed in the same county. The EIS contractor for the Lake Ralph Hall project is in contact with Mangi and a full analysis of the cumulative impacts of both projects will be included in both EISs. Economic and tax roll impacts may interact. There could be a possible increase in traffic and other simultaneous impacts. Michael Baker is the consulting firm handling the EIS on Lake Ralph Hall.

EPA (Jeanene) – Will the Marvin Nichols project also impound water into Fannin County?

NTMWD (Mike) – No, it won't.

Restroom and Coffee Break

USACE (Andy): We are conducting formal scoping now. Please have all comments to me by January 9th. Nevertheless, comments can continue to be received throughout the EIS process and we will address any new issues that arise during the process.

USFWS (Syd): Endangered species and trust species have to be part of the EIS. There is a newly discovered bald eagle nest by on USFS land near Coffee Mill Lake, though the eagle was recently taken off the ES list. There is a possibility that the interior least tern may be in the project area, as well as the Louisiana black bear.

USACE (Andy): We are fully aware that we have to comply with ESA. Interior least terns use the Red River and possibly very lower portion of Lower Bois d'Arc Creek. Other species include the American burying beetle (evidence at Camp Maxey east of Bonham) and Ouachita rock pocketbook mussel (speculative).

EPA(Jeanene): The EIS should also address state-listed species.

USACE (Andy): The EIS will address state-listed species. Species of concern, if brought to our attention, would be covered. State-listed species don't establish any separate procedures for compliance, that is, they have no regulatory protection.

TCEQ (Mark): Will the instream flow study address mussels?

F&N (Mike): It will address their presence.

TCEQ (Mark): Will any additional water quality modeling be done for downstream reaches? How is water chemistry in downstream changes being considered?

F&N (Steve): The instream flow study has four parameters: hydrology/hydraulics, biology, fluvial geomorphology, and water quality (including downstream DO concentrations), Collection of data is proceeding for these standard parameters. The proposed facility will include a multi-level control structure that will allow for low flow water quality releases from different levels of the water column within the reservoir.

TCEQ: Will the comments received today and last night be included in the EIS?

USACE (Andy): All comments from the public notice and from the public meetings will be included in an appendix to the EIS. Will check to see if there is a requirement to prepare a "scoping report" – not promised unless required.

Acronyms and Abbreviations

USACE – U.S. Army Corps of Engineers, Tulsa District
EPA – U.S. Environmental Protection Agency
F&N – Freese & Nichols
Mangi – Mangi Environmental Group
NTMWD – North Texas Municipal Water District
TCEQ – Texas Commission on Environmental Quality
TPWD – Texas Parks & Wildlife Department
USFS – U.S. Forest Service
USFWS – U.S. Fish and Wildlife Service

APPENDIX C: REVISED MITIGATION PLAN

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

THE Lower Bois d'Arc Creek RESERVOIR
NORTH TEXAS MUNICIPAL WATER DISTRICT

Proposed Lower Bois d'Arc Creek Reservoir
Fannin County, Texas

Mitigation Plan

January 2017

prepared for:
North Texas Municipal Water District

prepared by:
Freese and Nichols, Inc.

Proposed Lower Bois d'Arc Creek Reservoir

Fannin County, Texas

Michael Votaw, CWB, PWS, Biologist

MITIGATION PLAN

Steve Watters, PWS, Hydrologist

January 2017

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FREESE AND NICHOLS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHICS

LIST OF PHOTOGRAPHS

APPENDICES

EXECUTIVE SUMMARY

This Mitigation Plan was developed to compensate for impacts to aquatic and terrestrial resources associated with the proposed Lower Bois d'Arc Creek Reservoir (LBCR) project. This plan was prepared in accordance with the applicable statutory and regulatory requirements, particularly, Regulatory Guidance Letter 02-2, "Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899" and the "Aquatic Resource Mitigation and Monitoring Guidelines", Department of the Army Regulatory Program, Tulsa District U.S. Army Corps of Engineers (USACE), October 2004.

Per Regulatory Guidance Letter 02-2, the USACE gives preference to mitigation projects that use watershed and ecosystem approaches when determining compensatory mitigation requirements (USACE, 2002). Applicants are encouraged to provide compensatory mitigation projects that include a mix of habitats such as open water, wetlands, and adjacent uplands and buffers that, when viewed from a watershed perspective, provide a greater variety of functions and a greater likelihood of success. The proposed Mitigation Plan for the LBCR project utilizes a watershed approach and includes mitigation for both uplands and wetlands over many thousands of contiguous acres within the Bois d'Arc Creek watershed where the potential impacts would occur. While these cover types are addressed separately for accounting purposes in this plan, the relative locations and functions are contiguous and interrelated.

As proposed, the LBCR project encompasses approximately 36,200 acres of habitat within the Bois d'Arc Creek watershed and adjacent Red River watershed (excluding the dam footprint). This includes the 16,641-acre reservoir site, 2,700 acres of shoreline (between elevations 534 ft. msl. and 541 ft. msl.), a 14,959-acre mitigation site (Riverby Ranch Mitigation Site) downstream of the proposed reservoir, and a 1,900-acre mitigation site (Upper Bois d'Arc Creek Mitigation Site) located upstream of the proposed reservoir. These project components are all located within Bois d'Arc Creek watershed, with the exception of about half of Riverby Ranch that lies within the immediate adjacent watershed. Embedded between the proposed reservoir site and the downstream Riverby Ranch Mitigation Site sits the Bois d'Arc Unit of the Caddo National Grasslands (approximately 13,370 acres), managed by the U.S. Forest Service (USFS). With implementation of the proposed mitigation plan, approximately 50,170 acres of aquatic and terrestrial habitat along an approximately 42-mile long corridor adjacent to and connected by Bois d'Arc Creek would be protected in perpetuity (see Figure 1).

Aquatic Resources (Waters of the U.S.)

The mitigation plan for impacts to aquatic resources was developed considering applicable state and federal rules, regulations, and guidelines. Public comments, and state and federal resource agency comments on the Section 404 permit application for the proposed LBCR project, including the scoping meeting for the Environmental Impact Statement (EIS), were also considered.

There has been extensive coordination with state and federal resource agencies throughout the permitting process for this project. Interagency teams have participated in the collection and analysis of data from the proposed reservoir site and the proposed mitigation sites. North Texas Municipal Water District (NTMWD) has presented the mitigation concepts to the state and federal resource agencies in multiple meetings and workshops, and has considered the agencies' input during the development of this plan.

The compensatory mitigation proposed for the LBCR project undertakes a "watershed approach" to address the project's impacts to the overall ecological function of the Bois d'Arc Creek watershed. Moreover, the aquatic resources mitigation plan was developed to comply with the national goal of "no overall net loss of wetland functions" and to provide compensatory mitigation, to the extent practicable, for impacts to other types of waters of the U.S. that would be impacted by construction of the proposed project. All compensatory mitigation for waters of the U.S. would be provided through mitigation that would occur through on-site or near-site mitigation strategies. Through a watershed approach to mitigation, on-site mitigation would be provided at the proposed reservoir site and near-site mitigation would be provided on the nearly 15,000-acre Riverby Ranch and the 1,900-acre Upper Bois d'Arc Creek (BDC) Mitigation Site, which are shown on Figure 1. The NTMWD has acquired the Riverby Ranch and is in the process of acquiring properties within the Upper BDC Mitigation Site because of the unique characteristics and qualities these sites provide to achieve the mitigation required for the proposed project.

Some of the characteristics and benefits that are offered by the three mitigation areas include:

- A watershed approach to mitigation is proposed with the goal of offsetting potential impacts to overall ecological function of the Bois d'Arc Creek watershed;
- The mitigation sites would provide compensatory mitigation to meet the national goal of "no overall net loss of wetland functions";

- Existing habitat at the mitigation sites is degraded due to past and ongoing land use practices, providing the opportunity for mitigation actions to result in considerable ecological uplift;

- The mitigation sites are located near the impact site and in the same watershed (Riverby Ranch is located downstream, the Upper BDC Mitigation Site is located upstream, and the Littoral Wetlands are located on-site);

- The mitigation proposal includes one large contiguous tract of land (Riverby Ranch) and one smaller contiguous area that abuts the project site (Upper BDC Mitigation Site), which avoid "fragmentation" of mitigation;

- The Riverby Ranch mitigation site is located adjacent to the Caddo National Grasslands and other lands that are currently protected in perpetuity through the Wetlands Reserve Program, which would provide synergistic uplift to the resources at the mitigation site and to these adjacent federally protected lands and further increase the contiguous area of protected resources. Considering these other protected properties, NTMWD's mitigation proposal would provide a 42-mile corridor along Bois d'Arc Creek for aquatic and terrestrial habitat;

- The mitigation sites would be protected in perpetuity by a deed restriction or other USACE-approved instrument and could be transferred to a public agency for long-term management following fulfillment of mitigation requirements;

- Existing site conditions including surrounding land uses, soils, climate, and hydrology, make the sites ideal for restoring waters of the U.S.;

- The risk and uncertainty of providing appropriate compensatory mitigation is minimized because the NTMWD has already acquired the majority of the proposed mitigation areas from willing sellers; and

- Mitigation can begin prior to or concurrent with impacts, if permitted, thus minimizing temporal losses of aquatic resources.

The existing conditions at the proposed project site and associated facilities and the proposed mitigation sites were assessed using three functional assessment tools. The Habitat Evaluation Procedures (HEP) was used to assess terrestrial habitats and emergent and shrub wetland habitats. The

Modified East Texas Hydrogeomorphic Method (Modified East Texas HGM) was used to assess the functions of forested wetlands, and the Rapid Geomorphic Assessment (RGA) tool was used to assess stream quality.

The HEP methodology is recommended by the U.S. Fish and Wildlife Service (USFWS) as their basic tool for evaluating project impacts to wildlife habitat and developing mitigation recommendations. Both impacts and mitigation credits are measured using Habitat Units (HUs), a metric specific to the HEP methodology. At the request of the USEPA and other federal and state resource agencies, the East Texas HGM functional assessment tool was modified specifically for this project to assess impacts and mitigation for forested wetlands. The Modified East Texas HGM assesses up to six functions associated with forested wetlands, which are reported as Functional Capacity Units (FCUs). This metric is the basis for determining forested wetlands mitigation debits and credits. Existing conditions for streams within the footprint of the proposed reservoir, including tributaries to the proposed littoral zone wetlands, and streams at the proposed mitigation sites were assessed using a geomorphic methodology for streams (RGA). The RGA method used to evaluate stream condition at the impact site and the mitigation sites is similar to other geomorphic assessment methods used in various regions of the U.S. These methods generally use measures of erosion, channel stability, riparian habitats, instream habitats, and other visual attributes of stream channels to evaluate and measure stream conditions. The RGA method integrates data from field and desktop sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features (FNI, 2009, 2016b). Both stream impacts and mitigation credits are measured using Stream Quality Units (SQUs), a metric developed for this assessment to assign a value to stream reaches that could be used to assess impacts, measure baseline conditions, and measure uplift at the mitigation sites.

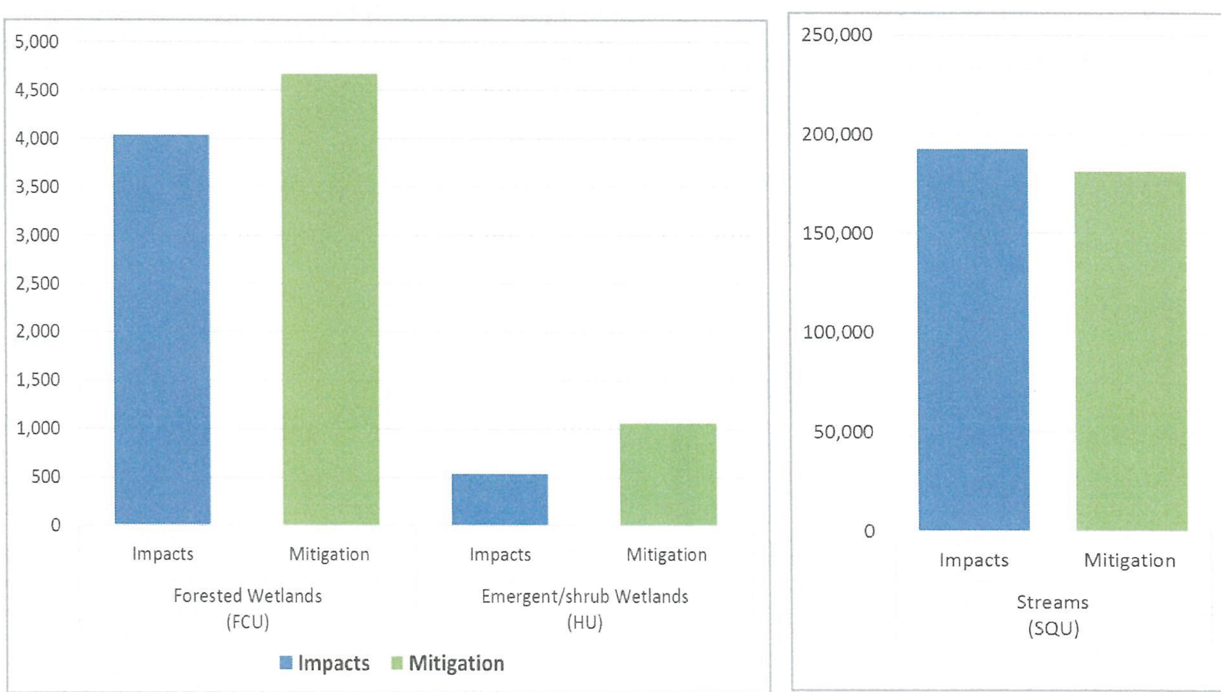
During the development of this mitigation plan, efforts were made by NTMWD to avoid and/or minimize, to the extent practicable, impacts to potential waters of the U.S. Such actions include locating project components within the grading limits of the proposed dam and spillways (e.g., the proposed intake pump station and electrical substation), siting other components (e.g., the proposed terminal storage reservoir) entirely within upland areas, minimizing impacts to streams when possible by restoring preconstruction contours and stabilizing exposed slopes and stream banks, purchase of additional lands and flowage easement around the proposed reservoir, and coordinating with local authorities to implement water quality protection measures. A summary of potential impacts to waters of the U.S. and proposed compensatory mitigation for unavoidable impacts to waters of the U.S. from the proposed action are shown in Table ES-1 and Graphic ES-1. As proposed, this mitigation plan would provide:

- Enhancement and/or protection for 1,026 acres of forested wetlands, 1,377 acres of emergent wetlands, 98 acres of shrub wetlands, 50 acres of open water, and 263,597 linear feet of streams;
- Restoration of 4,775 acres of forested wetlands, 1,100 acres of emergent wetlands, 150 acres of shrub wetland, and 128,668 linear feet of streams;
- Creation of 605 acres of littoral zone wetlands, 32,597 linear feet of stream, and an offset to open water losses through the creation of abundant open water areas in the proposed reservoir;
- A net gain of 640 FCUs of forested wetlands, 80.5 HUs of shrub wetlands, and 443 HUs of emergent wetlands; and
- Provision of 181,153 SQUs of stream mitigation that reflects a deficit of 11,224 SQUs, which would be sufficiently compensated through the synergistic uplift provided by the watershed approach and surplus aquatic mitigation credits.

Table ES-1 Summary of Potential Impacts to Waters of the U.S. and Proposed Mitigation

Type of Water of the U.S.	Amount Impacted		Amount of Mitigation		Net Gain (+) / Net Loss (-)	
	Acres	Functional Capacity/Habitat Units (FCU/HU)	Acres	Functional Capacity/Habitat Units (FCU/HU)	Acres	Functional Capacity/Habitat Units (FCU/HU)
Forested Wetland	4,602	4,035	5,801	4,675	(+) 1,199	(+) 640
Shrub Wetland	49	23	248	103.5	(+) 199	(+) 80.5
Emergent Wetland	1223	514	3,082	957	(+) 1,859	(+) 443
Open Waters	78	N/A	16,036[1]	N/A	(+) 15,958	N/A
	Linear Feet	SQUs	Linear Feet	SQUs	Linear Feet	SQUs
Streams	651,140	192,377	392,265	181,153	(-) 258,875	(-) 11,224

[1] This represents the offset of open waters by the creation of the reservoir, less the acreage identified for littoral wetlands.



Graphic ES-1 Summary of Proposed Aquatic Mitigation

Terrestrial Resources

In addition to providing compensatory mitigation for potential impacts to waters of the U.S., this mitigation plan would also provide compensatory mitigation for potential impacts to terrestrial resources, to the extent practicable. The proposed terrestrial mitigation components of this plan were developed to support and meet the permitting and mitigation requirements associated with the state of Texas water right permit for the LBCR issued by the Texas Commission on Environmental Quality (TCEQ) on June 26, 2015. During the development of this section of the mitigation plan, specific consideration was given to Title 30 of the Texas Administrative Code (TAC) §297.53, which addresses habitat mitigation associated with water rights permitting.

It should be noted that most of the proposed aquatic and terrestrial mitigation would occur on the Riverby Ranch, a single, nearly 15,000-acre tract of land located downstream of the proposed reservoir site (Figure 1). Having both terrestrial and aquatic mitigation sites located together on one tract will provide synergistic ecological uplift to both ecosystems and avoid fragmentation of habitat. Also, the control over entire subwatersheds located within the Riverby Ranch increases the potential for success in comparison to risks associated with permittee responsible mitigation where entire subwatersheds are not under the permittee's control and protection. The remaining terrestrial mitigation area is located adjacent to the project site. The proximity of these sites to each other, including lands enrolled in the Pintail Farms Wetlands Reserve Program (WRP) area and the nearby Caddo Grasslands, also offers synergistic ecological uplift at a watershed/landscape scale, increases long-term habitat connectivity, and reduces habitat fragmentation.

The HEP methodology was used to evaluate the terrestrial resources that could be impacted following construction of the proposed reservoir and its related components. In addition to the USFWS's recognition of HEP as an appropriate method to assess impacts and make mitigation recommendations, HEP is also identified by the state of Texas (30 TAC §297.53) as an appropriate tool for impact assessment and mitigation. As such, both impacts and mitigation credits are measured using Habitat Units, a metric specific to the HEP methodology, except for shrubland. As agreed by the inter-agency assessment team, shrubland is measured in acres because there is limited opportunity to improve the habitat value of the existing shrubland at the mitigation site. A summary of potential impacts to terrestrial resources and proposed compensatory mitigation to offset those impacts is shown in Table ES-2.

Table ES-2 Summary of Potential Impacts to Terrestrial Resources and Proposed Mitigation

Terrestrial Resource Type	Amount Impacted	Amount of Mitigation	Net Gain (+) / Net Loss (-)
Upland Deciduous Forest (HU)	1,058	742	(-) 316
Riparian Woodland / Bottomland Hardwood (HU)	434	855	(+) 421
Grassland / Old Field (HU)	2,896	2,393	(-) 503
Shrubland (acre)	64	41	(-) 23

Organization of this Report

Part 1, *Mitigation Plan for Impacts to Aquatic Resources* (Chapters 2 – 10), of this mitigation plan was prepared to address Section 404 permitting and mitigation requirements as well as aquatic mitigation requirements for the state of Texas water right. Detailed discussions of impacts to waters of the U.S. and proposed mitigation to offset those impacts are included in this section. Part 2, *Mitigation Plan for Impacts to Terrestrial Resources* (Chapters 11 – 14), was prepared to address the state of Texas water rights permit mitigation requirements. Part 3, *Site Protection, Management and Financial Assurances* (Chapters 15 – 18), includes the proposed methods for long-term protection and management of the mitigation areas. All referenced figures in this report are in Appendix A. Appendix B contains a table of the common and scientific names of organisms referenced in the report. Appendices C through H provide technical memoranda and detailed data used to develop the Mitigation Plan. Appendix I provides typical plan and details associated with aquatic mitigation development. Appendix J contains a sample deed restriction and two draft resolutions to be executed in substantially the same form by the NTMWD Board of Directors on financial assurance and site protection.

1.0 PROJECT INTRODUCTION AND BACKGROUND

Name: North Texas Municipal Water District's Lower Bois d'Arc Creek Reservoir Project, USACE Project No.: 14659

Project Location: The proposed reservoir site, intake pump station, electrical substation, and a portion of the raw water pipeline are located within the Bois d'Arc Creek watershed (HUC 11140101), as shown on Figure 1. The center coordinates of the proposed dam are approximately 33° 43' 05" N, 95° 58' 56" W. The proposed dam is on Bois d'Arc Creek and Honey Grove Creek approximately 15 miles northeast of the City of Bonham, Fannin County, Texas. The reservoir area is generally bounded by State Highway 82 to the south, Farm-to-Market (FM) 273 to the north, FM 100 to the east, and FM 898 to the west. The water treatment plant, which is being proposed irrespective of the reservoir, and proposed terminal storage reservoir are located near the City of Leonard, TX in the Trinity River Basin (Figure 1). The proposed pipeline extends from near the proposed dam site to the southwest for approximately 35 miles to the proposed water treatment plant site.

Mitigation Site Location: There are three proposed mitigation sites as shown on Figure 1. One proposed mitigation site is located in the northeast corner of Fannin County and the northwest corner of Lamar County, TX near the confluence of Bois d'Arc Creek and the Red River (HUC11140101). This proposed mitigation site is known as the "Riverby Ranch" and the center coordinates are approximately 33° 50' 20" N, 95° 53' 55" W. The other proposed near-site mitigation area is located along Bois d'Arc Creek immediately upstream of the proposed reservoir. The Upper Bois d'Arc Creek Mitigation Site (Upper BDC Mitigation Site) extends 5.76 miles along Bois d'Arc Creek to State Highway 78. The center coordinates are 33° 34' 22.40" N, 96° 9' 30.83" W. The third mitigation site is the on-site littoral wetlands and streams shown on Figure 1.

River Basins: Trinity River, Sulphur River, Red River Basins

Watershed, Aquatic Impacts: Bois d'Arc Creek Watershed

Counties: Fannin, Lamar

The proposed Lower Bois d'Arc Creek Reservoir (LBCR) is located in a rural area northeast of the City of Bonham, Texas (Figure 1). For purposes of this Mitigation Plan, the term "LBCR project" consists of:

- 17,068 acres, which includes 16,641 acres at the conservation pool elevation 534 ft. msl. and 427 acres for the dam and spillways;
- 860 acres associated with the proposed raw water pipeline, water treatment plant[1], terminal storage reservoir, and rail spur; and
- 104 acres associated with the relocation of FM 1396 outside of the reservoir footprint.

The proposed reservoir would provide approximately 120,000 acre-feet per year of water supply to the North Texas Municipal Water District (NTMWD). This project is one of several water supply projects that the NTMWD is pursuing to meet its growing water needs. As part of the development of this project, an application for a State of Texas water right permit for the LBCR was submitted by NTMWD to the Texas Commission on Environmental Quality (TCEQ) on December 29, 2006. The water right permit was issued by TCEQ on June 26, 2015. An application for a Section 404 permit, which is necessary to construct the proposed reservoir, was submitted to the U.S. Army Corps of Engineers (USACE) on June 3, 2008 (FNI, 2008a).

Throughout the permitting process for this project, NTMWD and Freese and Nichols, Inc. (FNI) have coordinated extensively with numerous state and federal resource agencies, including:

- U.S. Fish and Wildlife Service (USFWS);
- U.S. Army Corps of Engineers (USACE);
- U.S. Environmental Protection Agency (USEPA);

1 As noted above, the proposed water treatment plant will be pursued by NTMWD with or without the LBCR project because of the need for increased treated water capacity in the northern part of NTMWD's service area. The draft EIS describes the plant in the context of the proposed reservoir project, and FNI has included it here as a measure of consistency.

- U.S. Forest Service (USFS);
- Natural Resources Conservation Service (NRCS);
- Texas Parks and Wildlife Department (TPWD);
- Texas Water Development Board (TWDB); and
- Texas Commission on Environmental Quality (TCEQ).

As part of the ongoing coordination effort, multiple reports documenting the findings from studies conducted for the proposed project have been prepared and submitted by NTMWD to the USACE and these agencies in support of the water right permit and 404 permit applications. The following reports were used in developing the Mitigation Plan:

- *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir*, 2 volumes, submitted to TCEQ on December 29, 2006 (FNI, 2006).
- *Section 404 Permit Application and Jurisdictional Determination Report*, submitted to USACE on June 3, 2008 and submitted to the TCEQ water rights permitting section on October 8, 2008 (FNI, 2008a).
- *Environmental Report, Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir*, submitted to USACE on July 1, 2008 and to the TCEQ water rights permitting section on October 8, 2008 (FNI, 2008b).
- *Instream Flow Study Report for the Proposed Lower Bois d'Arc Creek Reservoir*, May 2010, submitted to USACE and Cooperating agencies on May 27, 2010. Submitted to TCEQ on June 1, 2010 (FNI, 2010a).
- *Instream Flow Study Supplemental Data*, September 2010, submitted to USACE and cooperating agencies on September 17, 2010. Submitted to TCEQ on September 23, 2010 (FNI, 2010b).
- Technical Memorandum on Supplemental Habitat Evaluation Procedures (HEP) Data Associated with the Proposed Lower Bois d'Arc Creek Reservoir Pipeline and Associated Treatment Facilities, December 2013, submitted to USACE on December 18, 2013 (FNI, 2013c).

- *Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries for the Lower Bois d'Arc Creek Reservoir Project*, January 2009, submitted to the USACE on November 16, 2009 (FNI, 2009).
- Technical Memorandum on Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment, November 12, 2014, updated November 4, 2016, and included in Appendix E (FNI, 2016b).
- Technical Memorandum on Functional Assessment of Forested Wetlands at the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM, June 22, 2016, submitted to the USACE on June 22, 2016 and included in Appendix D (FNI, 2016c).
- Technical Memorandum on Lower Bois d'Arc Creek Reservoir – Additional Forested Wetland Mitigation Proposal Based on the Modified East Texas HGM Functional Assessment, September 30, 2016, included in Appendix D (FNI, 2016d).
- Technical Memorandum on Assessment of Potential Impacts of Wetlands Downstream of LBCR, June 3, 2016, submitted to the USACE on June 6, 2016 and Included in Appendix F (FNI, 2016a).
- Technical Memorandum on Lower Bois d'Arc Creek Littoral Zone/ Fringe Wetland Development, May 7, 2014, submitted to the USACE on September 3, 2014 and included in Appendix G (FNI, 2014).

Additionally, a synopsis of the impacts of the proposed project on terrestrial and aquatic functions was provided to the TCEQ in the response to a Request for Information, dated May 13, 2011. A copy of this response is included in Appendix H of this mitigation plan.

This mitigation plan is organized into three parts: Part 1 (Chapters 2 – 10) discusses the mitigation plan for impacts to aquatic resources; Part 2 (Chapters 11 – 14) presents the mitigation plan for impacts to terrestrial resources; and Part 3 (Chapters 15 – 18) outlines the long-term protections, adaptive management, and financial assurances.

PART 1 MITIGATION FOR IMPACTS TO AQUATIC RESOURCES

This Part of the mitigation plan was developed to provide compensatory mitigation, to the extent practicable, for impacts to aquatic resources that could occur from construction of the proposed Lower Bois d'Arc Creek Reservoir (LBCR) and its related components. All proposed compensatory mitigation for potential impacts to aquatic resources would be provided with on-site or near-site mitigation strategies. Although this document has been prepared in such a way to discuss impacts and proposed mitigation to aquatic (Part 1) and terrestrial (Part 2) resources independently, mitigation would be accomplished on-site and nearby on large, contiguous mitigation sites (Riverby Ranch and the Upper Bois d'Arc Creek Mitigation Site).

This mitigation plan was developed in compliance with Regulatory Guidance Letter 02-2, "Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899" (USACE, 2002) and the "Aquatic Resource Mitigation and Monitoring Guidelines" (USACE, 2004). This plan was also developed through consideration of public comments, as well as state and federal resource agency comments on the Section 404 permit application for the proposed LBCR project, including those received during the scoping process, scoping meetings for the Environmental Impact Statement (EIS), following publication of the DRAFT EIS in February 2015, and from the USACE and cooperating agencies in 2016 and 2017.

The Section 404 permit application was submitted to the USACE on June 3, 2008, which is prior to the effective date, June 9, 2008, of the regulations governing compensatory mitigation for losses of aquatic resources provided in 33 CFR Part 332 and 40 CFR Part 230 (Final Mitigation Rule, 73 Fed. Reg. 19593, 19608), and therefore is not subject to these regulations. Although this mitigation plan is not subject to the Final Mitigation Rule, the outline presented in the Final Mitigation Rule was considered in the development of this mitigation plan.

This mitigation plan was developed to meet the national goal of "no overall net loss of wetland functions" and to provide compensatory mitigation, to the extent practicable, for unavoidable impacts to wetlands and other types of waters of the U.S. that could be impacted by construction of the proposed LBCR project. All compensatory mitigation would be provided through permittee-responsible mitigation that would occur through on-site or near-site mitigation strategies. On-site mitigation would be provided at the proposed reservoir site and near-site mitigation would be provided on the 14,958.58-

acre Riverby Ranch, which is located on Bois d'Arc Creek downstream of the proposed reservoir, and at the approximately 1,900-acre Upper Bois d'Arc Creek Mitigation Site located along the creek immediately upstream of the proposed reservoir site. The NTMWD has selected these sites specifically because of their unique locations, characteristics and qualities to provide appropriate mitigation for the proposed project.

2.0 IMPACTS DUE TO THE PROPOSED PROJECT

2.1 PROJECT SITE DESCRIPTION

The proposed Lower Bois d'Arc Creek Reservoir (LBCR) is in a rural area northeast of the City of Bonham, Texas. The proposed reservoir 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 proposed reservoir site has been altered over the past 100 years, mainly by agricultural practices and stream channelization. Components of the proposed project and relevant other development also includes the relocation of FM 1396 to a new north-south alignment known as FM 897 near the mid-point of the reservoir as well as a proposed raw water pipeline, intake pump station, electrical substation, terminal storage reservoir, rail spur, and water treatment plant. The relocation of FM 1396 would occupy about 104 acres of uplands outside of the proposed reservoir pool. The proposed raw water pipeline, terminal storage reservoir, rail spur, and water treatment plant would be located within Fannin County and would have a total footprint of approximately 860 acres. The proposed intake pump station and electrical substation would be located within the 427 acres for the construction of the dam and spillways, and therefore do not add or result in any additional impacts associated with the proposed project. Considering these associated components and other relevant infrastructure, this Mitigation Plan addresses a total of 18,032 acres for the LBCR project.

Ecologically, the proposed project site would be located within the Post Oak Savannah and Blackland Prairie Ecological Regions of Texas (Gould et. al., 1960). 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 streams, or in areas protected from fire (TPWD, 2007).

Slopes in Fannin County range from nearly level to moderately steep. According to the NRCS Soil Survey of Fannin County, Texas (Goerdel, 2001), elevation ranges from 478 ft. msl. at the mouth of Bois d'Arc Creek and the Red River to 767 ft. msl. in the southwestern part of the county.

According to the 1946 Soil Survey of Fannin County (Templin et al., 1946), historical land uses were primarily cropland and pastureland. In 1939, harvested cropland represented almost half of the area of the county, with cotton representing the largest crop, followed by corn and oats. Most of the remaining land within the county was used for pasture. During this time, practically all the highly productive land was cultivated except for the lower floodplain of Bois d'Arc Creek, which needed protection from floods. These floodplain areas were densely forested with such species as bois d'arc, ash, water oak, willow oak, elm, hackberry, pecan, and lesser numbers of other trees. Although these areas could not be cultivated due to flooding, a considerable amount of rough lumber was cut, especially bois d'arc, due to its value as fence posts.

The 2001 Soil Survey of Fannin County (Goerdel, 2001) indicates that agriculture is still the main land use in Fannin County. The major land uses are cropland and improved pasture with nearly half of the agriculture income being derived from the sale of livestock. Crop production has shifted away from being primarily cotton based to close-growing crops such as wheat, grain sorghum, soybeans, and peanuts. Rangeland comprises about six percent of the county's land area with almost half of that being in the Caddo National Grasslands and the remainder being in the southern part of the county. Only 0.5 percent of the land in Fannin County is used as commercial woodland.

2.2 EXISTING SOILS

Soils within the footprint of the proposed LBCR are presented in Table 2.1. Descriptions of the soils can be obtained from the NRCS Soil Survey of Fannin County, Texas (Goerdel, 2001).

Table 2.1 Soils Located within the Proposed LBCR Site, including their Hydric Rating

Map Unit Name	Hydric
Austin silty clay loam, 1 to 3 percent slopes	No
Burleson clay, 0 to 1 percent slopes	No
Crockett loam, 1 to 3 percent slopes	No
Crockett loam, 2 to 5 percent slopes, eroded	No
Dams	No
Dela loam, frequently flooded	No
Dela loam, occasionally flooded	No
Derly silt loam, 0 to 1 percent slopes	Yes

Map Unit Name	Hydric
Derly-Raino complex, 0 to 1 percent slopes	Yes
Elbon silty clay loam, frequently flooded	No
Ellis clay, 5 to 12 percent slopes, eroded	No
Fairlie clay, 0 to 1 percent slopes	No
Fairlie-Dalco complex, 1 to 3 percent slopes	No
Ferris clay, 5 to 12 percent slopes, eroded	No
Freestone-Hicota complex, 0 to 2 percent slopes	Yes
Frioton silty clay loam, occasionally flooded	No
Heiden clay, 1 to 3 percent slopes	No
Heiden-Ferris complex, 2 to 6 percent slopes, eroded	No
Hopco silt loam, frequently flooded	No
Hopco silt loam, occasionally flooded	No
Houston Black clay, 1 to 3 percent slopes	No
Howe-Whitewright complex, 3 to 5 percent slopes	No
Lamar clay loam, 5 to 8 percent slopes	No
Leson clay, 1 to 3 percent slopes	No
Morse clay, 5 to 12 percent slopes, eroded	No
Normangee clay loam, 1 to 3 percent slopes	No
Normangee clay loam, 2 to 5 percent slopes, eroded	No
Porum loam, 2 to 5 percent slopes	No
Porum loam, 5 to 12 percent slopes	No
Stephen silty clay, 1 to 3 percent slopes	No
Tinn clay, frequently flooded	Yes
Tinn clay, occasionally flooded	Yes
Whakana very fine sandy loam, 3 to 5 percent slopes	No
Whakana very fine sandy loam, 5 to 12 percent slopes	No
Whitewright-Howe complex, 5 to 12 percent slopes, eroded	No
Wilson silt loam, 0 to 1 percent slopes	No

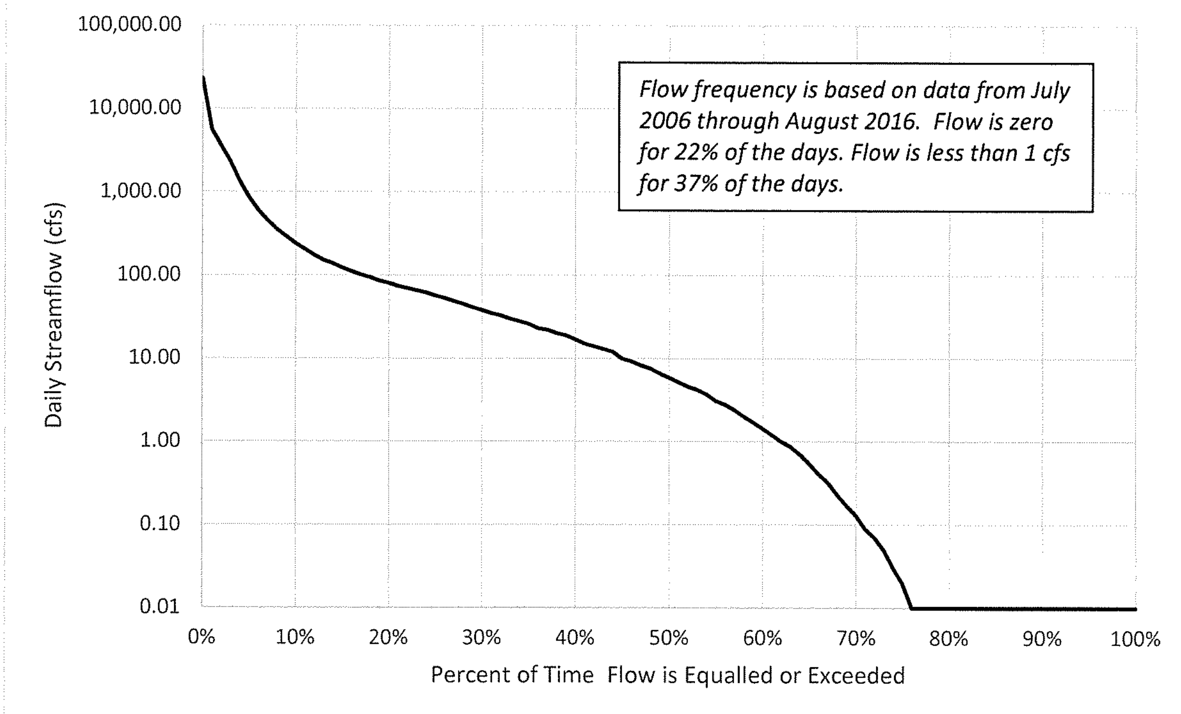
2.3 EXISTING HYDROLOGY

The watershed for Bois d'Arc Creek is located within the Red River Basin. The proposed reservoir would 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 recreational lakes.

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 proposed reservoir site has been channelized, as have portions of several tributaries. Much of the channelization was performed to reduce flooding along the creeks. The hydrology of the watershed is characterized by the rapid rise and fall of stream flow in response to rain events. Fluvial geomorphologic analyses indicate that prior channelization, lack of aquatic habitat, and lack of bank stability have contributed to excessive erosion and downcutting in Bois d'Arc Creek. This has resulted in reduced quality for the streams within the project site and immediately downstream of the proposed dam and spillway.

Photograph 2.1 Bois d'Arc Creek at FM 409 (9-8-2011)

Bois d'Arc Creek and several of its tributaries are listed in the NHD database as perennial streams. All other tributaries are listed as intermittent streams. These designations were used for the Preliminary Jurisdictional Determination, which was conducted in 2007 (FNI, 2008a). However, hydrologic gage data at FM 1396 and FM 409, as well as visual inspection over the past ten years demonstrate that Bois d'Arc Creek and its tributaries have extended periods of no flow. Analysis of the USGS stream flow data at FM 1396 reflected in Graphic 2.1 shows that Bois d'Arc Creek had no flow for 22 percent of the time during the hydrologic record from July 2006 through August 2016. Table 2.2 documents the recorded flows over the same period.



Graphic 2.1 Flow Frequency at USGS Gage 07332620 at FM 1396

Table 2.2 Streamflow Characteristics at USGS Gage 07332620 at FM 1396

Daily Mean Discharge Data Statistics (FM 1396) July 1, 2006 through June 30, 2016								
Month	Daily Mean Discharge (cfs)			Percentile Flows (cfs)				
	Min	Median	Max	Q_{10}	Q_{25}	Q_{50}	Q_{75}	Q_{90}
January	0.0	21.5	7,030	0.2	4.6	21.5	86.8	204.8
February	0.0	31.0	8,240	1.5	6.9	31.0	67.0	263.2
March	0.0	46.5	9,900	1.1	9.3	46.5	189.0	632.2
April	0.1	38.0	6,600	4.0	14.0	38.0	97.0	344.8
May	0.0	60.0	14,800	0.7	10.3	60.0	286.5	2,363.0
June	0.0	12.5	7,670	0.1	0.9	12.5	61.5	373.6
July	0.0	0.1	6,480	0.0	0.0	0.1	5.7	53.4
August	0.0	0.0	3,030	0.0	0.0	0.0	0.4	10.1
September	0.0	0.0	1,880	0.0	0.0	0.0	1.1	26.0
October	0.0	0.0	11,600	0.0	0.0	0.0	2.6	130.4
November	0.0	0.5	23,100	0.0	0.0	0.5	11.3	92.6
December	0.0	6.7	16,600	0.0	0.4	6.7	69.8	207.3
Annual	**0.0**	**6.0**	**23,100**	**0.0**	**0.0**	**6.0**	**52.0**	**232.0**

During the 10-year period of record at FM 1396, which includes both wet and dry periods, there was little to no flow (<0.1 cfs) in Bois d'Arc Creek over 50 percent of the days during the summer and autumn months (July-October). A similar analysis was conducted for the USGS stream gage at FM 409 for its period of record from June 2009 through June 2016. This analysis showed no stream flow at FM 409 over 14 percent of the time. Median flows during the summer and autumn months at FM 409 were less than 0.5 cfs during the period of record. The no-flow conditions were also observed during field investigations for the instream flow studies, archeological studies and rapid geomorphic assessment. The existing referenced 10 years of gage data, along with field observations, indicate that the NHD classification of "perennial" is incorrect and that the stream is actually functioning as an intermittent stream.

The Texas Commission on Environmental Quality (TCEQ) also uses a stream type classification for implementation of its Surface Water Quality Standards. Bois d'Arc Creek (Segment 0202A) is an evaluated tributary of the classified segment 0202 (Red River downstream of Lake Texoma) in the State's Water Quality Program (TCEQ, 2015). Under this program, Bois d'Arc Creek is classified as perennial from the confluence of Bois d'Arc Creek with the Red River upstream on Bois d'Arc Creek to the confluence with Pace Creek, which is located south (upstream) of Bonham. The remaining upstream section of Bois d'Arc Creek is unclassified. Honey Grove Creek is classified as intermittent, and all other tributaries to Bois d'Arc Creek are not classified. The TCEQ has reviewed the data for classification of Bois d'Arc Creek and provided a letter to NTMWD stating that the TCEQ has proposed a Texas Surface Water Quality Standard revision to reclassify the stream segment through the LBCR reach from perennial to "intermittent with perennial pools." A copy of the letter is included in Appendix E.

Considering these different sources of stream classifications (NHD, TCEQ, and NTMWD field data), the streams within the LBCR project site by stream classification are presented in Table 2.3. For this Mitigation Plan, based on best available data, the main stem of Bois d'Arc Creek that flows through the reservoir site and named tributaries are classified as intermittent. All other streams within the reservoir site are classified as intermittent/ephemeral. The use of a combined classification is based on field observations that many of the tributaries to the named streams are likely ephemeral, but field verification was not conducted to distinguish the point at which the stream transitioned from ephemeral to intermittent. The NTMWD *field data* classification for the reservoir site is used for this Mitigation Plan, as this information was either inspected by FNI staff directly in the field or from a GIS desktop analysis. A summary of the stream lengths by stream type, as defined based on field data, is presented in Table 2.4.

Table 2.3 Stream Type Designations and Lengths (ft) within LBCR Project Site

Stream Type Designation	NHD	TCEQ	NTMWD Field Data
Perennial	244,914	N/A	N/A
Intermittent with Perennial Pools	N/A	80,689[1]	N/A
Intermittent	383,093	37,432	286,139
Intermittent/Ephemeral	N/A	N/A	365,001
Artificial Path	23,134	N/A	N/A
Undesignated	N/A	533,019	N/A
Grand Total	**651,140**	**651,140**	**651,140**

1. *TCEQ has proposed to reclassify portions of Bois d'Arc Creek from "perennial" to "intermittent with perennial pools" in the 2017 triennial revision of the Texas Surface Water Quality Standards.*

Table 2.4 Summary of Field Data Stream Lengths within LBCR Project Site by Stream Type

Stream Type Designation	NTMWD Field Data
Intermittent	286,139
Intermittent/Ephemeral	365,001
Grand Total	**651,140**

2.4 EXISTING VEGETATION

The location and distribution of all vegetative cover types within the proposed LBCR lake and dam site are depicted in Figure 2 and the corresponding acreages are shown in Table 2.5. The location and distribution of vegetative cover types within the footprint of the proposed transmission and treatment facilities are reported within the *Supplemental Data Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir* report (FNI, 2013b). The vegetative upland cover types within the proposed FM 897 alignment (relocation of FM 1396) were identified in a separate analysis in 2016 conducted by Berg Oliver, Inc. and are discussed in Part 2 of this Mitigation Plan. It is important to note that all wetland impacts were avoided during site selection for the transportation, transmission and treatment project components. As such, the descriptions of wetlands impacts, excluding potential wetlands located downstream of the proposed reservoir (Section 2.8), pertain exclusively to the proposed reservoir site. The following subsections contain descriptions of the typical vegetative species that occur within each wetland cover type.

Table 2.5 Cover Type Acreages within LBCR Lake and Dam Site

Habitat Type	Acreage	Percent
Evergreen Forest	228	1
Upland/Deciduous Forest	2,216	13
Riparian Woodland/ Bottomland Hardwood/Forested Wetland (total)	6,330	37
Riparian Woodland/Bottomland Hardwood	*1,728*	*10*
Forested Wetland	*4,602*	*27*
Shrubland	63	0
Shrub Wetland	49	0
Grassland/ Old Field	4,761	28
Emergent / Herbaceous Wetland	1,223	7
Cropland	1,757	10
Riverine (not used in HEP analysis)	219	1
Lacustrine (not used in HEP analysis)	87	1
Tree Savanna	132	1
Shrub Savanna	4	0
Grand Total	**17,068**	**100**

2.4.1. Emergent Wetland

Emergent wetlands in the project site are dominated by an herbaceous layer made up of wetland obligates such as rushes, sedges, smartweed, and redstem. The herbaceous canopy includes numerous grass species such as barnyardgrass, crowngrass, and eastern gammagrass. Other plants found in the emergent wetlands include blue sedge, spikerush, flatsedge, sumpweed, frogfruit, water primrose, balloon vine, dock, and buttercup.

2.4.3. Shrub Wetland

Shrub wetlands in the study area can be considered wetlands in successional transition between emergent wetlands and bottomland wetland forests. The shrub layer is dominated by small trees such as green ash, sugarberry, and cedar elm, as well as species such as honey locust and baccharis. Dominant herbaceous plants include sedges, ragweed, ironweed, goldenrod, evening primrose, round-leaf groundsel, and wild pea.

2.4.4. Riparian Woodland/Bottomland Hardwood Forest (Forested Wetland)

The riparian woodland / bottomland hardwood cover type includes wetland areas dominated by woody vegetation at least six meters tall, with a total vegetation cover of more than 30 percent; this designation is synonymous with the Forested Wetland cover type described in the Ecological Services Manual (ESM) 103 (USFWS 1980c). The riparian woodland / bottomland hardwood cover type in the project site 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.

Dominant trees include black willow, boxelder, green ash, sugarberry, and cedar elm. Dominant shrubs are often small trees of the species listed above, as well as honey locust, poison ivy, coralberry, buttonbush, baccharis, and Virginia creeper. Common herbaceous plants in the bottomland hardwood forest include Cherokee sedge, ragweed, and Virginia wildrye.

2.5 EXISTING WILDLIFE USAGE

2.5.1. Emergent Wetland

Many species of birds were found in the emergent wetlands, including the northern cardinal, American crow, indigo bunting, tufted titmouse, great blue heron, great egret, red-tailed hawk, northern harrier, and several species of waterfowl. Other wildlife resident in the areas include several mammals, such as raccoon, beaver, feral hog, and white-tailed deer; aquatic species including frogs, mosquitofish, crayfish, mussels; and plentiful flying insects such as mosquitoes, butterflies, bees and dragonflies.

2.5.2. Shrub Wetland

Birds observed in the shrub wetlands of the project site included northern cardinal, painted bunting, American crow, great egret, solitary warbler, and common yellow throat. Evidence of mammalian residents includes tracks of the raccoon and bite marks of beaver. The southern leopard frog and crayfish were also observed in the shrub wetlands.

2.5.3. Riparian Woodland/Bottomland Hardwood Forest (Forested Wetland)

Common avian species observed in this cover type include the indigo bunting, white-eyed vireo, American crow, Carolina wren, barred owl, egret, Carolina chickadee, and northern cardinal. Evidence of mammalian residents included raccoon tracks, hog tracks, and beaver chew marks on trees. Although not observed during field surveys, it has been reported that the river otter may also occur in the area. Reptiles such as the ornate box turtle and unidentified frogs were also found in these forests, as were numerous invertebrate species, including crayfish and land snails.

2.6 WETLANDS ASSESSMENT AT PROJECT SITE

The assessment of existing habitat value for emergent and shrub wetlands within the proposed project site was estimated using the Habitat Evaluation Procedures (HEP), developed by the (USFWS 1980b). For forested wetlands, the Hydrogeomorphic Approach was used that is based on a modification of the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams et al., 2010), henceforth called "Modified East Texas HGM". This tool was developed by Stephen F. Austin (SFA) University, acting as an independent contractor to the USACE, specifically for this project. Documentation of how the guidebook was modified can be found in *Modifying the East Texas Regional*

HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project (Camp et al., 2016).

2.6.1. Emergent and Shrub Wetlands

A discussion of the application of the HEP methodology for emergent and shrub wetlands is in the Determination of Credits chapter of this Mitigation Plan (Chapter 7) and Appendix C. The process was conducted by an interagency team that included personnel from USFWS, USACE, USEPA, USFS, TPWD, TWDB, TCEQ, NTMWD, and FNI.

HEP methods were used to quantify the habitat value for all cover types within the study area to a set of wildlife evaluation species selected by the interagency HEP team. Sixteen evaluation species were selected by the HEP team based on their ecological significance and the availability of applicable habitat suitability index (HSI) models. This evaluation was made for baseline conditions (i.e., conditions present at the reservoir site during the 2007 HEP field studies). The HEP report for the baseline conditions at the proposed reservoir site is included as Appendix D of the *Environmental Report Supporting the 404 Permit Application for Lower Bois d'Arc Creek Reservoir* (FNI, 2008b). A supplemental HEP analysis to document existing conditions for the associated transmission and treatment facilities was completed in October and November of 2013 following the selection of the raw water pipeline route and locations of the water treatment plant and terminal storage reservoir (FNI, 2013a).

Photograph 2.2 Interagency HEP Team

The LBCR project 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 evaluation species: the American kestrel (Author Unknown, 1980a), barred owl (Allen, 1987), brown thrasher (Cade, 1986), Carolina chickadee (Author Unknown, 1980b), downy woodpecker

(Schroeder, 1983), eastern cottontail (Allen, 1984), eastern meadowlark (Schroeder and Sousa, 1982), eastern turkey (Schroeder, 1985), field sparrow (Sousa, 1983), fox squirrel (Allen, 1982), green heron (Author Unknown, 1980c), raccoon (Author Unknown, 1980d), racer (Author Unknown, 1980e), scissor-tailed flycatcher (Author Unknown, 1980f), swamp rabbit (Allen, 1985), and the wood duck (Schroeder and Farmer, 1983).

The habitat quality, expressed in HSI, of wetland cover types for the shrub wetland and emergent/herbaceous wetland evaluation species is presented in Table 2.6. Habitat suitability index values are dimensionless and range between zero and 1, where zero indicates no habitat value and 1 indicates the highest habitat value. The overall HSI value for the cover types 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 LBCR project site by multiplying the average cover type HSI values by the acres in each cover type, as presented in Table 2.7.

Table 2.6 Habitat Suitability Indices for Wetland Cover Types within the Proposed LBCR Project Site

Evaluation Species	Cover Types	
	Shrub Wetland	Emergent / Herbaceous Wetland
Green heron	0.81	0.87
Raccoon	0.28	0.17
Swamp rabbit	0.52	--
Wood duck	0.22	0.22
Average HSI Values	**0.46**	**0.42**

Table 2.7 Baseline Habitat Units by Wetland Cover Type within the Proposed LBCR Project Site.

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Shrub Wetland	0.46	49	**23**
Emergent / Herbaceous Wetland	0.42	1,223	**514**
TOTAL		**1,272**	**537**

2.6.2. Forested Wetlands

The Modified East Texas HGM model was used to assess the functional capacity of the forested wetlands in the vicinity of the proposed project. The Modified East Texas HGM evaluates forested wetlands for six wetland functions: 1) Detain Floodwaters, 2) Detain Precipitation, 3) Cycle Nutrients, 4) Export Organic Carbon, 5) Maintain Plant Communities, and 6) Provide Habitat for Fish and Wildlife.

Field data were collected within the proposed reservoir site by a team including FNI environmental scientists, regulatory staff from the Tulsa District USACE, and NTMWD representatives in December 2015. The team, in consultation with other resources agencies and SFA personnel, concluded that the wetlands within the reservoir site are contiguous and similar in vegetative cover. Accordingly, one Wetland Assessment Area (WAA) was defined for forested wetlands within the reservoir site. The team collected data at 12 sample plot locations within the footprint of the proposed LBCR site (Appendix D). Data collection was performed utilizing the modified low-gradient riverine data collection form and following the protocol described in the Regional Guidebook. At each sample plot location, data forms were completed, GPS coordinates were recorded, and photographs were taken.

In total, 14 different field measurements were collected and/or recorded at each sampling location. These measurements were entered into the Modified East Texas HGM calculator provided by USACE ERDC. Once data were entered, the calculator generated an average value for each HGM sub-index variable and an associated sub-index score. The sub-index scores for each variable were then utilized in the assessment models for each of the six functions to calculate a functional capacity index (FCI) value. The FCI value represents the ability of a wetland to perform a specific function relative to the ability of reference standard wetlands to perform the same function. The FCI output of this model is an index value on a scale from 0.0 to 1.0, where wetlands with an FCI of 1.0 perform the assessed function at a level that is characteristic of reference standard wetlands. A lower FCI indicates that the wetland is performing a function at a level below that characteristic of reference standard wetlands. For the Modified East Texas HGM, the FCI values for "poor" to "reference" wetlands tend to range from 0.5 to 1. The Modified East Texas HGM calculator completed data sheets for the LBCR site are included in Appendix D.

As directed by the USACE, both impacts and mitigation would be determined using an average of the FCI scores from the Modified East Texas HGM Calculator Tool for the modeled functions. The average FCI score for the forested wetland functions assessed within the footprint of the proposed reservoir was calculated to be 0.86 (Table 2.8). To estimate impacts, the average FCI score (0.86) is multiplied by the area (4,602 acres) of forested wetlands located within the footprint of the proposed reservoir. This results in 3,957 functional capacity units (FCUs) of impacts to forested wetlands (Table 2.9).

Table 2.8 Baseline Functional Capacity Index for Forested Wetlands within the Reservoir Site

Function	Functional Capacity Index (FCI)
Detain Floodwater	0.92
Detain Precipitation	0.78
Cycle Nutrients	0.85
Export Organic Carbon	0.87
Maintain Plant Communities	0.90
Provide Habitat for Fish and Wildlife	0.86
Average FCI	**0.86**

Table 2.9 Average Functional Capacity Index (FCI) Value and Functional Capacity Units (FCU) of the Forested Wetlands within the Proposed LBCR Site

Average Functional Capacity Index (FCI)	Wetland Assessment Area (Acres)	Functional Capacity Units (FCU)
0.86	4,602[1]	3,957

[1] Note: all discussion of FCUs in the Mitigation Plan is based on acres. The Modified East Texas HGM calculator that was used to compute the FCI values is based on hectares, so a conversion factor of 2.47 acres per hectare was applied to convert from hectares to acres.

2.7 STREAM ASSESSMENT

The condition and quality of the existing streams within the LBCR site (Figure 3) were evaluated using a hydrogeomorphic approach and an instream flow study. The hydrogeomorphic approach utilized is a method called LBCR Rapid Geomorphic Assessment (RGA). This method is based on established protocols to assess the conditions of a stream system. The instream flow study was conducted to assess the biological integrity of the stream system and provide data necessary to establish instream flows needed for an ecologically sound environment downstream of the proposed project.

2.7.1. Rapid Geomorphic Assessment of Proposed Project Site

At the time of this stream assessment, no functional or conditional stream assessment methods had been proposed, adopted, endorsed, or required by the U.S. Army Corps of Engineers (USACE) or other resource agencies having jurisdiction within the state of Texas. As the applicant, NTMWD was encouraged to use best scientific judgement in employing tools to assess the function or condition of streams to be affected by the applicant's proposed project. The RGA was selected as the method to assess the quality of streams within the reservoir site. An RGA was performed in 2008 along Bois d'Arc Creek and four of its major tributaries within the footprint of the proposed LBCR lake site to provide estimated measures of baseline stream conditions (FNI, 2009). At the behest of USEPA, USFWS, TPWD, TCEQ and the USACE, additional data were collected in January 2016 for selected tributaries to supplement the 2008 RGA of the streams within the reservoir site. Representatives from the Tulsa District USACE, TPWD and NTMWD accompanied FNI environmental staff during the 2016 RGA supplemental data collection effort. The streams analyzed using the RGA methodology are shown in Appendix E.

The RGA method integrates data collected from the field and desktop sources into a quantifiable description of the features that affect stream stability (FNI, 2009 and FNI, 2016b). The RGA method used to evaluate stream conditions for this project is similar to other geomorphic assessment methods used in various regions of the U.S. (Habberfield et al., 2014; Metropolitain Washington Council of Governments, 1992; Kline et al., 2007, and Heeren et al., 2012). These methods generally use measures of erosion, channel stability, riparian habitats, instream habitats, and other visual attributes of stream channels to evaluate and measure stream conditions. Also, as noted by Habberfield et al. (2014), "visual-based rapid assessment techniques provide an efficient method for characterizing the restoration potential of streams, with many focusing on channel stability and instream habitat features," and "[g]eomorphic indices can serve as effective proxies for biological indices in highly disturbed systems." As previously discussed, extensive prior channelization, and the resulting channel downcutting and widening, poor stream bank stability, and lack of aquatic habitat indicate that the Bois d'Arc Creek system is highly disturbed and that the use of a geomorphic assessment method such as RGA is appropriate for this stream system.

The RGA method is based on a rapid field assessment of stream properties and characteristics at representative sites along stream reaches that are being evaluated. In general, the types of data collected include observations of channel size and location, bank geometry, information describing riparian vegetation and rooting depths, general bank armoring characteristics, as well as conditions of the upper slopes, lower slopes, and channel bed. Morphological variables for channel stability were documented using the "Watershed Assessment of River Stability & Sediment Supply (WARSSS)" (Rosgen, 2006), the "Stream reach inventory and channel stability evaluation" (Pfankuch, 1975) and the "Incised Channels: Morphology, Dynamics and Control" (Schumm et al., 1984). Each are described on the USEPA technical tools website (http://water.epa.gov/scitech/datait/tools/warsss/). For each data collection point, six stream characteristics (evidence of bank erosion, bank root zone, vegetative bank cover, bank angle, sediment transport, and channel alteration) were assessed, scored, and then summed to calculate a final RGA score ranging between zero and 60. As part of developing this mitigation plan scores were normalized by dividing the score by 60 to produce a Stream Quality Factor (SQF) ranging between zero and one, where zero represents poorest stream conditions and one represents optimum stream conditions.

The calculated SQF score for a particular study reach was then multiplied by its length to calculate Stream Quality Units (SQUs) provided by that reach. This process was repeated for all study reaches within the footprint of the proposed LBCR site to establish baseline SQUs (Table 2.10). Table 2.11 shows the total stream quality units for Bois d'Arc Creek and its tributaries by stream type.

Table 2.10 Baseline Stream Quality Units within the Proposed LBCR Project Site[1]

Stream Quality Factor (SQF)	Existing Length (feet)	Stream Quality Units (SQUs)
0 - .09	35,261	2,368
.10 - .19	118,020	15,648
.20 - .29	163,585	37,261
.30 - .39	132,662	42,877
.40 - .49	144,541	63,635
.50 - .59	57,071	30,588
.60 - .69	0	0
.70 - .79	0	0
.80 - .89	0	0
.90 – .99	0	0
1	0	0
TOTAL	**651,140**	**192,377**

[1] *Calculations for stream quality units were conducted for each stream segment, and are included in Appendix E. The aggregation by SQF shown in the table is for presentation purposes only.*

Table 2.11 Baseline Stream Quality Units by Stream Type

Stream Type	Existing Length (feet)	Stream Quality Units (SQUs)
Intermittent	286,139	85,100
Intermittent/Ephemeral	365,001	107,277
TOTAL	**651,140**	**192,377**

2.7.2. Biological Integrity of Bois d'Arc Creek

FNI conducted an instream flow study following protocols of the Texas Instream Flow Program (TIFP). The study included analyses of hydrology, biology, geomorphology and water quality to assess the existing condition of Bois d'Arc Creek and to project the future condition of the stream with and without the proposed reservoir. Results of the study indicated that the stream channel is currently degrading, as exhibited by downcutting and widening, due to past disturbance. While the biological profile of the stream appeared moderately healthy, the observed fish species in the stream were primarily generalists and mostly lacked the fluvial specialists that might be expected in a non-disturbed stream setting.

As previously discussed, the Bois d'Arc Creek watershed has been significantly impacted by channelization, which began in the 1920s and continued well into the 1970s. Because of the channelization, the watershed is no longer in equilibrium to maintain a stable stream environment. Downcutting and streambank erosion have increased, and lateral migration of the stream (i.e., meander creation) has slowed. Channelization has also contributed to the "flashy" nature of flows in the watershed, with rapid rise and fall in flow in response to rainfall events. Channelization has also resulted in reduced base flows in the watershed. Habitats in the watershed change rapidly as high flows wash away gravel bars and large woody debris, or low flows reduce connectivity along the streams. The frequency of extreme flow events, both high and low, has resulted in an environment that favors generalist fish species. Although water quality in the watershed is generally good, Bois d'Arc Creek is not able to support a large variety of aquatic life because the limited habitat features in the watershed are frequently washed away by high flow events. In addition, the lack of reliable subsistence or base flow hydrology from year to year may be a limiting factor for fish and other aquatic species.

Without changes in the watershed, Bois d'Arc Creek is expected to continue to downcut and erode. As the channel becomes even more incised, lateral connectivity with the surrounding floodplain will continue to decrease. Due to the unstable nature of much of the stream banks along Bois d'Arc Creek and easily erodible bed materials, the stream channel will continue to enlarge. This will further reduce longitudinal connectivity at low flows and continue to constrain aquatic species to specific habitats that contain water (e.g., pools).

As part of the instream flow study, the biological integrity of Bois d'Arc Creek within the proposed reservoir site and downstream of the proposed dam was evaluated using the Index of Biotic Integrity (IBI) for fish and Rapid Bioassessment (RBA) for macroinvertebrates. Integrity scores for fish community structure ranged from limited to high (range from 33 to 47), with the lower scores observed within the reservoir site. The IBI scores tended to increase from upstream to downstream. This was not the case for the macroinvertebrate communities. It was found that overall biological integrity of Bois d'Arc Creek's macroinvertebrate community (RBA) was intermediate (mean: 28.93), with higher scores in the upstream reaches of Bois d'Arc Creek. Main stem sampling site scores ranged from 22 (intermediate) to 37 (high).

More detailed information can be found in the Instream Flow report prepared for Bois d'Arc Creek (FNI, 2010a and FNI, 2010b).

2.8 WETLANDS DOWNSTREAM OF PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR DAM

In response to comments received from federal resource agencies, a desktop analysis was conducted of the riverine corridor downstream of the proposed dam (FNI, 2016a). A jurisdictional delineation was not conducted within this corridor. However, during field investigations for the instream flow study and field efforts associated with modification of the East Texas HGM functional assessment tool, limited field data were collected and plant communities were noted. The desktop analysis and field observations indicated that the composition of the habitats in the downstream corridor are similar to the habitats identified within the reservoir site.

To identify the potential impact site, a corridor located within the two-year floodplain downstream of the proposed LBCR dam site to the Red River was defined. Potential wetlands within this corridor were identified using a desktop, GIS-based approach to identify the intersection of the existing two-year floodplain, NWI wetlands (emergent, shrub, and forested wetlands) and mapped hydric soils. This analysis indicates there are approximately 2,000 acres of potential wetlands downstream of the proposed dam. NWI data and aerial imagery indicate that most of these wetlands are forested with smaller, isolated areas of emergent wetlands. Assuming similar quality factors as those identified within the proposed reservoir site, the acreages and quality of the downstream wetlands under existing conditions and expected future conditions are shown in Table 2.12. Based on this analysis there is expected to be no loss of wetland area. The wetlands will continue to function as forested and emergent wetlands, with their hydrology being maintained through direct precipitation, overbanking flows from tributaries, seepage, and overland flow. However, there may be some reductions in flood frequencies for portions of the downstream corridor. Utilization of the Modified East Texas HGM Calculator Tool indicates that there may be a slight reduction in functional capacity units for approximately 541 acres of forested wetlands, as the frequency of flooding decreases from two years to five years. The potential reduction of functional capacity units is 78 FCUs (Appendix F).

Table 2.12 Potential Wetlands Downstream of the Proposed Dam

	Existing Conditions		Future Conditions	
Wetland Type	Study Area (Acres)	Functional Capacity/Habitat Units	Study Area (Acres)	Functional Capacity/Habitat Units
Emergent Wetland	149	63 HU	149	63 HU
Forested/ Shrub Wetland	1,852	1,593 FCU	1,852	1,515 FCU
Total	**2,001**		**2,001**	

2.9 WATERS OF THE UNITED STATES

Waters of U.S. within the reservoir site were identified and delineated during the Preliminary Jurisdictional Determination (PJD) conducted in 2007 (FNI, 2008a). Separate PJDs were conducted for the transmission and treatment facilities (FNI, 2013a) and for the proposed relocation of FM 1396 (Berg-Oliver, 2016). The PJDs for the proposed reservoir site and transmission and treatment facilities were verified by the USACE in an Approved JD (AJD) that was conducted in 2015 (USACE, 2015a). A verification of the PJD for the proposed relocation of FM 1396 corridor outside of the reservoir was conducted in 2016 and confirmed that there are no jurisdictional waters within this corridor (USACE, 2016).

The AJDs include a total of 5,874 acres of wetlands, 78 acres of open waters (ponds, stock tanks, etc.), and a total of 651,140 linear feet of streams within the proposed LBCR site. During field investigations, an additional 5,403 linear feet of streams and 0.1 acre of open water were observed within the limits of investigation of the associated transmission and treatment facilities (no wetlands were observed). However, no permanent impacts to streams or open waters would occur from construction of these components, therefore no additional impacts are included. Table 2.13 shows the types, acreages, and Functional Capacity/Habitat Units for the identified waters of the U.S.

Table 2.13 Types, Acreages and Functional Capacity/Habitat Units of Waters of the U.S. within LBCR Project Site

Category	Length (feet)	Area (acres)	Functional Capacity/Habitat Units
Streams			
Intermittent[1]	286,139		85,100 SQU
Intermittent/Ephemeral[2]	365,001	--	107,277 SQU
Open Waters			
Ponds, Stock Tanks, Small Lakes		78	N/A
Wetlands within Project Site			
Emergent		1,223	514 HU
Shrub		49	23 HU
Forested		4,602	3,957 FCU
TOTAL	**651,140**	**5,952**	

[1]*Intermittent streams are those streams that have continuous flow at least seasonally (e.g., typically three months during normal conditions).*

[2]*Intermittent/ephemeral streams are those streams that have continuous flow less than seasonally (e.g., typically less than 3 months but more than ephemeral).*

3.0 MITIGATION OBJECTIVES

The purpose of this mitigation plan is to identify and describe the mitigation measures proposed by NTMWD to compensate for the unavoidable adverse impacts to aquatic resources related to the proposed LBCR project. Alternatives to the proposed project are evaluated in detail and documented in the Environmental Impact Statement.

It is recognized by the USACE Regulatory Guidance Letter 02-2 ("RGL 02-2"; USACE, 2012) that compensatory mitigation projects that include a mix of habitats such as open water, wetlands, and adjacent uplands provide a holistic approach that increases the overall benefits to the ecological system, including a greater variety of aquatic functions, protections for success of the mitigation proposal, and greater uplift for the overall watershed. As such, a "watershed approach" takes on two meanings. First, the mitigation should take place in the same drainage basin as the impact, as practicable. Second, on a smaller scale, preference is given for restoration of connected habitats within a watershed instead of isolated components of the watershed (uplands, riparian areas, wetlands, open waters and streams; collectively a watershed ecosystem). The use of a watershed approach was an essential component of the broader mitigation objectives for the LBCR project.

Specific plan objectives are to mitigate, to the extent practicable, for unavoidable adverse impacts to waters of the U.S. in the project area, which include forested wetlands, emergent wetlands, shrub wetlands, open water, and streams, that would occur as a result of constructing the proposed LBCR. This mitigation would be achieved through wetland restoration and enhancement as well as stream restoration and enhancement at the nearby mitigation sites, Riverby Ranch and Upper BDC Mitigation Site. On-site, the creation of the lake would offset impacts to open waters and some of the stream impacts, and it would provide the means for creating emergent wetlands in shallow areas around the lake (littoral wetlands). The development of the reservoir also would enhance Bois d'Arc Creek through reductions in the frequency of destructive high flow events and the passage of sustainable environmental flows to enhance and maintain existing downstream habitats. Table 3.1 provides a summary of the types of mitigation that would be implemented for each impact type.

OBJECTIVES

Specific Plan objectives are to mitigate for impacts to:

- **4,035 FCUs of forested wetlands**
- **514 HUs of emergent wetlands**
- **23 HUs of shrub wetlands**
- **78 acres of open water**
- **192,377 SQUs of streams**

The mitigation plan undertakes a multifaceted watershed approach, applying a variety of mechanisms to mitigate impacts to waters of the U.S. Ancillary benefits of the proposed mitigation plan include providing other services (i.e., benefits) to the public including recreation, restoring and enhancing high quality emergent, shrub, and forested wetland habitats, improving wildlife habitat, and restoring and enhancing streams and open waters.

Table 3.1 Summary of On-Site and Near-Site Mitigation Associated with the Proposed LBCR Project

AQUATIC RESOURCE TYPE	MITIGATION COMPONENT					
	On-Site		Riverby Site		Upper BDC Mitigation Site	
	Reservoir Site	*Reservoir / Littoral-Wetlands* [1]	*Restoration*	*Enhancement*	*Restoration*	*Enhancement*
Wetlands						
Forested			X	X	X	X
Emergent		X	X	X		
Shrub			X	X		
Non-wetlands						
Streams		X	X	X		X
Open Water	X			X		X

[1] *Littoral wetlands (emergent wetlands) will develop and be protected in the reservoir.*

4.0 MITIGATION SITE SELECTION

4.1 BACKGROUND

As part of the permitting process, potential mitigation strategies have been identified and evaluated to address regulatory requirements and agency preferences to offset impacts to aquatic resources. Mitigation strategies that were considered included a suite of options including the purchase of mitigation bank credits, in-lieu fee compensation, and/or the purchase of lands that could be developed for permittee responsible mitigation.

On June 9, 2008, new regulations governing compensatory mitigation for losses of aquatic resources provided in 33 CFR Part 332 and 40 CFR Part 230 (Final Mitigation Rule) became effective. The Final Mitigation Rule, issued by the USACE and USEPA, made the purchase of mitigation bank credits and in-lieu fee payment methods the preferred mitigation method over permittee-responsible mitigation (73 Fed. Reg. 19593). The main justifications for changing mitigation preferences to mitigation banks and in-lieu fee payments included reducing the risk and uncertainty of compensatory mitigation projects and avoiding fragmentation of mitigation sites, especially for small projects.

RESULTS OF EVALUATION OF PURCHASING MITIGATION BANK CREDITS

- **The project is not located within the primary service area of any existing mitigation bank.**
- **No single mitigation bank could provide sufficient credits to offset the impacts, causing fragmentation of mitigation.**
- **Mitigation banks generally do not provide the multifaceted approach that may be warranted for this project.**

NTMWD submitted its Section 404 permit application for the proposed Lower Bois d'Arc Reservoir project on June 3, 2008, prior to the effective date of the Final Mitigation Rule (FNI, 2008a). As such, this mitigation plan is not subject to the regulations governing compensatory mitigation as outlined in the Final Mitigation Rule. (See Final Mitigation Rule, 73 Fed. Reg. 19593, 19608). However, following the publication of the Final Mitigation Rule in the Federal Register (April 10, 2008), NTMWD did evaluate the option of purchasing mitigation bank credits to compensate for all, or a portion of, the impacts to waters of the U.S. associated with the proposed LBCR project. The evaluation showed that:

- The project does not lie within the primary service area of any existing mitigation bank(s). As a result, the acreage/credit purchase required would increase because NTMWD must go outside of the primary service area of a bank. The resulting cost of purchasing bank credits would far exceed the estimated cost of the entire LBCR project making this mitigation method not practicable.
- No single mitigation bank could provide sufficient credits to offset the impacts identified for the LBCR project. Consequently, compensatory mitigation through bank credit purchase would be geographically fragmented.
- Large on-channel reservoir projects, like the proposed LBCR project, often require multifaceted mitigation approaches because of the typically large area of aquatic resource impacts, which differs from other types of development projects that are not on-channel. These multifaceted approaches may not be easily addressed through the use of mitigation banks.

After reviewing the practicability of satisfying the LBCR mitigation requirements through purchase of mitigation bank credits or in-lieu fee compensation, the latter of which is not currently a mitigation alternative in the Tulsa District or in Texas, NTMWD concluded that continuing its efforts to mitigate through a multifaceted permittee-responsible approach would keep the mitigation activities within the Bois d'Arc Creek watershed where the impacts would occur and would better achieve the purpose and goals of providing mitigation. The Regulatory Guidance Letter 02-2 (USACE, 2012) emphasizes a "watershed approach" like the approach NTMWD is undertaking (although not applicable to this project, the Final Mitigation Rule also emphasizes a watershed approach to mitigation for aquatic resources). This approach will satisfy mitigation requirements and will improve the aquatic resources within the same watershed in which impacts would occur.

During monitoring of the proposed mitigation sites (see Chapter 10), monitoring reports comparing field measurements to performance criteria (see Chapter 9) will be submitted to the USACE and TCEQ. If the data indicate that performance standards are not being met, adaptive management strategies would be identified in consultation with the USACE and the TCEQ. These strategies would focus on corrective actions, but may also include the purchase of mitigation bank credits if, at that time, a mitigation bank has been established with a primary service area encompassing the reservoir impact site.

4.2 MITIGATION SITE SELECTION STRATEGY

Recognizing the USACE mandate to compensate for impacts as close to the impact site as practicable, NTMWD's mitigation site selection strategy prioritized site location as follows: (1) on-site, within the reservoir footprint, and (2) near-site, within the same watershed.

4.2.1. On-Site Mitigation

On-site mitigation efforts will be utilized to the extent practicable to offset impacts to waters of the U.S. resulting from the construction of the proposed reservoir. Specific sites within the proposed reservoir footprint that will be utilized for wetland mitigation efforts will be in areas that are less than or equal to three feet in depth (i.e., sites within the footprint of the reservoir with elevations that fall between 531 ft. msl. and 534 ft. msl.) where tributaries enter the reservoir into broad, flat areas. Figure 4 shows the locations that are proposed for mitigation where these conditions are expected to develop and persist once the reservoir is constructed. Consideration was also given to the practicality of protecting these areas while still providing public access to the reservoir.

Typically, these areas are lumped into a single class of wetlands identified as littoral wetlands that develop in shallow portions of lakes, ponds, and reservoirs. Emergent wetlands are expected to develop within the littoral zone of the proposed reservoir and provide a functional wetland community which would offset some of the impacts resulting from the proposed reservoir project (see Appendix G). Many of the areas where these littoral wetlands are expected to develop are currently functioning emergent wetlands and would continue to function as emergent wetlands following impoundment of the reservoir. The existing wetlands would also serve as a seed source for the newly developed littoral wetlands, helping to establish vegetation.

The development of littoral zone wetlands within lake shallows appears to be common in the North Texas area (additional data supporting the development of littoral zone wetlands is included in Appendix G). This can be evidenced from evaluating data collected by TPWD under the Statewide Freshwater Fisheries Monitoring and Management Program. Under this program, biologists conduct periodic surveys, normally every four years, of freshwater fisheries and prepare detailed reports on their findings. A review of the data collected from seven freshwater reservoirs located within the North Texas area (Figure 5) was performed to estimate the likelihood of the establishment of littoral wetlands around the proposed LBCR (TPWD, 2008a; TPWD, 2008b; TPWD, 2010a; TPWD, 2010b; TPWD, 2010c; TPWD, 2013a; and TPWD, 2013b). The results are summarized in Table 4.1.

Table 4.1 Summary of Lake Vegetative Cover Collected by TPWD under the Statewide Freshwater Fisheries Monitoring and Management Program for Lakes/Reservoirs in the North Texas Area

Lake / Reservoir	River Basin	Total Surface Area (acres)	Surface Area with Aquatic Vegetation (submerged, floating leaved, emergent) (acres)	Percent of Reservoir Surface Area
Pat Mayse	Red	5,940	240	4
Lake Bonham	Red	1,020	200	19
Jim Chapman Lake (Cooper Lake)	Sulphur	19,280	3,662	19
Coffee Mill	Red	650	57	9
Davy Crockett	Red	355	160	45
Big Creek	Sulphur	520	213	41
Sulphur Springs	Sulphur	1,766	327	19
Average	--	**4,219**	**694**	**16**

Source: http://www.tpwd.state.tx.us/publications/pwdpubs/lake_survey/index.phtml

Based on these data it appears that, on average, approximately 16% of the total surface area of the lakes/reservoirs surveyed develop submerged, emergent, or floating leaved (or a combination of) vegetation within the littoral zone. If similar conditions were to develop at the proposed Lower Bois d'Arc Creek Reservoir site (reservoir area at conservation pool elevation is approximately 16,641 acres), this would equate to approximately 2,663 acres (16% of 16,641 acres) of littoral zone wetland development. However, a more conservative approach, and one that would likely have a greater probability for development, has been taken by using the reservoir area between elevations 531-534 ft. msl. While over 1,400 acres of littoral zone wetlands along the shoreline of LBCR would likely develop within this elevation envelope, only 605 acres of littoral wetlands are being proposed for mitigation (Figure 4). These areas were specifically identified based on their relative size (area) and NTMWD's ability to implement protective measures to prevent damage or disturbance to these sites. The NTMWD is purchasing lands (fee simple) up to elevation 541 ft. msl. and placing flowage easements on lands up to elevation 545 ft. msl. The littoral wetlands in the uppermost end of the reservoir would abut the proposed Upper BDC Mitigation Site, providing additional protection and continuity with mitigation habitats. As part of the protective measures for the designated littoral wetlands, the NTMWD would restrict development and construction within NTMWD-owned adjacent properties, implement site protection instruments for these areas, and protect the sites from intrusive activities through fencing or other means.

In addition to the 605 acres of littoral wetlands, the proposed reservoir would provide on-site compensatory mitigation for impacts to open waters (ponds, stock tanks, small lakes, etc.) within the proposed reservoir site. The reservoir will provide over 16,000 acres of open waters, in addition to the area expected to develop into littoral wetlands. Other on-site mitigation would be provided through protection and enhancement of the contributing streams (23,184 linear feet) upstream of the areas where littoral wetlands would become established (Figure 4). The NTMWD is purchasing land up to elevation 541 ft. msl. around the lake as the flood pool. Tributaries to the littoral zone wetlands that are above the conservation pool but flow within land owned by the NTMWD would be protected through deed restrictions or other USACE-approved site protection instrument. This stream length does not include the streams located in the Upper BDC Mitigation Site. Stream enhancement within the proposed Upper BDC Mitigation Site will also benefit the adjoining littoral wetlands.

4.2.2. Near-Site Mitigation

The NTMWD considered several factors in selecting their near-site mitigation areas. Chief among those factors was distance from the impact site and location within the watershed. The NTMWD began this process using a GIS-based desktop analysis attempting to identify potential mitigation sites downstream of the proposed reservoir site and within the Bois d'Arc Creek watershed. Data sources used to identify and assess site conditions included:

- Listings of real estate for sale in Fannin County;
- Historical and current aerial imagery to account for past and present land uses;
- USFWS National Wetlands Inventory (NWI) data;
- U.S. Geological Survey (USGS) National Hydrography Dataset;
- Floodplain analyses conducted for this project; and
- USDA National Resource Conservation Service (NRCS) Soil Survey Geography Database (SSURGO).

Additional landscape features that were taken into consideration during preliminary site screening included overall size of the site, connectivity or adjacency to other water features, surrounding land use, and potential for ecological uplift. Specific consideration was given to the Proclamation Boundary for the Caddo National Grasslands, which is located immediately downstream of the reservoir project (Figure 1).

This process resulted in identifying two distinct mitigation sites: the Riverby Ranch Mitigation Site and the Upper BDC Mitigation Site. Each of these mitigation sites are discussed below.

4.2.2.1. Riverby Ranch

The mitigation property investigations eventually led to the identification of the approximately 15,000-acre Riverby Land and Cattle Company, LLC property (Riverby Ranch) located downstream of the proposed reservoir site (Figures 1 and 6). This property was listed for sale in 2009, which met NTMWD's objective to purchase mitigation lands from willing sellers. Once identified, conditions of the site were further evaluated by biologists and environmental scientists during field investigations performed in July of 2009. The purpose of the field investigations was to verify that the site was ecologically suitable to provide mitigation for impacts to aquatic resources that could result from construction of the proposed LBCR. The factors considered and conclusions drawn from this evaluation are summarized in Table 4.2.

Table 4.2 Factors Considered and Conclusions Reached During the Evaluation of the Riverby Ranch as a Proposed Mitigation Site

Factors Evaluated	Conclusions
Hydrological Conditions	• The ranch is located within the Bois d'Arc Creek and Red River Watersheds • Hydrology has been drastically altered due to agricultural practices providing an opportunity for restoration • Many of the streams located on the ranch originate there, reducing the risk of potential upstream uses that would be non-compatible with mitigation efforts
Soil Characteristics	• Mitigation site contains nearly 8,600 acres of soils classified as hydric
Aquatic Habitat Diversity	• Mitigation site contains ephemeral, intermittent, and perennial streams, as well as forested, shrub, and emergent wetlands
Habitat Connectivity	• Mitigation site provides habitat connectivity to the Caddo National Grasslands to the south. • Mitigation site provides connectivity to adjacent lands protected in perpetuity through the NRCS Wetlands Reserve Program
Size and Location of the Site	• Mitigation site is nearby and proximal to the impact site • Mitigation site is downstream of impact site • Mitigation site is one large, contiguous property (approximately 15,000 ac.), being similar in size to the

Factors Evaluated	Conclusions
	impact site
Availability of Water	• Ranch comes with over 9,000 ac/ft of existing water rights and irrigation infrastructure, providing an excellent opportunity to increase mitigation success during initial phases of the planting plan • Water rights transfer with purchase of the property
Compatibility with Adjacent Land Uses	• Mitigation site is adjacent to lands enrolled in the Wetlands Reserve Program (WRP) • Mitigation site is adjacent to the Caddo National Grasslands, managed by the USFS • The Red River constitutes the entire northern boundary of the mitigation site
Reasonably Foreseeable Effects of Mitigation Project on Aquatic and Terrestrial Resources	• Most the soils located on the mitigation site have a potential for forested climax plant communities; under current use, most of these soils have been converted to cropland and grassland for agricultural purposes making it ideal for forested wetland/riparian woodland restoration • Approximately 8.5 miles of potential habitat for the endangered least tern is located along the Red River, which borders the mitigation site to the north, and would be protected from future disturbance as a result of setting the ranch aside as a mitigation site

Following the determination that the site was ecologically suitable for mitigation, NTMWD moved forward with its mitigation strategy by acquiring the Riverby Ranch in February 2010. In August of 2010, state and federal resource agencies, as well as The Nature Conservancy, were invited to participate in a multi-agency tour of this proposed mitigation site.

4.2.2.2. Upper Bois d'Arc Creek Mitigation Site

NTMWD decided to identify additional mitigation area to offset impacts to the forested wetlands. Considerations for this additional mitigation site were the locations of larger streams within the river basin, 5-year floodplain, hydric soils, and proximity to the project and/or Riverby Ranch Mitigation Site. The NTMWD also wanted to avoid fragmentation of the proposed mitigation.

After careful consideration, an approximate 1,900-acre riverine corridor along Bois d'Arc Creek upstream of the proposed reservoir was selected as the additional mitigation site (Figure 7). This site is located primarily within the 5-year floodplain of Bois d'Arc Creek with underlying hydric soils. These features are conducive for the development of forested wetlands. Stream enhancement in the Upper BDC Mitigation Site will be achieved through riparian plantings along approximately 11.8 miles of existing degraded streams. Areas located outside of the 5-year floodplain and/or hydric soils will be used for terrestrial mitigation. A summary of the factors considered for this site are shown in Table 4.3.

Table 4.3 Factors Considered and Conclusions Reached During the Evaluation of the Upper Bois d'Arc Creek Mitigation Site as a Proposed Mitigation Area

Factors Evaluated	Conclusions
Hydrological Conditions	• The Upper BDC Mitigation Site is located entirely within the Bois d'Arc Creek watershed • Hydrology has been altered due to agricultural practices, providing an opportunity for restoration • All forested wetland restoration and enhancement areas are within the 5-year floodplain of Bois d'Arc Creek
Soil Characteristics	• Upper BDC Mitigation Site contains 1,728 acres of soils classified as hydric
Aquatic Habitat Diversity	• Mitigation site contains 11.8 miles of streams, as well as forested, shrub, and emergent wetlands
Habitat Connectivity	• Mitigation site provides habitat connectivity to the littoral wetlands in the reservoir
Location of the Site	• Mitigation site is adjacent to the impact site • Mitigation site is upstream of impact site
Compatibility with Adjacent Land Uses	• Mitigation site is adjacent to the reservoir project, which is immediately upstream of the Caddo National Grasslands, which is immediately upstream of the Riverby Ranch Mitigation Site • The Upper BDC Mitigation Site, LBCR, Caddo National Grasslands, and Riverby Ranch provide an approximately 42-mile long contiguous corridor of aquatic and terrestrial habitat along Bois d'Arc Creek to the Red River
Reasonably Foreseeable Effects of Mitigation Project on Aquatic and Terrestrial Resources	• Most the soils located on the mitigation site have a potential for forested climax plant communities; under current use, many of these soils have been converted to cropland and grassland for agricultural purposes making it ideal for forested wetland/riparian woodland restoration

5.0 BASELINE CONDITION OF MITIGATION SITES

The aquatic mitigation proposal includes three distinct mitigation areas: Riverby Ranch, Upper BDC Mitigation Site and Littoral Wetland Areas (On-Site Mitigation). As previously discussed in Chapter 4, the proximity of these sites and the baseline characteristics provide an opportunity for synergistic uplift for both aquatic and terrestrial habitats and associated functions. The baseline conditions for each of these mitigation areas are presented in the following subsections.

5.1 RIVERBY RANCH MITIGATION SITE

The proposed Riverby Ranch mitigation site is located in the northeast corner of Fannin County, Texas, near the confluence of Bois d'Arc Creek and the Red River. A small portion of the ranch also lies within the northwestern corner of Lamar County, Texas. The project site is generally bound by the Red River to the north, the Fannin/Lamar County line to the east, the Caddo National Grasslands to the south, and County Road 2155 to the west (Figure 8). The ranch is approximately 15,000 acres in size with approximately 2,700 acres that are currently enrolled in the NRCS Wetlands Reserve Program (WRP) (Figure 6).

Ecologically, the proposed mitigation site is in the Post Oak Savannah Ecological Region of Texas (Gould et. al., 1960). 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 streams, or in areas protected from fire (TPWD, 2007).

While the NTMWD owns the Riverby Ranch property, it is leased to the former owner until such time as the property is needed for the proposed mitigation. Current land use on the Riverby Ranch is intensive agriculture, primarily geared toward crop and cattle production. There are approximately 3,000 acres under pivot irrigation used for the production of wheat, oats, and corn; approximately 2,700 acres are either tilled or no-tilled with wheat, oats, and perennial rye for winter grazing; approximately 4,300 acres of mixed bermuda/native pasture and 2,000 acres of coastal/common bermuda are used for grazing; and nearly 2,700 acres are enrolled in the WRP. Most of the ranch is grazed at some point during the year by cattle whose numbers range between 3,500 and 8,000 head.

5.1.1. Existing Hydrology

The proposed mitigation site is located within the Bois d'Arc Creek and Red River watersheds (Figure 1). In general, streams on the west side of the proposed mitigation site flow directly into the Red River and streams on the east side of the mitigation site flow into Bois d'Arc Creek, and then to the Red River (Figure 6). Most of the streams originate within the proposed mitigation site or in adjacent properties also enrolled in the WRP program. Additionally, the streams are characterized by channelization to expedite runoff for the ranch's ongoing agricultural operations. Many of these streams have had their riparian corridors (buffers) cleared to plant crops or non-native grasses to increase the grazing area on the ranch.

Considering the different sources of stream classifications (NHD, TCEQ, and NTMWD field data), the streams within the Riverby Ranch Mitigation Site by stream classification is presented in Table 5.1. All the streams on Riverby Ranch, including those in the WRP, have been field checked by NTMWD for stream type and stream quality, and the USACE issued an AJD for the Riverby Ranch, except for the WRP area. Stream lengths within the WRP area are based on a Preliminary Jurisdictional Determination (PJD) (FNI, 2017). A summary of the stream lengths by NTMWD field checked stream type is presented in Table 5.2.

Table 5.1 Stream Type Designations and Lengths (ft) within Riverby Ranch

Stream Type Designation	NHD	TCEQ	NTMWD Field Data
Perennial	6,921	32,316	65,281
Intermittent	229,990	N/A	77,772
Ephemeral	N/A	N/A	130,897
Artificial Path	37,039	N/A	N/A
Undesignated	N/A	241,631	N/A
Grand Total	**273,950**	**273,950**	**273,950**

Table 5.2 Summary of NTMWD Field Data Stream Lengths within Riverby Ranch by Stream Type

Stream Type Designation	NTMWD Field Data
Perennial	65,281
Intermittent	77,772
Ephemeral	130,897
Grand Total	**273,950**

5.1.2. Existing Vegetation

The location and distribution of vegetative cover types within the proposed mitigation site are depicted in Figure 9. The following subsections contain descriptions of the typical vegetative species that occur within each wetland cover type.

5.1.2.1. Emergent Wetland

Emergent wetlands at the proposed mitigation site are degraded due to current agricultural activities such as grazing and crop production. These wetlands are dominated by an herbaceous layer composed of wetland obligates such as rushes, sedges, smartweed, arrowhead and spikerush. Other species include barnyardgrass, flatsedge, water primrose, dock, and buttercup.

5.1.2.2. Shrub Wetland

Shrub wetlands at the proposed mitigation site were only found on the Red River floodplain. The shrub layer is dominated by small trees such as black willow, sandbar willow, and salt cedar, as well as species such as honey locust and baccharis.

5.1.2.4. Riparian Woodland/Bottomland Hardwood Forest (Forested Wetland)

The riparian woodland / bottomland hardwood (forested wetland) cover type at the proposed mitigation site includes the predominantly deciduous forests of riparian zones and wetlands, and is associated with the floodplains of local streams, including the Red River.

Dominant trees include black willow, boxelder, green ash, sugarberry, and cedar elm. Dominant shrubs are often small trees of the species listed above, as well as honey locust, poison ivy, coralberry, buttonbush, and Virginia creeper. Common herbaceous plants in the bottomland hardwood forest include Cherokee sedge, ragweed, and Virginia wildrye.

5.1.3. Existing Soils

Soils located within the proposed mitigation site are presented in Table 5.3. The locations of soils listed on the NRCS National List of Hydric Soils are depicted on Figure 10. Descriptions of the soils can be obtained from the NRCS Soil Surveys of Fannin (Goerdel, 2001) and Lamar counties (Ressel, D., 1979).

Table 5.3 Soils Identified on the Riverby Ranch, including their Hydric Rating

Map Unit Name	Hydric
Belk clay, rarely flooded	No
Dela loam, frequently flooded	No
Dela loam, occasionally flooded	No
Derly silt loam, 0 to 1 percent slopes	Yes
Derly-Raino complex, 0 to 1 percent slopes	Yes
Freestone-Hicota complex, 0 to 2 percent slopes	Yes
Ivanhoe silt loam, 0 to 1 percent slopes	Yes
Karma loam, 0 to 2 percent slopes	Yes
Karma loam, 5 to 12 percent slopes, eroded	No
Larton loamy fine sand, 0 to 2 percent slopes	No

Map Unit Name	Hydric
Morse clay, 5 to 12 percent slopes, eroded	No
Muldrow clay loam, rarely flooded	Yes
Norwood silt loam, rarely flooded	No
Okay loam, 0 to 1 percent slopes	No
Oklared-Kiomatia complex, occasionally flooded	No
Redlake clay, rarely flooded	No
Severn silt loam, rarely flooded	Yes
Tinn clay, frequently flooded	Yes
Tinn clay, occasionally flooded	Yes
Waskom silt loam, 0 to 1 percent slopes	Yes
Whakana very fine sandy loam, 1 to 3 percent slopes	No
Whakana very fine sandy loam, 5 to 12 percent slopes	No

5.1.4. Existing Wildlife Usage

5.1.4.1. Emergent Wetland

Many species of birds were observed in the emergent wetlands, including the northern harrier, red-tailed hawk, American crow, greater white-fronted goose, Canada goose, plentiful dabbling and diving ducks, great blue heron, and great egret. Other wildlife resident in the areas include several mammals, such as raccoon, beaver, coyote, feral hog, and white-tailed deer; aquatic species including frogs, mosquitofish, crayfish, and mussels; and plentiful flying insects such as butterflies, bees and dragonflies.

5.1.4.2. Shrub Wetland

Birds observed in the shrub wetlands were primarily the same species observed in the emergent wetland cover type of the proposed mitigation site. Evidence of mammalian residents includes tracks of the raccoon, feral hog, white-tailed deer, and bite marks of beaver. The cottonmouth water moccasin and copperhead were also observed in the shrub wetlands.

5.1.4.3. Forested Wetland

Common avian species observed in this cover type include the indigo bunting, white-eyed vireo, American crow, Carolina wren, tufted titmouse, barred owl, egrets, Carolina chickadee, and northern cardinal. Evidence of mammalian residents included raccoon tracks, hog tracks, white-tailed deer tracks, and beaver chew marks on trees. Reptiles such as the cottonmouth water moccasin and copperhead were also found in these forests, as were numerous invertebrate species, including crayfish and land snails.

5.1.5. Wildlife Habitat Value

The wildlife habitat value on the approximately 15,000-acre Riverby Ranch mitigation site was also estimated using the HEP procedures. The process was conducted by personnel from the same state and federal resource agencies that participated in the HEP study completed at the proposed reservoir site. Additionally, the same HEP species models were used within the same cover types to estimate habitat value. Using the same procedures to estimate wildlife habitat value for the impact site and mitigation site allows for a consistent comparison of impacts to mitigation as well as a more accurate estimate of potential ecological uplift expected at the mitigation site.

The proposed mitigation site was subdivided into the following seven cover types: Upland Deciduous Forest, Cropland, Grassland / Old Field, Riparian Woodland / Bottomland Hardwood Forest (Forested Wetland), Shrubland, Shrub Wetland, and Emergent / Herbaceous Wetland. Tree Savanna and Evergreen Forest cover types, which were identified at the project site, were not present at the mitigation site. While baseline habitat suitability and habitat units were developed for the Bottomland Hardwood Forest cover type, the Modified East Texas HGM was used to assess the baseline functional capacity value for the Forested Wetlands.

During an interagency HEP meeting (August 2010) held prior to collecting HEP data at the mitigation site, it was proposed and agreed to that preservation of the existing shrub wetland areas would likely be the best mitigation approach for this cover type. This conclusion was reached because the existing shrub wetland areas at the Riverby Ranch Mitigation Site are located below the first terrace of the Red River and are susceptible to overbanking conditions. Because of these factors, implementing mitigation actions such as shrub plantings, control of invasive species, etc. within the existing shrub wetland areas would have a low likelihood of success. As such, it was concluded that collecting HEP data within this cover type would not be necessary.

The habitat quality within each delineated cover type (excluding shrub wetland as discussed above) was evaluated in relation to the habitat requirements of one or more of the following sixteen evaluation species selected by the interagency 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, scissor-tailed flycatcher, swamp rabbit, and the wood duck.

The habitat quality, expressed in HSI, of the emergent/herbaceous wetland cover type for each emergent/herbaceous wetland evaluation species is presented in Table 5.4. The overall HSI value for the cover types 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 at the proposed mitigation site by multiplying the average cover type HSI values by the existing acres, as presented in Table 5.5.

Table 5.4 Habitat Suitability Indices for Emergent / Herbaceous Wetland Cover Type at the Proposed Riverby Ranch Mitigation Site

Evaluation Species	Emergent / Herbaceous Wetland
Green heron	0.54
Raccoon	0.14
Wood duck	0.00
Average HSI Values	**0.23**

Table 5.5 Baseline Habitat Units by Wetland Cover Type at the Proposed Riverby Ranch Mitigation Site

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Shrub Wetland	--	98	--
Emergent / Herbaceous Wetland	0.23	1,377	**316.7**

5.1.6. Functional Assessment of Forested Wetlands

The Modified East Texas HGM protocol that was used to assess the functional capacity of the forested wetlands within the reservoir site was also used for the two near-site mitigation sites. As part of the protocol, Wetland Assessment Areas (WAA) were defined based on topography, species composition, and hydrology. At the Riverby Ranch site, four WAAs were identified. (These areas are shown in Appendix D.)

Field sampling was conducted in February 2016 at Riverby Ranch. The number of data collection plots was based on the area of the WAA, and ranged from one plot for WAA #4 to three plots for WAA #2. In total, there were eight HGM data collection plots assessed at this mitigation site. A summary of the existing FCI values for each WAA is shown in Table 5.6. Using the average FCI value for each WAA, the functional capacity units for the existing forested wetlands at Riverby Ranch totaled 347 FCUs. The determination of FCUs is shown in Table 5.7.

Table 5.6 Baseline Functional Capacity Indices at the Proposed Riverby Ranch Mitigation Site

	Functional Capacity Indices (FCI)			
Function	**WAA 1**	**WAA 2**	**WAA 3**	**WAA 4**
Detain Floodwater	1.00	0.77	0.87	0.90
Detain Precipitation	0.80	0.73	0.95	0.80
Cycle Nutrients	0.85	0.60	0.71	0.80
Export Organic Carbon	0.88	0.63	0.77	0.84
Maintain Plant Communities	0.95	0.86	0.97	0.84
Provide Habitat for Fish and Wildlife	0.42	0.84	0.43	0.25
Average	**0.82**	**0.74**	**0.79**	**0.74**

Table 5.7 Baseline Functional Capacity Units at the Proposed Riverby Ranch Mitigation Site

Wetland Assessment Area	Acres	Average FCI	FCUs
WAA 1	82.3	0.82	67.5
WAA 2	200.2	0.74	148.1
WAA 3	121.8	0.79	96.2
WAA 4	47.7	0.74	35.3
Total	**452**	**N/A**	**347**

5.1.7. Stream Assessment

In June 2014, FNI completed field investigations to establish baseline stream conditions at the proposed mitigation site using the RGA method. Using the same method to evaluate stream conditions for the impact site and mitigation site allows for a consistent comparison of impacts to mitigation as well as a quantitative estimate of potential ecological uplift expected to be achieved at the mitigation site.

During the RGA study of Riverby Ranch, 42 data collection points were evaluated to quantify characteristics of the existing streams on the ranch, including the WRP area. The streams were each given a unique identifier/name and were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score. For each data collection point, six stream characteristics (evidence of bank erosion, bank root zone, vegetative bank cover, bank angle, sediment transport, and channel alteration) were assessed, scored, and then summed to calculate a final RGA score ranging between zero and 60. As with the streams in the LBCR site, the RGA scores were then normalized by dividing by 60 to produce a Stream Quality Factor (SQF) ranging between zero and one, where zero represents poorest stream conditions and one represents optimum stream conditions. The calculated SQF score for a particular study reach was then multiplied by its length to calculate Stream Quality Units (SQUs) provided by that reach. This process was repeated for all study reaches within the proposed mitigation site to establish baseline SQUs. A summary of the existing stream length by stream quality factor intervals for Riverby Ranch is shown in Table 5.8. The total baseline SQU value for streams on the Riverby Ranch (excluding streams within the WRP area), defined as the sum of the SQUs for each reach, was calculated to be 64,140. The total baseline SQU value for Bois d'Arc Creek and other tributary streams within the WRP was calculated to be 40,990. A discussion of the RGA methodology is included in Appendix E.

Table 5.8 Summary of the Baseline Conditions for Streams at the Riverby Ranch Mitigation Site[1]

SQF	Riverby Ranch, Excluding WRP		Tributaries within the WRP Area	
	Existing Length (ft)	SQU	Existing Length (ft)	SQU
0 - .09	8,507	457	7,649	382
.1 - .19	26,967	4,253	888	163
.2 - .29	47,789	10,764	0	0
.3 - .39	14,086	4,991	16,026	5,342
.4 - .49	37,838	17,395	46,721	21,504
.5 - .59	29,393	15,818	23,313	13,599
.6 - .69	10,905	7,239	0	0
.7 - .79	0	0	0	0
.8 - .89	3,868	3,223	0	0
.9 - .99	0	0	0	0
1.0	0	0	0	0
Total	**179,353[2]**	**64,140**	**94,596**	**40,990**

[1] Calculations for stream quality units were conducted for each stream segment, and are included in Appendix E. The aggregation by SQF shown in the table is for presentation purposes only.

[2] The AJD for Riverby Ranch (excluding WRP) reports a total stream length of 180,671 ft. (USACE, 2015b). NTMWD has determined based on field reconnaissance that only 179,353 linear feet of the AJD streams are amenable to mitigation use.

5.2 UPPER BOIS D'ARC CREEK MITIGATION SITE

The proposed Upper Bois d'Arc Creek (BDC) mitigation site is located along Bois d'Arc Creek upstream of the proposed LBCR in Fannin County, Texas (Figures 1 and 7). The Upper BDC Mitigation Site is generally bounded by State HWY 78 to the south and the upstream end of the proposed reservoir to the north. This mitigation site consists of approximately 1,900 acres of bottomlands located within the 5-year floodplain of Bois d'Arc Creek. Of the 1,900 acres, 1,728 acres are mapped as having hydric soils. Much of this land has been converted to farmland, making it an ideal location for forested wetland restoration, and the residual forested areas within the Upper BDC Mitigation Site provide an opportunity for forested wetlands enhancement. Approximately 62,353 linear feet of existing degraded stream are available for stream enhancement. As with the reservoir site, the streams within the Upper

BDC Mitigation Site have been channelized and are in a degraded state making them ideal for enhancement activities.

Ecologically, the proposed mitigation site is in the Northern Blackland Prairie Ecological Region of Texas (Gould et. al., 1960). The Blackland Prairie Ecological Region was originally dominated by tall grasses consisting of an assortment of diverse perennial and annual grasses and forbs. Over time much of this area was converted to farmland, with forested areas mostly limited to bottomlands along major rivers and streams.

5.2.1. Existing Hydrology

The Upper BDC Mitigation Site is located within the Bois d'Arc Creek watershed and almost entirely within the 5-year floodplain (Figure 7). As observed within the reservoir site, the streams within the Upper BDC Mitigation site have been channelized and straightened over time in support of the local agricultural activities. The hydrology is characterized by rapid rises and falls in response to rain events. This area along the creek is prone to localized flooding, especially during the wetter spring and fall months. The Bonham wastewater treatment facility discharges to Pig Branch, which flows into Bois d'Arc Creek between State HWY 56 and U.S. HWY 82. During dry times, there may be little to no flow in Bois d'Arc Creek upstream of the Bonham wastewater discharge. Even with the wastewater discharges, Bois d'Arc Creek is documented to be dry at times downstream at FM 1396 and at FM 409.

Considering the different sources of stream classifications (NHD, TCEQ, and NTMWD field data), the streams within the Upper BDC Mitigation Site by stream classification are presented in Table 5.9. For this Mitigation Plan, for the reasons stated above, the main stem of Bois d'Arc Creek that flows through the mitigation site and named tributaries are classified as intermittent. All other streams within the reservoir site are classified as intermittent/ephemeral. The use of a combined classification is based on the field observations that many of the tributaries of the named streams are likely ephemeral, but field verification was not conducted to distinguish the point at which the stream transitioned from ephemeral to intermittent. The *NTMWD Field Data* classification represents stream type based on field observations and desktop analyses. A summary of the stream lengths by stream type, based on field data and PJD only, is presented in Table 5.10.

Table 5.9 Stream Type Designations and Lengths (ft) within Upper BDC Mitigation Site

Stream Type Designation	NHD	TCEQ	NTMWD Field Data
Perennial	33,410	NA	N/A
Intermittent	26,432	29,508[1]	32,742
Intermittent/Ephemeral	N/A	N/A	29,793
Artificial Path	2,693	N/A	N/A
Undesignated	N/A	33,027	N/A
Grand Total	**62,535**	**62,535**	**62,535**

1. *TCEQ has proposed to reclassify portions of Bois d'Arc Creek from "perennial" to "intermittent with perennial pools" in the 2017 triennial revision of the Texas Surface Water Quality Standards.*

Table 5.10 Summary of Stream Lengths within Upper BDC Mitigation Site by Stream Type based on a PJD

Stream Type Designation	NTMWD Field Data
Intermittent	32,742
Intermittent/Ephemeral	29,793
Grand Total	**62,535**

5.2.2. Existing Vegetation

The location and distribution of vegetative cover types within the proposed Upper BDC Mitigation site are depicted in Figure 11. The following subsections contain descriptions of the typical vegetative composition within each wetland cover type.

5.2.2.1. Emergent Wetland

Emergent wetlands at the proposed mitigation site are degraded due to current agricultural activities such as grazing and crop production. These wetlands are dominated by an herbaceous layer of wetland obligates such as rushes, sedges, smartweed, arrowhead and spikerush. Other species include barnyard grass, flatsedge, water primrose, dock, and buttercup.

5.2.2.2. Shrub Wetland

Shrub wetlands at the proposed mitigation site were similar to the shrub wetlands identified at the proposed reservoir site. These areas are wetlands in successional transition between emergent wetlands and bottomland wetland forests. The shrub layer is dominated by small trees such as green ash, sugarberry, and cedar elm, as well as species such as honey locust and baccharis. Dominant herbaceous plants include sedges, ragweed, ironweed, goldenrod, evening primrose, round-leaf groundsel, and wild pea.

5.2.2.3. Riparian Woodland/Bottomland Hardwood Forest (Forested Wetland)

Similar to the reservoir site, the riparian woodland / bottomland hardwood cover type in the mitigation site includes the predominantly deciduous forests of riparian zones and wetlands and is associated with the floodplains of Bois d'Arc Creek and local tributaries.

Dominant trees include black willow, boxelder, green ash, sugarberry, and cedar elm. Dominant shrubs are often small trees of the species listed above, as well as honey locust, poison ivy, coralberry, buttonbush, and Virginia creeper. Common herbaceous plants in the bottomland hardwood forest include Cherokee sedge, ragweed, and Virginia wildrye.

5.2.3. Existing Soils

Soils located within the proposed mitigation site are presented in Table 5.11. The locations of soils listed on the NRCS National List of Hydric Soils are depicted on Figure 12. Descriptions of the soils can be obtained from the NRCS Soil Survey of Fannin County, Texas (Goerdel, 2001).

Table 5.11 Soils Identified within the Upper BDC Mitigation Site, including their Hydric Rating

Map Unit Name	Hydric
Ferris clay, 5 to 12 percent slopes, eroded	No
Frioton silty clay loam, occasionally flooded	No
Heiden-Ferris complex, 2 to 6 percent slopes, eroded	No
Hopco silt loam, occasionally flooded	No
Hopco silt loam, frequently flooded	No
Lamar clay loam, 5 to 8 percent slopes	No
Normangee clay loam, 1 to 3 percent slopes	No
Normangee clay loam, 2 to 5 percent slopes, eroded	No
Tinn clay, 0 to 1 percent slopes, occasionally flooded	Yes
Tinn clay, 0 to 1 percent slopes, frequently flooded	Yes
Wilson silt loam, 0 to 1 percent slopes	No

5.2.4. Existing Wildlife Usage

Existing wildlife usage is expected to be similar to the usage documented within the reservoir site. Since this area is proposed for forested wetland mitigation, which is assessed with the Modified East Texas HGM methodology, no additional HEP data were collected. However, field studies were conducted for the existing forested wetlands using the Modified East Texas HGM protocol, and streams were assessed using RGA methodology. Based on the habitat types, proximity to the proposed reservoir site, and wildlife that were observed during these field visits, the existing wetlands within this mitigation site provide very similar wildlife usage to that recorded in the reservoir footprint.

5.2.5. Wildlife Habitat Value

The wildlife habitat values for existing emergent and shrub wetlands are based on the HEP scores measured for the reservoir site. Table 5.12 shows the wildlife habitat value within the Upper BDC Mitigation Site.

Table 5.12 Summary of Existing Habitat Value for Emergent and Shrub Wetlands at the Upper BDC Mitigation Site

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Shrub Wetland	0.46	120	55.2
Emergent Wetland	0.42	117	49.1
TOTAL	**N/A**	**237**	**104.3**

5.2.6. Functional Assessment of Forested Wetlands

The Modified East Texas HGM protocol was used to assess the functional capacity of the forested wetlands within the Upper BDC Mitigation Site. A team consisting of personnel from the Tulsa District USACE, NTMWD, and FNI collected data within existing forested wetland areas in July 2016. Because this area has a similar hydrologic regime, similar vegetation structure, topography, soils, etc., one WAA was utilized. Data were collected in three forested wetland plots resulting in an average FCI score of 0.78 (Table 5.13). The baseline functional capacity value for the 574 acres of existing forested wetlands at the Upper BDC Mitigation Site is 448 FCUs, as shown on Table 5.14.

Table 5.13 Average Functional Capacity Index Value for the Existing Forested Wetlands in the Upper BDC Mitigation Site

Function	Functional Capacity Index (FCI)
Detain Floodwater	0.76
Detain Precipitation	0.67
Cycle Nutrients	0.78
Export Organic Carbon	0.74
Maintain Plant Communities	0.86
Provide Habitat for Fish and Wildlife	0.86
Average	**0.78**

Table 5.14 Baseline Functional Capacity Units for the Existing Forested Wetlands in the Upper BDC Mitigation Site

Wetland Assessment Area	Acres	Average FCI	FCUs
Upper BDC Mitigation Site	574	0.78	448

5.2.7. Stream Assessment

In October 2016, FNI completed field investigations to establish baseline stream conditions at the proposed Upper BDC Mitigation Site using the RGA method. Using the same method to evaluate stream conditions for the impact site and mitigation site allows for a consistent comparison of impacts to mitigation as well as a quantitative estimate of potential ecological uplift expected to occur at the mitigation site.

During the RGA study of the Upper BDC Mitigation Site, 11 data collection points were evaluated to quantify characteristics of the existing streams. The streams were each given a unique identifier/name and were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score. For each data collection point, six stream characteristics (evidence of bank erosion, bank root zone, vegetative bank cover, bank angle, sediment transport, and channel alteration) were assessed, scored, and then summed to calculate a final RGA score. As discussed in Appendix E, these RGA scores were then normalized to determine the SQF, ranging between zero and one. The calculated SQF score for a particular study reach was then multiplied by its length to calculate SQUs provided by that reach. This process was repeated for all study reaches within the proposed mitigation site to establish baseline SQUs. A summary of the existing stream length by stream quality factor intervals is shown in Table 5.15. The total baseline SQU value for streams in the Upper BDC Mitigation Site, defined as the sum of the SQUs for each reach, was calculated to be 17,119. A detailed discussion of the RGA methodology is in Appendix E.

Table 5.15 Summary of the Baseline Conditions for Streams at the Upper BDC Mitigation Site[1]

SQF	Upper BDC Mitigation Site	
	Existing Length (ft)	SQU
0 - .09	15,032	1,253
.1 - .19	3,800	633
.2 - .29	14,641	3,684
.3 - .39	20,763	6,575
.4 - .49	1,483	692
.5 - .59	1,962	1,046
.6 - .69	4,854	3,236
.7 - .79	0	
.8 - .89	0	
.9 - .99	0	
1.0	0	
Total	**62,535**	**17,119**

[1] Calculations for stream quality units were conducted for each stream segment, and are included in Appendix E. The aggregation by SQF shown in the table is for presentation purposes only.

5.3 TRIBUTARIES TO LITTORAL WETLANDS

The proposed littoral wetland areas and contributing streams are shown on Figure 4. The littoral wetlands lie within the conservation pool for the reservoir, and existing conditions within this area were discussed with the reservoir in Chapter 2. The contributing streams to the littoral wetlands lie within the acreage proposed for purchase by NTMWD, which includes land between elevations 534 ft msl (conservation pool) and 541 ft msl (flood pool). Stream lengths for the contributing streams are based on a PJD conducted by FNI. The baseline conditions for these streams are discussed below.

5.3.1. Existing Hydrology

Considering the different sources of stream classifications (NHD, TCEQ, and NTMWD field data), the streams that are tributaries of the proposed littoral wetlands by stream classification are presented in Table 5.16. For this Mitigation Plan, as discussed in Section 2.3, the named tributaries of Bois d'Arc Creek are classified as intermittent. All other tributaries of littoral wetlands are classified as intermittent/ephemeral. The use of a combined classification is based on the field observations that the tributaries to named streams are likely ephemeral, but field verification was not conducted to distinguish the point at which the stream transitioned from ephemeral to intermittent. A summary of the stream lengths by stream type, based on field observations and desktop analysis, is presented in Table 5.17.

Table 5.16 Stream Type Designations and Lengths (ft) for the Tributaries to Littoral Wetland Areas

Stream Type Designation	NHD	TCEQ	NTMWD Field Data
Perennial	10,550	N/A	N/A
Intermittent	12,544	N/A	11,837
Intermittent/Ephemeral	N/A	N/A	11,347
Artificial Path	90	N/A	N/A
Undesignated	N/A	23,184	N/A
Grand Total	**23,184**	**23,184**	**23,184**

Table 5.17 Summary of Stream Lengths for the Tributaries to Littoral Wetland Areas by Stream Type based on a PJD

Stream Type Designation	NTMWD Field Data
Intermittent	11,837
Intermittent/Ephemeral	11,347
Grand Total	**23,184**

5.3.2. Stream Assessment

The RGA method was used to evaluate the baseline condition of the tributary streams, between elevations 534 and 541 ft. msl, of the proposed littoral zone wetland areas. The baseline RGA scores of the littoral zone tributary streams were calculated based on the RGA scores of the downstream stream reaches within the conservation pool of the proposed reservoir that were determined during the 2008 RGA assessment of LBCR (FNI, 2009) and the January 2016 supplemental data collection (FNI, 2016b).

A summary of the existing stream length by stream quality factor intervals is shown in Table 5.18. The total baseline SQU value for the littoral zone tributary streams, defined as the sum of the SQUs for each reach, was calculated to be 3,745. A discussion of the RGA methodology is in Appendix E.

Table 5.18 Summary of the Baseline Conditions for Tributaries of Littoral Wetlands[1]

SQF	Littoral Wetland Tributaries	
	Existing Length (ft)	SQU
0 - .09	11,447	954
.1 - .19	0	0
.2 - .29	10,022	2,098
.3 - .39	1,075	341
.4 - .49	0	0
.5 - .59	640	352
.6 - .69	0	0
.7 - .79	0	0
.8 - .89	0	0
.9 - .99	0	0
1.0	0	0
Total	**23,184**	**3,745**

[1] *Calculations for stream quality units were conducted for each stream segment, and are included in Appendix E. The aggregation by SQF shown in the table is for presentation purposes only.*

5.4 WATERS OF THE UNITED STATES

At the Riverby Ranch Mitigation Site, a total of 347 FCUs (452 acres) of forested wetlands, 317 HUs (1,377 acres) of emergent wetlands, 98 acres of shrub wetland, 19 acres of open waters (ponds, stock tanks, etc.), and 105,130 SQUs for streams (approximately 273,949 linear feet) were identified. The total baseline stream length and SQUs include the streams in the WRP. The USACE issued an Approved Jurisdictional Determination (AJD) for the Riverby Ranch Mitigation Site (excluding the WRP) in August 2015 that confirmed the acreages of the three wetland types currently present at the ranch (USACE, 2015b). The AJD states that there is a total of 180,671 linear feet of existing jurisdictional streams at Riverby Ranch. NTMWD does not dispute the total stream length presented in the AJD but has determined that only 179,353 linear feet of these streams are amendable to mitigation use based on field reconnaissance.

At the Upper BDC Mitigation Site, a total of 448 FCUs (547 acres) of forested wetland, 49 HUs (117 acres) of emergent wetlands, 55 HUs (120 acres) of shrub wetlands, and 17,119 SQUs for streams (approximately 62,535 linear feet) were identified.

For the tributaries to littoral wetlands, 3,745 SQUs for streams (approximately 23,184 linear feet) were identified.

Table 5.19 Types, Lengths, and Acreages of Waters of the U.S. and Potential Waters of the U.S. Identified within the Proposed Mitigation Sites

Category	Length (feet)	Area (acres)	Functional Capacity/Habitat Units
RIVERBY RANCH[1]			
Streams			
Perennial	25,078	--	5,377 SQU
Intermittent	45,346	--	12,868 SQU
Ephemeral	108,929	--	45,895 SQU
Open Waters			
Ponds, Stock Tanks, Small Lakes		19	N/A
Wetlands			
Emergent	--	1,377	316.7 HU
Shrub	--	98	N/A
Forested	--	452	347 FCU
RIVERBY RANCH WRP AREA[2]			
Streams			
Perennial	40,170	--	18,490
Intermittent	29,214	--	12,322
Ephemeral	25,214	--	10,178
UPPER BDC MITIGATION SITE[2]			
Streams			
Intermittent	32,742	--	6,851 SQU
Intermittent/Ephemeral	29,793	--	10,267 SQU
Open Waters			
Ponds, Stock Tanks, Small Lakes	--	13	--
Wetlands			
Emergent	--	117	49 HU
Shrub	--	120	55 HU
Forested	--	547	448 FCU
TRIBUTARIES TO LITTORAL WETLANDS[2]			
Streams			
Intermittent	11,837	--	1,950 SQU
Intermittent/Ephemeral	11,347	--	1,795 SQU

[1]*Waters of the U.S. as determined by USACE Approved Jurisdictional Determination (AJD).*
[2]*Potential Waters of the U.S. as identified by FNI Preliminary Jurisdictional Determination (PJD).*

6.0 MITIGATION WORK PLAN

The purpose of the mitigation work plan is to describe the type of work that would be conducted at the proposed mitigation sites as part of the overall mitigation project. This mitigation work plan was developed with the intent of achieving ecological/functional uplift by improving aquatic habitat value for the many species of wildlife that are native to this area of Texas. The attainment of ecological uplift and improvement in habitat value for wildlife for emergent and shrub wetlands was evaluated utilizing the HEP procedures. For forested wetlands, the Modified East Texas HGM protocol was employed to demonstrate functional uplift, and the RGA method was used similarly for streams. The assumptions and application of these tools for mitigation are discussed in more detail in Appendices C - E. For this work plan, multiple data sources were used to identify potential sites for enhancement and restoration including:

- United States Geological Survey (USGS) 7.5' topographic maps;
- 2010 one-foot LiDAR survey data;
- 2015 six-inch LiDAR survey data;
- USGS National Hydrography Dataset (NHD);
- Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO);
- Project-specific floodplain mapping;
- Historical 1950 and 1969 aerial photographs;
- 1996 and 2007 color infrared imagery; and
- 2010 true color imagery.

In addition to these data sources, data collected during field work at the proposed mitigation sites were also used. The plant species selected to restore vegetation within forested wetlands, riparian areas, shrub wetlands, and emergent wetlands associated with this mitigation plan were derived from two primary sources: the NRCS 2001 Soil Survey of Fannin County, Texas and the USFWS's *National List of Plant Species That Occur in Wetlands: South Plains (Region 6)* (Reed, 1988). Consideration was also given to the species identified in the Modified East Texas HGM protocols for the forested wetlands. All species selected for restoration are native to this area of Texas and are expected to provide food, shelter, and nesting habitat for a variety of wildlife species, thus providing ecological/functional uplift.

6.1 LOCATION MAP

The location of the impact site and proposed mitigation sites are within Fannin County, Texas with a small portion of the Riverby Ranch Mitigation Site being in Lamar County, TX. The mitigation plan is comprised of on-site mitigation located at the proposed reservoir site (impact site) and near-site mitigation located at the Riverby Ranch and the Upper BDC Mitigation Site (mitigation sites). The location and boundaries of these sites are depicted on Figures 1, 4, 6, and 7. Both on-site and near-site mitigation areas lie within the same 8-digit Hydrologic Unit Code (HUC) Catalog Unit, HUC11140101.

6.2 TIMING OF MITIGATION ACTIVITIES

According to the 2002 USACE Regulatory Guidance Letter 02-2 (RGL 02-2; USACE, 2002), as well as the Final Mitigation Rule developed by the USACE and USEPA (73 Fed. Reg. 19593), the implementation of the compensatory mitigation should be in advance of or concurrent with the impacts. Because NTMWD has already purchased the proposed Riverby Ranch Mitigation Site that is comparable in size and located nearby and proximal to the impact site, NTMWD would be able to satisfy this goal. NTMWD has also purchased some of the properties within the Upper BDC Mitigation Site, and NTMWD is already preparing design plans and specifications to be ready to implement the mitigation plan immediately upon receipt of a favorable 404 permit decision. As part of this mitigation work plan, NTMWD proposes to implement mitigation measures such as securing deed restrictions, removing cattle from proposed wetland enhancement and restoration sites, including riparian areas, as well as beginning other activities such as restoring hydrology and implementing the planting plan prior to the start of construction at the proposed reservoir site. These mitigation measures are discussed in more detail in the following sections.

6.3 SOURCES OF WATER

Hydrology is the foundation of the aquatic mitigation plan. Successful establishment of wetland hydrology would improve the likelihood of success for the establishment of wetland vegetation and, over time, ecological/functional uplift.

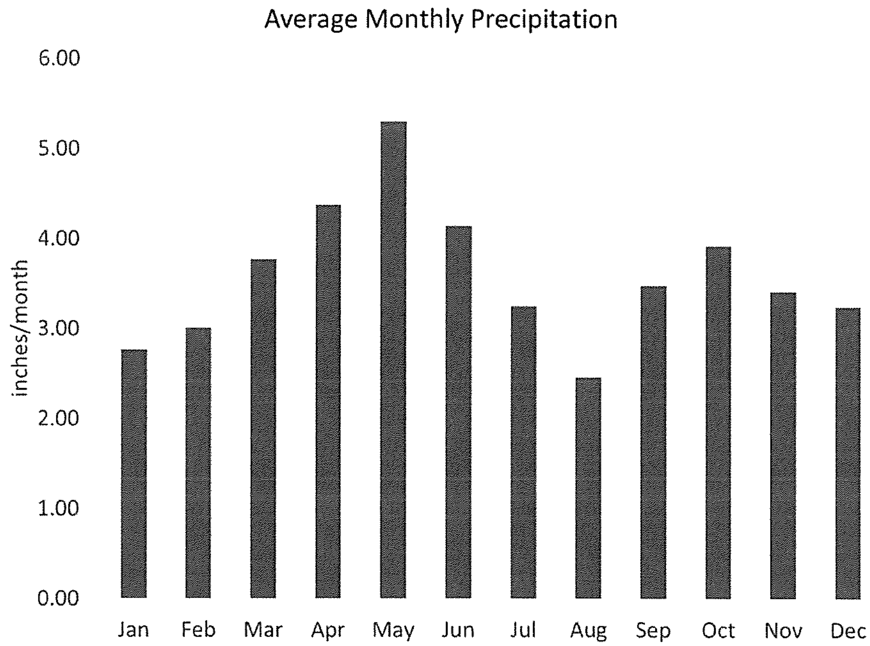
6.3.1. Riverby Ranch

Sustainable sources of water for this mitigation site would be provided by naturally occurring sources such as precipitation, normal stream flow, flood events, overland flow, and ground-water discharge. The goal is to avoid, to the extent practicable, the need to rely on artificial water sources such as the pumping of water and sources that would require ongoing maintenance and/or active management practices. Several factors that currently exist at the proposed mitigation site indicate that this goal is achievable.

One factor, as evidenced from aerial photographs and site reconnaissance, is that the existing hydrology of the ranch has been altered to maximize the area utilized for ongoing agricultural activities. Wetlands have been ditched and converted to agricultural land and stream channels have been straightened to expedite land drainage following rain events. In addition, the previous land owner constructed an earthen dike along the perimeter of Bois d'Arc Creek and its floodplain to prevent flooding of adjacent agricultural lands. The dike was constructed prior to the enrollment of this property into the WRP, and currently poses an impediment to hydrology of the streams and wetlands within this area. These historical alterations now provide opportunities for the restoration of hydrology, and ultimately, the restoration of wetlands and streams. Measures such as site grading, placement of berms, or plugging of drainage ditches could be used to restore the hydrology. To help restore hydrology to the WRP area, the existing dike that borders the upstream east and west sides of the WRP would be breached at key locations. This would reconnect the surface water runoff to the WRP streams. A conceptual depiction of these activities can be seen on Figures 13 and 14.

Another factor is the presence of approximately 8,600 acres of soils that are listed on the current National List of Hydric Soils of the United States (Figure 10). Hydric soils are those soils that are sufficiently wet in the upper horizons to develop anaerobic conditions during the growing season. The presence of these types of soils suggests that they have the capability to hold water or stay saturated for a sufficient duration to develop or support vegetation typically adapted for life in saturated soil conditions. Currently, most of these soils are being utilized for cropland or grassland production on the ranch. These soils would be specifically targeted for the restoration of hydrology and wetlands.

An additional factor indicating that the proposed mitigation site can be developed without relying upon artificial sources of hydrology is the amount of precipitation the area receives. The average annual precipitation for the NOAA precipitation station at Bonham (GHCND: USC00410923) is 42 inches. More than half of this amount, 23 inches, falls between April and September, which coincides with the growing season (see Graphic 6.1). A majority of the remaining precipitation falls during the dormant season which allows for soil moisture recharge and refilling of surface depressions.



Graphic 6.1 Average Monthly Precipitation at Bonham, TX

This mitigation plan would take advantage of these factors to develop a long-term sustainable source of water by:

- Restoring hydrology to sites that have been ditched or drained by filling, plugging, restoring stream meanders, and re-grading surface contours to increase surface water storage and slowing runoff;
- Focusing wetland restoration efforts on areas with hydric soils; and
- Re-grading surface contours to encourage infiltration of precipitation, flows from flood events, and overland flows to increase soil water recharge and thereby restore hydrology on the Riverby Ranch mitigation site.

If necessary, during the early phases of this mitigation plan when establishment of vegetation is most difficult, NTMWD could utilize the existing irrigation system and associated water rights for the ranch to enhance survival rates of newly planted seedlings, shrubs, trees, and ground cover vegetation. However, the goal would be to develop a self-sustaining mitigation site that would not require irrigation as soon as possible after planting.

6.3.2. Upper BDC Mitigation Site

The Upper BDC Mitigation Site lies almost entirely within the 5-year floodplain of Bois d'Arc Creek. The primary sources of water for the wetlands for this mitigation site would be provided by naturally occurring sources such as direct precipitation, overbank flood events from Bois d'Arc Creek and its tributaries within the mitigation site, overland flow, and shallow groundwater in the floodplain alluvium. Normal streamflow and groundwater discharge will continue to provide hydrology to the stream system within the mitigation site. The existing hydrology of the site is expected to be sufficient to support the mitigation proposal. Where necessary, re-grading surface contours to encourage infiltration of precipitation, water from flood events, and overland flows to increase soil moisture recharge on the mitigation site may be conducted in areas that have been drained for agricultural activities.

6.3.3. Littoral Wetlands

The littoral wetlands lie entirely within the footprint of the LBCR conservation pool. The primary sources of water for the wetlands will be LBCR and tributary streams. Water levels in LBCR will fluctuate over time, depending upon inflow and withdrawals, but even with these fluctuations, direct precipitation and inflow from the tributary streams will provide the required hydrology to the wetlands.

6.4 PLANTING PLAN FOR FORESTED WETLAND AND RIPARIAN CORRIDOR RESTORATION SITES

The list of species in Table 6.1 would be used as a guide for the selection of species based upon site conditions as well as commercial availability. This list was developed to be consistent with the Modified East Texas HGM and includes three groups of trees. Group 1 species would be planted as the dominant species (as determined by the 50/20 rule) across the restored forested wetland areas as these species achieve the highest functional uplift based on the Modified East Texas HGM models. Species within Groups 2 and 3 may also be planted (excluding eastern red cedar and honey locust) as non-dominant species (as determined by the 50/20 rule) to help increase diversity and functional uplift as measured through sub-index variables such as tree basal area, snag density, woody debris and log volume, vegetation strata, etc. Proposed tree species to be planted will be locally sourced. Areas identified for forested wetland and riparian corridor restoration where these species would be planted are depicted in Figures 15 and 16.

Table 6.1 Modified East Texas HGM Species Grouping for Determining Tree Composition (VTCOMP)

Group 1		Group 2		Group 3	
Pecan	*Carya illinoinensis*	Box Elder	*Acer negundo*	Eastern Redbud	*Cercis canadensis*
Sugarberry	*Celtis laevigata*	Red Maple	*Acer rubrum*	Hawthorn	*Crataegus spp.*
Ash	*Fraxinus spp.*	Hickory Spp.	*Carya spp.*	Honey Locust	*Gleditsia triacanthos*
Bur Oak	*Quercus macrocarpa*	Dogwood	*Cornus spp.*	Eastern Red Cedar	*Juniperus virginiana*
Water Oak	*Quercus nigra*	Persimmon	*Diospyros spp.*	Bois D'Arc	*Maclura pomifera*
Willow Oak	*Quercus phellos*	Black Walnut	*Juglans nigra*	Eastern Cottonwood	*Populus deltoides*
Shumard Oak	*Quercus shumardii*	Sycamore	*Platanus occidentalis*	Black Willow	*Salix nigra*
Elm	*Ulmus spp.*	Overcup Oak	*Quercus lyrata*	Soapberry	*Sapindus spp.*
		Cherrybark Oak	*Quercus pagoda*		

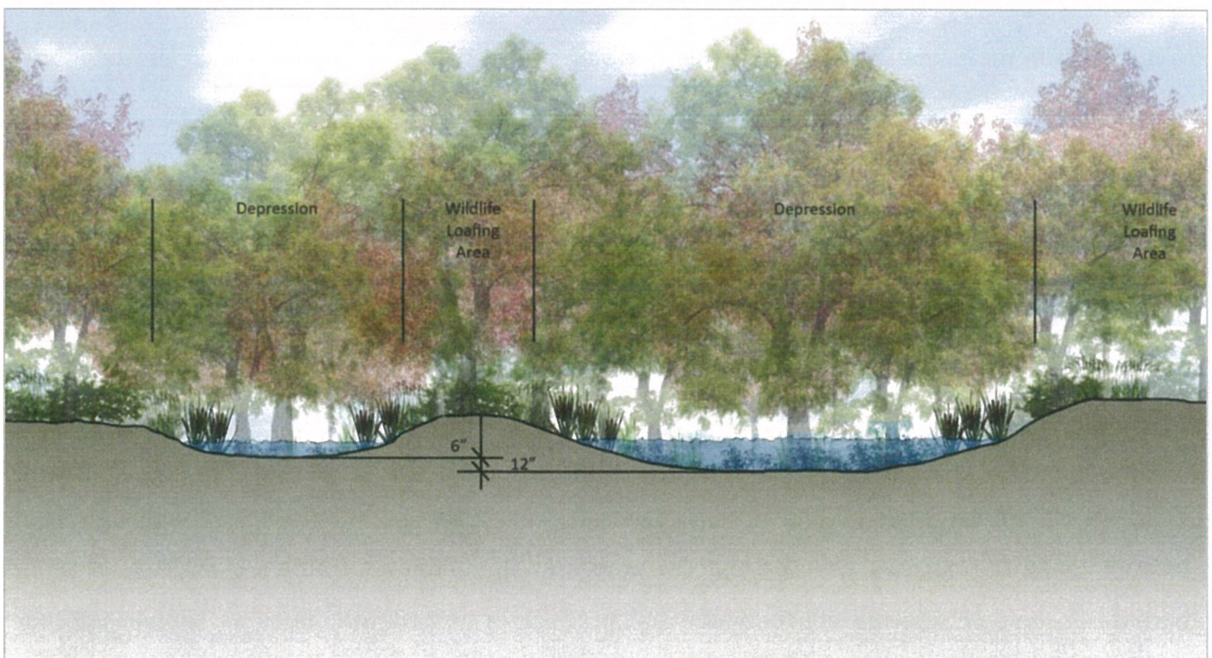
Group 1 = Common dominants in reference standard sites
Group 2 = Species commonly present in reference standard sites, but dominance generally indicates man-made or natural disturbance
Group 3 = Uncommon, minor or shrub species in reference standard sites, but may dominate in degraded systems

As described in the Modified East Texas HGM models, a tree density ranging between 81 and 202 trees per acre provides the highest functional uplift. As such, the trees identified in Table 6.1 would be planted at a rate to achieve the interim goal of 200 living trees per acre at the end of three years. Although species such as eastern red cedar and honey locust would not be planted as part of the planting plan, these species could occur through natural regeneration over time as they are native to this area of Texas. Unless it is determined during monitoring events that these species are becoming invasive or dominating restored sites, they would be left in place and included (along with other native species that naturally colonize the site) in tree counts made during monitoring events. It should also be noted that achieving 200 living trees per acre at the end of three years is not a final performance standard for this mitigation plan. Achieving 200 living trees per acre at the end of three years is an interim goal of this plan that ultimately would help to maximize the sub-index score for tree density (VTDEN) (and other sub-index variables) as scored using the Modified East TX HGM method. The plant material proposed for planting is one-year-old or older containerized plugs and/or bare-rooted seedlings that would be planted across the site by hand or machine. To the extent practicable with respect to facilitating planting, establishment and maintenance of forested wetland areas, trees will be planted in rows that follow land contours which will minimize the grid-like appearance of a plantation. Additionally, the sub-index variable associated with tree composition indicates that a minimum of three dominants (as determined by the 50/20 rule) from Group 1 provides the highest functional uplift on the restored forested wetland sites. As such, a minimum of three different species per acre from Group 1 would be planted as dominants. The diversity of species planted, along with recruitment of volunteer native species, will also foster the natural appearance of the forested wetlands.

Prior to planting, restored forested wetland sites would be graded, as needed, to achieve a total ponded area of 20 to 60 percent across the site. Based on the Modified East Texas HGM models, the sub-index variable for percent ponding indicates that forested wetlands with 20 to 60 percent ponding provide the highest function. Ponding would be achieved through a variety of methods including the creation of shallow depressions, terracing, bedding, plugging ditches, etc. Shallow monitoring wells will be installed to monitor hydrology during the first five years.

For existing shrub wetland areas that will be managed to become forested wetlands, a baseline review of the existing vegetation will be conducted. Based on these findings, supplemental plantings to improve species diversity, selected thinning of trees and/or shrubs to allow maturation of the forest stand, and invasive species control may be conducted as needed to attain the target FCI values.

Graphic 6.2 shows the expected development of forested wetlands within the restored areas. Typical details for the forested wetland plantings are included in Appendix I. Following construction, as-builts would be submitted to the USACE.



Graphic 6.2 Depiction of Restored Depressional Forested Wetland at the Riverby Ranch and Upper BDC Mitigation Sites

6.5 PLANTING PLAN FOR EMERGENT WETLAND RESTORATION

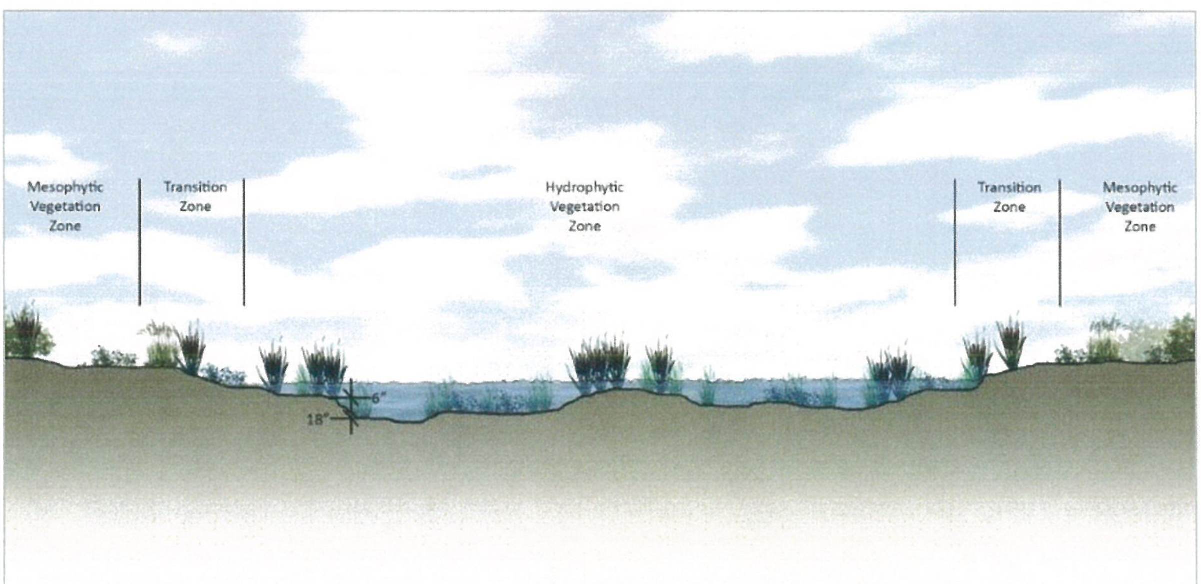
Two primary approaches will be utilized for establishing vegetation within the restored emergent wetland areas. One approach would include planting of these sites with a mixture of species listed in Table 6.2. This species list would be used as a guide for the selection of species based upon site conditions as well as commercial availability. Planting of the sites would be accomplished by hand or machine (broadcast seeded, drilled, and/or with plugs) following site grading if needed to restore hydrology. All restored emergent wetland areas proposed for seeding would be seeded at a rate recommended by the seed supplier. Seeds will be sourced from the watershed or adjacent watersheds to preserve the genetic integrity of local genotypes. Another restoration approach would involve the harvesting and import of seedbank soil from existing emergent wetlands located on Riverby Ranch. Plant materials harvested would consist of clumps with viable root-rhizome material to support growth of new shoots. Existing wetland areas targeted for seedbank harvest would contain species native to this area of Texas. Following transport of the soil seedbank, the material would be manually planted. Areas identified for emergent wetland restoration are depicted in Figure 16. Typical details for emergent wetland restoration are included in Appendix I. Following construction, as-builts would be submitted to the USACE.

Due to the presence of existing emergent wetland vegetation and seed banks, no plant list or planting plan has been developed for existing emergent wetland sites that will be enhanced at the proposed Riverby Ranch mitigation site or in the littoral wetland areas that would develop within the proposed reservoir site. There are no emergent wetland mitigation sites proposed within the Upper BDC Mitigation Site. Photograph 6.1 depicts typical emergent wetland vegetation observed at the Riverby Ranch mitigation site. If monitoring indicates that performance standards are not being met, the problem will be identified and corrective actions taken. These actions may include supplemental planting using the planting plan for restored emergent wetland sites (Table 6.2), change of species because of some unexpected site conditions, and predator or pest control measures. Graphic 6.3 shows the expected development of emergent wetlands within the restored areas.

Table 6.2 Species List for Emergent Wetland Restoration

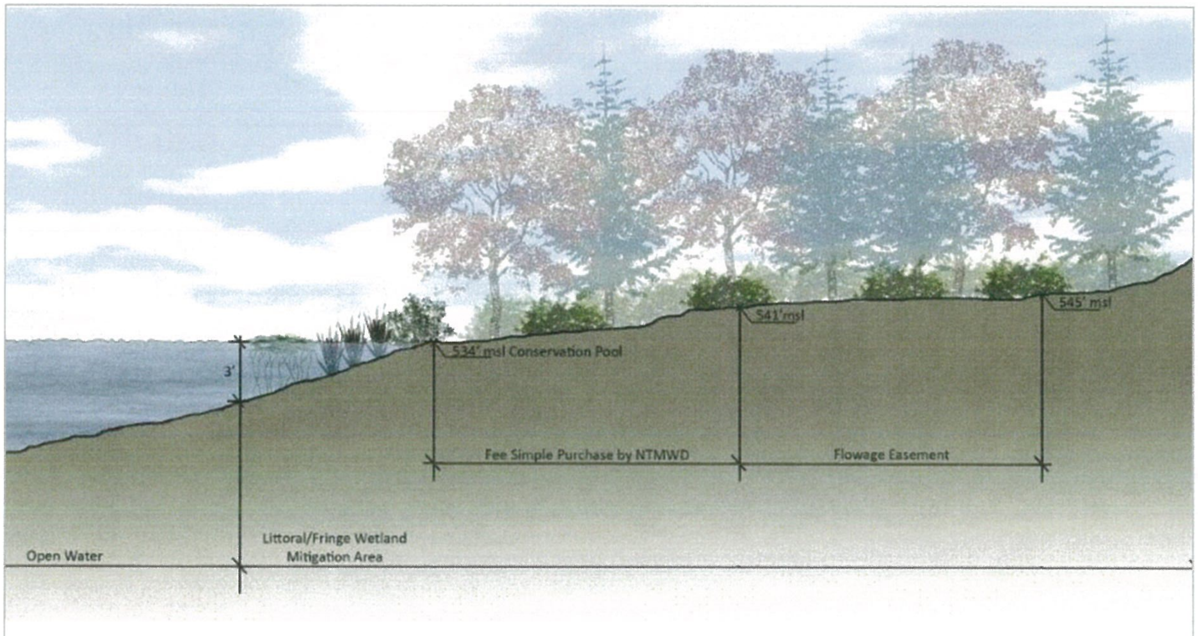
Common Name	Scientific Name	Region 6 Wetland Indicator Status
Bushy Bluestem	*Andropogon glomeratus*	FACW
Green Flatsedge	*Cyperus virens*	FACW
Eared Redstem	*Ammannia auriculata*	OBL
Grassleaf Rush	*Juncus marginatus*	FACW
Mockbishop Weed	*Ptilimnium nuttalli*	FACW
Water Lily	*Nymphaea odorata*	OBL
Arrowhead	*Sagittaria latifolia*	OBL
Inland Saltgrass	*Distichlis spicata*	FACW
Switchgrass	*Panicum virgatum*	FAC
Pennsylvania Smartweed	*Polygonum pensylvanicum*	FACW
Buttercup	*Ranunculus abortivus*	FAC
Horned Beakrush	*Rhynchospora corniculata*	OBL
Slimpod Rush	*Juncus diffusissimus*	FACW
Flatstem Spikerush	*Eleocharis compressa*	FACW

Photograph 6.1 Typical emergent wetland vegetation at the proposed Riverby Ranch mitigation site



Graphic 6.3 Expected emergent wetland development at Riverby Ranch

The littoral wetland areas at the proposed reservoir site would be inundated within the normal conservation pool. At depths less than three feet, the emergent wetlands would continue to exist and function as wetlands. If fluctuating water levels or other causes prevent this expected wetland development, then actions would be taken to facilitate wetland plant establishment and development as part of the adaptive management plan. Graphic 6.4 shows the expected development of littoral wetlands at the reservoir site.



Graphic 6.4 Expected littoral wetland development at LBCR

6.6 PLANTING PLAN FOR SHRUB WETLAND RESTORATION

The species presented in Table 6.3 would be used as a guide for the selection of shrub species based upon site conditions as well as commercial availability. These species will remain shrubs at maturity. Areas identified for shrub wetland restoration where these species would be planted are depicted in Figure 16.

Similar to the forested wetland restoration areas, the shrub wetland restoration areas would be planted at a rate to achieve the interim goal of 200 living shrubs per acre at the end of three years. It should be noted that achieving 200 living shrubs per acre at the end of three years is not a final performance standard for this mitigation plan. Achieving 200 living shrubs per acre at the end of three years is an interim goal of this plan as it would maximize the HSI score for shrub wetlands as determined using HEP. The plant material proposed for planting is one year old or older containerized plugs and/or bare-rooted seedlings that would be planted across the site by hand or machine. A minimum of three different species per acre from Table 6.3 would be planted across the site following grading to establish appropriate hydrology. Following construction, as-builts would be submitted to the USACE.

Table 6.3 Shrub Species List for Shrub Wetland Restoration

Common Name	Scientific Name	Region 6 Wetland Indicator Status
Deciduous Holly	*Ilex decidua*	FAC
American Beautyberry	*Calicarpa americana*	FACU
Swamp Privet	*Forestiera acuminata*	OBL
Buttonbush	*Cephalanthus occidentalis*	OBL
Coralberry	*Symphoricarpos orbiculatus*	FACU
Hydrolea	*Hydrolea ovata*	OBL

6.7 INVASIVE AND NON-NATIVE SPECIES CONTROL

During monitoring events, particularly during the early stages of plant establishment, assessments would be made to identify areas where invasive and non-native species pose a potential threat to the success of the proposed mitigation. Invasive and non-native plant species control would include control of competing vegetation such as volunteer herbaceous and woody species. Specific species targeted for control include Johnson grass, Bermuda grass, and eastern red cedar (if it threatens to dominate the mitigation sites). If chemical controls are employed, only herbicides that are specifically labeled for aquatic applications would be used, and they would be applied in accordance to their respective labels. Treatment of specific areas may be performed prior to initial plantings to discourage establishment of invasive species. Planting of annual rye grass and/or winter wheat along with initial tree plantings will also be considered for erosion and invasive species control. Such annuals will provide immediate cover to protect the soil surface from raindrop impact and a root network that will help to stabilize and incorporate organic matter into the soils. These plants will also help to control invasive plants by effectively competing for light, moisture and nutrients. As the hydrology of the planting areas becomes established in the first year, this annual cover is expected to give way to hydrophytic species such as *Carex* spp., *Cyperus* spp., *Juncus* spp., *Eleocharis* spp., and others. If it is determined that mechanical means of controlling these invasive species is feasible and more desirable in certain circumstances, these methods would also be employed.

Assessments would also be made during monitoring events to assess herbivory. Measures for controlling herbivory could include the use of tree tubes, fencing, nurse crops, trapping, hunting, chemical deterrents, attracting predators, etc.

6.8 GRADING PLAN / CONSTRUCTION METHODS

Site grading is a necessary component for success of the mitigation plan at the Riverby Ranch mitigation site. This property has been significantly altered over time in support of the on-going agricultural activities. Site grading will also be conducted in the Upper BDC Mitigation Site, as needed, to achieve 20 to 60 percent ponding within the restored forested wetland areas. No grading will be conducted within the Littoral Wetlands Area.

6.8.1. Riverby Ranch

NTMWD completed a one-foot aerial and LiDAR survey of the proposed mitigation site in 2010 and a six-inch aerial and LiDAR survey in 2015. This information will be used to develop a proposed grading plan for the restoration of wetland areas and streams at the proposed mitigation site. Wetland restoration sites would not be graded completely flat or level, but would incorporate pit-and-mound microtopography to mimic natural wetland areas, thereby enhancing infiltration of rainfall and runoff and providing greater habitat diversity for flora and fauna. As mentioned previously, restored forested wetland sites would be graded, as necessary, to achieve a total ponded area of 20 to 60 percent. This target was established based on the Modified East Texas HGM which indicates that ponding between 20 and 60 percent provides the highest function. Streams would be graded to create meanders and provide stable stream banks. Engineered woody debris structures would be installed where appropriate to promote meander bend stability and, as a secondary benefit, provide stream habitat. Where appropriate, grade control structures may be utilized to prevent further downcutting of the streams that are discharging to the actively incising channels of the Red River and Bois d'Arc Creek. Grade control structures would consist of passive water control structures such as cross vanes, utilizing natural materials such as earth, logs, and rock to the extent practicable. Appendix I includes an example of a cross vane grade control structure. No grade control structure will require active management.

6.9 SOIL PREPARATION AND MANAGEMENT

In January 2015, a total of 259 soil samples were collected from Riverby Ranch to evaluate existing soil conditions and levels of primary nutrients for the purposes of establishing wetland and riparian vegetation. The resulting data will be used to determine if soil amendments are required for vegetation establishment/survival. If amendments are needed, they would be applied over the site and the site surface would be tilled to loosen the soil and reduce compaction. This would also mix the organics in the surface horizon to promote establishment of vegetation on the site.

In wetland and riparian restoration areas where site preparation could involve the excavation of the A and/or B-horizons (or, if over-excavation is required), the topsoil would be stockpiled and then spread back over the site following excavation or used in other restored wetland sites. This would reduce the need for additional soil amendments and would likely provide for a natural seed source of wetland plants that would help establish vegetation on these sites. If soil compaction is determined to be problematic for the establishment of vegetation, the soil could be ripped or chisel-plowed. Additionally, wide-tracked, low ground pressure equipment would be used on “soft” or moist soils to avoid additional soil compaction. These measures would facilitate the rooting and establishment of woody and herbaceous vegetation in restoration sites. It is likely that each restoration site would require a specific soil management strategy depending on the results of the soil analyses and existing site conditions.

6.10 STREAM RESTORATION

6.10.1. Riverby Ranch

Stream restoration activities at the mitigation site would vary from stream to stream depending on existing channel conditions and would include general stream restoration measures such as:

- laying back stream banks to reduce erosion and allow for riparian plantings;
- restoring riparian corridors through tree and shrub plantings;
- removing cattle and protection from livestock grazing;
- breaching impediments to hydrology, such as the previously constructed dike within the WRP;
- restoring channel bed variability (pools and riffles)
- installation of engineered woody debris structures to promote meander bend stability and provide in-stream habitat
- restoring meanders to straightened portions of stream channels; and

- improving water quality by reducing sediment, pesticides, herbicides, bacteria, etc. through the actions outlined above.

The development of the Riverby Ranch conceptual plan considered existing drainage patterns, meander geometry and sinuosity of reference streams in the watershed, soils/geology, and existing and proposed future land cover. A conceptual stream restoration plan for the proposed mitigation site is presented in Figure 13. Most of the streams within the primary Riverby Ranch mitigation site are identified for instream work (Figure 15). Approximately 50,700 linear feet of streams are identified for riparian plantings only. Most of these streams have existing riparian corridors, which would not be conducive to in-stream activities.

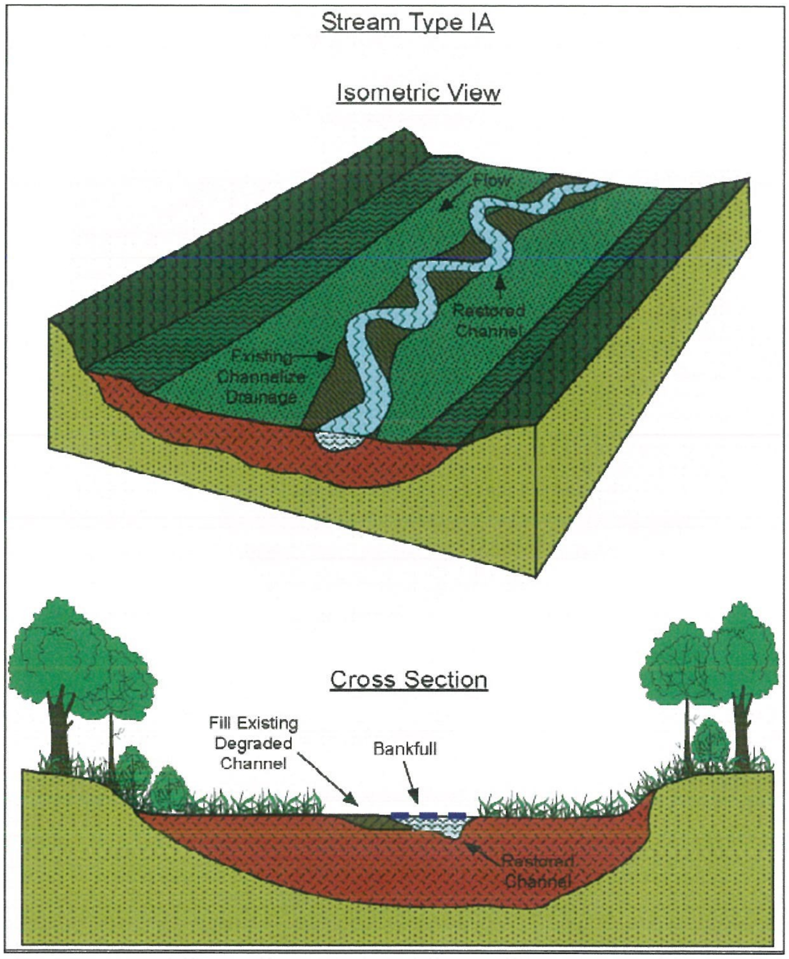
Enhancement of streams within the WRP would include the restoration of hydrology through modifications to the existing exterior dike and drainage ditch, and the creation of treed riparian corridors along selected stream alignments (Figure 13). Proposed locations for modifications to the dike are shown on Figure 14. These locations were selected to provide restoration of hydrology to the streams within the WRP, and will be finalized in consultation with the NRCS.

Establishing a treed riparian buffer will improve streambank stability, reduce bank erosion, provide shade to the stream, and generate wood debris storage/habitat. In-stream work is not being proposed within the WRP. However, fluvial geomorphic principles support the hypothesis that as upstream reaches of streams are improved and become stabilized, the downstream reaches of channel can experience indirect ecological uplift resulting from the upstream improvements, even with no direct channel work performed in the downstream reaches. For example, removing cattle and other agricultural practices, restoring meanders, modifying channel geometry to stable dimensions, and re-connecting the upstream channel to a floodplain would promote stability and provide uplift to the downstream reach by reducing the volume and velocity of incoming stream flow (thereby reducing channel erosion and bank failures), reducing incoming sediment and nutrient loads (that promote channel infilling and eutrophication), and providing a seed source for channel vegetation.

Stream restoration on Riverby Ranch would fall under three types. These restoration types are similar to the priority levels described in Harman et al. (2012) but have been tailored and adapted to the specific conditions on the mitigation property. In general, Type I stream restoration would involve restoring channel sinuosity and floodplain connectivity to the natural, historic floodplain, similar to Harman et al. (2012) Priority Level 1 restoration. Type I restoration is further broken down into two sub-types (Type IA and Type IB) based on the location of the new bankfull channel in relation to the existing channel. Type II stream restoration would increase floodplain connectivity, by creating an inset floodplain, similar to Harman et al. (2012) Priority Level 3 restoration. Type II restoration is only planned for relatively short reaches of channel where valley length or slope limit opportunities for Type I restoration. Type III restoration is generally planned for streams that flow through established riparian corridors.

6.10.1.1. Type IA Stream Restoration

This approach to stream restoration would take two forms. The first form would involve excavating a meandering bankfull channel within an existing drainage swale. It can be assumed that a defined channel would have formed in these locations had the land not been continuously disturbed by plowing; refer to Graphic 6.5 for a depiction of Stream Restoration Type IA. The second form would involve stabilizing the existing stream channel and would lay back existing stream banks to reduce erosion and add sinuosity to straightened reaches where appropriate. This second form would be taken on one reach of Willow Branch in the south-central portion of the ranch where the surrounding land topography makes a Type IB restoration impractical, and the existing channel is already connected to the floodplain or natural floodplain benches during relatively low flow events.

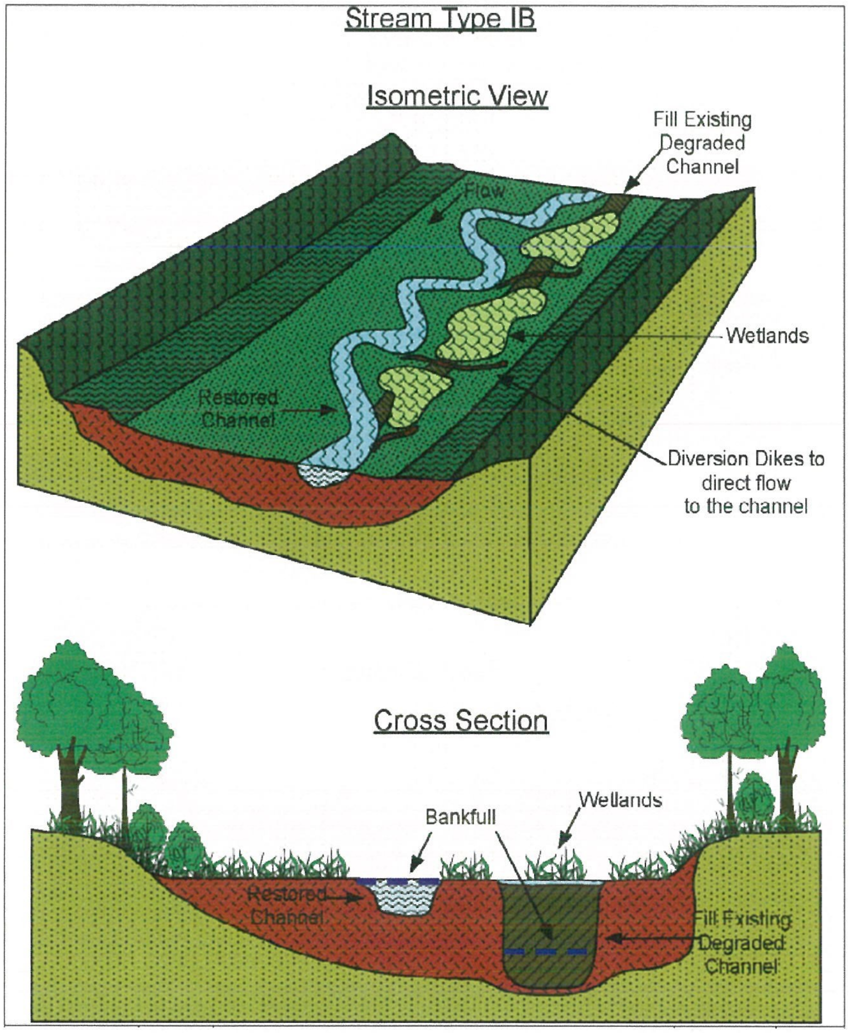


Graphic 6.5 Stream Restoration Type 1A

6.10.1.2. Type IB Stream Restoration

Type IB restoration would occur in areas where a stream channel currently exists and the adjacent landscape topography is such that it is practical to abandon the existing incised linear channel and excavate a new, stable meandering channel adjacent to it on the landscape; refer to Graphic 6.6 for a depiction of Stream Restoration Type IB.

The excavated material would be used to fill the existing channel either completely or in a manner that could potentially convert it to a floodplain wetland feature. If the existing channel is converted to a floodplain wetland feature, diversion dikes would be placed across the existing channel to divert excess flow into the new constructed meandering channel at an appropriate interval to deter downstream concentrated flow in the linear wetland feature.

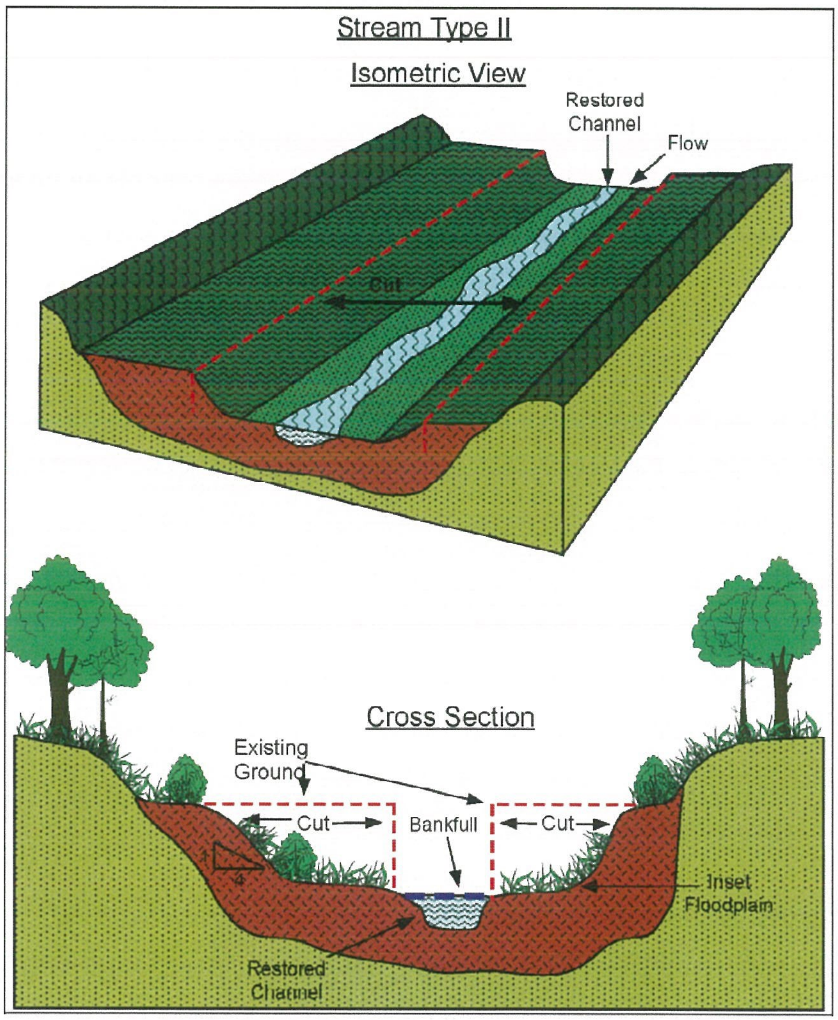


Graphic 6.6 Stream Restoration Type 1B

6.10.1.3. Type II Stream Restoration

Type II restoration would occur in areas where constraints such as valley or channel length, valley slope, or adjacent land topography make a Type IA or IB restoration approach impractical. Channel reaches designated for Type II restoration often flow across terrace scarps where land topography make a meandering channel design inappropriate. In other words, Type II restoration techniques would be used to transition streams between terrace surfaces, from higher elevation surfaces to lower elevation across a relatively short distance; refer to Graphic 6.7 for a depiction of Type II Stream Restoration.

Type II restoration would include the construction of a two-stage channel; a bankfull channel with a bed elevation either at, or close to, the existing channel bed elevation within a new, larger conveyance channel. The conveyance channel would be created by excavating the existing channel banks down to the bankfull elevation. The existing alignment, sinuosity, and bed elevation of the bankfull channel would remain the same as the existing channel. The bottom of the conveyance channel (excavated inset floodplain) would be approximately four-times the width of the bankfull channel. The side slopes of the conveyance channel would be excavated up to meet the existing ground surface at a slope of approximately 4H:1V. Grade control features may be required to artificially decrease bankfull channel slope.



Graphic 6.7 Stream Restoration Type II

6.10.1.4. Type III Stream Restoration

Type III restoration involves minimal spot alterations to channels that are already in a state of relative stability, or where more intense restoration activities would do more harm than good. These streams are primarily those that flow through wooded riparian corridors that contain mature trees of desirable species composition. Most of the stabilization activities in Type III streams would involve establishing grade control at the downstream end of the reach and at locations of existing knickpoints, reconfiguring select unstable streambanks, and/or enhancing channel stability through riparian plantings.

A preliminary designation of in-channel work by stream type is included in Appendix I. Appendix I also presents typical plan sections and details for stream restoration and creation. While careful consideration has been given to the stream restoration activities planned over the entire Riverby Ranch site, more precise stream locations and specific restoration activities will be identified for each stream segment during the detailed design phase. Following construction, as-builts would be submitted to the USACE.

6.10.2. Upper BDC Mitigation Site

Stream enhancement in the Upper BDC Mitigation Site would entail the enhancement and creation of riparian corridors along the streams. Establishing a treed riparian buffer will improve streambank stability, reduce bank erosion, provide shade to the stream, and generate wood debris storage/habitat. These corridors would be enhanced through riparian tree plantings within a minimum 30-foot wide corridor along each stream bank. For streams with no existing corridor, new corridors will be created at the same width. Beyond the riparian corridor would be the proposed forested wetland restoration and enhancement sites, which would effectively provide a much larger bottomland hardwood corridor. Details on riparian plantings are discussed in Section 6.4.

6.10.3. Tributaries to Littoral Wetlands

The tributaries to littoral wetlands up to elevation 541 ft. msl. at the proposed reservoir site will be enhanced by protection in perpetuity from future development and other non-compatible uses through an appropriate site protection instrument(s), such as a deed restriction. The cessation of farming practices such as the application of fertilizers and pesticides, removing cattle and other negative anthropogenic influences will benefit the littoral zone tributary streams and provide ecological uplift.

6.11 EROSION CONTROL

Best management practices (BMPs), identified in the USACE Tulsa District Aquatic Resource Mitigation and Monitoring Guidelines and stormwater construction permit BMPs would be employed throughout the construction phase of the mitigation project to control and reduce impacts to adjacent lands and waters. Mitigation construction would employ BMPs such as, but not necessarily limited to, the following:

- erosion control practices such as employing mulch, composts, excelsior matting, or temporary vegetation for construction-disturbed sites (such as planting of annual rye grass and/or winter wheat);
- runoff and sedimentation basins or vegetated filter strips where necessary to control transport of sediments to aquatic areas;
- siltation barriers on land (fences and mulch socks) and in water (turbidity curtains);
- minimization of size and duration of temporary activities in aquatic areas;
- storage of fuels and materials shall occur at a location above the existing and intended Ordinary High Water Mark where they cannot be carried into aquatic areas by high flows and would be removed from any likely flood zone prior to predicted flood events;
- fueling and servicing of vehicles and equipment would be done above the ordinary high water mark;
- If construction uncovers or disturbs any previously unknown historical, archaeological, or cultural materials, or human remains, construction activities shall cease in the immediate vicinity of the discovery and measures will be implemented to protect the site.
  - The USACE Tulsa District Regulatory Branch shall be immediately contacted for further instruction.
  - In the case of finding human remains a Treatment Plan Agreement effective October 27, 2016 between NTMWD, USACE Tulsa District, Texas Historical Commission and Caddo Nation of Oklahoma details procedures to be followed. This plan states that if human remains are found, local law enforcement officials and the Medical Examiner will be immediately notified and outlines procedures to be followed if the remains are determined to be affiliated with the Caddo Nation.

7.0 DETERMINATION OF CREDITS

7.1 UNITS OF MEASURE

The principal unit of measure for debits and credits associated with the impacts and mitigation for shrub and emergent wetlands will be Habitat Units (HUs) derived from HEP. The principal units of measure for debits and credits associated with the impacts and mitigation for forested wetlands will be Functional Capacity Units (FCUs) derived from the Modified East Texas HGM. The principal unit of measure for debits and credits associated with streams is SQUs derived from the RGA. The principal unit of measure for open waters (ponds, stock tanks, etc.) will be acres. An overview of HEP, HGM, and RGA, as well as the methods used for determining uplift for habitat units, functional capacity units, and stream quality units, are included in the following sections. More detailed information on these assessment tools and their application to this project can be found in Appendices C through E.

CREDIT DETERMINATION TOOLS

- **Modified East Texas HGM**
  - Forested Wetlands
- **Habitat Evaluation Procedures**
  - Emergent Wetlands
  - Shrub Wetlands
- **Rapid Geomorphic Assessment**
  - Streams

7.2 ASSESSMENT METHODS

7.2.1. Habitat Evaluation Procedures (HEP)

The Habitat Evaluation Procedures (HEP) is a habitat-based evaluation methodology developed by the USFWS in 1974 for use as an analytical tool in impact assessments and project planning (USFWS, 1980a; USFWS, 1980b; USFWS, 1980c). HEP is a species-habitat analysis of the ecological value of a study area; its approach is to quantify the value of habitat available to a selected set of wildlife species within a specified geographic area of interest. The method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time. The HEP methodology also provides a functional evaluation for wetland cover types in that it evaluates the functional value of the plant communities within the ecosystem by measuring plant characteristics and their values for fish and wildlife. The use of HEP, in conjunction with hydrologic studies and condition indices determined for fish (IBI scores) and macroinvertebrates (RBA scores), provides a defensible assessment of the functions and habitat values for aquatic mitigation. Since HEP provides a quantitative method for assessing both aquatic and terrestrial cover types, it may be used in planning applications such as the assessment of current and future wildlife habitat, trade-off analyses, or compensation analyses (mitigation).

HEP is used to appraise a study area by quantifying its habitat value, calculated as the product of habitat quantity and habitat quality; this value is expressed in habitat units (HUs). Habitat quantity is simply the total area of habitat available within the study area, usually expressed in number of acres. Habitat quality is expressed in terms of a dimensionless habitat suitability index (HSI), which is determined by comparing the ecological characteristics of the study area to the habitat characteristics that are optimum for evaluation species. The evaluation species are representative wildlife species with known habitat requirements and are selected to provide a basis to assess habitat suitability.

HSI values are based on two components: the habitat characteristics that provide ideal conditions for an evaluation species, and the habitat characteristics existing in the study area. These characteristics are described by a set of measurable habitat variables, such as the height and percent cover of various vegetation types, the distance to water or grain, the availability of perching or nesting sites, or the frequency of flooding. The set of habitat variables needed to determine HSI values are obtained from documented habitat suitability models for each evaluation species. These models describe the species' life requisites (i.e., its habitat requirements for food, cover and reproduction), the relationship between the habitat variables' values, and the suitability of the area to meet its life requisites.

The HEP methodology incorporated into this study is recommended by the USFWS as their basic tool for evaluating project impacts and developing mitigation recommendations (USFWS, 1996), and it has been used as a method to evaluate impacts to wildlife habitat for similar projects in Texas. Additionally, Title 30 §297.53 of the Texas Administrative Code (TAC) states that "functions and values for wetland habitats shall be determined on an individual case basis using the most technically appropriate habitat evaluation methodology (e.g., USFWS's Habitat Evaluation Procedures and Wetlands Evaluation Techniques; TPWD's Wildlife Habitat Appraisal Procedure)". An interagency team with representatives from the USFWS, USACE, USEPA, USFS, TPWD, TWDB, and TCEQ, as well as NTMWD and FNI was convened in May 2007 and August 2010 to identify and agree upon the parameters to guide the HEP studies performed at the reservoir (impact) site and at the Riverby Ranch mitigation site. No HEP studies were undertaken at the Upper BDC Mitigation Site because the site is proposed for forested wetland mitigation.

7.2.2. Hydrogeomorphic Approach (HGM)

The HGM approach is a method that assesses the functions of a wetlands ecosystem by analyzing the physical, chemical, and biological interactions of the ecosystem's structural components within the surrounding landscape. The HGM approach is based on the hydrogeomorphic classification system, which considers the geomorphic setting, water source, and hydrodynamics. Each HGM Method is developed in the context of the geographic setting and common ecological characteristics. There is no USACE-approved HGM Method that includes the geographic setting of this project. The East Texas HGM, developed in 2010, applies to the Pineywoods Ecoregion of East Texas, which lies to the east of this project. The East Texas HGM Regional Guidebook assesses the functions for three forested wetland subclasses including low-gradient riverine, mid-gradient riverine, and connected depression subclasses.

At the request of the USACE and other federal and state resource agencies, the East Texas HGM Method was modified specifically for this project. The USACE contracted with Stephen F. Austin University (SFA) to conduct studies to verify or adjust the sub-index curves that are used to calculate the functional indices. In cooperation with the USACE, the USACE Engineer Research and Development Center (ERDC), and SFA, modifications to the protocol were completed in May 2016. Documentation of the modification process can be found in *Modifying the East Texas Regional Hydrogeomorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016). The resulting tool, referred to as the Modified East Texas HGM Calculator Tool, was used to calculate the functional capacity units (FCUs) for the forested wetlands at both the impact site and mitigation sites. This tool is only applicable to the LBCR Project.

The Modified East Texas HGM assesses six functions for forested riverine wetlands: Detain Floodwater, Detain Precipitation, Cycle Nutrients, Export Organic Carbon, Maintain Plant Communities, and Provide Habitat for Fish and Wildlife. Each of these functions are calculated using sub-index variables and formulas (models) that were developed for this project. The Calculator Tool developed by ERDC provides a functional capacity index (FCI), which ranges from zero to one, for each function. At the direction of the USACE, the average of the FCIs for each wetland function is the basis of determination for the Functional Capacity Units (FCUs). As such, FCUs are the currency used to assess debits and credits for mitigation purposes. For forested wetlands located outside the 5-year floodplain, two functions (Detain Floodwater and Export Organic Carbon) are not assessed. While these two functions continue to perform within these wetlands, they are not considered in the average FCI value.

The Modified East Texas HGM tool was applied to assess the reservoir site, downstream forested wetlands, and both near-site mitigation sites. It was also used to assess the expected uplift at the proposed mitigation sites.

7.2.3. Rapid Geomorphic Assessment (RGA)

The LBCR RGA method integrates data collected from the field and desktop sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features (FNI, 2009; FNI, 2016b). The RGA method is based on a rapid field assessment of stream properties and characteristics at representative sites along stream reaches that are being evaluated. In general, the types of data collected include observations of channel size and location, bank geometry, information describing riparian vegetation and rooting depths, general bank armoring characteristics, as well as conditions of the upper slopes, lower slopes, and channel bed. At each data collection point, six stream characteristics (evidence of bank erosion, bank root zone, vegetative bank cover, bank angle, sediment transport, and channel alteration) are assessed. These data are later scored and then summed to calculate a final RGA score ranging between zero and 60. The RGA scores are then normalized by dividing by 60 producing a Stream Quality Factor (SQF) ranging between zero and one, where zero represents poorest stream conditions and one represents optimum stream conditions. The calculated SQF score for a particular study reach is then multiplied by its length to calculate SQUs provided by that reach. Based on field observations, streams were identified as perennial, intermittent, intermittent/ephemeral, or ephemeral. The calculated SQUs are presented by stream type and mitigation component. This process was utilized at both the proposed reservoir site as well as the proposed mitigation sites.

7.3 MITIGATION COMPONENTS

7.3.1. Avoidance and Minimization

This mitigation plan was developed to compensate for the unavoidable impacts to waters of the U.S. due to the construction of the proposed LBCR project. The NTMWD has followed the USACE required sequencing process whereby (1) impacts to waters of the U.S. were avoided to the extent practicable while addressing the purpose and need for the project, (2) impacts that could not be avoided were minimized to the extent practicable, and (3) mitigation actions were identified in this plan to compensate for the remaining unavoidable but minimized impacts to waters of the U.S.

The NTMWD has taken the following measures to avoid and minimize impacts of the proposed project on the aquatic environment.

1. Avoidance of Wetlands and other Waters of the U.S.

   Reservoir Site. The applicant's purpose of the proposed project is to establish a new, reliable water supply for the NTMWD by creating a new drinking water reservoir. To accomplish this goal, the NTMWD has proposed to impound water on Bois d'Arc Creek and its tributaries. As described in its Section 404 Permit application and EIS, the reservoir is one part of the NTMWD's plan to fulfill its obligation to provide water to meet the increasing demands of its service area. Because the proposed reservoir must be sited in waters of the U.S. to achieve the applicant's goal of optimizing the storage and yield of water at the site, avoidance of impacts to waters of the U.S. within the reservoir footprint is not possible.

   Intake Pump Station, Transmission and Treatment Facilities. During the route selection and site layout process for the proposed raw water pipeline, intake pump station, electrical substation, terminal storage reservoir, rail spur, and water treatment plant, all impacts to wetlands were avoided (FNI, 2013a). In addition, all impacts to streams and jurisdictional open waters (ponds, stock tanks, etc.) that would occur as a result of constructing the raw water pipeline would be minimized and considered temporary by restoring pre-construction contours, stabilizing exposed stream banks, and revegetating the area immediately following construction. Consequently, no permanent impacts to waters of the U.S. would occur as a result of constructing these features.

   FM 1396 Relocation. Three alternative routes were reviewed and evaluated for the roadway relocation. During this process, the loss of jurisdictional waters outside of the proposed LBCR footprint was avoided. Temporary impacts during construction would be minimized by restoring pre-construction contours, stabilizing exposed stream banks, and revegetating the area immediately following construction. No permanent impacts to waters of the U.S. outside of the reservoir footprint would occur as a result of relocating FM 1396.

   Removal of 14.4 Miles of Proposed Pipeline. The originally proposed project included piping water from LBCR to Pilot Grove Creek upstream of Lake Lavon. NTMWD has since removed 14.4 miles of proposed pipeline and the associated discharge structures proposed to be located on Pilot Grove Creek (Trinity River Basin) from the originally proposed project. This would result in the avoidance of impacts to 23 streams, nine potential wetlands (forested and emergent), and three on-channel ponds (APAI, 2008). Additionally, this reduces the potential risk of spreading non-native/invasive species from one watershed to another.

2. Minimization of Impacts to Waters of the U.S.

Reservoir Site. The site of the proposed LBCR dam was selected to minimize impacts to the Caddo National Grasslands, Lake Bonham Dam, and potential flooding in the City of Bonham while maximizing water supply. As part of a 1984 feasibility study for the reservoir (FNI, 1984), different conservation pool elevations were evaluated. The selected conservation pool elevation (534 ft. msl.) minimizes impacts to waters of the U.S. by establishing the smallest size reservoir that provides optimal water supply at the site, which is necessary to meet the NTMWD's needs.

Land and Flowage Easement Acquisitions at Proposed Reservoir Site. NTMWD is purchasing land from elevation 534 ft. msl. (conservation pool elevation) up to elevation 541 ft. msl., which is the elevation of the emergency spillway (seven feet above the conservation pool). This is approximately 3,324 acres. Flowage easements would be purchased for land from 541 ft. msl. up to elevation 545 ft. msl. Approximately 2,217 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. This would avoid or minimize indirect impacts to approximately 5,541 acres of land contiguous with the conservation pool of the proposed reservoir. Except for the proposed Upper BDC Mitigation Site and tributaries to the littoral wetlands, NTMWD has not calculated specific credit units for this area or claimed any preservation credits. However, these restrictions would minimize water quality and secondary development impacts by establishing a buffer area surrounding the reservoir.

Water Quality Regulations. NTMWD will cooperate with Fannin County and resource agencies to regulate boating, fishing, hunting and other recreational and commercial activities on and surrounding the proposed LBCR. Legislation was passed in 2011 that allows Fannin County to regulate development in a 5,000-ft buffer area around the lake. NTMWD will cooperate with local agencies and Fannin County to protect water quality through measures addressing erosion, septic tank installations, fuel spills, etc. The County ultimately will be responsible for managing development around the lake, including protection of the lake's water quality. The County has initiated this process and recently approved a Comprehensive Plan for development around the lake (FNI, 2016e).

Instream Flow Regime. The NTMWD proposes to release water from the proposed LBCR for environmental flow purposes. These releases would minimize or reduce potential downstream impacts to Bois d'Arc Creek.

7.3.2. Mitigation for Unavoidable Impacts to Waters of the U.S.

Based on the HEP results from the proposed reservoir site, a total of 531 HUs of shrub and emergent wetlands would be lost from the construction of LBCR. The Modified East Texas HGM indicated that 4,035 FCUs (based on acres) associated with the forested wetlands along Bois d'Arc Creek would be lost. These FCUs include a small functional loss associated with the forested wetlands located downstream of the proposed dam. Additionally, 78 acres of open waters (ponds, stock tanks, etc.) and 192,377 SQUs of streams would be impacted. Mitigation for impacted waters of the U.S. (i.e., forested wetlands, shrub wetlands, emergent wetlands, streams, and open waters) would be achieved through three primary mitigation components, including (1) the reservoir (on-site mitigation); (2) wetland restoration and enhancement (near-site mitigation); and (3) stream creation, restoration and enhancement (both on-site and near-site mitigation). A full description of how each mitigation component would provide compensation for unavoidable impacts to waters of the U.S. is presented below, following the discussion of temporal losses.

7.4 TEMPORAL LOSSES

Temporal losses are defined as the time lag between the loss of aquatic resource functions caused by the permitted action and the replacement of aquatic resource functions at the compensatory mitigation site(s). NTMWD's proposed mitigation plan would minimize potential temporal losses associated with this project, as described in the following paragraphs.

The NTMWD has already purchased an approximately 15,000-acre mitigation site downstream of the proposed reservoir. If the Section 404 permit is issued, NTMWD would immediately begin implementing components of the mitigation work plan such as establishing deed restrictions, removing cattle, controlling invasive species, grading to restore hydrology, and planting to establish desired vegetation. This would result in an immediate uplift and increase in habitat units for emergent and shrub wetlands, functional capacity units for existing forested wetlands, and stream quality units for existing streams.

Following issuance of the Section 404 permit, the final design and construction of the dam is expected to take approximately three years to complete. The initial impacts to waters of the U.S. within the vicinity of the dam and spillways would be minor in comparison to the impacts following full inundation of the reservoir and would be offset through establishing site protection and implementing components of the mitigation work plan over this three-year period. NTMWD has already initiated preliminary engineering design for portions of the Riverby Ranch Mitigation Site. This three-year period will allow NTMWD to implement protection, enhancement, and restoration activities for the streams and wetland habitats immediately upon issuance of the permit and /or concurrent with impacts to waters of the U.S. associated with dam construction.

Following construction of the dam and spillways, it is anticipated to take an additional three years for the proposed reservoir to reach its conservation pool elevation of 534 ft. msl. This would result in impacts to the remaining waters of the U.S., but these impacts would be spread out over a three-year period. This expected six-year period for dam construction and reservoir filling would allow the enhanced and restored emergent and shrub wetlands on Riverby Ranch to reach maturity and provide the anticipated habitat value uplift (819 HUs). This would more than compensate for the 531 HUs of impacts to emergent and shrub wetlands.

Temporal losses associated with forested wetlands would be offset using the following strategic measures. In anticipation of the issuance of the Section 404 permit, NTMWD has acquired 500,000 native, hard mast producing trees grown from local seed sources. Having the needed plant materials in hand and planting plans and specifications complete prior to issuance of the permit allows NTMWD to implement forested wetland restoration prior to, or commensurate with, impacts at the proposed reservoir site. This measure significantly shortens the time between anticipated impacts and implementation of the mitigation work plan. An additional benefit to having acquired the plant materials prior to the permit decision is that the trees would be older and planted as one gallon stock vs. a one year seedling. This would also shorten the time for the planted site to develop into a "forested" wetland, further reducing temporal loss.

Another strategy that NTMWD would utilize is protection of the existing forested wetlands through deed restrictions (or other site protection instrument approved by USACE) that would be implemented immediately following issuance of the permit (Appendix J). There are approximately 452 acres of forested wetlands at the Riverby Ranch Mitigation Site and 574 acres of forested wetlands in the Upper BDC Mitigation site (1,026 acres total) that have historically been altered (see Photograph 7.1), and now would be protected from future logging, agriculture, and other activities that reasonably would be expected to impact this resource. In addition to protection, NTMWD could also begin enhancement activities such as controlling invasive, non-native species in these areas to promote growth of native vegetation that would provide immediate functional uplift. A third strategy NTMWD proposed to utilize is allowing the 120 acres of existing shrub wetlands in the Upper BDC Mitigation Site to develop into forested wetlands. The identified shrub wetlands (Figure 11) are wetlands in successional transition between emergent wetlands and bottomland hardwood forests. The shrub layer is dominated by small trees such as green ash, sugarberry, and cedar elm. By protecting these areas, they are expected to develop into fully functional forested wetlands in a much shorter time frame, further reducing any anticipated temporal losses. These strategies, coupled with the fact that NTMWD is providing more mitigation for aquatic resources than are being impacted, more than offsets any anticipated temporal losses associated with forested wetlands.

Photograph 7.1 1984 Aerial Photo of Upper BDC Mitigation Site

7.5 FORESTED WETLAND MITIGATION

Impacts to forested wetlands at the proposed reservoir site are expected to result in the loss of 3,957 FCUs (4,602 acres). (Note: all discussion of FCUs in the Mitigation Plan is based on acres. The Modified East Texas HGM calculator that was used to compute the FCI values uses hectares.) In addition, there are 78 FCUs of loss associated with changes to the flooding frequency of the forested wetlands downstream of the proposed reservoir, resulting in a total net loss of 4,035 FCUs for forested wetlands. To compensate for these losses, NTMWD is proposing to enhance 1,026 acres of existing forested wetlands and restore 4,775 acres of existing grassland and cropland sites to their natural state as forested wetlands. The locations of these areas can be seen on Figures 15 and 16. Over a 20-year period, the proposed mitigation activities are expected to produce a total of 4,675 FCUs of forested wetland mitigation, resulting in an overall net gain of 639 FCUs above what is expected to be impacted as a result of constructing the proposed reservoir. The following paragraphs describe the mitigation analysis that was performed to reach these conclusions.

7.5.1. Functional Capacity Unit Production for Enhancement of Existing Forested Wetlands

Currently, there are 452 acres of existing forested wetlands located within Riverby Ranch and 574 acres of existing forested wetlands within the Upper BDC Mitigation Site. An analysis of the HGM data collected within this cover type resulted in a total overall existing functional value of 794 FCUs at the mitigation sites. This value reflects the current mixture of forested species, maturity, and degradation due to ongoing activities. Through implementing the enhancement actions (i.e., implementing deed restrictions, removing cattle, cessation of logging, controlling invasive species, feral hog control, supplemental plantings, etc.) and development of adjacent mitigation areas (forested wetlands restoration and upland deciduous restoration) as described in the Mitigation Work Plan section (Chapter 6), the future functional value of the wetland enhancement areas is projected to be 955 FCUs. This provides an uplift of 161 FCUs. To determine projected uplift, each HGM sub-index variable contained in the Modified East Texas HGM calculator was evaluated with respect to expected changes over 20 years. This analysis is discussed in Appendix D. The results of this evaluation are summarized in Tables 7.1 through 7.3.

Table 7.1 Functional Capacity Indices Expected from the Enhancement of Existing Forested Wetlands at Riverby Ranch

	Functional Capacity Indices (FCI)							
	WAA 1		WAA 2		WAA 3		WAA 4	
Function	Year 0	Year 20	Year 0	Year 20	Year 0	Year 20	Year 0	Year 20
Detain Floodwater	1.00	1.00	0.77	0.88	0.87	0.88	0.9	0.88
Detain Precipitation	0.80	0.96	0.73	0.96	0.95	0.96	0.8	0.96
Cycle Nutrients	0.85	0.89	0.6	0.89	0.71	0.89	0.8	0.89
Export Organic Carbon	0.88	0.90	0.63	0.90	0.77	0.90	0.84	0.90
Maintain Plant Communities	0.95	0.97	0.86	0.97	0.97	0.97	0.84	0.97
Provide Habitat for Fish and Wildlife	0.42	0.97	0.84	0.97	0.43	0.97	0.25	0.97
Average	**0.82**	**0.95**	**0.74**	**0.93**	**0.79**	**0.93**	**0.74**	**0.93**

Table 7.2 Functional Capacity Indices Expected from the Enhancement of Existing Forested Wetlands at Upper BDC Mitigation Site

	Functional Capacity Indices (FCI)	
Function	Year 0	Year 20
Detain Floodwater	0.76	0.88
Detain Precipitation	0.67	0.96
Cycle Nutrients	0.78	0.89
Export Organic Carbon	0.74	0.90
Maintain Plant Communities	0.86	0.97
Provide Habitat for Fish and Wildlife	0.86	0.97
Average	**0.78**	**0.93**

Table 7.3 Expected Functional Capacity Uplift Over Time for Forested Wetland Enhancement

Year	Acres	Functional Capacity Units (FCUs)	Net Gain (+) of Forested Wetland FCUs
Existing Conditions (Year 0)	1,026	794	0
10-Year Future Conditions	1,026	880	86
20-Year Future Conditions	1,026	955	161

7.5.2. Functional Capacity Unit Production for the Restoration of Forested Wetlands on Existing Cropland and Grassland Sites

Currently, large portions of both Riverby Ranch and the Upper BDC Mitigation Site are being utilized as cropland and grassland as part of intensive agricultural operations. To maximize use of the Riverby Ranch property for these operations, many areas have been altered hydrologically, primarily through the practices of ditching and diverting water to drain areas that were historically too wet to farm. This provides opportunities to restore many areas to their original state as forested wetlands. In the Upper BDC Mitigation Site, about half of the site has been converted from wetlands to cropland and grasslands.

As part of this mitigation plan, NTMWD is proposing to restore 4,775 acres of existing grassland, cropland, and selected shrub and emergent wetland (Upper BDC Mitigation Site only) back to forested wetlands. The locations of these areas can be seen on Figures 15 and 16. This would be accomplished by implementing the mitigation actions described in the Mitigation Work Plan (i.e., deed restrictions, restoring hydrology, planting vegetation, controlling invasive species, etc.).

To predict future functional conditions of forested wetland mitigation areas using the Modified East Texas HGM calculator, FNI wetland scientists evaluated each of the HGM sub-index variables to predict achievable values in 20 years. It was assumed that restored forested wetland areas would grow into a forest stand by year 20 with most dominant trees reaching a diameter at breast height (dbh) of at least 4 inches. The results of this evaluation of future sub-index variable scores are summarized in Tables 7.4 and 7.5, and the detailed evaluation is presented in Appendix D.

Table 7.4 Functional Capacity Indices Expected from Restoring Forested Wetlands on Existing Cropland, Grassland and Selected Emergent and Shrub Wetland[1] Sites

	Functional Capacity Indices (FCI)			
	Riverby Ranch		Upper BDC Mitigation Site	
Function	Year 0	Year 20	Year 0	Year 20
Detain Floodwater	0	N/A	0	0.88
Detain Precipitation	0	0.96	0	0.96
Cycle Nutrients	0	0.89	0	0.89
Export Organic Carbon	0	N/A	0	0.90
Maintain Plant Communities	0	0.97	0	0.97
Provide Habitat for Fish and Wildlife	0	0.97	0	0.97
Average	**0**	**0.95**	**0**	**0.93**

[1] *Restoration of forested wetlands within the existing shrub and emergent wetland sites is only proposed for the Upper BDC Mitigation Site.*

Table 7.5 Functional Capacity Units Expected from Restoring Forested Wetlands on Existing Cropland,Grassland and Selected Emergent and Shrub Wetland[1] Sites

Year	Acres	Functional Capacity Units (FCUs)	Net Gain (+) of Forested Wetland FCUs
Riverby Ranch			
Existing Conditions (Year 0)	3,675	0	0
20-Year Future Conditions	3,675	0.95	3,491
Upper BDC Mitigation Site			
Existing Conditions (Year 0)	1,100	0	0
20-Year Future Conditions	1,100	0.93	1,023
Total Uplift	**4,775**		**4,514**

[1] ***Restoration of forested wetlands within the existing shrub and emergent wetland sites is only proposed for the Upper BDC Mitigation Site.***

7.5.3. Summary of Forested Wetland Mitigation Credits

The forested wetland mitigation proposal includes compensation for the loss of functions for forested wetlands that would be converted to lacustrine habitat at the proposed reservoir site and the loss of some functional capacity within the forested wetlands located downstream of the proposed dam. Utilizing both enhancement and restoration of forested wetlands at the Riverby Ranch and Upper BDC Mitigation Site, this mitigation proposal generates a surplus of 640 FCUs above what is expected to be impacted. Table 7.6 shows the net gain in functional capacity units resulting from the mitigation activities.

Table 7.6 Net Gain in Forested Wetland Functional Capacity Units Resulting from the Proposed Mitigation Activities

Mitigation Activities	Future FCU Uplift Produced by Year	
	Existing Conditions (Year 0)	20-Year Future Conditions
Enhancement of Existing Forested Wetlands	0	161
Restoration of Forested Wetlands	0	4,514
TOTAL	**0**	**4,675**
Impacts at Proposed Reservoir Site and Downstream	(-) 4,035	(-) 4,035
Net Gain/Loss	**(-) 4,035**	**(+) 640**

7.6 SHRUB WETLAND MITIGATION

Impacts to shrub wetlands at the proposed reservoir site are expected to result in the loss of 23 HUs. To compensate for these losses, NTMWD is proposing to preserve and protect 98 acres of existing shrub wetlands and restore 150 acres of existing grassland and cropland sites to shrub wetlands. The locations of these areas can be seen on Figure 16. The following paragraphs describe the analysis for shrub wetland mitigation.

7.6.1. Habitat Unit Production for the Restoration of Shrub Wetlands on Existing Cropland and Grassland Sites

As previously discussed, a large portion of the mitigation site was hydrologically altered for agricultural purposes. While some of this area is proposed for forested wetland restoration (Section 7.5.2), there are also opportunities to restore existing cropland and grassland sites to their original state as shrub wetlands.

Restoration of shrub wetlands would be accomplished by implementing the mitigation actions described in the Mitigation Work Plan (i.e., deed restrictions, restoring hydrology, planting vegetation, controlling invasive species, etc.). The evaluation of HU production for these areas was completed by evaluating the variables contained in the HEP species models and determining expected future habitat conditions of the restored shrub wetland cover type. During this evaluation, it was assumed that over time variables such as percent emergent herbaceous cover in the littoral zone, percent of water area covered by shrub or herbaceous cover, percent shrub crown closure, and number of refuge sites per acre would generally increase. These assumptions are based on standard growth rates and species diversity for species identified in the planting plan. This analysis was conducted for the five-year future time interval (the five-year analysis period assumes that 150 acres of existing cropland and grassland cover types to shrub wetlands at Riverby Ranch would result in an overall net gain of 103.5 HUs above existing conditions. A summary of this analysis is presented in Table 7.7. The overall net gain in shrub wetland HUs is summarized in Table 7.8. (*Note: No HU credits have been included in the overall net gain in shrub wetland HUs for the preservation and protection of the 98 acres of existing shrub wetland at the mitigation site.*)

Table 7.7 Habitat Unit Production Expected from Restoring Shrub Wetlands on Existing Cropland and Grassland Sites

Year	Acres	Habitat Suitability Index (HSI)	Habitat Units (HUs)	Net Gain (+) of Shrub Wetland HUs
Existing Conditions (Year 0)	150	0.00	0.00	0.00
Five Year Future Conditions	150	0.69	103.5	(+)103.5

Table 7.8 Net Gain in Shrub Wetland Habitat Units Resulting from the Proposed Mitigation Activities

Mitigation Activities	Future Habitat Units (HUs) Produced by Year (Net)	
	Existing Conditions (Year 0)	Five Year Future Conditions
Restoration of Shrub Wetlands on Cropland and Grassland Sites (near-site)	0.00	(+)103.5
TOTAL	**0.00**	**(+)103.5**
Impacts at Proposed Reservoir Site	(-)23.0	(-)23.0
Net Gain/Loss	**(-)23.0**	**(+)80.5**

7.7 EMERGENT WETLAND MITIGATION

Impacts to emergent wetlands at the proposed reservoir site are expected to result in the loss of 514 HUs. To compensate for these losses, NTMWD is proposing to enhance 1,377 acres of existing emergent wetlands and restore 1,100 acres of emergent wetlands on existing grassland and cropland at Riverby Ranch. The locations of these areas can be seen on Figure 16. Over a five-year period (analysis period assumes that emergent wetlands develop to maturity during this time), the mitigation plan is expected to produce a total of 715.4 HUs of emergent wetland, resulting in an overall net gain of 201.4 HUs above what is expected to be impacted at the proposed reservoir site.

In addition to the HUs generated from the enhancement and restoration of emergent wetlands at the Riverby Ranch Mitigation Site (near-site mitigation), an additional 605 acres of littoral wetlands would develop within the proposed reservoir (on-site mitigation) (Figure 4). The littoral wetland areas are expected to develop in locations three feet deep or less (between elevations 531-534 ft. msl.) within the designated shallow areas of the proposed reservoir. Many of the areas where littoral wetlands are expected to develop are existing emergent wetlands that are impacted by grazing or other agricultural activities and would continue to function as emergent wetlands following impoundment of the reservoir. The existing wetlands would also serve as a seed source for these newly developed littoral wetlands helping to establish vegetation. If desirable vegetation is not observed during routine monitoring events, these areas may be supplemented with additional plantings (see Section 6.5). These littoral wetland areas are expected to provide an additional 242 HUs of emergent wetlands assuming a conservative estimate that they would have an HSI value of 0.40 (HSI value based on existing HSI values documented at the proposed reservoir site of 0.42). On-site and near-site mitigation would result in an overall net gain of 443 HUs of emergent wetlands. The following paragraphs summarize the methods used to reach this conclusion. Appendix C describes the analysis used to determine future HSI values for the different cover types, including emergent wetlands.

7.7.1. Habitat Unit Production for the Enhancement of Existing Emergent Wetlands

Currently, there are 1,377 acres of existing emergent wetlands located at the Riverby Ranch. An analysis of the HEP data collected within this cover type resulted in an overall HSI value of 0.23, which equates to 316.7 HUs (1,377 ac. X 0.23 HSI = 316.7 HUs) of existing emergent wetlands at the mitigation site. Through implementing the enhancement mitigation actions described in the Mitigation Work Plan (i.e., deed restrictions, removing cattle, invasive species control, feral hog control, etc.) and evaluating the variables contained in the HEP species models, the expected future habitat conditions of the emergent wetland cover type was estimated at the end of a five-year time interval. With these actions, the HSI values of the existing wetlands are expected to attain a similar, if not higher, overall value as the emergent wetlands at the existing reservoir site. The results of this analysis indicate that the enhancement of existing emergent wetlands at the mitigation site would result in a future HSI value of 0.43, resulting in an overall net gain of 275.4 HUs above existing conditions. A summary of this analysis is presented in Table 7.9.

Table 7.9 Habitat Unit Production Expected from Enhancing Existing Emergent Wetlands

Year	Acres	Habitat Suitability Index (HSI)	Habitat Units (HUs)	Net Gain (+) of Emergent Wetland HUs
Existing Conditions (Year 0)	1,377	0.23	316.7	0.00
Five Year Future Conditions	1,377	0.43	592.1	(+)275.4

7.7.2. Habitat Unit Production for the Restoration of Emergent Wetlands on Existing Cropland and Grassland Sites

Based on the presence of hydric soils and existing emergent wetlands along the lower terraces at the mitigation site, it appears that these areas may have previously been wetlands or have the potential to become wetlands. As part of this mitigation, NTMWD is proposing to restore 1,100 acres of existing grassland and cropland to emergent wetland. This would be accomplished by implementing the mitigation actions described in the Mitigation Work Plan (i.e., deed restrictions, restoring hydrology, planting of native emergent wetland vegetation, controlling invasive species, etc.). The evaluation of HU production for these areas was completed by evaluating the variables contained in the HEP species models and determining expected future habitat conditions of the restored emergent wetland cover type. This analysis was conducted at the five-year future time interval (expected time for maturity). The results of this analysis indicate that restoration of 1,100 acres of existing cropland and grassland cover types to emergent wetlands at the mitigation site would result in a future HSI value of 0.40, resulting in an overall net gain of 440 HUs above existing conditions. The HSI value of 0.40 is slightly less than that of the enhancement of existing emergent wetlands. Both values reflect conservative estimates of the potential future HSI values for emergent wetlands at the mitigation site. A summary of this analysis is presented in Table 7.10.

Table 7.10 Habitat Unit Production Expected from Restoring Emergent Wetlands on Existing Cropland and Grassland Sites

Year	Acres	Habitat Suitability Index (HSI)	Habitat Units (HUs)	Net Gain (+) of Emergent Wetland HUs
Existing Conditions (Year 0)	1,100	0.00	0.00	0.00
Five Year Future Conditions	1,100	0.40	440	(+)440

7.7.3. Habitat Unit Production for the Establishment of Littoral (Emergent) Wetlands at the Proposed Reservoir Site

An estimated 605 acres of littoral wetlands would develop between elevations 531 to 534 ft. msl. around the proposed reservoir. As discussed previously, data collected and published by TPWD under the Statewide Freshwater Fisheries Monitoring and Management Program indicates the development of littoral zone wetlands along lake margins appears to be common in Northeast Texas. Littoral wetlands provide several habitat and water quality functions and comprise a complex of community types that occur in zones that reflect a wide variety of potential water depths, energy regimes, and fluctuation patterns (ERDC/EL TR-10-17). The wetland littoral zone of lakes is dominated by rooted emergent, floating, and submersed vascular plants, collectively called macrophytes. Macrophytes are large plants, usually with roots, leaves, and stems, and are only found in shallow water. The littoral zone is characterized by high plant and animal diversity, and is commonly the site where fish reproduction and development occurs. Wetland-littoral communities are also important habitats for waterfowl (Cooke et. al., 1993). While as many as 1,400 acres of littoral wetlands are expected to develop around the fringes of LBCR, only 605 acres are proposed for mitigation credits (Figure 4). These areas will act and function as emergent wetlands and are considered in-kind mitigation for emergent wetland impacts.

The littoral wetland areas are expected to provide an additional 241.8 HUs of emergent wetlands assuming a conservative estimate that they would have an HSI value of 0.40 as shown on Table 7.12 (the HSI values documented at the proposed reservoir site is 0.42). The development of these wetlands would provide on-site, in-kind mitigation for impacts to emergent wetlands following construction of the proposed reservoir.

Table 7.11 Habitat Unit Production Expected from Establishing Emergent Wetlands at the Proposed Reservoir Site

Year	Acres	Habitat Suitability Index (HSI)	Habitat Units (HUs)	Net Gain (+) of Emergent Wetland HUs
Existing Conditions (Year Reservoir Fills)	605	0.00	0.00	0.00
Five Year Future Conditions	605	0.40	241.8	(+)241.8

The proposed mitigation activities would more than compensate for impacts to emergent wetlands at the proposed reservoir site. A summary of the emergent wetland mitigation proposal is presented in Table 7.12.

Table 7.12 Net Gain in Emergent Wetland Habitat Units Resulting from the Proposed Mitigation Activities

	Future Habitat Units (HUs) Produced by Year (Net)	
Mitigation Activities	**Existing Conditions (Year 0)**	**Five Year Future Conditions**
Restoration of Existing Emergent Wetlands (near-site)	0.00	(+)275.4
Restoration of Emergent Wetlands on Cropland and Grassland Sites (near-site)	0.00	(+)440.0
Establishment of Emergent/Littoral Wetlands at Proposed Reservoir Site (on-site)	0.00	(+)241.8
TOTAL	**0.00**	**(+)957.2**
Impacts at Proposed Reservoir Site	(-)514.0	(-)514.0
Net Gain/Loss	**(-)514.0**	**(+)443.2**

7.8 OPEN WATER (PONDS, STOCK TANKS, SMALL LAKES, ETC.) MITIGATION

Impacts to open waters at the proposed reservoir site are expected to result in the loss of approximately 78 acres of ponds, stock tanks, small lakes, etc. To compensate for these losses, NTMWD is proposing to enhance the existing 34 acres of open waters at Riverby Ranch and 16 acres of open waters at the Upper BDC Mitigation Site by placing them under a USACE-approved site protection instrument and removing cattle. Currently, open waters at the mitigation sites are primarily utilized as stock tanks, providing a reliable source of water and a place for cattle to "cool off" during higher temperatures (Photographs 7.2 and 7.3). By removing cattle, these areas would develop vegetation along the banks and in the littoral zone which would result in improvements to water quality (i.e., reductions in sediment, bacteria, and nutrient loading) and overall habitat improvement for wildlife species that utilize these areas; specifically, waterfowl, wading birds, reptiles, amphibians, and fish. These improvements are also expected to expand into other water bodies (streams, wetlands, etc.) located downstream resulting in enhanced functions and services provided by these waters as well.

In addition to the 50 acres of open waters at the mitigation sites, the proposed reservoir would provide an additional 16,036 acres of open waters, excluding the 605 acres of littoral wetlands that are expected to develop around the reservoir. It is expected that the proposed reservoir would fully compensate for the inundation of 78 acres of open water within the proposed reservoir footprint. Table 7.13 summarizes how the mitigation plan would offset all impacts to open waters that would result from construction of the proposed reservoir.

Table 7.13 Summary of the Proposed Mitigation Actions to Offset Impacts to Open Waters

Impacts to Open Waters (acres)	Near-Site Mitigation (acres)	On-Site Mitigation (acres)	Net Gain (+) / Net Loss (-) of Open Waters (acres)
(-)78	(+)50	(+) 16,036	(+) 16,008

Photograph 7.2 Impacts from cattle to open waters on the mitigation site

Photograph 7.3 Impacts from cattle to open waters on the mitigation site

7.9 STREAM MITIGATION

Impacts at the proposed reservoir site are expected to result in the loss of approximately 192,377 SQUs (651,140 linear feet) of streams. Both Regulatory Guidance Letter 02-2 (USACE, 2002) and the Final Mitigation Rule (See RGL 02-2, Section 5) recognize the difficulties associated with stream mitigation. Although stream mitigation is not always practicable, such mitigation can be successful for improving water quality, habitat creation, species recovery, and recreation. For successful stream mitigation, compensatory mitigation provided through stream preservation, rehabilitation, or enhancement is generally recommended by USACE and USEPA, if practical. To the extent stream mitigation is available, or deemed feasible, a watershed approach is undertaken for mitigation, as set forth in Regulatory Guidance Letter 02-2 (USACE, 2002), to offset impacts to the overall ecological function of the Bois d'Arc Creek watershed.

To compensate for unavoidable impacts to streams, NTMWD is proposing a multifaceted stream mitigation approach. The approach includes three main components, specifically: creation, restoration, and enhancement of streams at the proposed Riverby Ranch Mitigation Site (near site); protection and enhancement of streams at the Upper BDC Mitigation Site (near-site) and protection and enhancement of the streams flowing to the littoral wetlands at the proposed reservoir site (on-site). For streams that NTMWD actively improves and protects through deed restrictions, the total of existing SQUs and improved SQUs (i.e., uplift) are proposed as compensatory mitigation. For streams that NTMWD will enhance in the WRP area at Riverby Ranch, which are already protected through an easement under the NRCS Wetland Reserve Program, only the uplift in SQUs are proposed as compensatory mitigation. The rationale for taking credit for the baseline condition of the streams in all areas but the WRP is as follows:

- The acquisition of large tracts of contiguous property provides protection from stream stability stressors including current adjacent agricultural activities such as plowing and cattle trampling. The proposed future adjacent land uses (restored wetlands, riparian forests, and grasslands) provide additional protection to these existing streams.
- Applicable statutory and regulatory requirements allow credit for baseline conditions for stream mitigation purposes. Regulatory Guidance Letter 02-2 and USACE Tulsa District Guidelines afford preservation credit when aquatic resources, such as streams, are "preserved in conjunction with establishment, restoration, and enhancement activities. ... when the preserved resources will augment the functions of newly established, restored, or enhanced aquatic resources." (USACE, 2002).
- Mitigation guidance further allows preservation credit when there is a demonstrable threat of loss from some future activity that is outside of the control of the permit applicant. Most of the streams within the mitigation properties are currently subject to degradation by past and ongoing ranching and agricultural uses, and the streams would

continue to be subjected to these activities and resulting further degradation if NTMWD were not preserving, enhancing, and restoring such streams.

- Existing streams provide the foundation for the proposed stream restoration and enhancement efforts, and are critical to the success of the other proposed aquatic mitigation. NTMWD proposes to take credit for the full future condition of the mitigated streams because without the existing stream, no matter its baseline condition, there would be no opportunity for stream mitigation uplift through restoration and/or enhancement. Unlike wetlands, streams cannot be created where the landscape does not afford a watershed to provide hydrology to support fluvial processes.

Each component of the proposed stream mitigation and anticipated ecological benefits are discussed below and results are summarized in Section 7.9.4.

7.9.1. Restoration, Enhancement and Creation of Streams at Riverby Ranch

Currently, many of the streams located at the mitigation site are in poor condition as a result of existing agricultural practices. The practice of cattle grazing has resulted in the destruction of stream bank vegetation, increased erosion, and down-cutting of the channels (Photograph 7.4). Other existing impacts to the streams from historical land practices at the mitigation site includes the straightening of channels and clearing of trees and other vegetation in former riparian areas to open them up for crop production and/or grazing (Photograph 7.5). NTMWD mitigation of stream impacts caused by the proposed LBCR through stream restoration, enhancement, and creation at the Riverby Ranch Mitigation Site is as follows:

1. NTMWD is proposing to restore and enhance approximately 179,353 linear feet of existing, degraded streams (not including streams located within the Wetlands Reserve Program area) at the mitigation site by placing them in a deed restriction, removing cattle, laying back stream banks, establishing a balanced sediment supply, and establishing riparian corridors and buffers (Figure 9).

2. NTMWD is proposing to enhance approximately 94,596 linear feet of existing degraded streams within the WRP area, including the main channel of Bois d'Arc Creek, through a combination of upstream restoration to stream reaches outside the WRP, instream flow releases from the proposed reservoir (i.e., stabilized flow regime), breaching the existing dike(s) around the perimeter of the WRP in key locations to restore stream hydrology (Figure 14), and establishing riparian corridors along the streams through tree plantings . Additionally, fluvial geomorphic principles support the hypothesis that as upstream reaches of streams are improved and become stabilized, the downstream reaches of the channel can experience indirect ecological

uplift resulting from the upstream improvements, even with no direct channel work performed in the downstream reaches. For example, removing cattle and other agricultural practices, restoring meanders, modifying channel geometry to stable dimensions, and re-connecting the upstream channel to a floodplain would promote stability and provide uplift to the downstream reach by reducing the volume and velocity of incoming stream flow (thereby reducing channel erosion and bank failures), reducing incoming sediment and nutrient loads (that promote channel infilling and eutrophication), and providing a seed source for channel vegetation.

3. NTMWD is proposing to restore meanders to several first and second-order streams located on the ranch that have been straightened to expedite runoff (Figure 9). Based on field visits to the mitigation site and nearby streams and a desktop analysis using aerial photos and topographic maps, it was determined that a sinuosity ratio of 1.3 is a reasonable ratio for the restored channels. A sinuosity ratio of 1.3 applied to streams appropriate for meander restoration would add (create) approximately 32,597 linear feet of additional stream length to the mitigation site.

These activities would result in longer and higher-quality streams that would provide a variety of ecological benefits including:

- Decreasing erosion and downcutting of stream channels and increasing bank stability;
- Reductions in sediment, bacteria, and nutrient loading downstream from currently degraded areas;
- Improvements in water quality from the cessation of farming practices such as the application of fertilizers, pesticides, herbicides, etc., as well as from restoring a vegetated buffer in riparian corridors; and
- Increasing the quality and quantity of available habitat for aquatic and terrestrial wildlife species.

Photograph 7.3 Typical cattle impacts to streams at the proposed mitigation site

Photograph 7.4 Cleared and degraded riparian corridors along streams at the proposed mitigation site

The LBCR RGA method was used to evaluate the streams on the Riverby Ranch Mitigation Site, at the Upper BDC Mitigation Site, within Bois d'Arc Creek downstream of the proposed reservoir site as well as streams that are tributaries of littoral wetlands between elevations 534 and 541 ft. msl. The evaluation of future SQU values for these streams was completed by evaluating the variables contained in the RGA method and determining expected future stream conditions at the mitigation site. The RGA method allows the measurement of stream mitigation credit or uplift for both restored and enhanced streams. Proposed measures or treatments to provide "uplift" of the RGA scores for the Riverby Ranch streams include:

- laying back stream banks to reduce erosion and allow for tree and shrub plantings
- restoration of riparian corridors through tree and shrub plantings
- stabilization of channel bed slopes using passive grade control
- removal of cattle for protection from livestock grazing and stream bank trampling/erosion
- restoring meanders to straightened portions of stream channels
- improving water quality by reducing sediment, pesticides, herbicides, bacteria, etc. from the actions outlined above
- restoration of hydrology through removal of physical impediments (e.g., dike around the WRP)

Both in-channel and out-of-channel (riparian buffers, for example) treatments would be implemented, depending on baseline conditions for each reach, to increase the SQU scores and thereby provide uplift. The removal of man-made impediments, such as the dike, provides uplift to the affected streams. Additional information regarding the evaluation of stream mitigation components using RGA is in Appendix E.

Based on this analysis, this component of the proposed stream mitigation (creation of new stream length and enhancement and restoration of existing stream length) at the Riverby Ranch, including the WRP area, is expected to generate a total of 194,137 SQUs. As previously discussed, only the uplift provided by enhancement of streams in the WRP area is included in the total mitigation credit. So, the total stream mitigation credits provided by the Riverby Ranch Mitigation Site is 153,146 SQUs. Breakdowns of the SQUs for the three mitigation components (stream restoration, creation, and WRP enhancement) on the mitigation property by SQF category and by stream type are shown in Table 7.14 and Table 7.15, respectively.

Table 7.14 Proposed Stream Mitigation at the Riverby Ranch Mitigation Site

SQF	Riverby Stream Restoration		Riverby Stream Creation		WRP Stream Enhancement	
	Mitigated Length (ft)	Mitigated SQU[2]	Mitigated Length (ft)	Mitigated SQU	Mitigated Length (ft)	Mitigated SQU[1]
0-.09	0	0	0	0	0	0
.1-.19	1,907	286	0	0	4,502	600
.2-.29	10,584	2,486	0	0	3,045	520
.3-.39	18,167	6,457	0	0	0	0
.4-.49	10,517	4,381	0	0	23,048	1,431
.5-.59	6,762	3,719	0	0	40,688	2,336
.6-.69	27,288	16,505	2,852	1,711	23,313	1,265
.7-.79	1,215	911	0	0	0	0
.8-.89	102,913	85,761	29,745	24,777	0	0
.9-.99	0	0	0	0	0	0
1	0	0	0	0	0	0
Total	**179,353**	**120,506**	**32,597**	**26,488**	**94,596**	**6,152[1]**

1. Represents uplift only.

2. The total of existing and uplift SQUs are reported in this table because these mitigation components will include active restoration/enhancement and protection by perpetual site protection instrument.

Table 7.15 Summary of Stream Mitigation Credits at the Riverby Ranch Mitigation Site in SQUs

Stream Type	Enhancement/ Restoration[2]	Stream Creation	WRP Enhancement[1]	Total
Perennial	8,309	0	2,255[1]	10,564
Intermittent	26,761	5,069	2,079[1]	33,909
Ephemeral	85,436	21,419	1,818[1]	108,673
TOTAL	**120,506**	**26,488**	**6,152[1]**	**153,146[2]**

1. Represents uplift only.

2. The total of existing and uplift SQUs are reported in this table because these mitigation components will include active restoration/enhancement and protection by perpetual site protection instrument.

7.9.2. Enhancement of Streams at the Upper BDC Mitigation Site

Similar to streams at the Riverby Ranch Mitigation Site, many of the streams located at the Upper BDC Mitigation Site are in poor condition as a result of existing agricultural practices. The practice of cattle grazing has resulted in the destruction of stream bank vegetation, increased erosion, and down-cutting of the channels. Other existing impacts to the streams from historical land practices at the mitigation site includes the straightening of channels and clearing of trees and other vegetation in former riparian areas to open them up for crop production and/or grazing. NTMWD proposes mitigation of stream impacts at the Upper BDC Mitigation Site through enhancing approximately 62,535 linear feet of existing, degraded streams and by protecting them through deed restrictions (or other site protection instrument), removing cattle, and establishing riparian corridors and buffers (Figure 17).

Based on an analysis of the expected enhanced conditions of streams in the Upper BDC Mitigation Site, this component of the proposed stream mitigation (enhancement of existing stream length) is expected to generate a total of 22,330 SQUs, which represents an uplift of 5,211 SQUs above the baseline of 17,119 SQUs. Breakdowns of the SQUs for stream mitigation components on the mitigation property by SQF category and by stream type are shown in Table 7.16 and Table 7.17, respectively.

Table 7.16 Proposed Stream Mitigation at the Upper BDC Mitigation Site

SQF	Mitigated Length (ft)	Mitigated SQU[1]
0-.09	0	0
.1-.19	15,032	2,505
.2-.29	3,800	950
.3-.39	14,641	4,904
.4-.49	20,763	8,305
.5-.59	1,483	816
.6-.69	1,962	1,210
.7-.79	4,854	3,640
.8-.89	0	0
.9-.99	0	0
1	0	0
Total	**62,535**	**22,330**

[1] *The total of baseline and uplift SQUs are reported in this table because these mitigation components will include enhancement and protection by perpetual site protection instrument.*

Table 7.17 Summary of Stream Mitigation Credits at the Upper BDC Mitigation Site in SQUs

Stream Type	Enhancement SQUs
Intermittent	9,580
Intermittent/Ephemeral	12,750
TOTAL	**22,330**

7.9.3. Maintenance of Bois d'Arc Creek Downstream of Proposed Reservoir

Bois d'Arc Creek and many tributaries within the Bois d'Arc Creek watershed have been significantly impacted by channelization, which began in the 1920s and continued well into the 1970s. As a result of the channelization, the watershed is no longer in equilibrium. Downcutting and stream bank erosion have increased, and lateral migration of the stream (i.e., meander migration) has slowed. Channelization has most likely increased the "flashy" nature of flows in the watershed, characterized by the rapid rise and fall in flow in response to rainfall events.

If channelization had not occurred in the Bois d'Arc Creek watershed, the stream system would have likely continued to meander, reducing stream velocities and allowing sediment to deposit along the banks and within the floodplain. Old stream remnants show a previous stream depth of two to five feet downstream of the proposed dam location. The expected stream characteristics without channelization would be very different from the current stream condition. There would have been greater connectivity to the floodplain, flows would have been slower and the likelihood of connectivity through the stream system would have been greater, resulting possibly in perennial flows.

The NTMWD's proposed instream flow regime is expected to maintain, and likely improve, the future condition of Bois d'Arc Creek downstream of the dam by reducing the frequency and magnitude of high flows which contribute to the degrading, ongoing cycle of channel bed erosion, followed by slumping/sloughing of the resulting steepened channel banks and the subsequent erosion and transport of the bank material downstream. Reducing the frequency and magnitude of high flows is expected to allow the existing channel to reach an equilibrium condition with less steep and more vegetated banks and a stable meandering low flow channel within the existing deep and incised channel. This equilibrium condition is expected to provide improved habitat conditions downstream of the dam to maintain an ecologically sound aquatic environment.

These anticipated changes to Bois d'Arc Creek are supported through studies of streams downstream of dams. Chin et al. (2002) showed that a reduction of stream power in Yegua Creek downstream of Somerville Dam has caused a 61 percent decrease in channel depth from estimated pre-dam conditions because of reduced stream power. Similar changes in channel dimension have been observed on the Platte River in Nebraska (Williams, 1978), Canadian River in Texas (Williams and Wolman, 1984), and Sandstone Creek in Oklahoma (Bergman and Sullivan, 1963). These changes in channel dimensions result from aggradation of sediment when carrying capacity is reduced, and from the establishment of vegetation on channel banks that is no longer removed by high magnitude flows.

This situation represents an improvement over current conditions downstream of the proposed reservoir site, which are characterized by ongoing erosion and downcutting in the reach.

Based on the analyses conducted as part of the instream flow study on Bois d'Arc Creek and coordination with state and federal resource agencies, a proposed environmental flow regime was developed with the goal of providing a sound ecological environment downstream of the proposed dam and spillway. Stream flow frequency analysis indicated that Bois d'Arc Creek flow is less than one cubic foot per second (1 cfs) approximately 37 percent of the time at FM 1396 and 30 percent of the time at FM 409. Recent stream gaging data from the USGS at FM 1396 demonstrate that the creek stops flowing for periods ranging from days to months in some years. Instream flow modeling results indicated that flows between 1 and 3 cfs would achieve longitudinal stream connectivity, with modeled pool habitats connected by run-riffle habitats. This connectivity is important for maintaining fish passage, aquatic habitat, and water quality. As such, during normal hydrologic conditions (i.e., when LBCR storage is greater than 40 percent of its capacity), a minimum base flow of 3 cfs that would be made from reservoir releases with higher base flows (10 cfs) during the spring spawning season. This proposed flow regime for Bois d'Arc Creek downstream of the proposed dam would provide a sound ecological environment by maintaining flow in the creek, maintaining existing aquatic habitat and communities, promoting bank stability, and protecting water quality. The environmental flow criteria also include periodic pulse flows to provide sediment transport and habitat maintenance. The pulse flows are defined by a peak flow trigger, volume, and duration. During subsistence conditions, i.e., when the reservoir is less than 40 percent of its capacity, NTMWD will pass the higher of either 1 cfs or the wastewater discharges from the City of Bonham. NTMWD will also pass a small pulse (freshet) every 60 days if such inflows enter the reservoir and a corresponding pulse does not occur naturally at the downstream gage at FM 409. Based on the hydrologic record, subsistence conditions are expected to occur approximately 9 percent of the time. Table 7.18 shows the environmental flow criteria for passing reservoir inflows to Bois d'Arc Creek downstream of the dam. Consistent with the requirements in NTMWD's water right permit for the proposed project, releases of inflows for environmental flow purposes is limited to inflow to the reservoir.

Table 7.18 Environmental Flow Criteria for Bypassing Inflows through the Reservoir

Season	Months	Subsistence	Base	Pulse
Fall-Winter	November - February	1 cfs[1]	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 ac-ft Duration: 7 days
Spring	March - June	1 cfs[1]	10 cfs	2 per season Trigger: 500 cfs Volume: 3,540 ac-ft Duration: 10 days
Summer	July - October	1 cfs[1]	3 cfs	1 per season Trigger: 100 cfs Volume: 500 ac-ft Duration: 5 days

cfs = cubic feet per second
ac-ft = acre-feet
1. A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 ac-ft, and a duration of 3 days, to occur no more than every 60 days, also applies.

This instream flow regime is expected to maintain the biological integrity of Bois d'Arc Creek downstream of the proposed reservoir for the reasons discussed above. NTMWD does not propose to take specific stream credit (SQUs) for Bois d'Arc Creek that are not directly owned and controlled by NTMWD. Approximately 27,100 linear feet of Bois d'Arc Creek flows through the Wetlands Reserve Program (WRP) area on Riverby Ranch. The stream enhancements of this section of Bois d'Arc Creek are discussed with the Riverby Ranch Mitigation Site

7.9.4. Tributaries to Littoral Wetlands (On-Site Stream Mitigation)

To further offset the loss of streams that would result from construction and operation of the proposed LBCR, additional stream mitigation would be provided through protection and enhancement of the contributing streams in specific areas adjacent to where fringe or littoral zone wetlands are expected to develop (Figure 4). The NTMWD is purchasing land up to elevation 541 ft. msl. around the lake to serve as the flood pool. Tributaries to the proposed LBCR that are above the conservation pool (534 ft. msl.) but flow within land owned by the NTMWD to the littoral wetlands would be protected through deed restrictions or other site protection instrument. These streams (Figure 4) would provide ecological uplift by providing fish spawning habitat and other aquatic habitat functions when the reservoir is at or above the normal pool elevation of 534 ft. msl. Additionally, these streams would be enhanced and experience ecological uplift from the termination of agricultural practices (farming, grazing, etc.) and other man-made negative impacts. These actions are expected to result in the natural re-stabilization of stream channels by reducing sediment and nutrient contributions and allowing natural re-vegetation of stream banks and riparian buffers. The length of streams benefitting from these protected buffers is approximately 23,184 linear feet.

Based on the benefits described above, an evaluation of SQU production for these streams was conducted by evaluating the variables contained in the RGA method and identifying expected future stream conditions. Based on this analysis, this component of the proposed stream mitigation is expected to generate a total of 5,677 SQUs for the selected contributing streams at the reservoir site following construction. Table 7.19 shows the existing and expected future SQUs for the contributing streams to the littoral wetlands, and Table 7.20 shows a breakdown of mitigation SQUs by stream type.

Table 7.19 Proposed Stream Mitigation for Streams within Littoral Wetlands

SQF	Existing Conditions		Future Conditions	
	Length (ft)	SQU	Length (ft)	SQU[1]
0 - .09	11,447	954	0	0
.1 - .19	0	0	11,447	1,908
.2 - .29	10,022	2,098	4,399	1,246
.3 - .39	1,075	341	5,623	1,678
.4 - .49	0	0	1,075	430
.5 - .59	640	352	0	0
.6 - .69	0	0	640	405
.7 - .79	0	0	0	
.8 - .89	0	0	0	
.9 - .99	0	0	0	
1.0	0	0	0	
Total	**23,184**	**3,745**	**23,184**	**5,677**

[1] *The total of baseline and uplift SQUs are reported in this table because these mitigation components will include enhancement and protection by perpetual site protection instrument.*

Table 7.20 Summary of Stream Mitigation Credits for Streams within Littoral Wetlands

Stream Type	Length (ft)	SQU
Intermittent	11,838	2,936
Intermittent/Ephemeral	11,347	2,741
TOTAL	**23,184**	**5,677**

7.9.5. Summary of Proposed Stream Mitigation

Table 7.21 shows the total stream quality units of the proposed stream mitigation program by each major mitigation component. This program includes a total of 392,265 linear feet of enhanced, restored or created streams that collectively have an expected future stream quality value of 181,153 SQUs. Table 7.22 shows the proposed stream mitigation by stream type.

Table 7.21 Summary of Proposed Stream Mitigation

Mitigation Location	Mitigation Type	Amount (linear feet)	Stream Quality Units (SQUs)
Riverby Ranch	Restoration/Enhancement	179,353	120,506
Riverby Ranch	Creation	32,597	26,488
WRP (Riverby Ranch)	Enhancement	94,596	6,152[1]
On-Site Tributaries to Littoral Wetlands	Enhancement	23,184	5,677
Upper BDC Mitigation Site	Enhancement	62,535	22,330
TOTAL		**392,265**	**181,153**

[1.] *Includes only the uplift in SQUs for Riverby Ranch WRP area.*

Table 7.22 Summary of Proposed Stream Mitigation by Stream Type

Stream Type	Amount (linear feet)	Stream Quality Units (SQUs)
Perennial	65,247	10,565[1]
Intermittent	125,667	46,425[1]
Intermittent/Ephemeral	41,140	15,491
Ephemeral	160,212	108,672[1]
TOTAL	**392,265**	**181,153**

[1.] *Includes only the uplift in SQUs for Riverby Ranch WRP area.*

7.10 SUMMARY OF PROPOSED MITIGATION CREDITS

Construction of the proposed LBCR would result in unavoidable impacts to waters of the U.S. including 4,035 FCUs of forested wetlands, 514 HUs of emergent wetlands, 23 HUs of shrub wetland, 78 acres of open waters (ponds, stock tanks, etc.), and 192,377 SQUs of streams. This mitigation plan provides both on-site and near-site compensatory mitigation for these anticipated impacts. The mitigation plan, if implemented, would meet the federal goal of "no net loss of wetland functions." It would also provide protection, in perpetuity, to thousands of acres of existing and restored wetlands, riparian areas, and open waters through an appropriate site protection instrument approved by the USACE. These areas would be protected from future development, grazing, clearing, and other non-compatible uses. The mitigation plan would also provide compensatory mitigation for impacts to streams through creation, restoration, and enhancement activities. While the NTMWD has endeavored to maximize opportunities to create, restore, and enhance streams to compensate for the identified impacts, a shortfall remains based on stream length and a small deficit in SQUs (less than 6 percent). This deficit is offset by the synergistic effect of NTMWD's watershed-based mitigation approach, which is further discussed in Section 7.11.

A summary of impacts to waters of the U.S. that could result from the construction of the proposed reservoir and proposed mitigation is summarized in Table 7.23. Table 7.23 compares existing cover type acreages and functional capacity/habitat/stream quality units (FCU, HU, or SQU) at the mitigation sites to the expected cover type acreages and functional capacity/habitat/stream quality units following implementation of the mitigation plan.

Table 7.23 Summary of Impacts to Waters of the U.S. and Proposed Mitigation

Type of Water of the U.S.	Amount Impacted		Amount of Mitigation		Net Gain (+) / Net Loss (-)	
	Acres	FCUs/HUs	Acres	FCUs/HUs	Acres	FCUs/HUs
Forested Wetland	(-) 4,602	(-) 4,035	(+) 5,801	(+) 4,675	(+) 1,189	(+)640
Emergent Wetland	(-) 1,223	(-)514	(+) 3,082	(+)957.2	(+) 1,859	(+)443.2
Shrub Wetland	(-)49	23	(+)248	(+)103.5	(+)199	(+)80.5
Open Waters	(-)78	N/A	(+) 16,086	N/A	(+) 16,008	N/A
	Linear Feet	SQUs	Linear Feet	SQUs	Linear Feet	SQUs
Streams[1]	(-) 651,140	(-) 192,377	(+) 392,265	(+) 181,153	(-) 258,875	(-) 11,224
Perennial	None	None	65,247	10,565	-	-
Intermittent	286,139	85,100	125,667	46,425[4]	-	-
Intermittent/ Ephemeral[2]	365,001	107,277	41,140	15,491	-	-
Ephemeral[3]	N/A	N/A	160,212	108,672[4]	-	-

[1] *Stream type is based on the Field Checked Stream Type.*

[2] *For the tributaries located within the LBCR site, Upper BDC Mitigation Site and contributing streams to the Littoral Wetlands, the differentiation between intermittent and ephemeral stream types was not conducted. Stream type designations are based on named streams (intermittent) and unnamed tributaries (intermittent/ephemeral).*

[3] *Ephemeral streams were field checked at the Riverby Ranch Mitigation Site.*

[4] *Includes only the uplift in SQUs for Riverby Ranch WRP area.*

7.11 SYNERGISTIC EFFECT OF MITIGATION PLAN

As proposed, the LBCR project encompasses approximately 36,200 acres of habitat within the Bois d'Arc Creek watershed and adjacent Red River watershed (excluding the dam footprint). This includes the 16,641-acre reservoir site, 2,700 acres of shoreline (between elevations 534 ft. msl and 541 ft. msl.), a 14,959-acre mitigation site (Riverby Ranch Mitigation Site) downstream of the proposed reservoir, and a 1,900-acre mitigation site (Upper BDC Mitigation Site) located upstream of the proposed reservoir. These project components are all located within Bois d'Arc Creek watershed, except about half of Riverby Ranch that is located in the adjacent watershed within the Red River watershed, of which Bois d'Arc Creek is a tributary. The project components located within the Bois d'Arc Creek watershed represent over 10 percent of the entire watershed. Embedded between the proposed reservoir site and the downstream Riverby Ranch Mitigation Site sits the Bois d'Arc Unit of the Caddo National Grasslands (approximately 13,370 acres), managed by the U.S. Forest Service (USFS). With implementation of the proposed mitigation plan, approximately 50,170 acres of aquatic and terrestrial habitat along an approximately 42-mile long corridor adjacent to and connected by Bois d'Arc Creek would be protected in perpetuity (see Figure 1).

When considered individually, these sites, including the reservoir site, provide an abundance of stream, wetland, open water, and terrestrial habitat providing functions ranging from floodwater detention to providing for fish and wildlife habitat as well as recreation. However, with NTMWD's watershed approach to mitigation, these resources would be aligned resulting in a positive synergistic uplift to aquatic and terrestrial functions on a watershed/ecosystem scale. To date, this synergy has not been accounted for, nor has credit been given, for utilizing a watershed approach. Instead, the mitigation components have been evaluated as separate, isolated features, when in fact they are encompassed by a watershed boundary and are knit together by an extensive stream network that NTMWD proposes to enhance and restore along with many acres of adjacent wetlands and contiguous upland areas.

This Mitigation Plan utilizes a watershed approach and includes mitigation for both uplands and wetlands over 50,000 contiguous acres within the Bois d'Arc Creek watershed where the potential impacts would occur. Ultimately, the streams would be the beneficiaries of this as they are the lowest points within the landscape and are thus influenced by what happens in and to the watershed. As such, the "net benefit" to the streams being enhanced, restored, created, and protected by the Mitigation Plan will be substantial. While these benefits are not quantified in this Mitigation Plan, the Plan recognizes the value provided by the synergistic effect of the multi-faceted mitigation actions.

Another point that should be taken into consideration is the type of project being proposed by NTMWD. The proposed reservoir, if constructed, would result in the development of a 16,641-acre productive and functional aquatic resource that would be open and available for public use. Reservoirs, like wetlands, provide a variety of ecological functions that are valuable to society. Some of the more important functions provided by wetlands include providing fish and wildlife habitats, natural water quality improvement, flood detention storage, shoreline erosion protection, opportunities for recreation and aesthetic appreciation, and natural products for our use at little or no cost. These beneficial functions would be provided by the proposed reservoir and contribute to the synergistic effects of this Mitigation Plan. Moreover, two of these functions—providing flood detention storage and providing recreation and aesthetic appreciation—would increase considerably. The reservoir will open up the 16,641-acre site and surrounding NTMWD-owned properties for potential public use for various types of outdoor recreation (e.g., boating, fishing, swimming, hunting, camping, hiking, bird watching, etc.).

8.0 MAINTENANCE PLAN

Proposed mitigation would be, to the maximum extent practicable, planned and designed to become self-sustaining over time. However, it is anticipated that some active management and maintenance activities would need to occur to maintain the long-term viability and sustainability of the proposed mitigation project.

Once initial construction is completed, the mitigation site would be monitored as provided in the Monitoring Requirements and Performance Standards sections of this plan. In addition to corrective actions, as may be required, maintenance of the property will include the following activities:

- protection from encroachment by neighboring landowners;
- protection from timber thefts;
- maintaining boundary markings;
- maintaining necessary fence lines;
- maintaining access roads;
- providing for compatible uses such as hiking, bird watching, hunting, camping, etc., which do not interfere with achieving and maintaining mitigation goals and objectives and meeting performance standards;
- remedial vegetation planting;
- protection of newly planted mitigation sites;
- conducting prescribed burns;
- maintaining water control structures;
- conducting deed restriction enforcement;
- controlling invasive plant and animal species; and
- taking such other actions, as may be necessary, under the Adaptive Management Plan.

Many of the above maintenance activities would occur on an as needed and/or as identified basis. It is anticipated that more effort would be required at the mitigation site during the early phases of the mitigation project for routine, day-to-day maintenance activities and that the effort would diminish over time as mitigation goals and objectives are achieved. This effort would improve the likelihood of achieving a successful mitigation project. The funding associated with maintenance activities would be provided by NTMWD and would be included in the cost for operating and maintaining the proposed LBCR. NTMWD would continue to monitor and maintain the site until the mitigation project has met its stated goals and objectives as confirmed by the USACE. It is anticipated that once the goals and objectives have been met, the mitigation site would be a self-sustaining system.

9.0 PERFORMANCE STANDARDS

The standards that would be used to evaluate the performance of the various restored and enhanced stream and wetland mitigation sites would be based upon the assessment methodology originally used to establish existing conditions. As such, performance standards for forested wetlands would be based on the Modified East Texas HGM, performance standards for emergent and shrub wetlands would be based on HEP, and performance standards for streams would be based on RGA. The proposed performance standards for each of these habitat types are discussed below.

9.1 FORESTED WETLANDS

Performance standards for forested wetlands would be based on the Modified East Texas HGM methodology. The Modified East Texas HGM assesses six functions for forested riverine wetlands: Detain Floodwater, Detain Precipitation, Cycle Nutrients, Export Organic Carbon, Maintain Plant Communities, and Provide Habitat for Fish and Wildlife. Each of these functions are calculated using sub-index variables and formulas (models) that were developed for this project. For forested wetlands located outside the 5-year floodplain, two functions (Detain Floodwater and Export Organic Carbon) are not assessed. As previously discussed, FNI wetland scientists evaluated each of the HGM sub-index variables to predict achievable values in 20 years. The results of this evaluation of future sub-index variable scores are summarized in Appendix D. Based on this evaluation, at the end of 20 years the restored forested wetlands at the Riverby Ranch Mitigation Site are expected to achieve an average FCI value of 0.95 and the restored forested wetlands in the Upper BDC Mitigation site are expected to achieve an average FCI value of 0.93. These values are the proposed performance standard for the restored forested wetlands for each mitigation site. The same procedure was used to establish performance standards for the existing forested wetlands that are proposed for enhancement. Existing forested wetlands at both the Riverby Ranch Mitigation Site and the Upper BDC Mitigation Site were predicted to achieve an average FCI value of 0.93, which is the proposed performance standard for existing forested wetlands at the end of 20 years. The performance standards for forested wetlands are summarized in Table 9.1.

Table 9.1 HGM Based Performance Standards for Forested Wetland Mitigation Sites

Mitigation Strategy	20-year Performance Goal (Avg. FCI Value)
Riverby Ranch Mitigation Site	
Restoration	0.95
Enhancement	0.93
Upper BDC Mitigation Site	
Restoration	0.93
Enhancement	0.93

During the interim between planting and reaching the 20-year performance goal for forested wetland mitigation areas, monitoring would be performed that would include periodic field inspections and assessments using the Modified East Texas HGM data collection form. Collecting data for each sub-index variable within the forested wetland areas during the interim period would demonstrate if the mitigation sites are on a trajectory to meet the 20-year performance standards. The frequency of the monitoring events and specific activities are described in the subsequent section (Chapter 10). Monitoring reports will be submitted every year for the first five years, every other year from year five to year 15, and then again in year 20. During the HGM monitoring events, a team composed of qualified professionals from NTMWD and its consultants would collect HGM data within the forested wetland mitigation areas. The USACE and the state and federal resource agencies that participated in the baseline studies would be notified of monitoring dates and invited to participate. The monitoring data would be compared to the Modified East Texas HGM sub-index variable curves to evaluate whether the mitigation sites are on a trajectory to accomplish the performance standards or if adaptive management strategies would need to be considered.

9.2 SHRUB AND EMERGENT WETLANDS

Performance standards for the shrub and emergent wetlands would be based on the USFWS Habitat Evaluation Procedures (HEP). A discussion of the HEP methodology is presented in Chapter 7. The method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time. Because HEP provides a quantitative method for such comparisons, it may be used in planning applications such as the assessment of current and future wildlife habitat, trade-off analyses, or compensation analyses. The use of HEP to evaluate performance standards would allow for the objective evaluation of the proposed mitigation site to determine if it is achieving its objectives.

Like the forested wetlands, FNI biologists and wetland scientists evaluated each of the variables within the species models that are used to assess the shrub and emergent wetlands to predict achievable values in five years. A five-year analysis period was used for these habitat types based on their expected time of development. Based on this evaluation, at the end of five years the restored shrub wetlands at the Riverby Ranch Mitigation Site are expected to achieve an HSI value of 0.69. The restored and enhanced emergent wetlands at the Riverby Ranch Mitigation Site are expected to achieve an HSI value of 0.40 and 0.43, respectively. The littoral zone wetlands are also expected to achieve an HSI value of 0.40. These HSI values are the proposed performance standards for shrub and emergent wetlands and are summarized in Table 9.2.

Table 9.2 HEP Based Performance Standards for Shrub and Emergent Wetland Mitigation Sites

Mitigation Strategy	5-year Performance Goal (HSI Value)
Riverby Ranch Mitigation Site	
Shrub Wetland Restoration	0.69
Emergent Wetland Restoration	0.40
Emergent Wetland Enhancement	0.43
Reservoir Site	
Littoral Zone Wetlands	0.40

During the interim between planting and reaching the five-year performance goal for shrub and emergent wetland mitigation areas, monitoring would be performed that would include periodic field inspections and assessments using HEP. Collecting HEP data within the shrub and emergent wetland areas during the interim period would demonstrate if the mitigation sites are on a trajectory to meet the five-year performance standards. The frequency of the monitoring events and specific activities are described in the subsequent section (Chapter 10). Monitoring reports will be submitted every year for the first five years, every other year from year five to year 15, and then again in year 20. During the HEP monitoring events, a team composed of qualified professionals from NTMWD and its consultants would collect HEP data within the shrub and emergent wetland mitigation areas. The USACE and the state and federal resource agencies that participated in the baseline studies would be notified of monitoring dates and invited to participate. The monitoring data would be compared to the HEP variable curves to evaluate whether the mitigation sites are on a trajectory to accomplish the performance standards or if adaptive management strategies would need to be considered.

9.3 PERFORMANCE STANDARDS FOR BOIS D'ARC CREEK

While no stream mitigation credit is included in the mitigation proposal for Bois d'Arc Creek downstream of the dam, except for the segment that flows entirely through the WRP area on Riverby Ranch, NTMWD proposes to monitor the biological integrity of Bois d'Arc Creek downstream of the dam. Monitoring would include water quality and biological indices. Performance standards for Bois d'Arc Creek downstream of the dam would be based on fish Index of Biotic Integrity (IBI) and macroinvertebrate Rapid Bioassessment (RBA) scores. Results obtained during the instream flow study on Bois d'Arc Creek in 2010 showed that integrity scores for fish community structure were intermediate to high (mean: 43.83). Main stem site scores ranged from 33 (limited) to 49 (high). It was found that overall biological integrity of Bois d'Arc Creek's macroinvertebrate community was intermediate (mean: 28.93). Main stem sampling site scores ranged from 22 (intermediate) to 37 (high). The goal or performance standard for Bois d'Arc Creek downstream of the proposed dam site would be no degradation of the aquatic community from the baseline metrics (based on IBI and RBA scores). This would be done by comparing RBA and IBI scores from the mitigation monitoring with baseline data collected during the 2010 instream flow study. If the aquatic life use does not meet the water quality standards for Segment 0202A, the potential causes would be identified and remedial management strategies would be implemented to meet the designated aquatic life use. Biological monitoring would be conducted in compliance with the Monitoring Plan for the Texas water right permit, which was issued in June 2015.

In addition to using the IBI and RBA performance standards dissolved oxygen, water temperature, pH, and specific conductivity will be continuously recorded at the USGS gage at FM 409. These parameters will be used to verify compliance with the stream standards and as indicators for overall stream health.

9.4 PERFORMANCE STANDARDS FOR RESTORED STREAMS

Performance standards for streams targeted for creation, restoration, and enhancement on mitigation sites and on-site streams within littoral zone wetlands would be based on the RGA methodology. The performance standard for the mitigation proposal is the achievement of 181,153 SQUs within 10 years (following implementation of mitigation) for streams located in the stream mitigation sites (Riverby Ranch, WRP, Upper BDC Mitigation Site, and on-site tributaries). If it is determined that the performance standard of 181,153 SQUs is not being met, stream adaptive management strategies would be identified in consultation with the USACE and TCEQ and a plan would be developed and implemented (see Chapter 17). The performance goals discussed below for each of the mitigation areas reflect the expected 10-year SQU values as determined from the measured RGA scores. For streams within the WRP, the SQUs that contribute to the project performance standard are the calculated uplift only.

9.4.1. Riverby Ranch

The proposed stream creation, restoration, and enhancement activities would restore and/or enhance approximately 306,546 linear feet of streams on Riverby Ranch, including streams in the WRP area. During the RGA monitoring events, a team composed of qualified professionals from NTMWD and its consultants would collect RGA data at the same sampling locations used to establish baseline RGA conditions for streams on Riverby Ranch (see Appendix E for monitoring locations). New RGA sampling locations for the created stream reaches would be identified upon completion of construction activities, and data would be collected following the same RGA methodology used to establish baseline stream conditions. The proposed RGA based performance standards for these streams by mitigation strategy are summarized in Table 9.3.

The Riverby Ranch stream performance goals are an aggregate SQU score for the combined stream types rather than a separate score for ephemeral, intermittent and perennial streams. Implementation of the proposed mitigation measures at Riverby Ranch are expected to cause a general increase in soil moisture and groundwater recharge by restoring wetlands and meandering streams. This expected increase in water retention over much of the ranch could lead to the conversion of some streams from ephemeral to intermittent, and possibly from intermittent to perennial wherever the water table rises above stream channels. While it is plausible that such conversion might occur, predicting which streams, if any, might undergo such a conversion is not possible. Combining the stream performance goals into a single score, rather than partitioning the goal by stream type, avoids a potential future performance standard accounting issue if streams undergo a conversion during the monitoring period.

Table 9.3 RGA Based Performance Goals for Streams on Riverby Ranch

Mitigation Strategy	Year 0 Existing Conditions (SQUs)	5-year Performance Goal (SQUs)	10-year Performance Goal (SQUs)
Restoration and Enhancement on Riverby Ranch (existing streams)	64,140	92,323	120,506
Stream Creation on Riverby Ranch	0	13,244	26,488
Enhancement in WRP Area	40,990	44,065	47,142

9.4.2. Upper BDC Mitigation Site

The proposed stream enhancement and protection activities would restore and/or enhance approximately 62,535 linear feet of streams on the Upper BDC Mitigation Site. During the RGA monitoring events, a team composed of qualified professionals from NTMWD and its consultants would collect RGA data at the same sampling locations used to establish baseline RGA conditions for streams on the Upper BDC Mitigation Site, as well as at two additional points as shown in Figure 18. The proposed RGA based performance goals for these tributary streams by mitigation strategy are summarized in Table 9.4.

Table 9.4 RGA Based Performance Goals for Upper BDC Mitigation Site

Mitigation Strategy	Year 0 Existing Conditions (SQUs)	5-year Performance Goal (SQUs)	10-year Performance Goal (SQUs)
Stream Protection and Enhancement	17,119	19,724	22,330

9.4.3. Tributaries of Littoral Zone Wetlands

The proposed stream enhancement and protection activities would restore and/or enhance approximately 23,184 linear feet of streams on-site upstream of the littoral wetlands expected to develop at the proposed reservoir site. During the RGA monitoring events, a team composed of qualified professionals from NTMWD and its consultants would collect RGA data at new RGA sampling locations that would be identified and data would be collected following the same RGA methodology used to establish baseline stream conditions. Proposed RGA monitoring locations are shown in Figure 19. The proposed RGA based performance goals for these tributary streams by mitigation strategy are summarized in Table 9.5.

Table 9.5 RGA Based Performance Goals for Tributaries of Littoral Zone Wetlands

Mitigation Strategy	Year 0 Existing Conditions (SQUs)	5-year Performance Goal (SQUs)	10-year Performance Goal (SQUs)
Protection and Enhancement of Tributaries of Littoral Zone Wetlands	3,745	4,711	5,677

9.5 SUMMARY

In summary, the performance standards identified for this mitigation plan would help determine if the project is achieving its overall objectives. These standards are based on attributes that are objective and verifiable by field measurements and analysis. Additionally, data collection and analysis would be based on methods established and/or approved by the USACE to determine if the performance standards are being met. If it is determined that performance standards are not being met, adaptive management strategies would be identified in consultation with the USACE and TCEQ and a plan would be developed and implemented (see Chapter 17). Such measures may include additional plantings, removal of invasive species, predator or pest control measures, selectively cutting trees, hydrologic manipulation, and, if available and necessary, the purchase of mitigation bank credits to supplement the permittee-responsible mitigation actions. These measures would help improve the chances of mitigation success.

10.0 MONITORING REQUIREMENTS

10.1 GENERAL

The purpose of monitoring the proposed mitigation sites is to determine if the compensatory mitigation project is on a trajectory to meet the stated performance standards and/or to determine if adaptive management is needed. Monitoring requirements for this mitigation plan would be based on guidance provided in the Aquatic Resource Mitigation and Monitoring Guidelines, Department of the Army Regulatory Program, Tulsa District U.S. Army Corps of Engineers, October 2004 (USACE, 2004).

Performance standards for emergent and shrub wetlands on Riverby Ranch and within the littoral zone wetlands at the proposed reservoir site would be based on wildlife habitat value (i.e., HSI value). For the forested wetlands, monitoring would focus on the data collected for the sub-index variables from the Modified East Texas HGM. The uplift trajectory of the forested wetlands would be based on observed values compared to optimal values for the sub-index variables during the initial 15 years of monitoring as the restored areas develop into forested wetlands. No Functional Capacity Index (FCI) value would be calculated or reported until these areas mature into "forested wetlands". Currently, it is anticipated that the monitoring report submitted in year 20 (or after the areas become forested, if earlier) would contain average FCI values for the functions that are assessed. For the forested wetland enhancement areas, the HGM protocol would be applied at years 5, 10, 15, and 20, or until the forested wetlands meet the expected performance standards.

As previously discussed, monitoring of the wetlands will include visual inspections and field measurements using appropriate assessment methodologies. Shallow monitoring wells will be placed in the wetland restoration areas to monitor hydrology (Figure 20). Once it is determined that there is adequate hydrology to sustain the wetlands, well monitoring will cease. As with the baseline studies, the USACE, TCEQ, and other state and federal resource agencies would be invited to participate in field data collection. It is anticipated that the monitoring sites within the enhanced mitigation areas would be similar in number and location as the baseline HEP and HGM sites. The locations of new monitoring sites in areas proposed for shrub, emergent, and forested wetland restoration will be identified following construction and planting of these sites. It is anticipated that the number of monitoring sites would be comparable to those used to establish existing conditions at the proposed reservoir site and mitigation sites. Table 10.1 shows the schedule of proposed monitoring events for the restored wetland mitigation sites. Table 10.2 shows the schedule of proposed monitoring events for the enhanced wetland mitigation sites. Data collection during monitoring events would be conducted using the methodologies described in the Performance Standards section of this mitigation plan.

Table 10.1 Proposed Wetland Mitigation Restoration Monitoring Events

Monitoring Year (Season)	Wetland Types	Protocol	Activities		
1 (Spring, Summer)	Emergent, Forested, Shrub		Field inspection[1]		Photographs
1 (Fall)	Emergent, Forested, Shrub	HEP/Tree survival	Field measurements		Photographs
2 (Spring, Summer)	Emergent, Forested, Shrub		Field inspection		Photographs
2 (Fall)	Emergent, Forested, Shrub	HEP/Tree survival	Field measurements		Photographs
3 (Spring, Summer)	Emergent, Forested, Shrub		Field inspection		Photographs
3 (Fall)	Emergent, Forested, Shrub	HEP/Tree survival	Field measurements		Photographs
4 (Fall)	Emergent, Forested, Shrub	HEP/Tree survival	Field measurements		Photographs
5 (Fall)	Emergent, Forested, Shrub	HEP/Applicable HGM sub-index variables	Field measurements	Species diversity	Photographs
6	Forested		Field inspection		Photographs
7 (Fall)	Emergent, Forested, Shrub	Applicable HGM sub-index variables	Field inspection/Field measurements		Photographs
8	Forested		Field inspection		Photographs
9 (Fall)	Emergent, Forested, Shrub	Applicable HGM sub-index variables	Field inspection/Field measurements		Photographs
10	Forested		Field inspections		Photographs
11 (Fall)	Emergent, Forested, Shrub	Applicable HGM sub-index variables	Field inspection/Field measurements		Photographs
13 (Fall)	Emergent, Forested, Shrub	Applicable HGM sub-index variables	Field inspection/Field measurements		Photographs
15 (Fall)	Emergent, Forested, Shrub	Applicable HGM sub-index variables	Field inspection/Field measurements		Photographs

Monitoring Year (Season)	Wetland Types	Protocol	Activities		
20 (Fall)	Emergent, Forested, Shrub	HGM	Field inspection/Field measurements		Photographs

[1] Field inspection includes visual assessment of survival and overall health of vegetation. During the first five years, hydrology will be inspected as part of this effort or until demonstrated sufficient to maintain wetlands. The field inspection will identify if there are potential issues that may impact mitigation success and identify corrective measures if needed.

Table 10.2 Proposed Wetland Mitigation Enhancement Monitoring Events

Monitoring Year (Season)	Wetland Types	Protocol	Activities		
1 (Spring, Summer)	Emergent, Forested		Field inspection[1]		Photographs
1 (Fall)	Emergent, Forested	HEP	Field measurements		Photographs
2 (Spring, Summer)	Emergent, Forested		Field inspection		Photographs
2 (Fall)	Emergent, Forested	HEP	Field measurements		Photographs
3 (Spring, Summer)	Emergent, Forested		Field inspection		Photographs
3 (Fall)	Emergent, Forested	HEP	Field measurements		Photographs
4 (Fall)	Emergent, Forested	HEP	Field measurements		Photographs
5 (Fall)	Emergent, Forested	HEP/HGM	Field measurements	Species diversity	Photographs
7 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs
9 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs
11 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs
13 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs
15 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs

Monitoring Year (Season)	Wetland Types	Protocol	Activities		
20 (Fall)	Emergent, Forested	HGM	Field inspection/Field measurements		Photographs

[1] *Field inspection includes visual assessment of survival and overall health. The field inspection will identify if there are potential issues that may impact mitigation success and identify corrective measures if needed.*

Performance standards for Bois d'Arc Creek downstream of the dam will be assessed by comparing RBA and IBI scores from the mitigation monitoring with baseline data collected during the 2010 instream flow study. Biological monitoring would be performed twice per year in years one, three, and five following deliberate impoundment in the reservoir and again at year 10. Monitoring events will be conducted and the data will be collected and analyzed in accordance with the TCEQ approved *Surface Water Quality Monitoring Procedures Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (TCEQ, 2014). Field sampling will be conducted at the FM 409 and downstream of FM 100 instream flow study reaches established during the 2010 instream flow study.

Water quality measurements will be continuously monitored at the USGS gage at FM 409 beginning upon deliberate impoundment of the reservoir. A grab sample also will be collected at each biological monitoring site during each monitoring event to be analyzed for total dissolved solids, chlorides, sulfates, total suspended solids, total nitrogen and total phosphorus.

If the monitoring results indicate that aquatic life use is not meeting the water quality standards for Segment 0202A, the potential causes will be identified, including a review of the required flow regime, and a remedial management strategy will be identified and implemented in consultation with and under the approval of the TCEQ Executive Director. If the metrics indicate no degradation of the aquatic community and the annual diversions from the reservoir have exceeded 100,000 acre-feet during at least one year of operation prior to the year 5 monitoring, then monitoring will end after 10 years. If diversions have not reached 100,000 acre-feet prior to the fifth year following deliberate impoundment, instream biological monitoring and water quality sampling will continue to be performed every fifth year thereafter until monitoring has been conducted during two years following the diversion of 100,000 acre-feet in a given year.

Table 10.3 Proposed Bois d'Arc Creek Monitoring Events

Monitoring Event (Year)	Protocol	Activities	
1	IBI, RBA	Seining, electroshock Macroinvertebrate sampling	Photographs
3	IBI, RBA	Seining, electroshock Macroinvertebrate sampling	Photographs
5	IBI, RBA	Seining, electroshock Macroinvertebrate sampling	Photographs
10[1]	IBI, RBA	Seining, electroshock Macroinvertebrate sampling	Photographs

[1]If additional monitoring is required after year 10 because the annual diversions from the reservoir have not exceeded 100,000 acre-feet, then the monitoring activities identified for year 10 will continue every 5 years until there are two monitoring years following the diversion of 100,000 acre-feet or more.

Performance standards for streams within Riverby Ranch, Upper BDC Mitigation Site, and streams within the littoral wetlands will be based on the RGA methodology. The proposed stream mitigation activities will enhance, restore, and/or create approximately 306,546 linear feet of streams on Riverby Ranch, 23,184 linear feet of streams within the littoral zone wetlands, and 62,535 linear feet of streams in the Upper BDC Mitigation Site. As discussed in Chapter 9, the RGA data would be collected at the same monitoring locations used to establish baseline RGA conditions for streams on Riverby Ranch (including the WRP area) and in the Upper BDC Mitigation Site (Figure 18). The general locations of RGA monitoring sites for the on-site streams that flow into the littoral wetlands are depicted on Figure 19. Data would be collected following the same RGA methodology used to establish baseline stream conditions. Stream monitoring events will be conducted annually for the first five years, every other year from year five to year 15, and then again in year 20following implementation of the initial hydrological modifications and plantings. For the streams at the reservoir, the monitoring period will begin when the water surface elevation in the reservoir reaches 534 ft. msl. Monitoring activities for stream mitigation on Riverby Ranch the Upper BDC Mitigation Site, and on-site streams within the littoral zone wetland areas will include RGA data collection and photographs.

All monitoring events would be conducted by qualified, professional geologists and/or environmental scientists that are retained by the NTMWD. Additionally, state and federal resource agencies that are involved in this mitigation project would be invited to participate in these events.

10.2 MONITORING PERIOD

Monitoring reports would be submitted every year for the first five years, every other year from year five until year 15, and again in year 20 for all components of the proposed mitigation plan. As such, all components of the proposed mitigation plan would be monitored for 20 years. However, the proposed mitigation plan contains different types of mitigation with varying times to reach maturity or to become established. As such, the types of data collected and reported for the different types of mitigation components (i.e., emergent wetland restoration, forested wetland restoration, etc.) could vary. For example, emergent (including littoral zone wetlands) and shrub wetland mitigation areas are anticipated to meet their respective HEP performance standards approximately five years following completion of construction. If data collected during monitoring events demonstrates that HEP performance standards are being met, or exceeded, for these mitigation components, no future HEP data collection efforts would be proposed. However, these areas would continue to be visually inspected and reported to the USACE to demonstrate that these mitigation components continue to function as intended. This is reflected in Tables 10.1 and 10.2. One exception to the proposed 20-year monitoring period includes Bois d'Arc Creek downstream of the proposed reservoir. As proposed, NTMWD is not claiming or receiving mitigation credit for the uplift expected to occur within Bois d'Arc Creek following construction of the reservoir. The performance standards and monitoring period for Bois d'Arc Creek, as described in this plan, are required as part of the water right permit received from TCEQ.

During the early phases of the mitigation project, monitoring of tree survival, invasive species, etc. would be conducted more frequently to identify potential concerns or threats to the success of the mitigation project and to determine if corrective actions are needed. If corrective actions are determined to be needed and implemented, monitoring may be extended to ensure that the mitigation goals are being met.

10.3 MONITORING REPORTS

Monitoring reports would be submitted every year for the first five years, every other year from year five until year 15, and again in year 20 to the USACE Tulsa District Engineer, and a copy would be sent to the TCEQ. Findings from the periodic monitoring events would be summarized in the report. The monitoring reports would reflect the activities proposed in the mitigation plan, including the specific field activities in Tables 10.1 and 10.2 and monitoring activities associated with stream mitigation at the Riverby Ranch Mitigation Site, Upper BDC Mitigation Site, and littoral wetlands and tributary streams at the reservoir site. An annual report documenting the environmental flow releases that is required under the Texas water right would be prepared and submitted with the monitoring report. The monitoring report will include the following elements, as applicable:

1. Project name and permit number
2. Project location, map, site drawings, photograph station locations
3. Permittee's name, address, phone
4. Report preparer's name, address, phone
5. Purpose and goals for mitigation site
6. Brief summary of mitigation strategy/actions
7. Date mitigation action commenced
8. Dates of site inspections
9. Dates of maintenance activities
10. Summary of observations and measurements
11. Assessment of success toward the performance standards or success criteria
12. Report any observed problems (adverse water levels, failure, underperformance, vandalism, erosion, invasive plants, storm damage, etc.)
13. Implemented or recommended solutions to identified problems or deficiencies
14. Documentation of completed corrective actions taken at the mitigation site
15. Photos from each of the site inspections by photographic station location and date

PART 2 MITIGATION PLAN FOR IMPACTS TO TERRESTRIAL RESOURCES

This part of the mitigation plan addresses impacts to and proposed mitigation for terrestrial resources that could be impacted following construction of the proposed Lower Bois d'Arc Creek Reservoir (LBCR) project, and was developed to support and meet the permitting and mitigation requirements associated with the State of Texas water right permit for the LBCR issued by the TCEQ on June 26, 2015. During the development of this section of the mitigation plan, specific consideration was given to 30 TAC §297.53, which addresses habitat mitigation associated with water rights permitting.

All proposed terrestrial compensatory mitigation for potential terrestrial impacts would be provided through near-site mitigation strategies. All of the proposed aquatic and terrestrial mitigation would be connected by Bois d'Arc Creek from the 1,900-acre Upper BDC Mitigation Site, which lies just upstream of the proposed reservoir, to the approximately 15,000-acre Riverby Ranch which lies along the Red River and just downstream of the Caddo National Grasslands below the proposed dam site (Figure 1). Having both terrestrial and aquatic mitigation sites located adjacent to one another and connected along the Bois d'Arc Creek corridor will provide synergistic ecological uplift to both ecosystems and avoid fragmentation of habitat.

11.0 IMPACTS TO TERRESTRIAL RESOURCES

The impacts of the proposed project have been evaluated by the NTMWD with participation of state and federal resource agencies, including the TCEQ, over the past several years. Reports documenting these studies and the findings have been submitted to the TCEQ in support of the water right permit application. A listing of these reports is presented below.

- *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir*, 2 volumes, submitted to TCEQ on December 29, 2006.
- *Section 404 Permit Application and Jurisdictional Determination Report*, submitted to TCEQ Water Rights Permitting Team on October 8, 2008.
- *Environmental Report, Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir*, submitted to TCEQ water rights permitting section on October 8, 2008.
- *Instream Flow Study Report for the Proposed Lower Bois d'Arc Creek Reservoir*, May 2010. Submitted to USACE and Cooperating agencies on May 27, 2010. Submitted to TCEQ on June 1, 2010.
- *Instream Flow Study Supplemental Data*, September 2010, Submitted to USACE and cooperating agencies on September 17, 2010. Submitted to TCEQ on September 23, 2010.

A synopsis of the impacts of the proposed project on terrestrial and aquatic habitats was provided to the TCEQ in the response to a Request for Information, dated May 13, 2011. A copy of this response is included in Appendix H of this mitigation plan. Impacts to waters of the U.S., including wetlands, are summarized in Part 1 of this mitigation plan. A summary of the project's potential terrestrial impacts is presented below.

11.1 DIRECT IMPACTS

The proposed LBCR project will directly impact 17,068 acres associated with the construction of the dam and spillway and subsequent filling of the reservoir to the conservation pool elevation of 534 ft. msl. An additional 860 acres would be impacted as a result of constructing the proposed transmission and treatment facilities, and 104 acres that would be impacted within the proposed right-of-way associated with the relocation of FM 1396 outside of the reservoir footprint, for a total of 18,032 acres. Impacts within the proposed reservoir project site were assessed with an interagency team using HEP, developed by the USFWS. A supplemental HEP analysis to document existing conditions was completed for the associated transmission and treatment facilities in October and November of 2013 following the selection of the raw water pipeline route and locations of the water treatment plant and terminal storage reservoir (FNI, 2013). A similar analysis was applied to the impact area of FM 1396 outside of the reservoir area in 2016. The HEP methodology is recommended by the USFWS as their basic tool for evaluating a project's impacts and developing mitigation recommendations. It is also a recommended methodology by the TCEQ for habitat evaluations (30 TAC §297.53).

The LBCR project 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 sixteen evaluation species selected based on their ecological significance and the availability of applicable HSI models.

The acreages and baseline HUs for each terrestrial cover type within the LBCR project site are presented in Table 11.1. (Note: Areas of riparian woodland / bottomland hardwood that were delineated as forested wetlands are discussed in Part 1. Table 11.1 addresses only non-wetland cover types.)

Table 11.1 Baseline Habitat Units by Terrestrial Cover Type at the Proposed LBCR Site

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Upland Deciduous Forest	0.47	2,251	**1,058**
Riparian Woodland / Bottomland Hardwood	0.25	1,734	**434**
Shrubland	0.57	64	**36**
Grassland / Old Field	0.60	4,827	**2,896**
Cropland	0.72	2,045	**1,472**
Tree Savanna	0.73	132	**96**
Evergreen Forest	0.35	231	**81**
TOTAL		**11,284**	**6,073**

11.2 INDIRECT IMPACTS

Indirect impacts include associated actions of the project that potentially impact terrestrial habitat upstream, adjoining, and downstream of the project site. These impacts are discussed in Appendix H of this plan and in Appendix C of the *Instream Flow Study Supplemental Data* (FNI, September 2010). Impacts associated with wetlands downstream of the proposed dam is discussed in Appendix F.

While changes in terrestrial habitats may have occurred without the project, construction of the reservoir may impact the timing of these changes. Impacts to the habitats downstream of the reservoir are expected to be minimal due to several factors:

(1) the existing vegetative community is not dependent upon overbank flow for reproduction and overall success and many of the species along Bois d'Arc Creek riparian corridor are equally likely to occur in uplands;

(2) the local site conditions (e.g., rainfall, soil type, and land cover) contribute to floodplain inundation;

(3) the proposed release of base flows should provide channel connectivity and promote growth of stream bank vegetation;

(4) the reduction in erosive high flows would allow the stream to aggrade over time increasing the potential for floodplain connectivity; and

(5) downstream hydrology will continue to contribute to instream flow and supplement floodplain connectivity and certain aspects of the riparian corridor may even be improved as a result of the dam, including increased stream bank stabilization, and vegetation growth.

12.0 TERRESTRIAL MITIGATION OBJECTIVES

The purpose of Part 2 of the mitigation plan is to identify and describe in detail the mitigation measures proposed by NTMWD to compensate for impacts to terrestrial habitats that could result following construction of the proposed LBCR project. Specific plan objectives are to mitigate, to the extent practicable, for the 434 habitat units of non-wetland riparian woodland / bottomland hardwoods, 1,058 habitat units of upland deciduous forest, 2,896 habitat units of grassland / old field cover types, and 64 acres of shrubland. Terrestrial mitigation efforts will focus on the restoration, enhancement, and/or preservation of these habitat types at the proposed mitigation site.

Mitigation for the habitats units associated with cropland, evergreen forest, and tree savanna cover types are not an objective of this mitigation plan. These cover types are either man-induced/created habitat types, consist largely of invasive species, or are transitional habitats that are not sustainable and would require extensive ongoing management activities to maintain.

13.0 TERRESTRIAL MITIGATION SITE SELECTION AND BASELINE CONDITIONS

13.1 SITE SELECTION PROCESS

The NTMWD has acquired the Riverby Ranch specifically because of its unique characteristics and qualities to provide mitigation for potential impacts from the proposed project. In addition, NTMWD proposes to acquire a 1,900-acre corridor upstream of the proposed reservoir along Bois d'Arc Creek (the Upper BDC Mitigation Site) primarily for forested wetland mitigation; however, there are approximately 128 acres located outside proposed wetland mitigation areas that would be used for terrestrial mitigation. Maps showing the location of the mitigation sites and existing cover types are shown on Figures 9 and 11. A detailed description of the mitigation site selection process to identify the proposed mitigation sites is described in Part 1 of this mitigation plan.

13.2 BASELINE CONDITIONS OF THE PROPOSED TERRESTRIAL MITIGATION SITES

Descriptions of the following existing conditions of the mitigation sites are described in Part 1 of this mitigation plan:

- Overall project site description;
- Existing hydrology;
- Existing soils;
- Existing wetland vegetation;
- Existing wetland wildlife use; and
- Existing wildlife habitat value for emergent and shrub wetland cover types, including a description of the HEP methodology and how it was applied at the proposed mitigation sites.
- Existing wetland functional values for forested wetlands, including a description of the Modified East Texas HGM protocols and how it was applied at the proposed mitigation sites.

13.2.1. Existing Terrestrial Cover Types

The location and distribution of all existing vegetative cover types within the proposed mitigation sites are depicted on Figures 9 and 11. The following provides descriptions of the terrestrial cover types that were identified and evaluated using the HEP methodology at the proposed mitigation sites.

Upland Deciduous Forest

Upland forests are defined as non-wetland areas dominated by trees of at least five meters in height with a minimum tree canopy closure of 25 percent. In upland deciduous forests, at least 50 percent of that canopy is composed of deciduous species, or those that completely shed their foliage during part of the year (USFWS 1980c).

Grassland / Old Field

The grassland / old field cover type consists of upland areas with at least a 25 percent canopy cover of predominantly non-woody vegetation in which grasses, whether native or introduced, are dominant. This cover type includes mostly prairies and rangeland (USFWS 1980c).

Riparian Woodland / Bottomland Hardwood (non-wetland)

The riparian woodland / bottomland hardwood cover type includes wetland areas dominated by woody vegetation at least six meters tall, with a total vegetation cover of more than 30 percent; this designation is synonymous with the Forested Wetland cover type described in Ecological Services Manual (ESM) 103 (USFWS 1980c).

Shrubland

Shrublands are defined as upland areas that are dominated by a shrub layer, which may be composed of shrub species and/or small trees shorter than five meters. This cover type should have a shrub canopy cover of at least 25 percent (USFWS 1980c).

Cropland

Croplands are defined as agricultural uplands which are planted and harvested annually with agricultural crops; pasture and hayland are excluded from this cover type (USFWS 1980c).

13.2.2. Existing Wildlife Habitat Value

The wildlife habitat value of the approximately 15,000-acre Riverby Ranch Mitigation Site and Upper BDC Mitigation Site that would become the primary terrestrial mitigation sites for the proposed LBCR project was estimated using the HEP procedures. The HEP analysis was conducted by personnel from FNI and the same state and federal resource agencies that participated in the HEP study completed at the proposed reservoir site. Additionally, the same HEP species models were used within the same cover types to estimate habitat value. Using the same procedures to estimate wildlife habitat value for the impact site and mitigation sites allows for a more consistent comparison of impacts to mitigation as well as a more accurate assessment of potential ecological uplift that could occur at the mitigation site. For the Upper BDC Mitigation Site, the HEP values determined for the cover types within the reservoir site were applied to this mitigation area, as appropriate.

During an interagency HEP meeting (August 2010) held prior to collecting HEP data at the Riverby Ranch mitigation site, it was proposed and agreed to that preservation of the existing shrubland areas would likely be the best mitigation alternative. This conclusion was reached since the shrubland areas at the proposed Riverby Ranch Mitigation Site are located adjacent to the Red River and are susceptible to overbanking conditions. Because of these factors, implementing mitigation actions such as shrub plantings, control of invasive species, etc. would have a very low likelihood of success. As such, it was concluded that collecting HEP data within this cover type would not be beneficial or necessary. Therefore, further discussion of impacts and mitigation for shrubland is in acres, not HUs.

Baseline HUs were calculated for each cover type at the proposed mitigation sites by multiplying the average cover type HSI values by the acres of each cover type, as presented in Tables 13.1 and 13.2.

Table 13.1 Baseline Habitat Units for Terrestrial Cover Types at Riverby Ranch Site

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Upland Deciduous Forest	0.58	78	**46**
Grassland / Old Field	0.41	5,413	**2,220**
Riparian Woodland / Bottomland Hardwood	0.38	840	**319**
Shrubland	N/A	41	**N/A**
Cropland	0.44	3,858	**1,697**
TOTAL		**10,230**	**4,282**

Table 13.2 Baseline Habitat Units for Terrestrial Cover Types at Upper BDC Mitigation Site

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Upland Deciduous Forest	0.47	9	4.2
Grassland / Old Field	0.60	218	130.8
Cropland	0.72	773	556.6
TOTAL		**1,000**	**691.6**

14.0 TERRESTRIAL MITIGATION PLAN

14.1 AVOIDANCE AND MINIMIZATION

Part 1 of this mitigation plan was developed to compensate for the unavoidable impacts to waters of the U.S. due to the construction of the proposed LBCR. Impacts were avoided to the extent practicable while addressing the purpose and need of the project, and those impacts that could not be avoided were minimized to the extent practicable. The mitigation actions identified in Part 2 of this plan are designed to compensate for the remaining unavoidable, but minimized, impacts to terrestrial habitats.

The measures proposed by NTMWD to avoid and/or minimize impacts to aquatic resources are described in Part 1 of this mitigation plan. Some of these actions will also avoid and/or minimize impacts to terrestrial resources. Specifically, the removal of the 14.4 miles of proposed pipeline avoids all habitat impacts associated with this previously proposed component. While the impacts to terrestrial resources associated with the construction of a pipeline are generally temporary, there would likely have been maintenance activities within the permanent right-of-way that would prevent the regrowth of forested habitat types. Removal of the pipeline would avoid and minimize impacts to these resources.

14.2 TERRESTRIAL MITIGATION APPROACH

The proposed Riverby Ranch and Upper BDC Mitigation Sites will be used to meet the compensatory mitigation requirements for terrestrial resources. The approximate 15,000-acre Riverby Ranch Mitigation Site and 1,900-acre Upper BDC Mitigation Site offer the opportunity to restore terrestrial resources that would complement the proposed aquatic resource mitigation sites. As discussed in other sections of this plan, the synergistic effect of the proposed watershed mitigation approach encompasses both terrestrial and aquatic mitigation, as both of these habitat types are located on the mitigation properties. Additionally, permanently protected lands (i.e., Pintail Farms WRP, and Caddo National Grasslands) adjacent to the Riverby Ranch Mitigation Site would provide further synergistic ecological uplift (Figure 8).

The proposed approach to terrestrial mitigation would include the restoration of forested riparian buffer zones along stream channels, restoration of native grasslands, restoration and enhancement of upland deciduous forests, and preservation of shrublands.

14.3 MITIGATION FOR TERRESTRIAL IMPACTS

Potential impacts at the proposed reservoir project could result in the loss of 434 HUs of riparian woodland / bottomland hardwood, 1,058 HUs of upland deciduous forest, 2,896 HUs of grassland / old field, and 64 acres of shrubland. To compensate for these losses, NTMWD is proposing to restore and enhance riparian woodland / bottomland hardwoods, native grasslands, upland deciduous forests, and preserve shrublands on the Riverby Ranch. Currently, there are approximately 4,307 acres on the ranch that are not being utilized as part of the aquatic resources mitigation plan that could be utilized to offset these potential impacts. Additionally, the aquatic resources mitigation plan includes enhancing approximately 1,375 acres of riparian woodland/bottomland hardwood to create riparian corridors/buffers. A smaller amount of terrestrial mitigation would be located at the Upper BDC Mitigation Site and would consist of the enhancement and restoration of 128 acres of upland deciduous forests. All proposed mitigation areas are identified in Figures 15 and 16. The following paragraphs describe the analysis and mitigation benefits associated with this plan.

14.3.1. Terrestrial Habitat Unit (Credit) Determination

Upland Deciduous Forest

The plant species selected to restore vegetation within upland deciduous forest areas associated with this mitigation plan were derived from two primary sources - the NRCS 2001 Soil Survey of Fannin County, Texas and the USFWS's *National List of Plant Species That Occur in Wetlands: South Plains (Region 6)*. The following list of species would be used as a guide for the selection of species based upon site conditions, soils, hydrology, etc., as well as commercial availability. Tree species identified in Table 14.1 are hard mast producing trees native to this area of Texas. Soft mast producing tree species with lighter seeds such as cedar elm, eastern cottonwood, and American sycamore as well as fruit bearing tree species such as red mulberry, sugarberry, and black cherry are expected to establish in restoration areas on their own from natural sources. This mixture of hard mast, soft mast, and fruit bearing tree species is expected to provide food, shelter, and nesting habitat for a variety of wildlife species, thus providing ecological uplift.

The tree species identified in Table 14.1 would be planted at a rate to achieve 200 living trees per acre at the end of three years with a minimum of three different species per acre. The plant material proposed for planting is one year old containerized plugs that would be planted across the site by hand or machine.

Through implementing mitigation actions (i.e., establishing a deed restriction, removing cattle and controlling feral hogs, invasive species control, and hard mast plantings and evaluating the variables contained in the HEP species models), the expected future habitat conditions of the upland deciduous forest cover type was estimated at a 20-year time interval for existing and newly restored upland deciduous forest areas. During this evaluation, it was assumed that over time variables such as tree canopy closure, number of hard mast producing trees, average diameter at breast height (dbh) and height of trees, number of snags, overall number of trees, and basal area of woody stems would generally increase. The results of this analysis are presented in Table 14.2.

Table 14.1 Tree Species List for Upland Deciduous Forest Restoration

Common Name	Scientific Name
White Oak	*Quercus alba*
Black Oak	*Quercus velutina*
Bur Oak	*Quercus macrocarpa*
Southern Red Oak	*Quercus falcata*
Shumard Oak	*Quercus shumardii*
Chinkapin Oak	*Quercus muhlenbergii*
Pecan	*Carya illinoensis*
Black Hickory	*Carya texana*
Black Walnut	*Juglans nigra*

Table 14.2 Habitat Unit Production Expected from the Restoration and Enhancement of Upland Deciduous Forest at Riverby Ranch and Upper BDC Mitigation Site

Mitigation Type	Acres	20- Year Habitat Suitability Index (HSI)	20-Year Habitat Unit (HU) Production
Enhancement of Existing Upland Deciduous Forest	87	0.76	(+) 66
Restoration of Upland Deciduous Forest	1,146	0.59	(+) 676
		TOTAL	**(+) 742**
		IMPACTS	**(-) 1,058**
		NET GAIN / LOSS	**(-) 316**

Grassland / Old Field

The plant species selected to restore vegetation within grassland areas associated with this mitigation plan were derived from consultation with private vendors that specialize in the establishment and restoration of native grasslands and prairies. The species within Table 14.3 would be used as a guide for the selection of species based upon site conditions (as they would likely vary from site-to-site) as well as commercial availability. Species within this table would be planted as a mixture and would be expected to provide food, shelter, and nesting habitat for a variety of wildlife species, thus providing ecological uplift.

Table 14.3 Grass and Forb Species list for Grassland / Old Field Restoration

Common Name	Scientific Name
Bushy Bluestem	*Andropogon glomeratus*
Eastern Gamagrass	*Tripsacum dactyloides*
Broomsedge Bluestem	*Andropogon virginicus*
Indiangrass	*Sorghastrum nutans*
Little Bluestem	*Schizachyrium scoparium*
Prairie Wildrye	*Elymus canadensis*
Virginia Wildrye	*Elymus virginicus*
Sideoats Grama	*Bouteloua curtipendula*
Switchgrass	*Panicum virgatum*
Purpletop	*Tridens flavus*
Sand Dropseed	*Sporobolus cryptandrus*
Sand Lovegrass	*Eragrostis trichodes*
Clasping Coneflower	*Rudbeckia amplexicaulis*
Lemon Mint	*Monarda citriodora*
Indian Blanket	*Gaillardia pulchella*

Common Name	Scientific Name
Partridge Pea	*Chamaechrista fasciculata*
Plains Coreopsis	*Coreopsis tinctoria*
Black-Eyed Susan	*Rudbeckia hirta*
Drummond Phlox	*Phlox drummondii*
Illinois Bundleflower	*Desmanthus illinoensis*
Pink Evening Primrose	*Oenothera speciosa*
Lazy Daisy	*Aphanostephus skirrhobasis*

Through implementing mitigation actions at Riverby Ranch (i.e., establishing a deed restriction, removing cattle and controlling feral hogs, invasive species control, and native grassland plantings and evaluating the variables contained in the HEP species models), the expected future habitat conditions of the grassland / old field cover type was estimated at a five-year time interval (it was assumed that restored grassland areas would reach maturity within five years) within restored areas. The results of this analysis are presented in Table 14.4.

Table 14.4 Habitat Unit Production Expected from the Restoration of Grassland / Old Field Habitat at Riverby Ranch

Mitigation Type	Acres	5-Year Habitat Suitability Index (HSI)	5-Year Habitat Unit (HU) Production
Restoration of Grassland / Old Field	3,277.5	0.73	(+) 2,393
		TOTAL	**(+) 2,393**
		IMPACTS	**(-) 2,896**
		NET GAIN / LOSS	**(-) 503**

Riparian Woodland / Bottomland Hardwood (non-wetland)

The proposed approach to riparian woodland / bottomland hardwood restoration and enhancement is discussed in Part 1 of this mitigation plan (see Section 6.4). Through implementing mitigation actions such as establishing a deed restriction, removing cattle and controlling feral hogs, invasive species control, and hard and soft mast plantings and evaluating the variables contained in the HEP species models, the expected future habitat conditions of the riparian woodland / bottomland hardwood cover type was estimated at a 20-year time interval for existing and newly restored mitigation areas. During this evaluation, it was assumed that over time, variables such as tree canopy closure, average dbh of trees, number of snags, number of refuge sites, and basal area of woody stems would generally increase. The results of this analysis are presented in Table 14.5.

Table 14.5 Habitat Unit Production Expected from the Restoration and Enhancement of Riparian Woodland / Bottomland Hardwoods (non-wetland) at Riverby Ranch

Mitigation Type	Acres	20-Year Habitat Suitability Index (HSI)	20-Year Habitat Unit (HU) Production
Enhancement of Riparian Woodland / Bottomland Hardwood	840	0.63	(+) 529
Restoration of Riparian Woodland / Bottomland Hardwood	535	0.61	(+) 326
		TOTAL	**(+) 855**
		IMPACTS	**(-) 434**
		NET GAIN / LOSS	**(+) 421**

Shrubland

During an interagency HEP meeting (August 2010) held prior to collecting HEP data at the Riverby Ranch Mitigation Site, it was proposed and agreed to that preservation of the shrubland areas on the ranch would likely be the best mitigation alternative for this cover type. This conclusion was reached because the shrubland areas at the proposed mitigation site are located adjacent to the Red River and are susceptible to disturbances from overbanking conditions (i.e., plants are uprooted and easily disturbed) and long-term survivability is low. Because of these factors, plant diversity is low. Implementing mitigation actions such as shrub plantings, control of invasive species, etc. would have a very low likelihood of success. As such, NTMWD is proposing to preserve 41 acres of existing shrubland habitat at the mitigation site to offset 64 acres of potential impacts at the proposed reservoir site.

As proposed, this mitigation plan would provide, to the extent practicable, compensatory mitigation for impacts to terrestrial resources. A summary of impacts to terrestrial resources that could result from the construction of the proposed reservoir and proposed mitigation is summarized in Table 14.6.

Table 14.6 Summary of Impacts to Terrestrial Resources and Proposed Mitigation[1]

Terrestrial Resource Type	Amount Impacted	Amount of Mitigation	Net Gain (+) / Net Loss (-)
Upland Deciduous Forest (HU)	(-) 1,058	(+) 742	(-) 316
Riparian Woodland / Bottomland Hardwood (HU)	(-) 434	(+) 855	(+) 421
Grassland / Old Field (HU)	(-) 2,896	(+) 2,393	(-) 503
Shrubland (acre)	(-) 64	(+) 41	(-) 23

[1] *Mitigation for cropland, evergreen forest, and tree savanna cover types are not an objective of this mitigation plan and are not included in this table.*

14.3.2. Terrestrial Mitigation Work Plan

The mitigation activities associated with the terrestrial resources would be conducted in conjunction with the mitigation activities for the aquatic resources. These activities would occur on the same properties, Riverby Ranch and Upper BDC Mitigation Sites. Descriptions of the timing of restoration activities, invasive and non-native species control, construction methods, grading plan, soil preparation and management, and erosion control are discussed in Part 1 of this mitigation plan. Planting species and planting rates for upland trees, grasses and forbs are discussed in the previous section.

14.3.3. Monitoring and Success Criteria

Monitoring of the terrestrial mitigation sites will be conducted in conjunction with the monitoring of the aquatic mitigation areas during monitoring events as described in Part 1 of this mitigation plan. Restored upland deciduous forest areas will be monitored to determine if they are on a trajectory to meet performance standards. The proposed performance standards for the restored upland deciduous forest mitigation sites would be based on HEP and are summarized in Table 14.7. This information will be included as a brief section within the monitoring reports and would be sent to the TCEQ. If a site is not performing as expected, the problem will be identified (i.e., herbivory, invasive species, etc.) and corrective actions will be implemented and monitoring will continue until the mitigation areas are on target to meet the performance standards. Table 14.8 shows the schedule of proposed monitoring events for the upland mitigation sites.

Table 14.7 Proposed Performance Standards for Upland Deciduous Forest Sites

Habitat Type	Performance Goal (HSI Value)
Restored Upland Deciduous Forest	Twenty years following construction, obtain an HSI score of 0.59.

Table 14.8 Proposed Terrestrial Mitigation Monitoring Events

Monitoring Year (Season)	Terrestrial Cover Types	Protocol	Activities		
1 (Spring, Summer)	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood, Grassland/Old Field		Field inspection[1]		Photographs
1 (Fall)	Grassland/Old Field	HEP	Field measurements		Photographs
2 (Spring, Summer)	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood, Grassland/Old Field		Field inspection		Photographs
2 (Fall)	Grassland/Old Field	HEP	Field measurements		Photographs
3 (Spring, Summer)	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood, Grassland/Old Field		Field inspection		Photographs
3 (Fall)	Grassland/Old Field	HEP	Field measurements		Photographs
4	Grassland/Old Field	HEP	Field measurements		Photographs
4	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood		Field inspection		Photographs
5	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood, Grassland/Old Field	HEP	Field measurements	Species diversity	Photographs
6	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood		Field inspection		Photographs
7	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood		Field inspection		Photographs
8	Upland Deciduous Forest, Riparian Woodland/Bottomland		Field inspection		Photographs

Monitoring Year (Season)	Terrestrial Cover Types	Protocol	Activities		
	Hardwood				
9	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood		Field inspection		Photographs
10	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood	HEP	Field measurements	Species diversity	Photographs
15	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood	HEP	Field measurements	Species diversity	Photographs
20	Upland Deciduous Forest, Riparian Woodland/Bottomland Hardwood	HEP	Field measurements	Species diversity	Photographs

[1.] Field inspection includes visual assessment of survival and overall health. The field inspection will identify if there are potential issues that may impact mitigation success and identify corrective measures if needed.

PART 3 SITE PROTECTION, MANAGEMENT, AND FINANCIAL ASSURANCES

This part of the Mitigation Plan addresses the site protection, management, and financial assurances that would be used for both the aquatic and terrestrial mitigation components.

15.0 SITE PROTECTION INSTRUMENT

This compensatory mitigation project will provide long-term protection through USACE-approved deed restrictions for the time the NTMWD owns and controls the properties. Should the properties be transferred to a third-party land manager other than a governmental entity, a conservation easement, or some other similar USACE-approved agreement, shall be placed on the properties for perpetual protection. A sample deed restriction document is included in Appendix J.

The NTMWD shall record the USACE-approved deed restrictions with each of the Fannin and Lamar County clerks and provide a copy of the recorded deed restrictions to the USACE Tulsa District. The deed restrictions will allow for the implementation of the compensatory mitigation plan, and, to the extent practicable, specifically prohibit incompatible uses (e.g., clear cutting or land surface disturbance for mineral extraction) that might otherwise jeopardize the objectives of the compensatory mitigation project. In addition, the deed restrictions will contain a provision requiring 60-day advance notification to the USACE District Engineer before any action is taken to void or modify the instrument, management plan, or long-term protection mechanism, including transfer of title to, or establishment of any other legal claims over, the compensatory mitigation site.

Included in Appendix J is a draft resolution to be approved and executed in substantially the same form by the NTMWD Board of Directors for the commitment to immediate and long-term site protection of the mitigation property for the LBCR project.

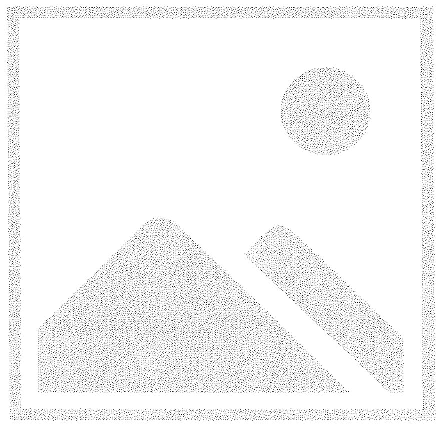
16.0 LONG-TERM MANAGEMENT PLAN

All sites proposed as part of this mitigation plan would be managed long-term as compensatory mitigation areas associated with impacts to waters of the U.S. resulting from construction of the LBCR. In general, long-term management of the mitigation lands would include planting in designated areas, maintenance of topographical features, control of invasive species, prescribed burns, monitoring natural progression, and responding to occurrences that may be detrimental to the success of the mitigation project. The long-term management of the mitigation site would be provided by the NTMWD until the USACE has determined that the mitigation project is meeting its performance standards or is on an acceptable trajectory to meeting those standards.

Once the USACE determines the mitigation project is fulfilling the compensatory mitigation requirements, and the mitigation site is self-sustaining, NTMWD may seek to convey the mitigation site and long-term management to a public agency (i.e., state or federal resource agency). The public agency would have a background in the field of natural resources management and possess the expertise and ability to manage wetlands and other aquatic resources. A USACE-approved memorandum of understanding (MOU), or other similar agreement between the NTMWD and the public agency will establish a framework for obligations and expectations. If such a conveyance were to occur, the public agency would provide for the long-term management of the site once the conveyance is final. With approval of the USACE, the site may be conveyed to a public agency prior to the achievement of all performance standards. If this occurs, NTMWD would continue to provide the monitoring and corrective actions as necessary to achieve all performance standards. Financial assurance instruments between NTMWD and the other consenting parties would be developed at the time of conveyance.

17.0 ADAPTIVE MANAGEMENT PLAN

An adaptive management plan for a compensatory mitigation project is generally described as a management strategy to address unforeseen changes in site conditions or other mitigation components of the mitigation project. Adaptive management plans facilitate the decision-making process for revising mitigation plans and instituting measures to address both foreseeable and unforeseeable circumstances that adversely affect mitigation success. For the current project, the indicator of the need to develop an adaptive management plan would come from monitoring of mitigation performance standards as described in this mitigation plan. If monitoring reports comparing mitigation progress to performance standards indicate that mitigation progress is falling short of such standards, consultation with the USACE and TCEQ would be initiated regarding the need for adaptive management.

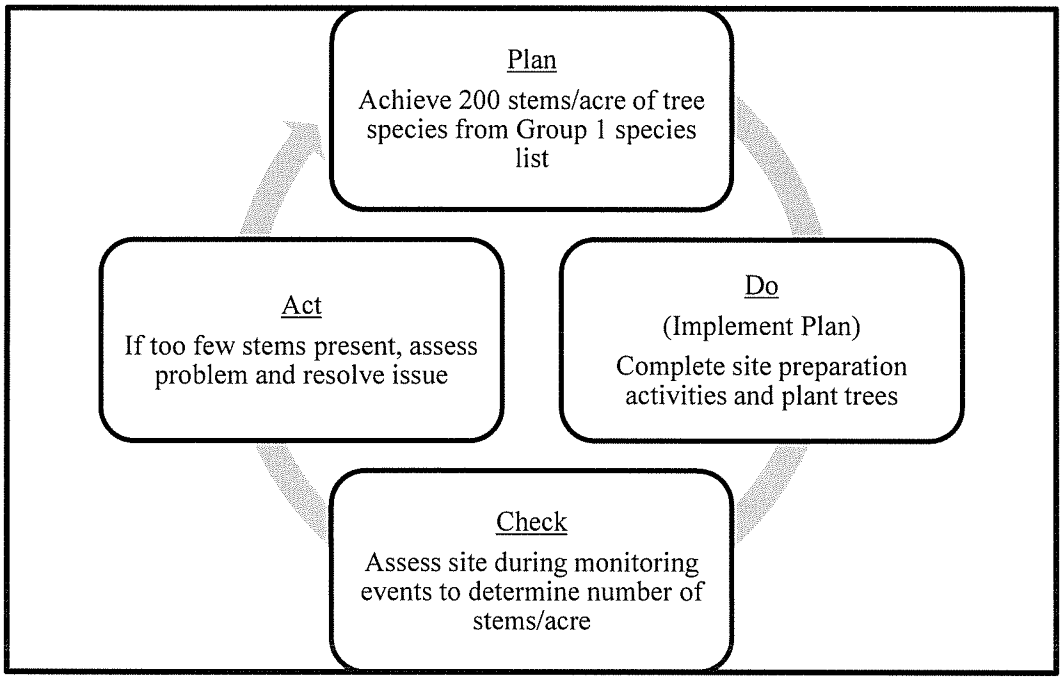


To meet the purpose of the adaptive management plan, NTMWD proposes to implement a method known as the "Plan-Do-Check-Act" cycle. This model was developed for use when implementing change, developing a new product, or starting a new improvement project and it acts as a model for continuous improvement through repetition. Incorporating this model into the adaptive management plan for this mitigation project will increase the likelihood of meeting performance standards and overall mitigation goals and objectives. An example of how this process can be applied is depicted in Graphic 17.1.

The following features would be monitored and evaluated during monitoring events to determine whether any corrective actions need to be implemented utilizing the "Plan-Do-Check-Act" concept.

17.1 HEP AND HGM VARIABLES

As proposed, during monitoring events for the emergent, shrub, and forested wetland mitigation sites, data for the variables contained within the species models for HEP (shrub and emergent wetlands) and data for the sub-index variables for the Modified East Texas HGM would be collected. Once collected, the data would be compared to the curves that have been developed for the variables and sub-index variables to determine if they are on a positive trajectory toward meeting the predicted values. If it is discovered that one or more of the variables being assessed are not positively progressing, then the variable will be evaluated to determine if there is a problem, and if so, a solution will be identified.



Graphic 17.1 Example of Utilizing the "Plan-Do-Check-Act" Cycle

17.2 RGA

If the stream monitoring indicates that the operations are not meeting stream performance standards for geomorphic, water quality, or biological indices, NTMWD will identify such issues in its monitoring report and make an initial assessment of possible causes. Such report would trigger consultation with the USACE and/or TCEQ to determine the need to begin an adaptive management initiative. If needed, the initiative would assess the root cause of the problem and identify remedial actions to implement to address the problem.

18.0 FINANCIAL ASSURANCES

The NTMWD is a conservation and reclamation district and political subdivision of the State of Texas, created and functioning under Article XVI, Section 59, of the Texas Constitution, pursuant to Chapter 62, Acts of 1951, 52nd Legislature of Texas, Regular Session, as amended (the ACT). As an entity of the state, the district is committed to providing funding necessary to satisfy compensatory mitigation requirements associated with the LBCR project. As a sign of this commitment, the NTMWD has already purchased the approximately 15,000-acre Riverby Ranch Mitigation Site and portions of the 1,900-acre Upper BDC Mitigation Site that would be used for compensatory mitigation.

Included in Appendix J is a draft resolution to be approved and executed in substantially the same form by the NTMWD Board of Directors for the commitment to financially support the implementation of the Mitigation Plan and long-term management of the LBCR mitigation sites following issuance of a permit. If required, additional assurances or financial instruments will be developed for approval by the USACE, either prior to issuance of the Section 404 permit or as a condition of the permit.

19.0 REFERENCES

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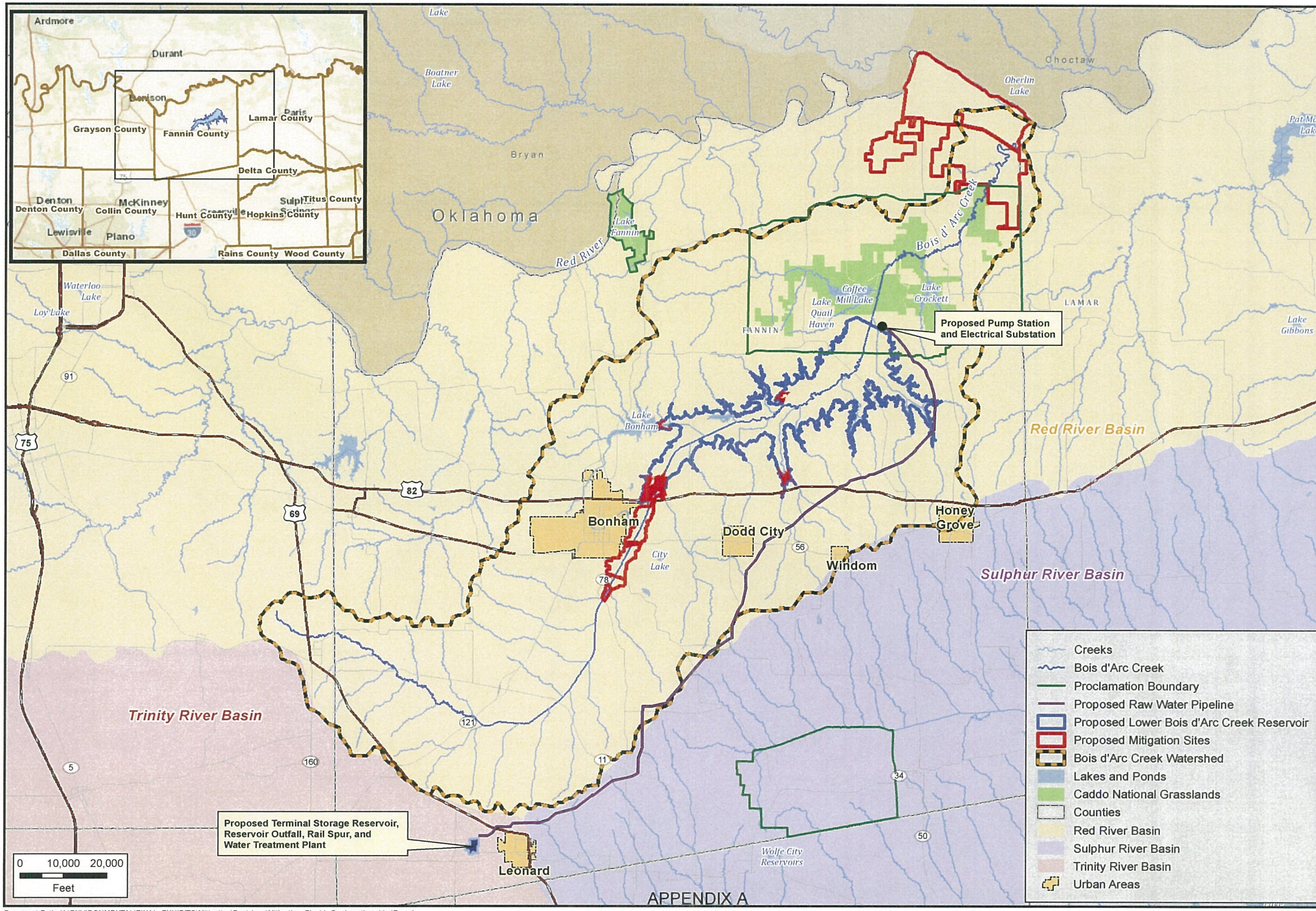
Appendix A

Figures



APPENDIX A

North Texas Municipal Water District

General Location Map - Proposed Reservoir Project Site and the Proposed Mitigation Sites

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FIGURE
1

F&N JOB NO	NTD06128
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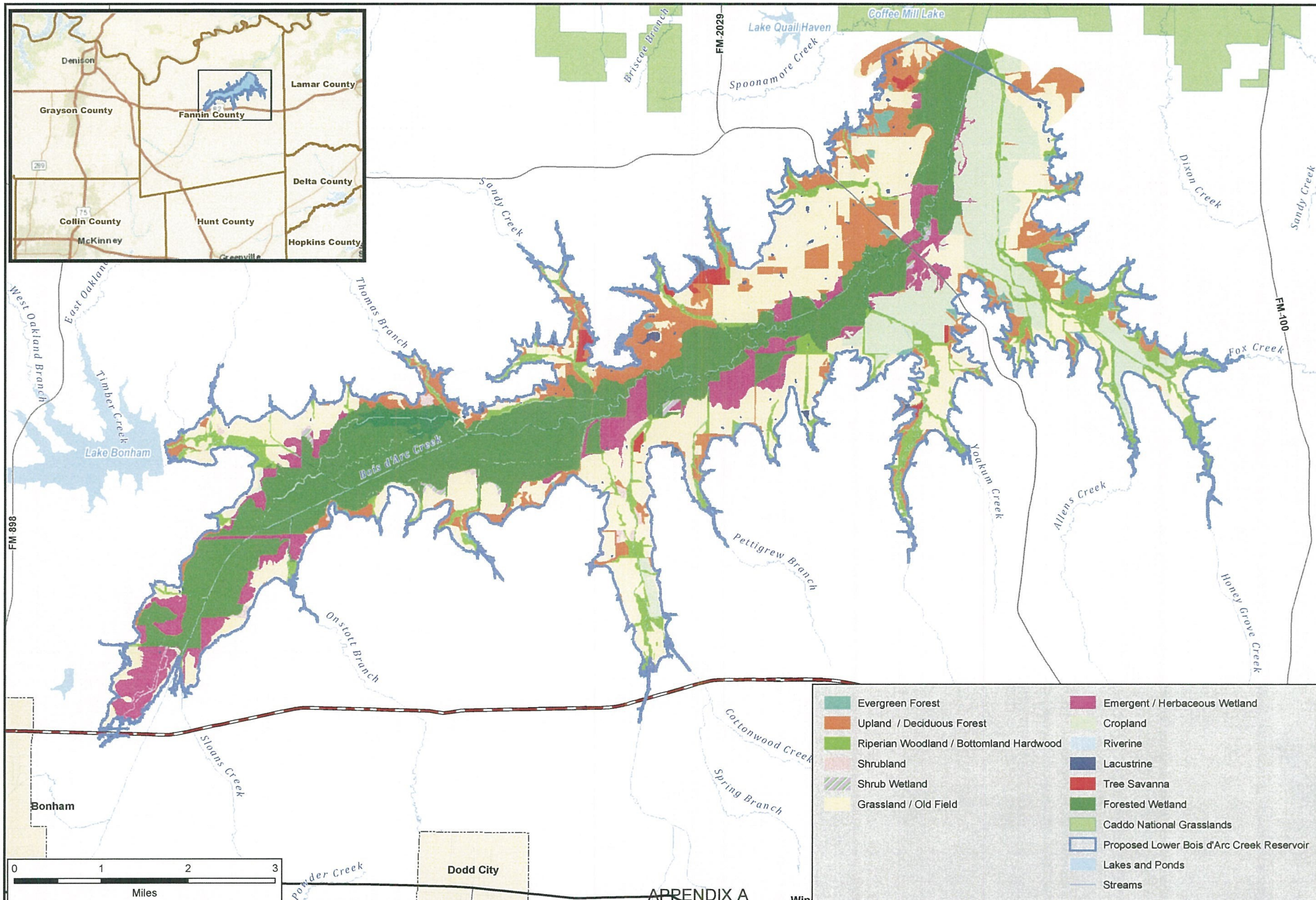

North Texas Municipal Water District

Existing Cover Types
Proposed Lower Bois d'Arc Creek Reservoir Site

F&N JOB NO	NTD06128
DATE	Nov 2016
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FIGURE 2

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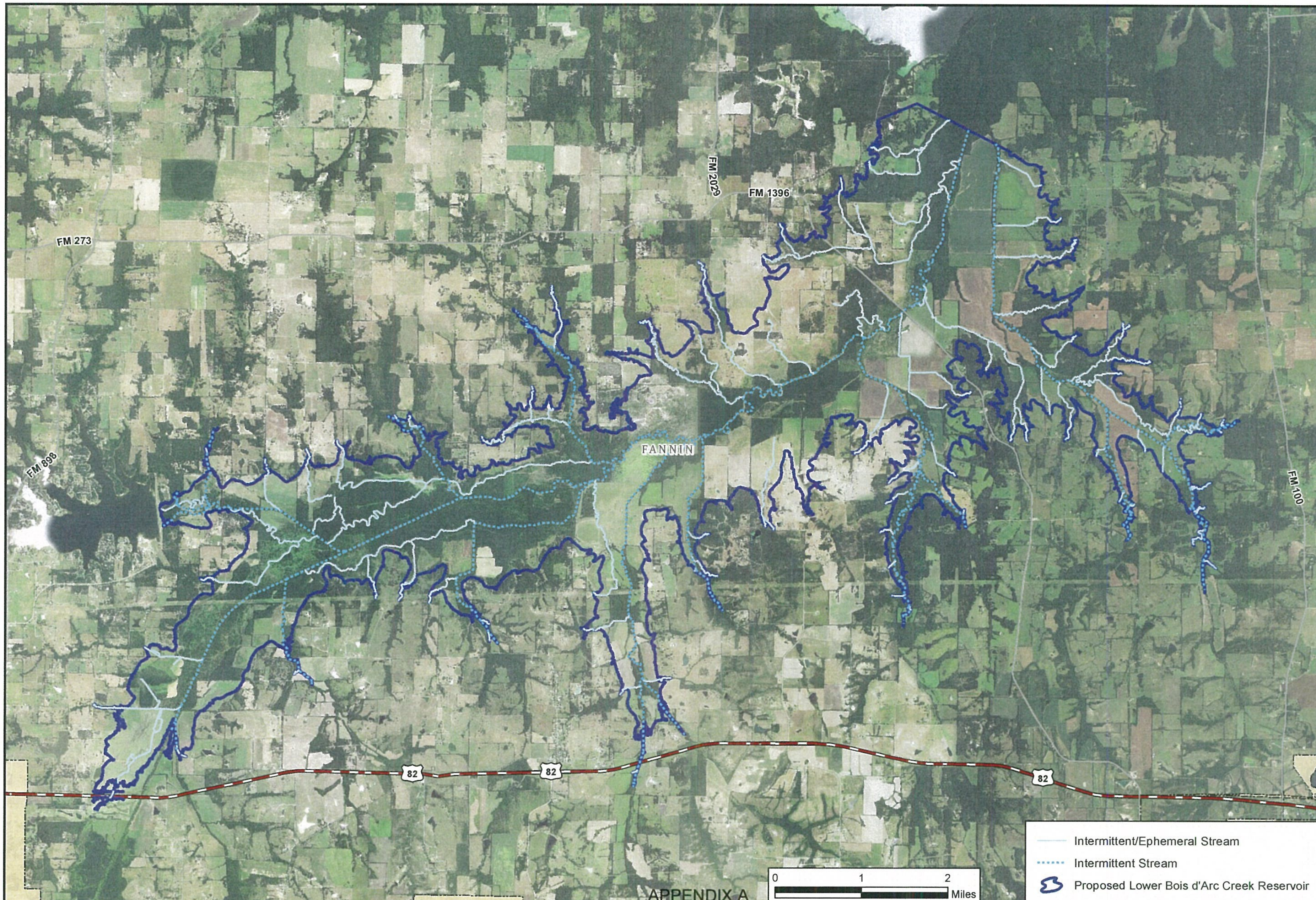

APPENDIX A

North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir Site
LBCR Streams

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FIGURE
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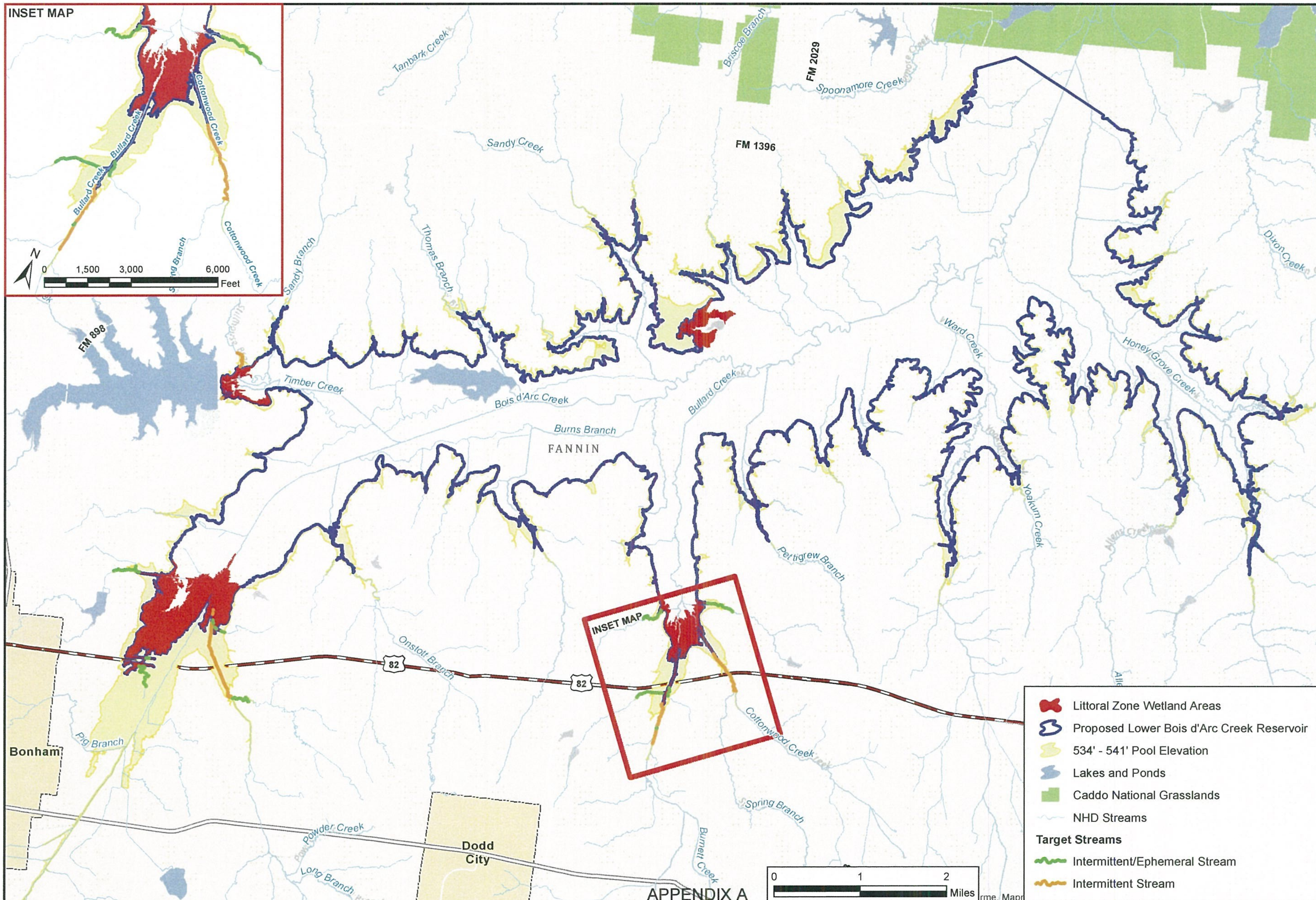

APPENDIX A

North Texas Municipal Water District

Littoral Zone Wetlands and On-Site Tributary Streams
Proposed Lower Bois d'Arc Creek Reservoir Site

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DRAFTED	HHM
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FIGURE
4

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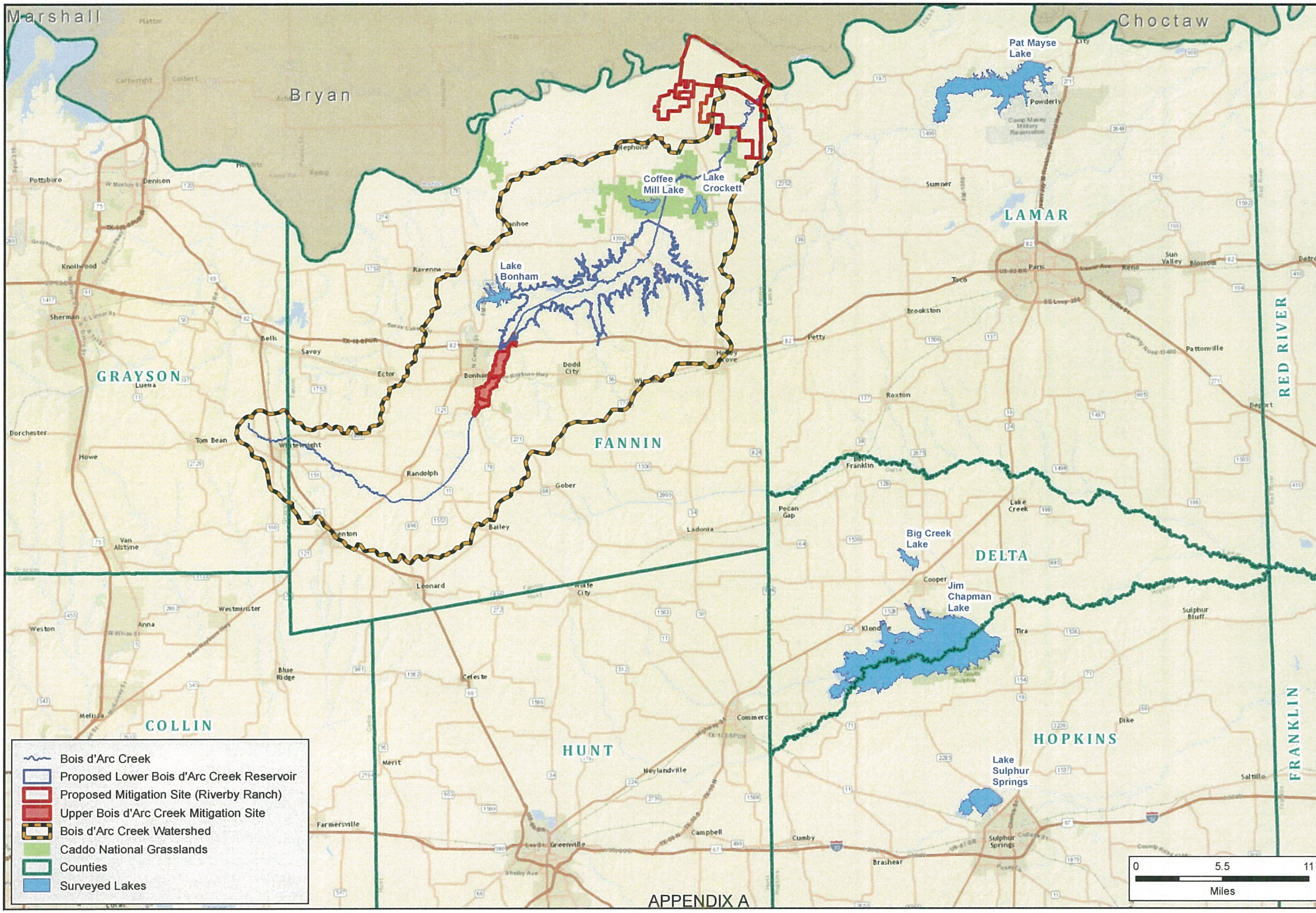

APPENDIX A

North Texas Municipal Water District

Location of Area Reservoirs Surveyed by the Texas Parks and Wildlife Department

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FIGURE 5

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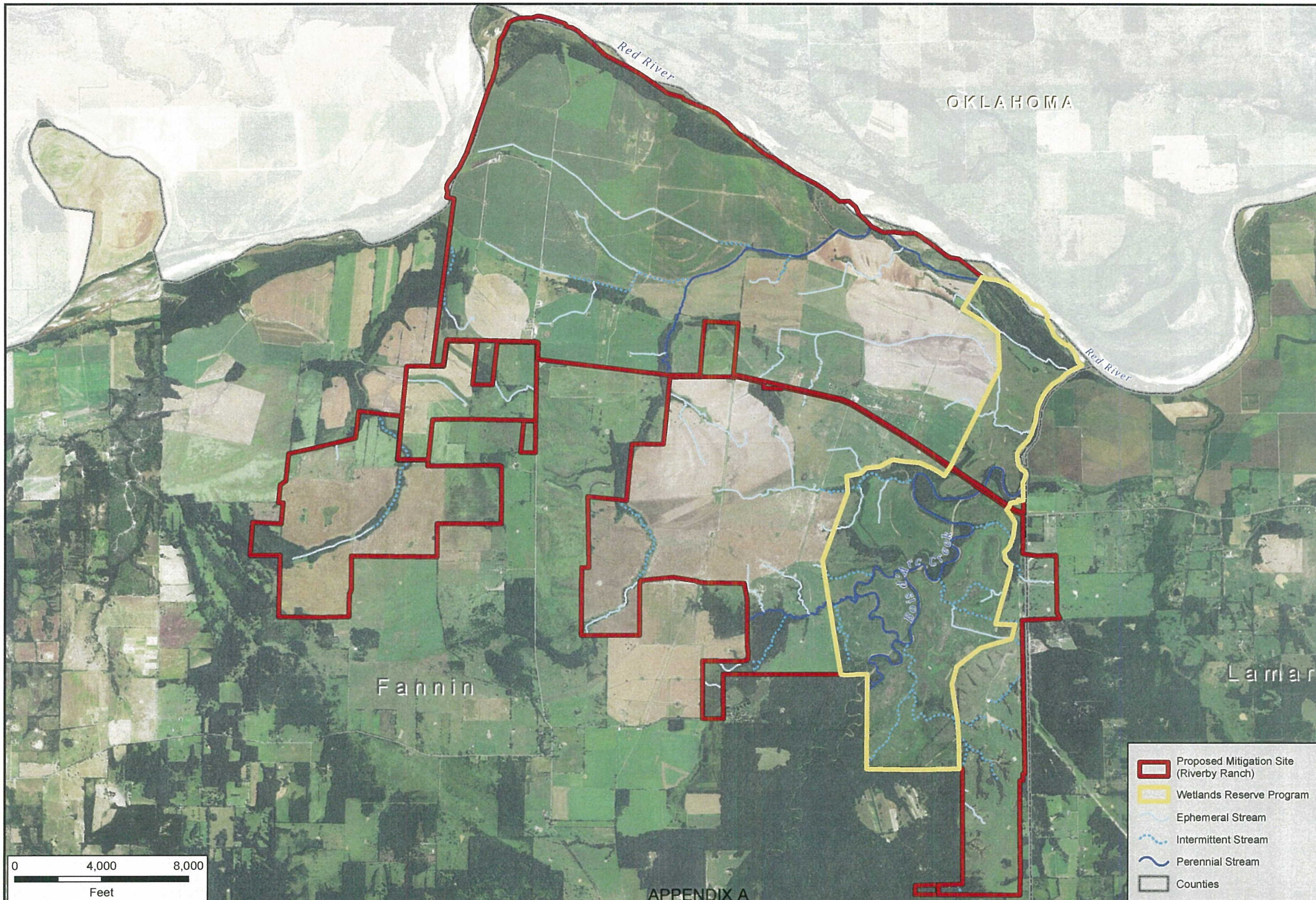

APPENDIX A

North Texas Municipal Water District

Riverby Ranch Aerial Imagery

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DATE Nov 2016
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DRAFTED HHM

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FIGURE 6

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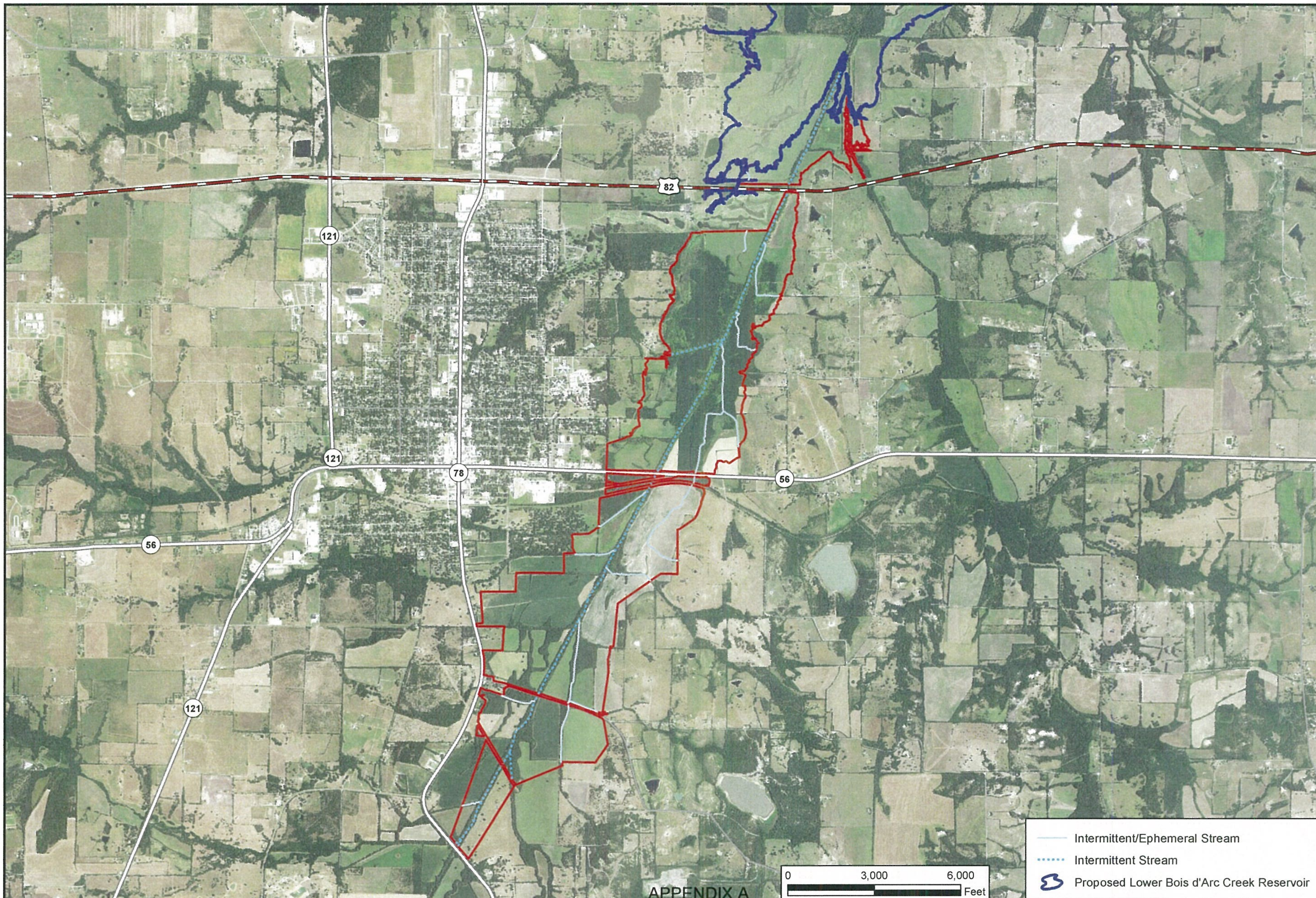

APPENDIX A

North Texas Municipal Water District

Proposed Upper Bois d'Arc Creek Mitigation Site
Aerial Imagery

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FIGURE 7

FN JOB NO	NTD06128
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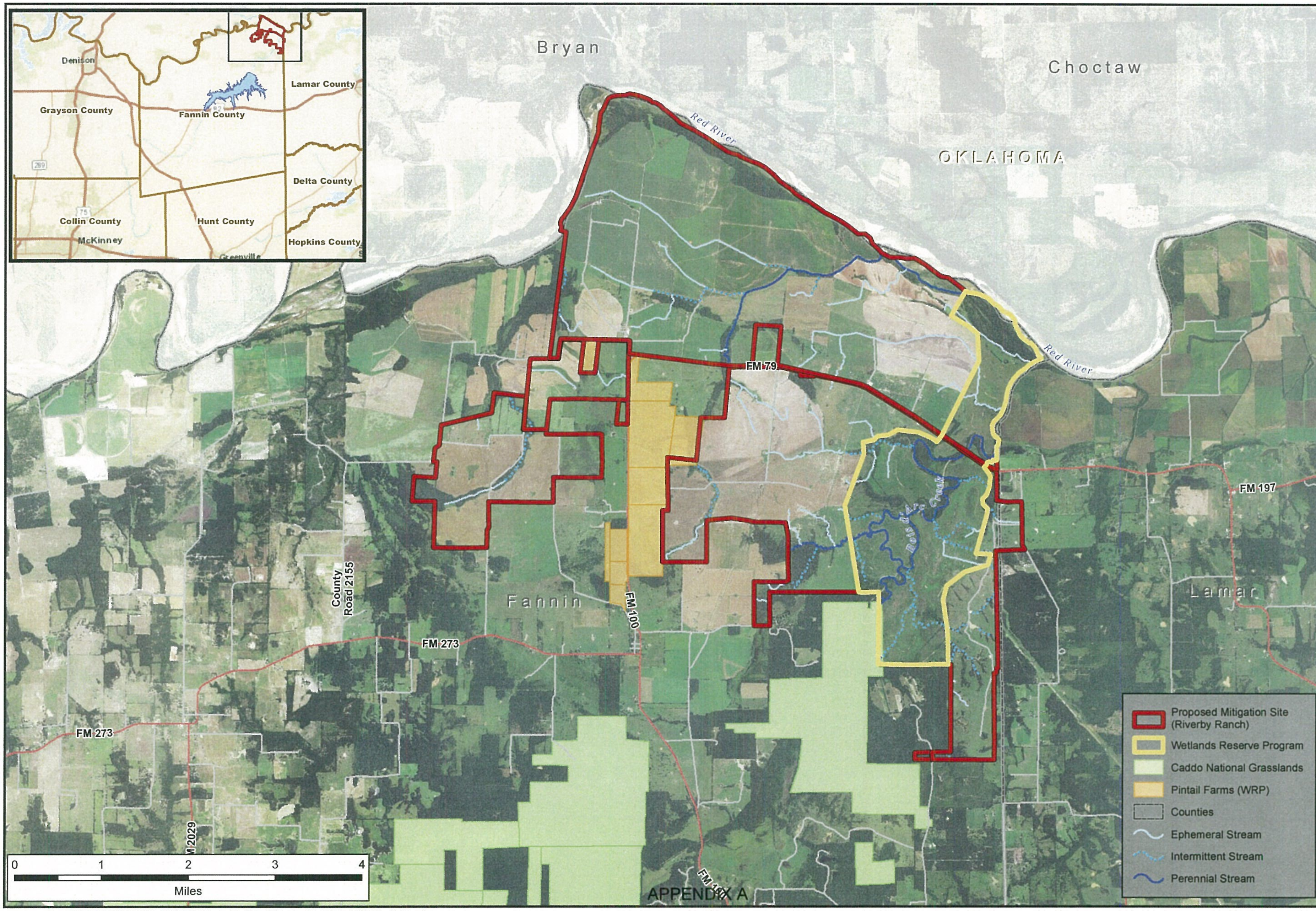

APPENDIX A

North Texas Municipal Water District

Riverby Ranch Vicinity Map

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FIGURE 8

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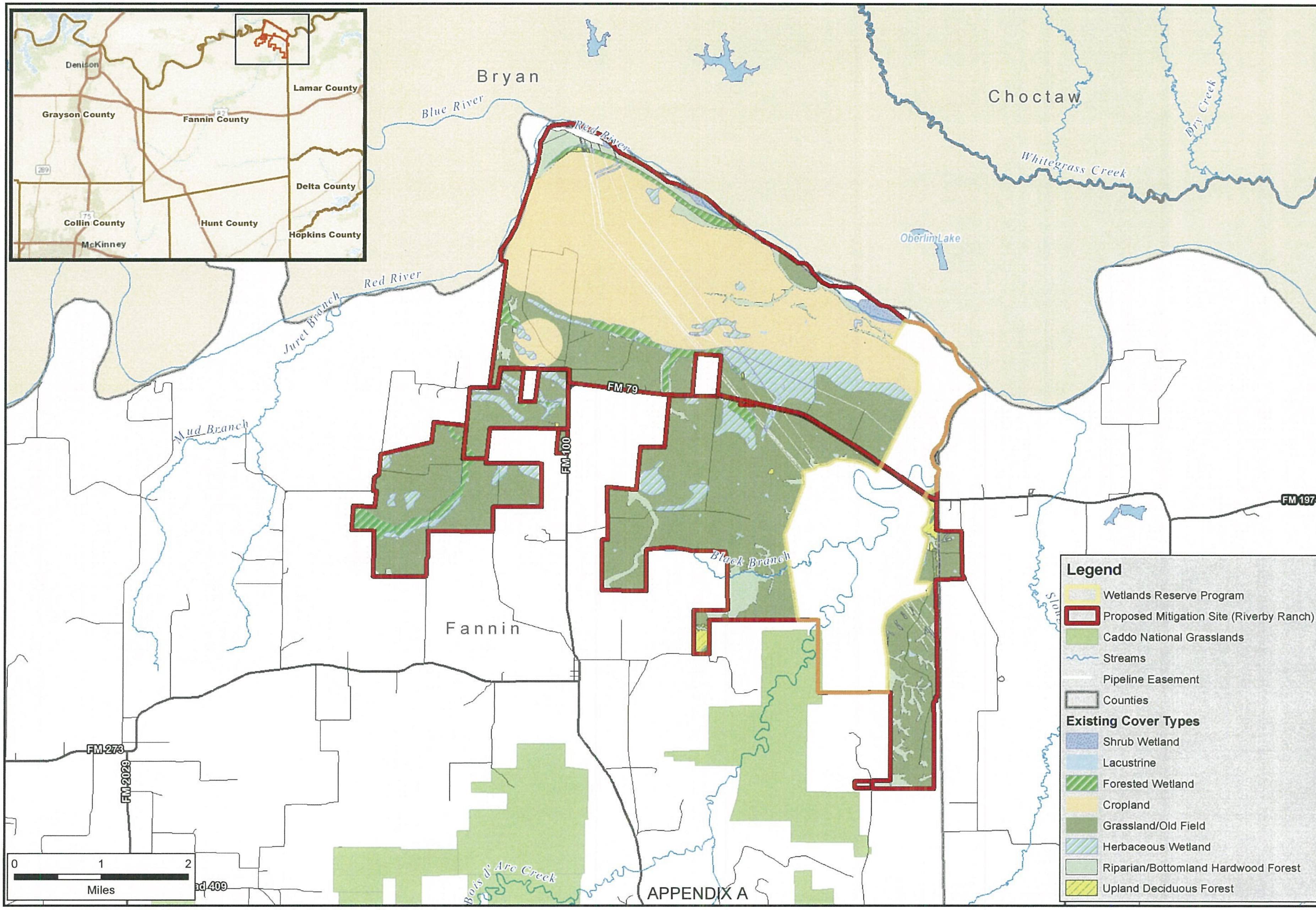

APPENDIX A

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Existing Cover Types at Proposed Mitigation Site

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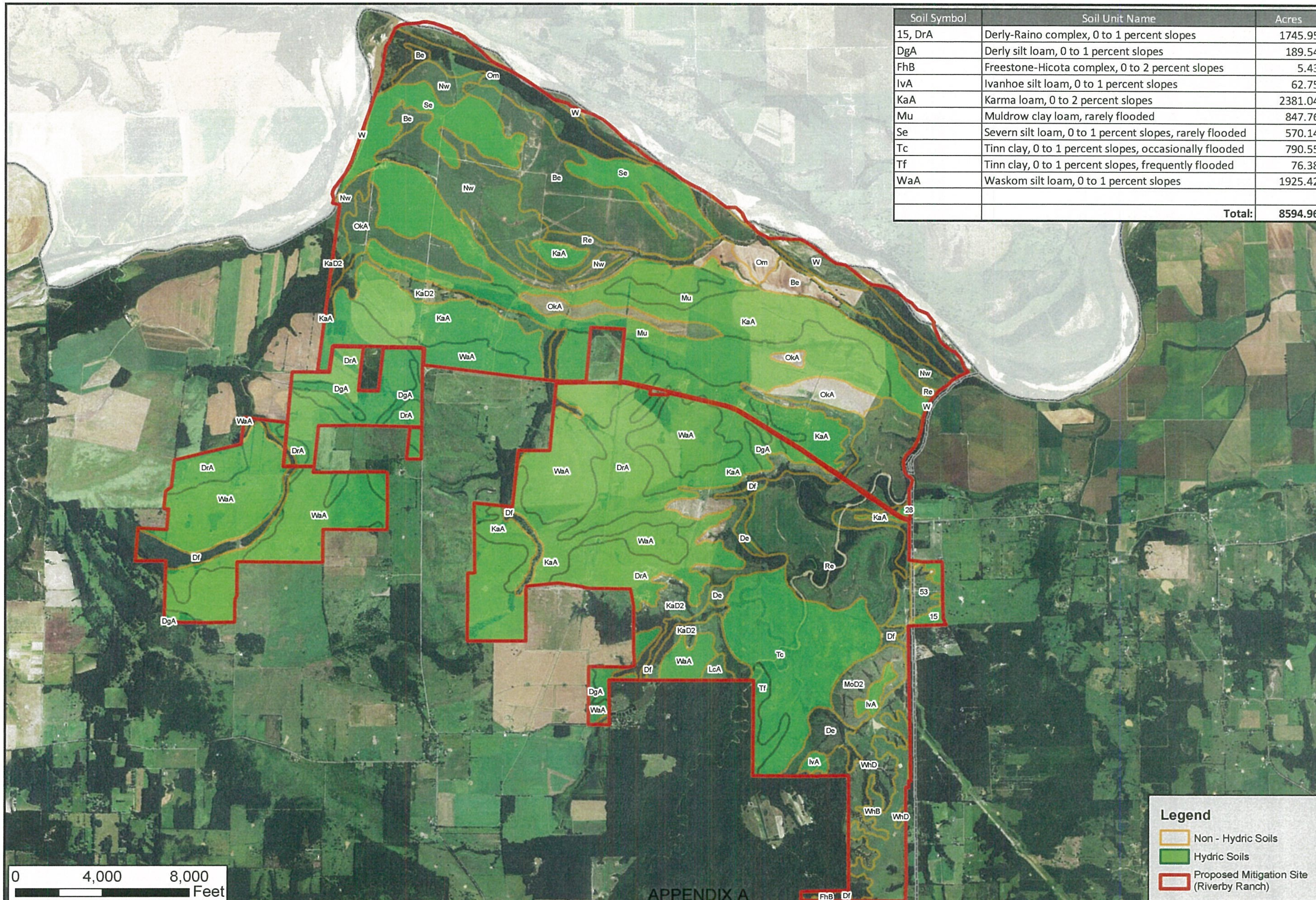
FIGURE 9



Soil Symbol	Soil Unit Name	Acres
15, DrA	Derly-Raino complex, 0 to 1 percent slopes	1745.95
DgA	Derly silt loam, 0 to 1 percent slopes	189.54
FhB	Freestone-Hicota complex, 0 to 2 percent slopes	5.43
IvA	Ivanhoe silt loam, 0 to 1 percent slopes	62.75
KaA	Karma loam, 0 to 2 percent slopes	2381.04
Mu	Muldrow clay loam, rarely flooded	847.76
Se	Severn silt loam, 0 to 1 percent slopes, rarely flooded	570.14
Tc	Tinn clay, 0 to 1 percent slopes, occasionally flooded	790.55
Tf	Tinn clay, 0 to 1 percent slopes, frequently flooded	76.38
WaA	Waskom silt loam, 0 to 1 percent slopes	1925.42
	Total:	8594.96

APPENDIX A

North Texas Municipal Water District

Location of Hydric Soils at the Proposed Mitigation Site

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DATE 11/8/2016
SCALE 1:50,000
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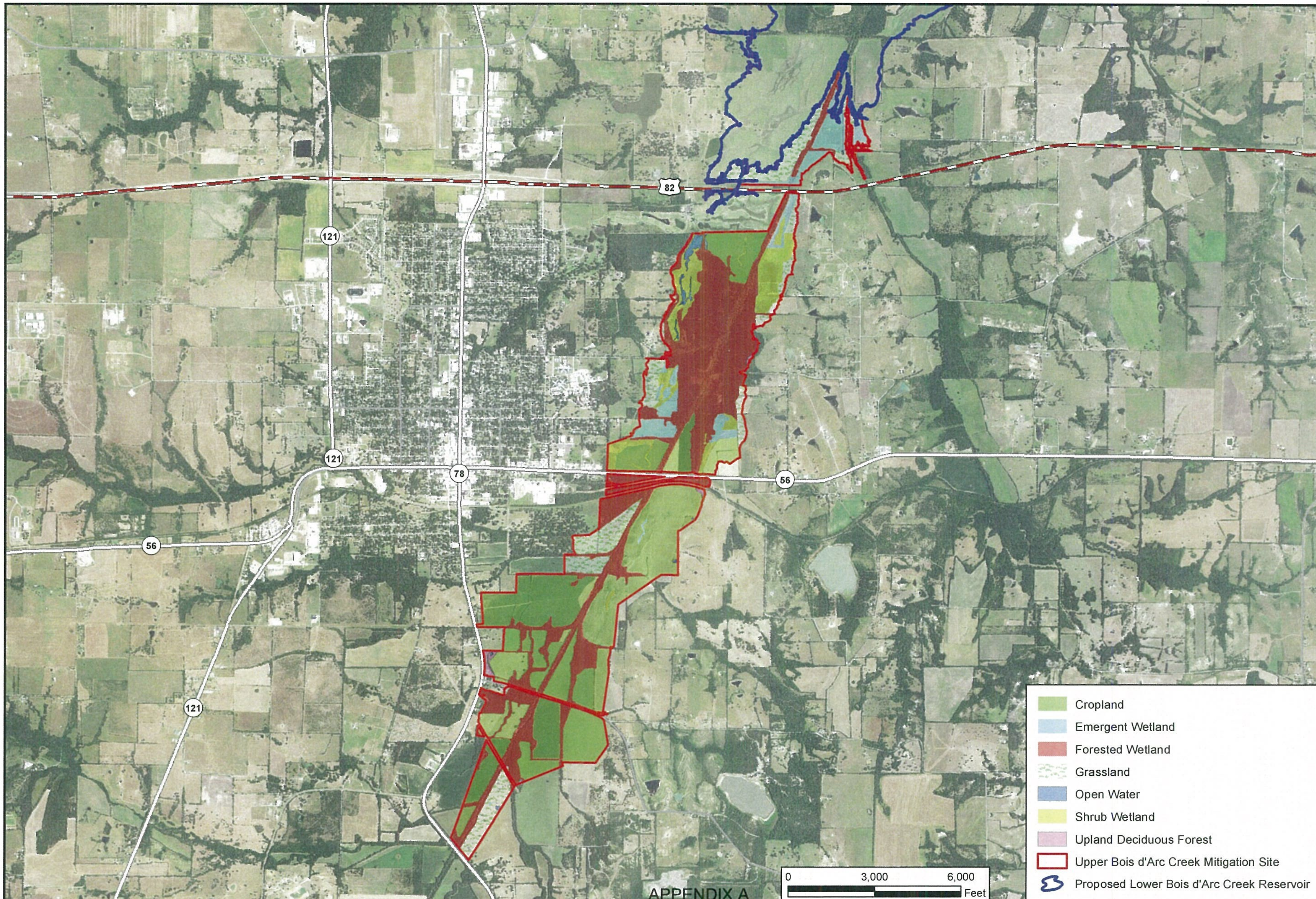
FIGURE 10



APPENDIX A

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North Texas Municipal Water District

Proposed Upper Bois d'Arc Creek Mitigation Site
Existing Cover Types

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DATE	Nov 2016
SCALE	1:36,000
DESIGNED	HHM
DRAFTED	HHM

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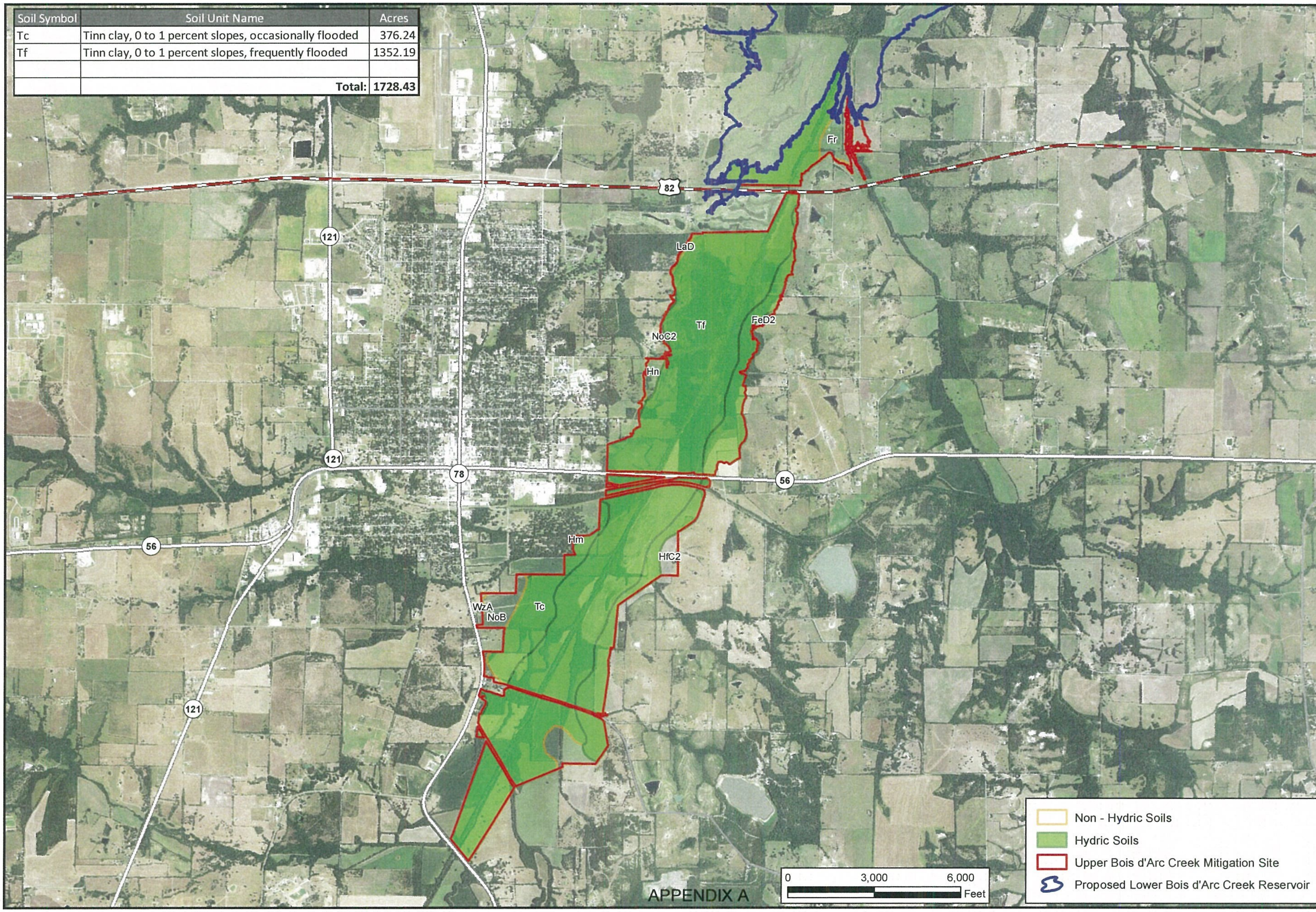
FIGURE
11

North Texas Municipal Water District

Proposed Upper Bois d'Arc Creek Mitigation Site
Hydric Soils

Soil Symbol	Soil Unit Name	Acres
Tc	Tinn clay, 0 to 1 percent slopes, occasionally flooded	376.24
Tf	Tinn clay, 0 to 1 percent slopes, frequently flooded	1352.19
	Total:	1728.43



APPENDIX A

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FIGURE 12

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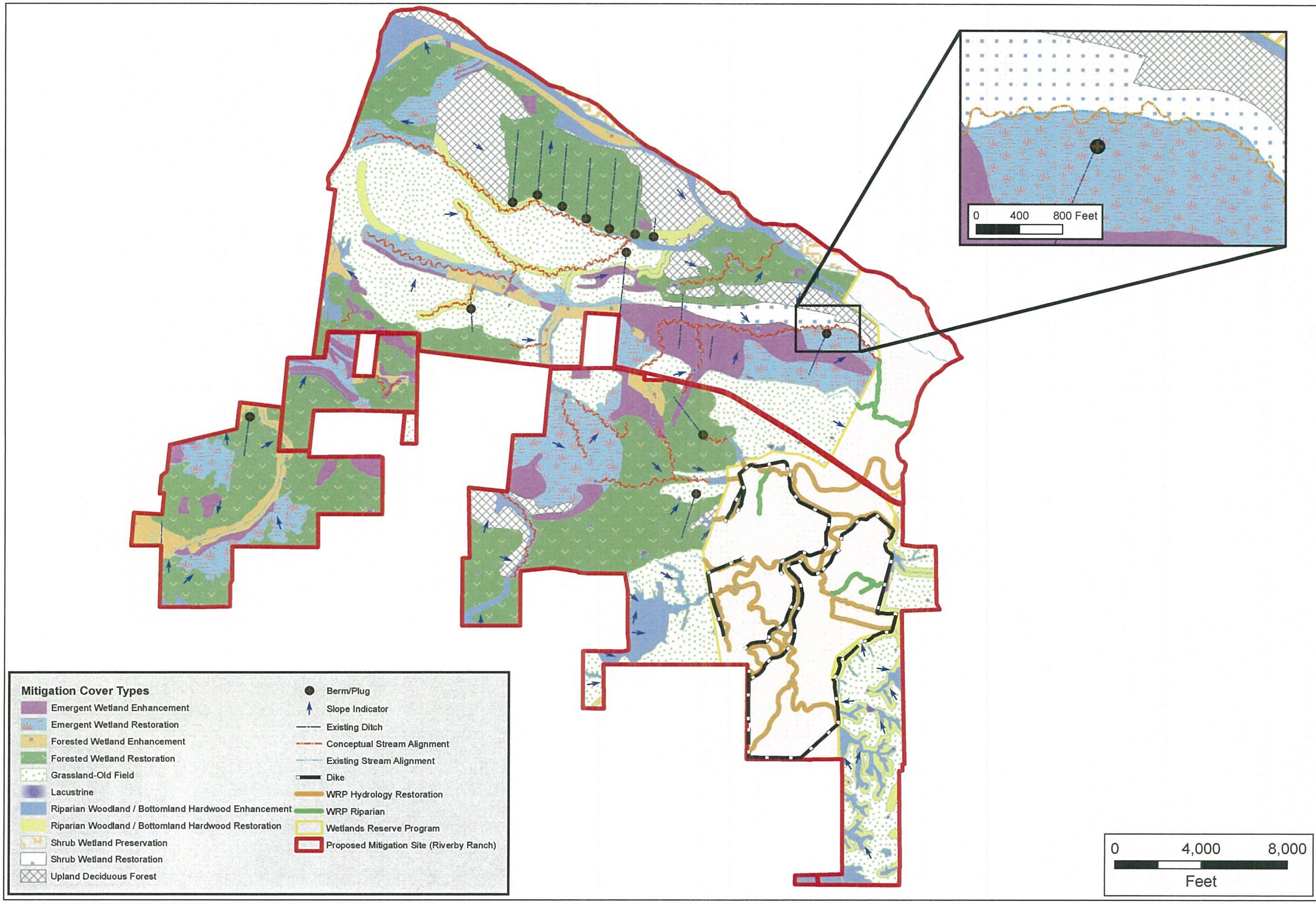

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North Texas Municipal Water District

Conceptual Plan For Stream and Hydrology Restoration

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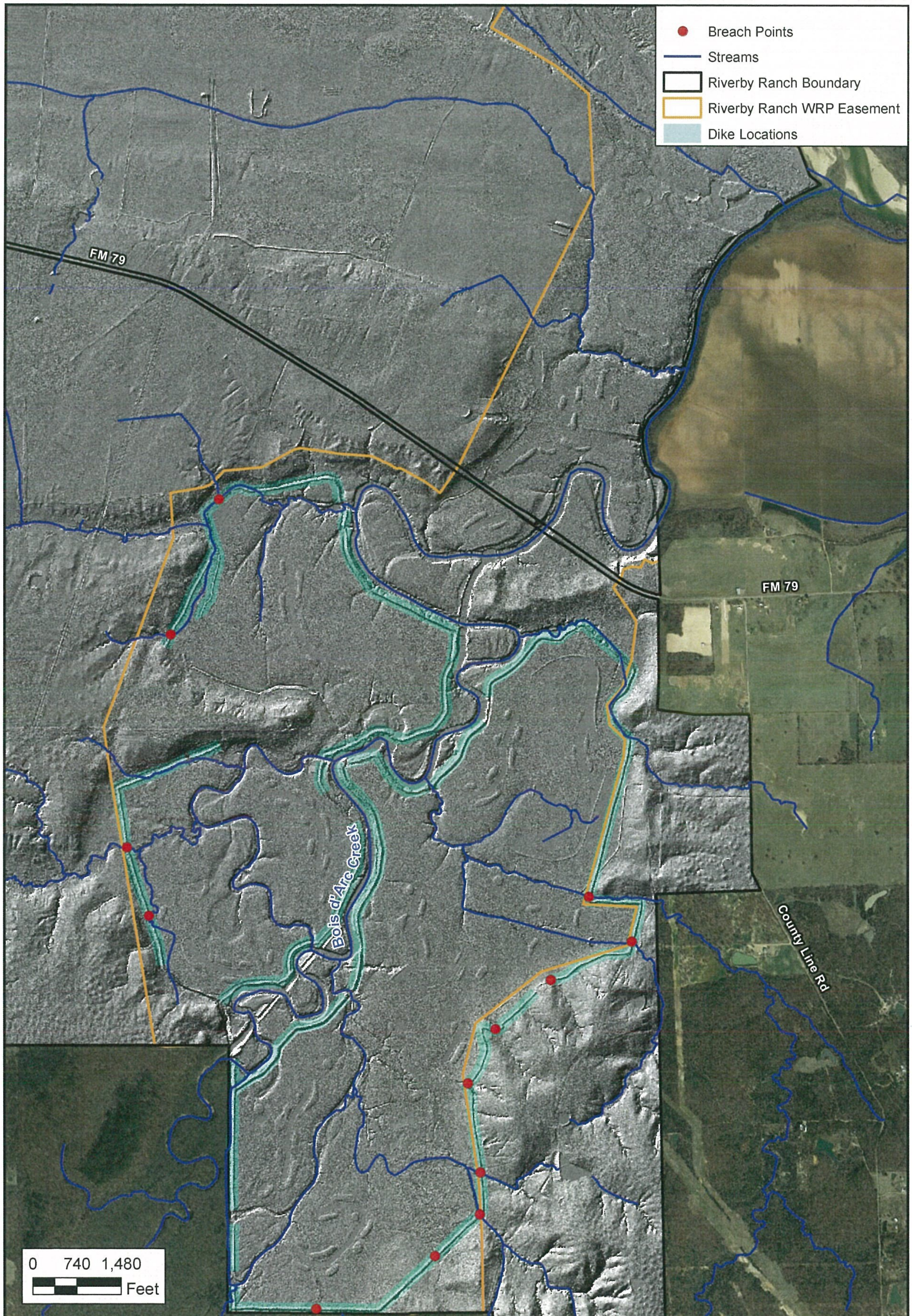
FIGURE
13



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NORTH TEXAS MUNICIPAL WATER DISTRICT
Wetlands Reserve Program Relief

Proposed Dike Breach Locations

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14
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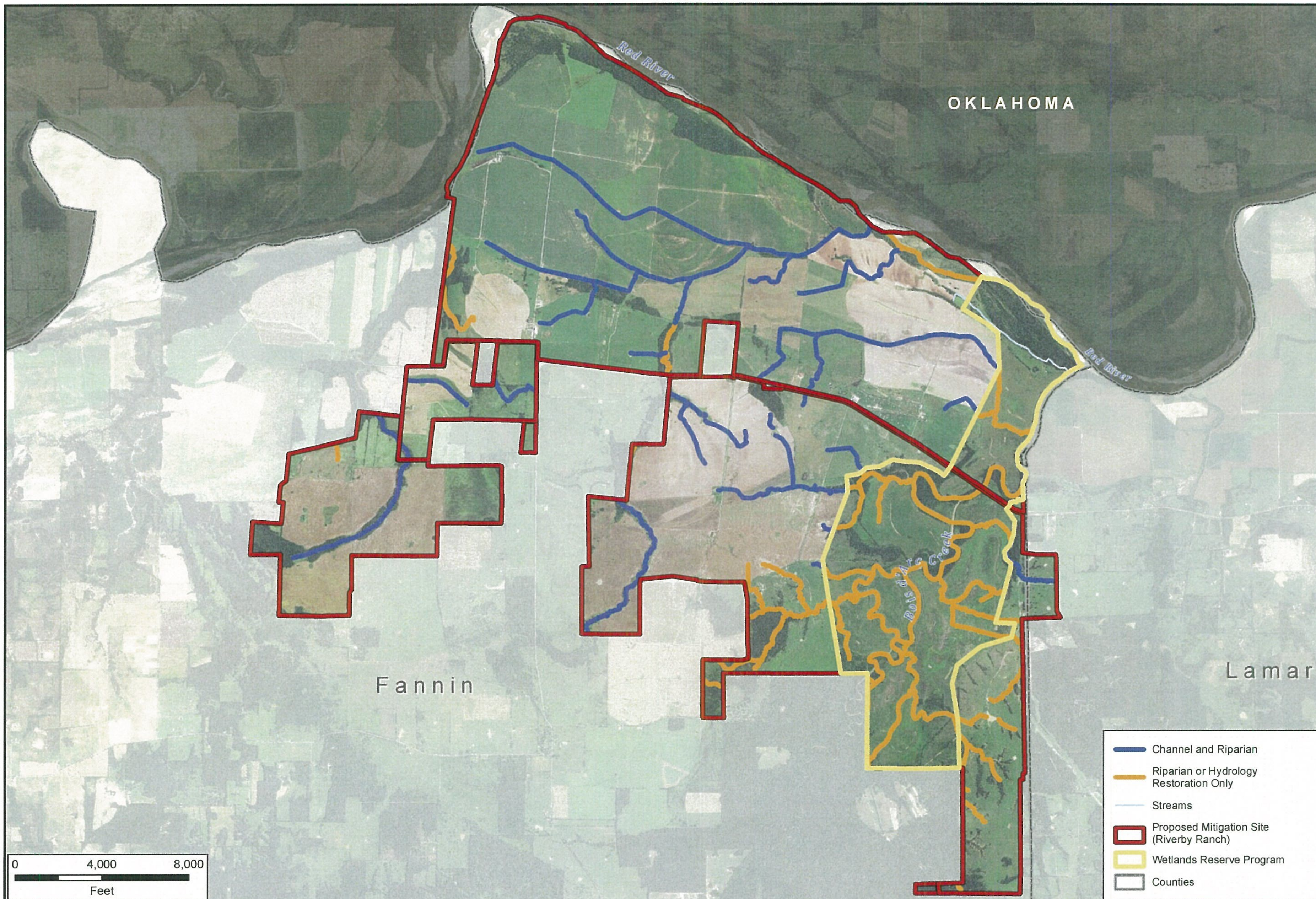

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Riverby Ranch Stream Work Type

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FIGURE 15

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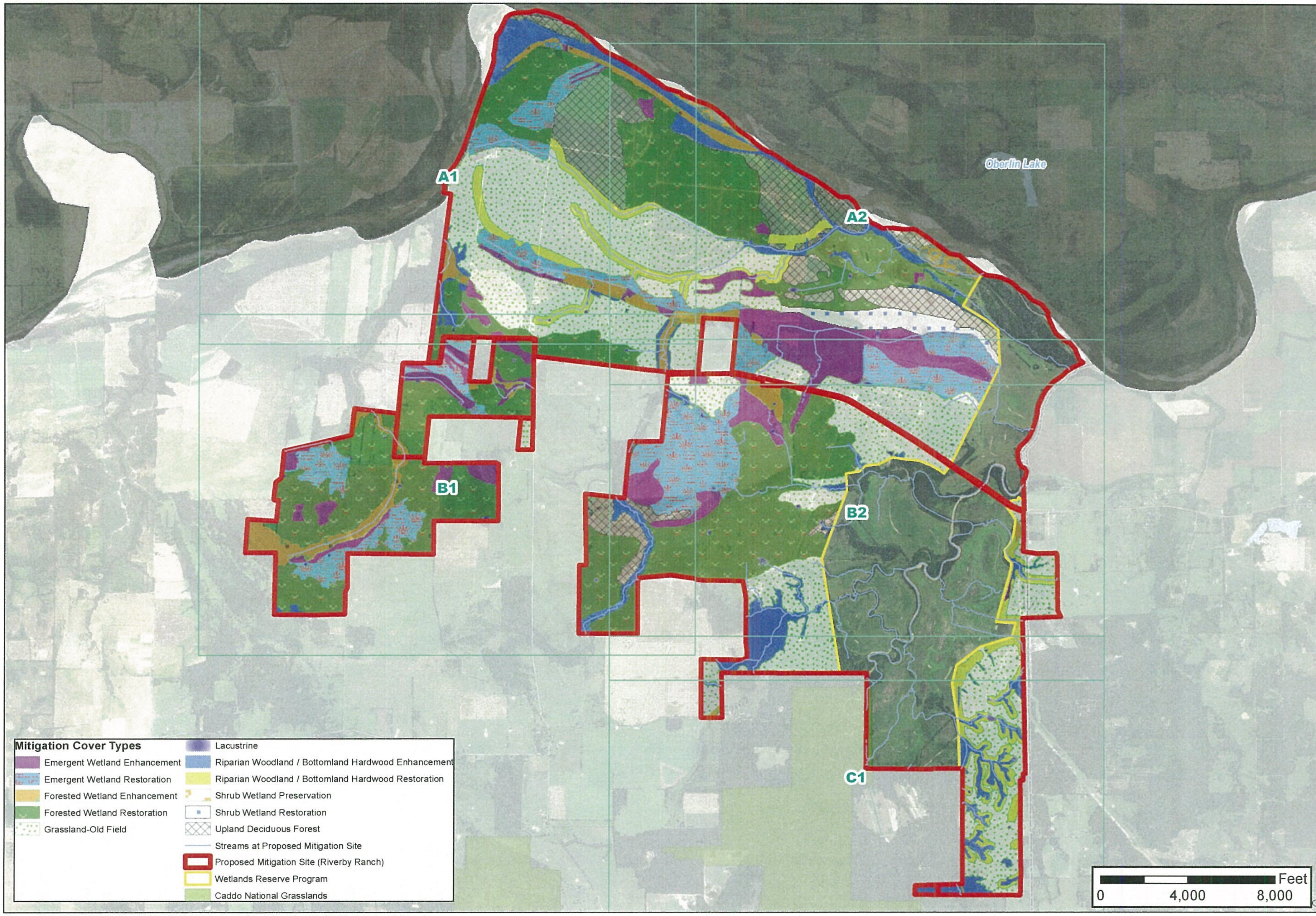

North Texas Municipal Water District

Index for Aquatic and Terrestrial Mitigation Area Maps

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FIGURE 16

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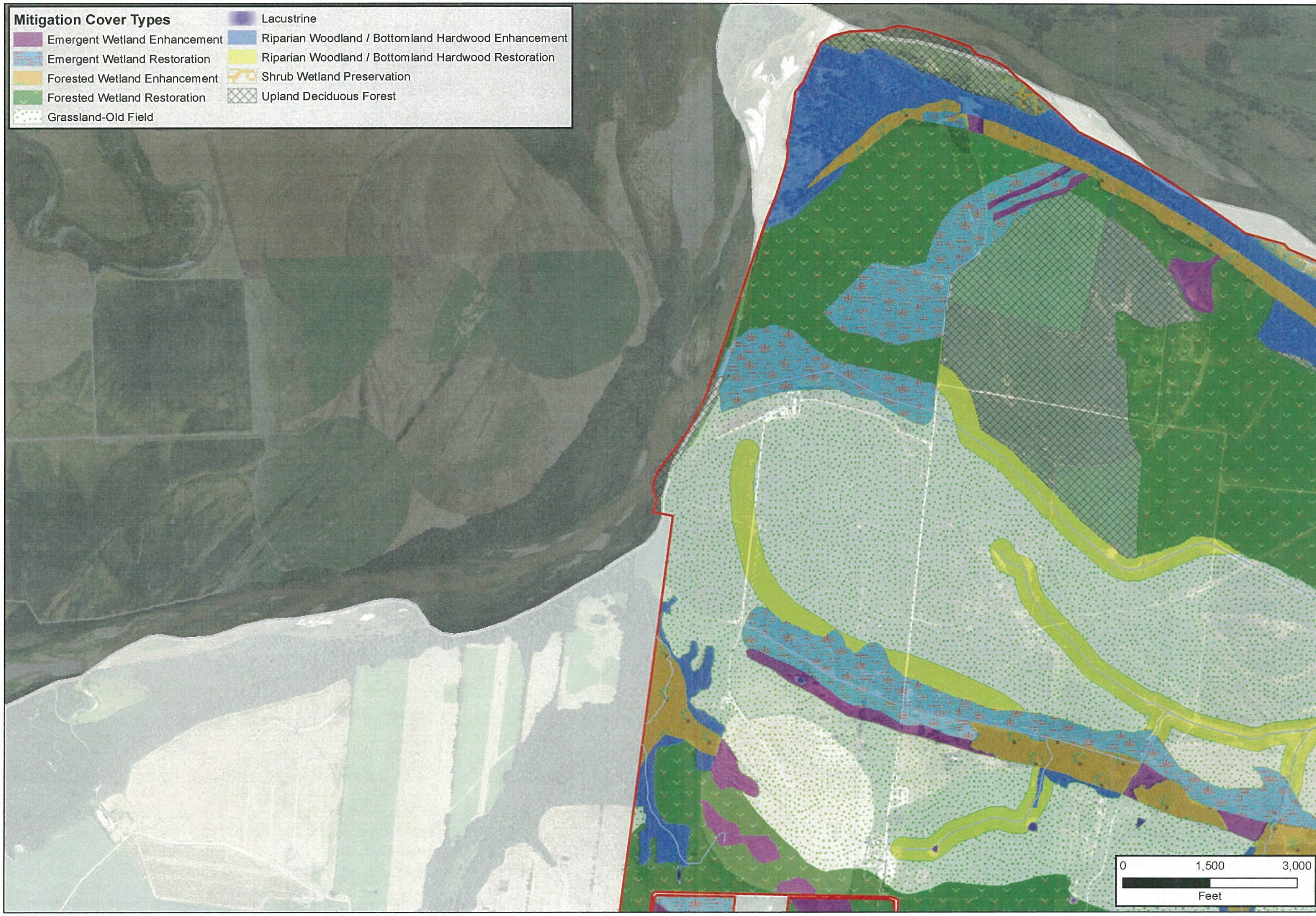

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North Texas Municipal Water District

Aquatic and Terrestrial Mitigation Area Maps

F&N JOB NO	NTD06128
DATE	Jan 2017
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16A-1
FIGURE

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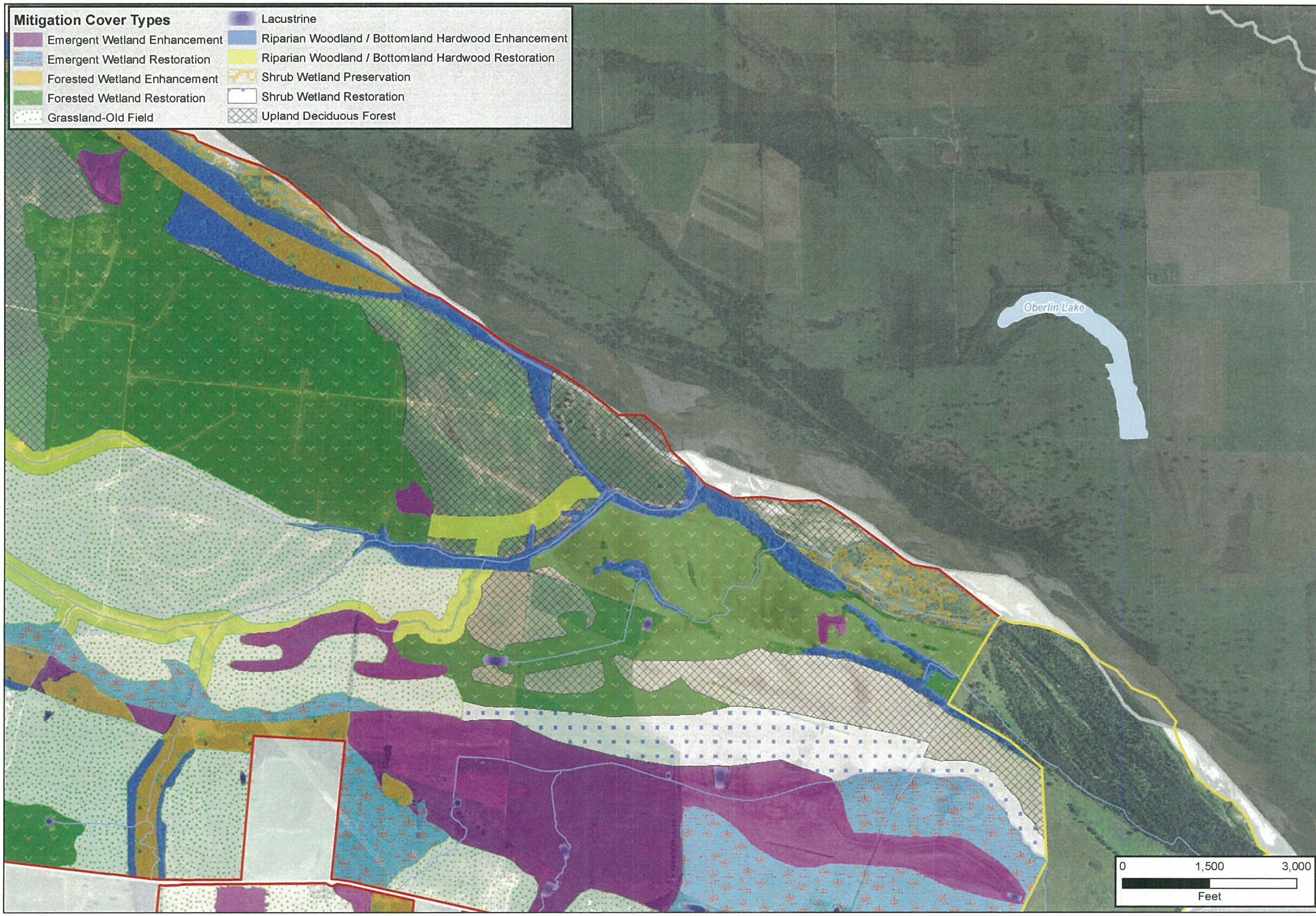

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North Texas Municipal Water District

Aquatic and Terrestrial Mitigation Area Maps

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16A-2
FIGURE

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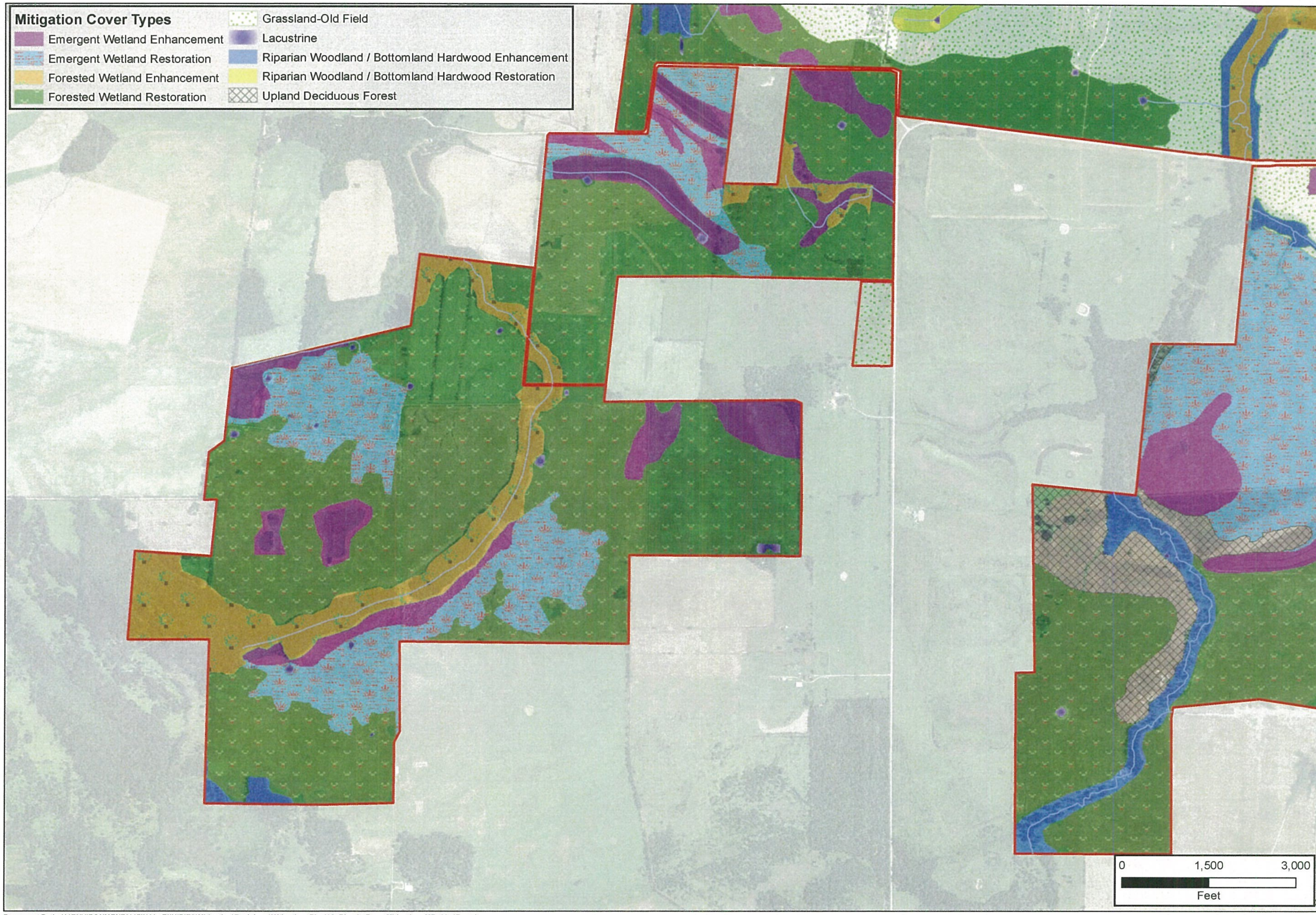

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North Texas Municipal Water District

Aquatic and Terrestrial Mitigation Area Maps

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16B-1

FIGURE

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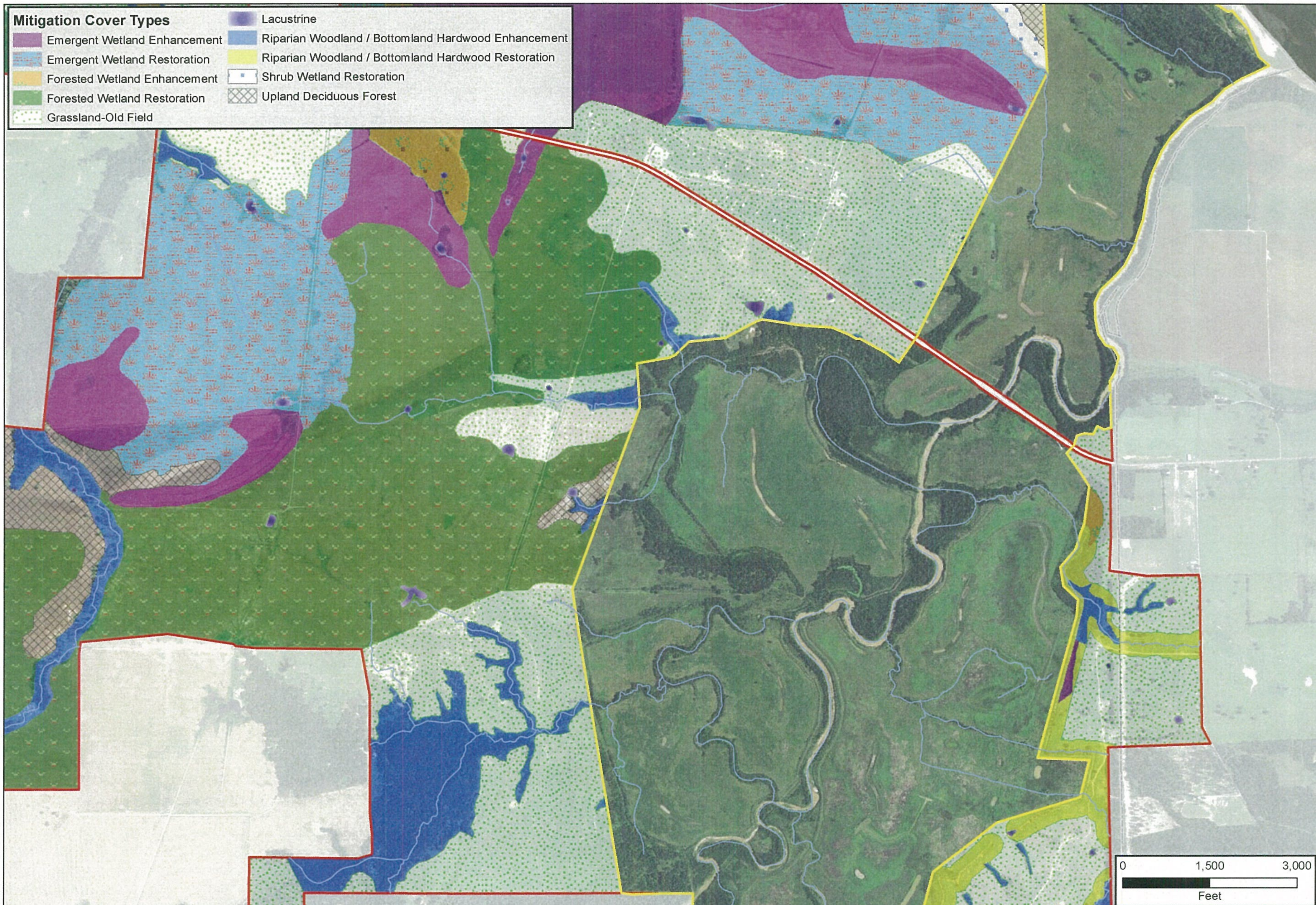

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North Texas Municipal Water District

Aquatic and Terrestrial Mitigation Area Maps

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16B-2

FIGURE

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North Texas Municipal Water District

Aquatic and Terrestrial Mitigation Area Maps

F&N JOB NO	NTD06128
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16C-1

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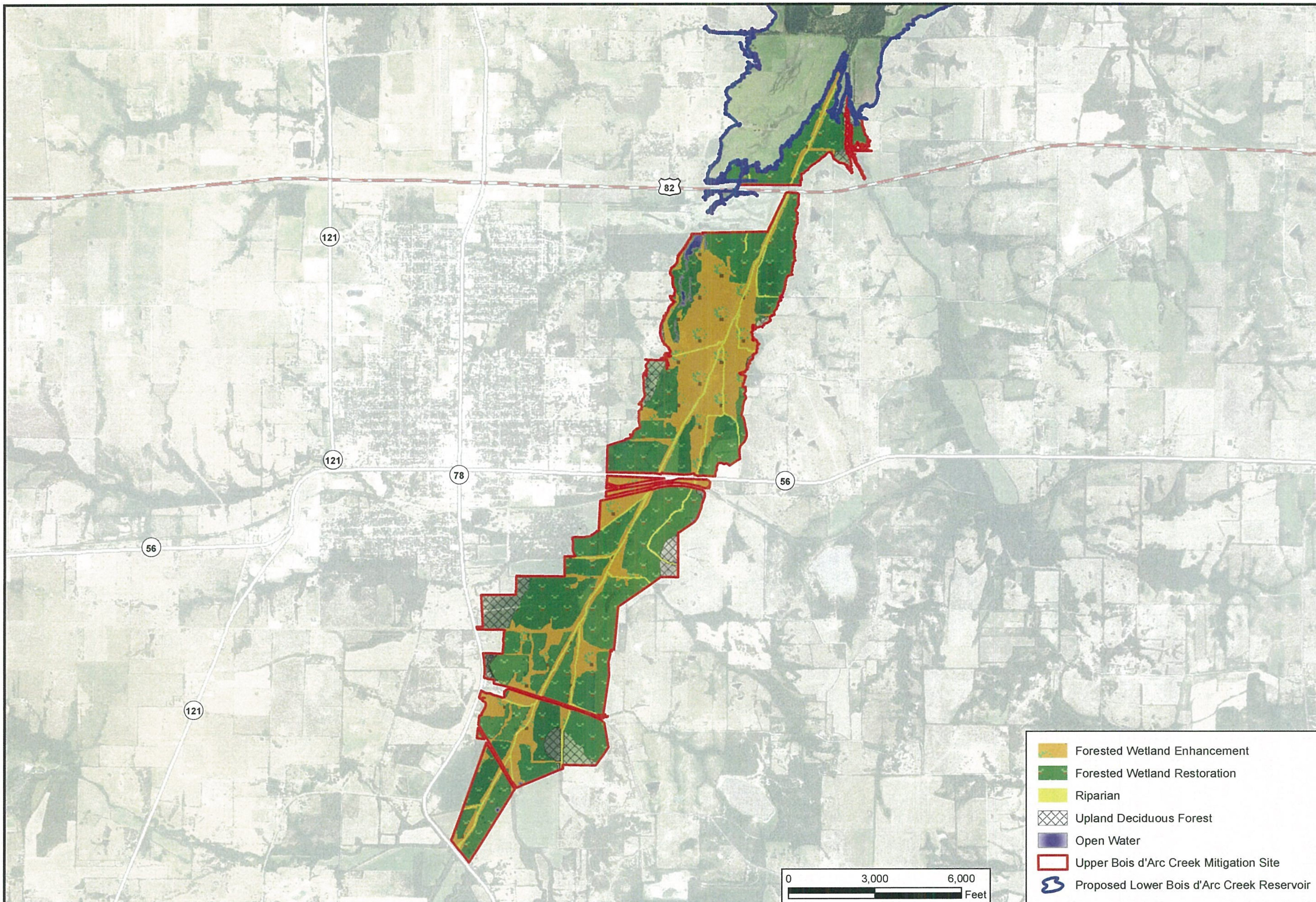

North Texas Municipal Water District

Proposed Upper Bois d'Arc Creek Mitigation Site
Proposed Cover Types

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FIGURE
17

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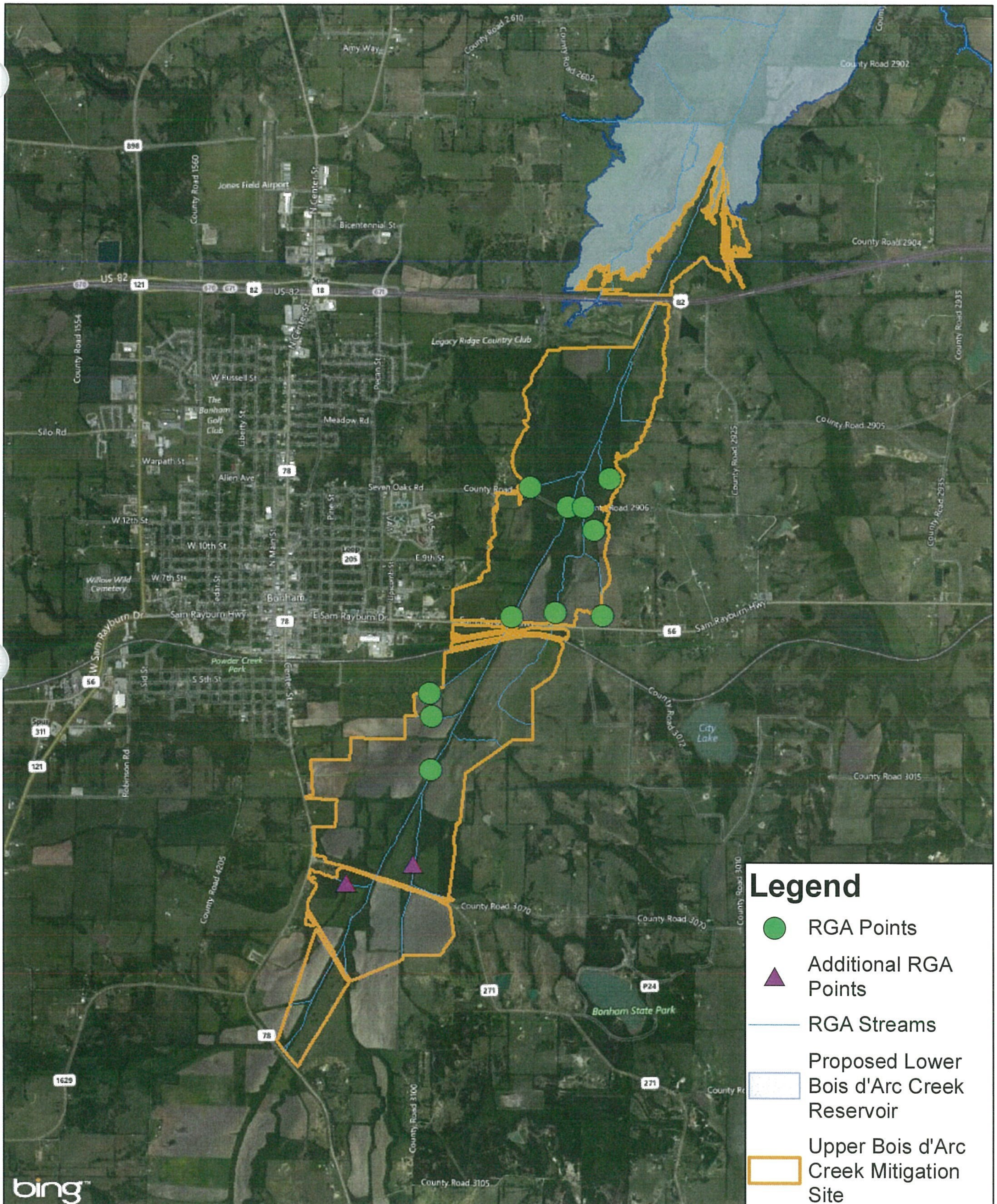

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NORTH TEXAS MUNICPAL WATER DISTRICT

Upper Bois d'Arc Creek Mitigation Site

Proposed RGA Monitoring Sites

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18
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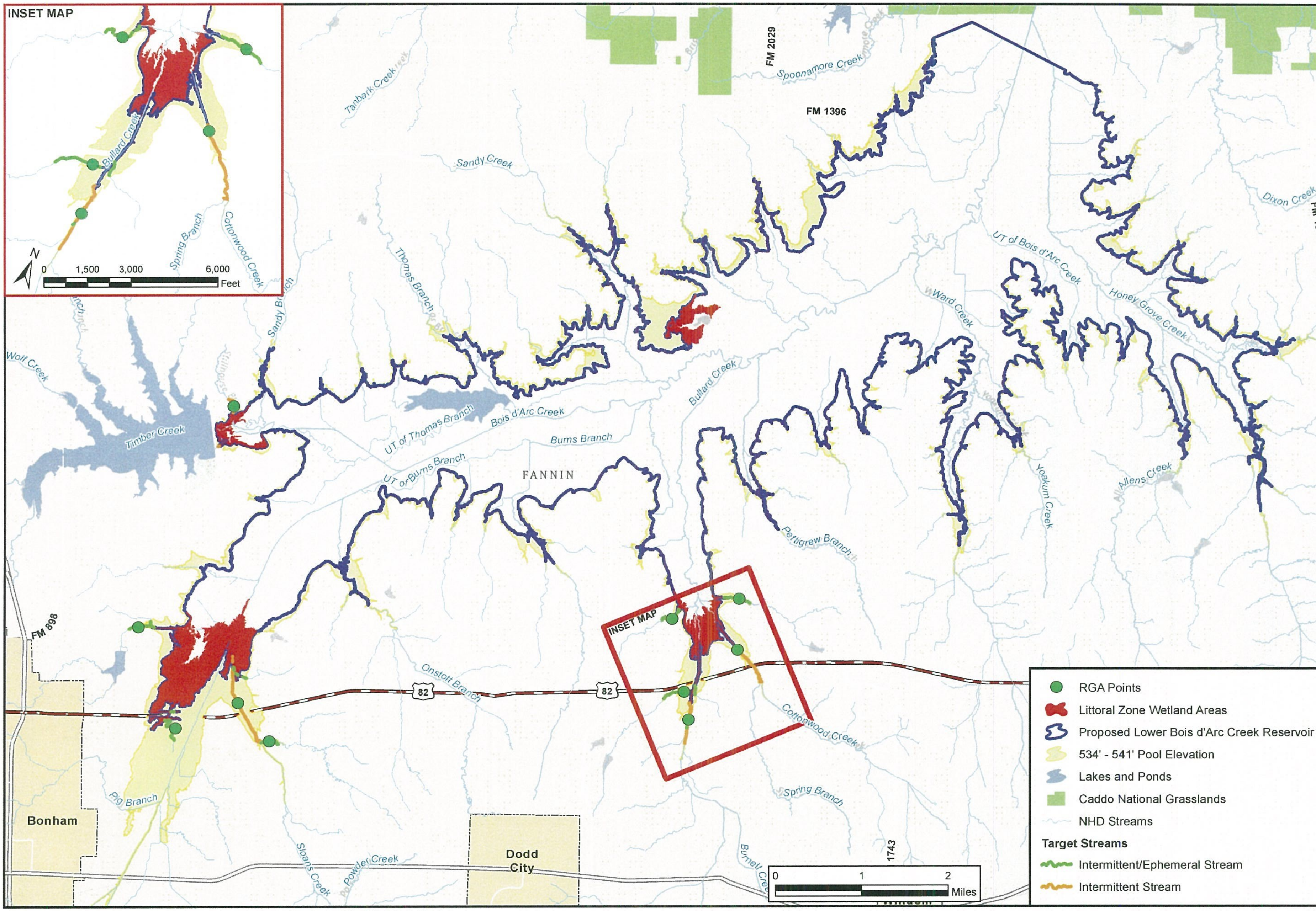

North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir Site

Littoral Zone Wetlands and On-Site Tributary Streams
Proposed RGA Monitoring Sites

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DATE	Jan 2017
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FIGURE **19**

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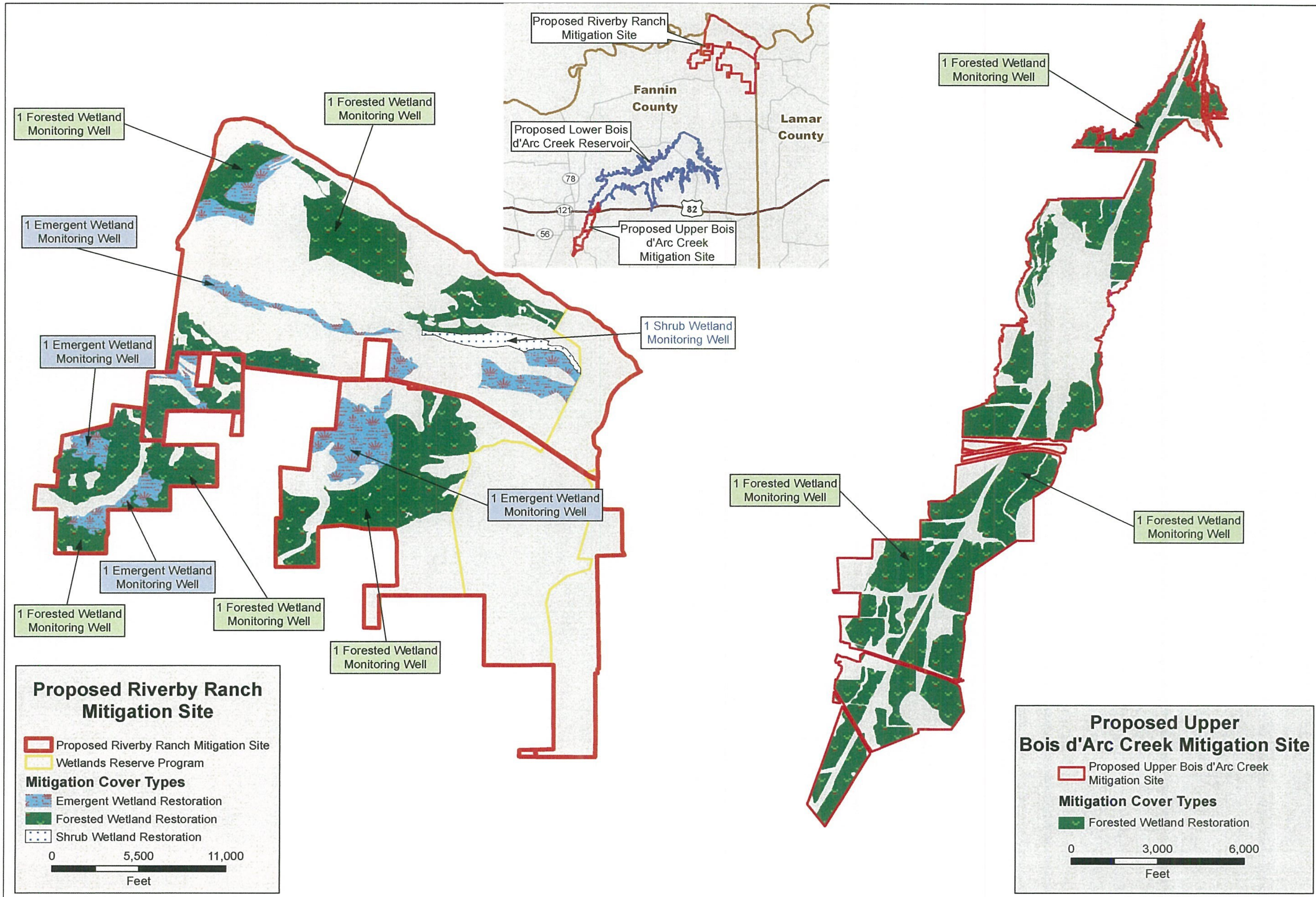

North Texas Municipal Water District

Potential Wetland Hydrology Monitoring Wells

N W E S

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

20
FIGURE

F&N JOB NO	NTD06128
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Appendix B

Common and Scientific Names (Existing)

Organisms Identified within Mitigation Plan

Common Name	Scientific Name
Birds	
American crow	*Corvus brachyrhynchos*
Barred owl	*Strix varia*
Canada goose	*Branta canadensis*
Carolina chickadee	*Poecile carolinensis*
Carolina wren	*Thryothorus ludovicianus*
Common yellowthroat	*Geothylpis trichas*
Ducks	Family: *Anatidae*
Great blue heron	*Ardea Herodias*
Great egret	*Ardea alba*
Indigo bunting	*Passerina cyanea*
Northern cardinal	*Cardinalis*
Northern harrier	*Circus cyaneus*
Painted bunting	*Passerina ciris*
Red-tailed hawk	*Buteo jamaicensis*
Solitary warbler	Family: *Parulidae*
Tufted titmouse	*Baeolophus bicolor*
White-eyed vireo	*Vireo griseus*
White-fronted goose (greater)	*Anser albifrons*
Forbs	
American lotus	*Nelumbo lutea*
Arrowhead	*Sagittaria* spp.
Balloon vine	*Cardiospermum halicacabum*
Black-eyed susan	*Rudbeckia hirta*
Buttercup	*Ranunculus* spp.
Clasping coneflower	*Dracopis amplexicaulis*
Dock	*Rumex* spp.
Drummond phlox	*Phlox drummondii*
Eared redstem	*Ammannia auriculata*
Evening primrose (pink)	*Oenothera speciosa*
Frogfruit	*Phyla* spp.
Goldenrod	*Solidago* spp.
Illinois bundleflower	*Desmanthus illinoensis*
Indian blanket	*Gaillardia pulchella*
Ironweed	*Vernonia* spp.
Lazy daisy	*Aphanostephus* sp.
Lemon mint	*Monarda citriodora*
Mockbishop weed	*Ptilimnium nuttallii*
Partridge pea	*Chamaecrista fasciculata*
Pennsylvania smartweed	*Polygonum pensylvanicum*
Plains coreopsis	*Coreopsis tinctoria*
Ragweed	*Ambrosia* spp.
Redstems	*Ammannia* spp.

Common Name	Scientific Name
Roundleaf groundsel	*Packera obouta*
Smartweeds	*Polygonum* spp.
Sumpweed	*Iva annua*
Water primrose	*Ludwigia* spp.
Wild pea	*Lathyrus* spp.
Grasses	
Barnyardgrass	*Echinochloa crus-galli*
Broomsedge bluestem	*Andropogon virginicus*
Bushy bluestem	*Andropogon glomeratus*
Crowngrass	*Paspalum* sp.
Eastern gamagrass	*Tripsacum dactyloides*
Indiangrass	*Sorghastrum nutans*
Little bluestem	*Schizachyrium scoparium*
Prairie wildrye	*Elymus canadensis*
Purpletop	*Tridens flavus*
Sand dropseed	*Sporobolus cryptandrus*
Sand lovegrass	*Eragrostis trichodes*
Sideoats grama	*Bouteloua curtipendula*
Switchgrass	*Panicum virgatum*
Virginia wildrye	*Elymus virginicus*
Insects	
Butterflies	Order: *Lepidoptera*
Mosquitoes	Family: *Culicidae*
Bees	Order: *Hymenoptera*
Dragonflies	Order: *Odonata*
Mammals	
Raccoon	*Procyon lotor*
American Beaver	*Castor canadensis*
River otter	*Lutra canadensis*
Feral hog	*Sus scrofa*
White-tailed deer	*Odocoileus virginianus*
Reptiles	
Ornate box turtle	*Terrapene ornata*
Cottonmouth water moccasin	*Agkistrodon piscivorus*
Copperhead	*Agkistrodon contortrix*
Amphibians	
Frogs	Order: *Anura*
Southern Leopard frog	*Rana sphenocephala*
Rushes and Sedges	
Blue sedge	*Carex glaucodea*
Cherokee sedge	*Carex cherokeensis*
Flatsedge	*Cyperus* spp.
Flatstem spikerush	*Eleocharis compressa*

Common Name	Scientific Name
Grassleaf rush	*Juncus marginatus*
Green flatsedge	*Cyperus virens*
Horned beakrush	*Rhynchospora corniculata*
Slimpod rush	*Juncus diffusissimus*
Spikerush	*Eleocharis* spp.
Shrubs and Vines	
American beautyberry	*Callicarpa americana*
Baccharis	*Baccharis* spp.
Buttonbush	*Cephalanthus occidentalis*
Coralberry	*Symphoricarpos orbiculatus*
Deciduous holly	*Ilex decidua*
Hydrolea	*Hydrolea ovata*
Poison ivy	*Toxicodendron radicans*
Salt cedar	*Tamarix chinensis*
Sandbar willow	*Salix exigua*
Swamp privet	*Forestiera acuminata*
Virginia creeper	*Parthenocissus quinquefolia*
Trees	
American sycamore	*Platanus occidentalis*
Black cherry	*Prunus serotina*
Black hickory	*Carya texana*
Black oak	*Quercus velutina*
Black walnut	*Juglans nigra*
Black willow	*Salix nigra*
Bois d'Arc	*Maclura pomifera*
Box elder	*Acer negundo*
Bur oak	*Quercus macrocarpa*
Cedar elm	*Ulmus crassifolia*
Cherrybark oak	*Quercus pagoda*
Chinkapin oak	*Quercus muehlenbergii*
Dogwood	*Cornus spp.*
Eastern cottonwood	*Populus deltoides*
Eastern redbud	*Cercis canadensis*
Eastern red cedar	*Juniperus virginiana*
Elm	*Ulmus* spp.
Green ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis occidentalis*
Hawthorn	*Crataegus spp.*
Hickory	*Carya spp.*
Honey locust	*Gleditsia triacanthos*
Overcup oak	*Quercus lyrata*
Pecan	*Carya illinoinensis*
Post oak	*Quercus stellata*
Persimmon	*Diospyros spp.*
Red maple	*Acer rubrum*

Common Name	Scientific Name
Red mulberry	*Morus rubra*
Shumard oak	*Quercus shumardii*
Soapberry	*Sapindus spp.*
Southern red oak	*Quercus falcata*
Sugarberry	*Celtis laevigata*
Water oak	*Quercus nigra*
White oak	*Quercus alba*
Willow oak	*Quercus phellos*
Other	
Crayfish	Family: *Cambaridae*
Mussels	Family: *Unionidae*
Mosquitofish	*Gambusia affinis*
Land snails	Class: *Gastropoda*

Appendix C

Habitat Evaluation Procedures

Estimation of Future Wetland Habitat Unit Production at Riverby Ranch

The purpose of this memo is to describe the methods used to estimate the Habitat Units (HU) values at the near-site mitigation property Riverby Ranch. Baseline and future HU values were estimated for three wetland cover type categories. *Existing Emergent Wetlands* refer to the acreage of land at Riverby Ranch designated as these cover types in the July 2009 field evaluations. *Restored Shrub Wetlands* and *Restored Emergent Wetlands* are those acreages expected to be converted from existing *Cropland* or *Grassland* acreage.

Baseline (year 0) HU values for *Existing Emergent Wetlands* were calculated using Habitat Evaluation Procedures (HEP) analysis of habitat variables measured in the field in September and October 2010. No baseline (year 0) HU calculations for Existing Shrub Wetlands was performed, as discussed in the Mitigation Plan. Baseline HU values for *Restored Shrub Wetlands* and *Restored Emergent Wetlands* and expected future HU values for all cover type categories were calculated from predicted values for each habitat variable used in the HEP analysis.

The following sections describe the planned enhancement and/or restoration actions that were predicted to affect a change in future habitat variable values. Other mitigation efforts may be proposed in the Mitigation Plan, but are not included in the following discussion.

Restored Shrub Wetlands

The Mitigation Plan proposes to construct 150 acres of *Restored Shrub Wetlands* from existing *Cropland* and *Grassland* areas of Riverby Ranch. The baseline HSI value for this cover type category was calculated from the predicted values of *Shrub Wetland* habitat variables if measured in a *Cropland* or *Grassland* area, resulting in a Year 0 value of 0 HUs. The Mitigation Plan proposes the following preservation, enhancement, and restoration efforts at these sites:

- Establishment of a deed restriction
- Cessation of land clearing
- Cattle removal/control of herbivores
- Invasive species removal/control
- Restoration of vegetation, particularly the planting of native shrub wetland species
- Restoration of wetland hydrology

These efforts, along with a 5-year time period of vegetative growth, were predicted to result in positive changes to habitat variables for this cover type. These changes, described in the table below, would produce an expected gain of 103.5 HUs.

Habitat Variable Affected	Predicted Values	
	Year 0	Year 5
Distance to water (mi.) *(Raccoon)*	0	0.1
Water regime: A) Permanent water; B) Semi-permanent water; C) None or ephemeral flooding *(Raccoon and Green Heron)*	0	B
Water regime: 1) Permanent; 2) Intermittently exposed; 3) Semi-permanent; 4) Seasonally flooded; 5) None or ephemeral *(Swamp Rabbit)*	0	4
Water current: A) Still or slow; B) Moderately slow; C) Moderately fast; D) Fast *(Green Heron)*	A	A
Number per acre of refuge sites *(Raccoon)*	0	1
Percent water area <10" deep *(Green Heron)*	0	100
Percent emergent herbaceous cover in littoral zone *(Green Heron)*	0	50
Percent water area covered by logs, trees limbs, shrub cover or herbaceous vegetation in summer *(Wood duck)*	0	50
Percent water surface covered by logs, tree or shrub overhangs, etc. in winter *(Wood duck)*	0	50
Aquatic substrate composition: A) Muddy; B) Sandy; C) Rocky *(Green Heron)*	A	A
Number per acre of potential nest cavities *(Wood Duck)*	0	1
Percent shrub crown closure *(Swamp Rabbit)*	0	50
Percent herbaceous canopy cover *(Swamp Rabbit)*	0	75

Existing Emergent Wetlands

Riverby Ranch contains 1,377 acres of *Existing Emergent Wetlands*. The baseline HSI value of this covertype was calculated from field data to be 0.23, which equates to 316.7 HUs. The Mitigation Plan proposes the following preservation and enhancement efforts at the site:

- Establishment of a deed restriction
- Cattle removal/control of herbivores
- Invasive species removal/control

These efforts along with a 5-year time period of vegetative regeneration are predicted to result in positive changes to the habitat variables for this cover type. These changes, described in the table below, would produce a expected gain of 275.4 HUs in 5 years.

Habitat Variable Affected	Predicted Change in Value (Year 5)
Percent cover of emergent herbaceous in littoral zone *(Green heron)*	Increase from 0% to 80%
Percent of water area covered by logs, trees limbs, shrub cover or herbaceous vegetation in summer (live or dead & overhanging within 1 m of surface) *(Green heron)*	Increase from 0% to 30%
Percent of water surface covered by logs, tree or shrub overhangs, etc. in winter (persistent) *(Wood duck)*	Increase from 0% to 10%

Restored Emergent Wetlands

The Mitigation Plan proposes to construct 1,100 acres of *Restored Emergent Wetlands* from existing *Cropland* and *Grassland* areas of Riverby Ranch. The baseline HSI value for this cover type category was calculated from the predicted values of *Emergent Wetland* habitat variables if measured in a *Cropland* or *Grassland* area, resulting in a Year 0 value of 0 HUs. The Mitigation Plan proposes the following preservation, enhancement, and restoration efforts at these sites:

- Establishment of a deed restriction
- Cattle removal/control of herbivores
- Invasive species removal/control
- Restoration of wetland hydrology
- Restoration of vegetation

Over the 5-year period, the above actions are expected to result in positive changes to the habitat variables for this cover type. These changes, described in the table below, would produce an expected gain of 440 HUs.

Habitat Variable Affected	Predicted Change in Value (Year 5)
Distance to water *(Raccoon)*	Decrease from ~500 yd. to 0 yd.
Water regime category (Permanent, Semi-permanent, or None/Ephemeral) *(Raccoon, Green heron)*	Change from "None/Ephemeral" to "Permanent"
Percent of water area less than 10 in. deep in average summer conditions *(Green heron)*	Increase from 0% to 50%
Percent cover of emergent herbaceous in littoral zone *(Green heron)*	Increase from 0% to 80%
Percent of water area covered by logs, trees limbs, shrub cover or herbaceous vegetation in summer (live or dead & overhanging within 1 m of surface) *(Green heron)*	Increase from 0% to 30%

Percent of water surface covered by logs, tree or shrub overhangs, etc. in winter (persistent) (*Wood duck)*	Increase from 0% to 10%

Appendix D

Hydrogeomorphic Method (HGM) for Forested Wetlands

Technical Memorandum on Functional Assessment of Forested Wetlands at the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

MEMORANDUM

FREESE AND NICHOLS

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TO: Robert McCarthy, North Texas Municipal Water District

CC: Simone Kiel, P.E., Steve Watters, PWS

FROM: Michael Votaw, PWS, CWB

SUBJECT: Functional Assessment of Forested Wetlands at the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

DATE: 6/22/2016

PROJECT: NTD06128 - Lower Bois d'Arc Creek Reservoir

INTRODUCTION

At the request of the Tulsa District U.S. Army Corps of Engineers (USACE), the North Texas Municipal Water District (NTMWD) has completed a functional assessment of forested wetlands located within the footprint of the proposed Lower Bois d'Arc Creek Reservoir project (Figure 1). The functional assessment method utilized is a modification of the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams, et al., 2010). Modifications to the guidebook were completed as a joint effort between the Tulsa District USACE, the U.S. Army Corps of Engineers Research and Development Center (ERDC), and Stephen F. Austin State University (SFA). Documentation of how the guidebook was modified can be found in *Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016). The purpose of conducting the functional assessment was to develop indices for the wetland functions being performed by the forested wetlands within the proposed reservoir site and to estimate potential impacts to those forested wetlands resulting from reservoir construction. The six functions assessed using the modified hydrogeomorphic (HGM) assessment method include, Detain Floodwater, Detain Precipitation, Cycle Nutrients, Export Organic Carbon, Maintain Plant Communities, and Provide Habitat for Fish and Wildlife. The following information describes the application of the modified HGM method and the results from this effort.

METHODS

The methods used for this assessment followed the protocol as described in the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams, et al. 2010) and from *Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016).

The 4,602 acres (1,862 hectares) of forested wetlands within the footprint of the proposed Lower Bois d'Arc Creek Reservoir site would be classified as riverine wetlands according to the Regional Guidebook. Riverine wetlands are a class of wetlands that occur within the 5-year floodplains and riparian corridors associated with stream channels. Their primary source of water comes from overbank or backwater flow from the channel. Other sources of hydrology include interflow, overland flow from adjacent uplands, tributary inflow, and direct precipitation. The forested wetlands within the proposed reservoir site and associated 5-year floodplain are shown on Figure 2.

Following the HGM methodology, riverine wetlands are further refined into two sub-classes: low-gradient riverine, and mid-gradient riverine. Low-gradient riverine wetlands occur within the floodplains of major rivers. The floodplains can be very wide even along relatively narrow channels, a common feature of modern coastal plain river systems (Bridge 2003). Typically, these systems have large, distinctive geomorphic features and often receive both backwater and overbank flooding. Their typical hydrogeomorphic setting includes point bars, backswamps, and natural levee deposits associated with meandering streams within the 5-year floodplain (Williams et al. 2010). Based on these characteristics, it was determined that the forested wetlands within the footprint of the proposed reservoir would fall within the sub-class, low-gradient riverine.

The Wetland Assessment Area (WAA) utilized for this functional assessment includes all of the forested wetlands identified within the footprint of the proposed reservoir (4,602 acres/1,862 hectares). According to the Regional Guidebook, each WAA belongs to a single regional wetland sub-class and is relatively homogenous with respect to the criteria used to assess wetland functions (i.e., hydrologic regime, vegetation structure, topography, soils, successional stage). All of the forested wetlands within the footprint of the proposed reservoir were identified as sub-class low-gradient riverine, are contiguous, and are located within the 5-year floodplain of Bois d'Arc Creek (Figure 2). Additionally, these wetlands are strongly associated with the Tinn Clay, 0-1 percent slopes, frequently flooded and Tinn Clay, 0-1 percent slopes, occasionally flooded soil map units (Figure 3) and all are dominated by three primary tree species including, green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*). Based on these data, one WAA was identified that included all forested wetlands within the project area.

Following the identification of the WAA to designate the project boundary, sample plot locations were identified to collect field data. The plot locations were reviewed by all cooperating agencies involved in the project prior to data collection efforts. From December 15 through 17, 2015, FNI environmental scientists, regulatory staff from the Tulsa District USACE, and NTMWD representatives collected field data at 12 sample plot locations within the footprint of the proposed Lower Bois d'Arc Creek Reservoir site (Figure 4). Data collection was performed utilizing the modified low-gradient riverine data collection form and following the protocol described in the Regional Guidebook. At each sample plot location, data forms were completed, GPS coordinates were recorded, and photographs were taken. Photographs from each sample plot are located in Attachment A.

Field data collected during the December 2015 field efforts at the proposed Lower Bois d'Arc Creek Reservoir site were entered into the modified East TX HGM calculator provided by ERDC. Once data were entered, the calculator provided an average measure for each variable and its associated sub-index score. The average measure and sub-index scores for each variable evaluated for the forested wetlands at the proposed Lower Bois d'Arc Creek Reservoir site are summarized in Table 1. The sub-index scores for each variable were then utilized in the formulas (assessment models) for each of the six functions assessed to calculate a functional capacity index (FCI) value for each function. The FCI value represents the ability of a wetland to perform a specific function relative to the ability of reference standard wetlands to perform the same function. The theoretical FCI value ranges from 0.0 to 1.0, where wetlands with an FCI of 1.0 perform the assessed function at a level that is characteristic of reference standard wetlands. A lower FCI indicates that the wetland is performing a function at a level below that characteristic of reference standard wetlands. The FCI values for each function were then multiplied by the area (hectares) of forested wetlands in the WAA to determine functional capacity units (FCU) for each function, as shown in the following equation:

Functional Capacity Unit (FCU) = Functional Capacity Index (FCI) x Area (hectares)

RESULTS

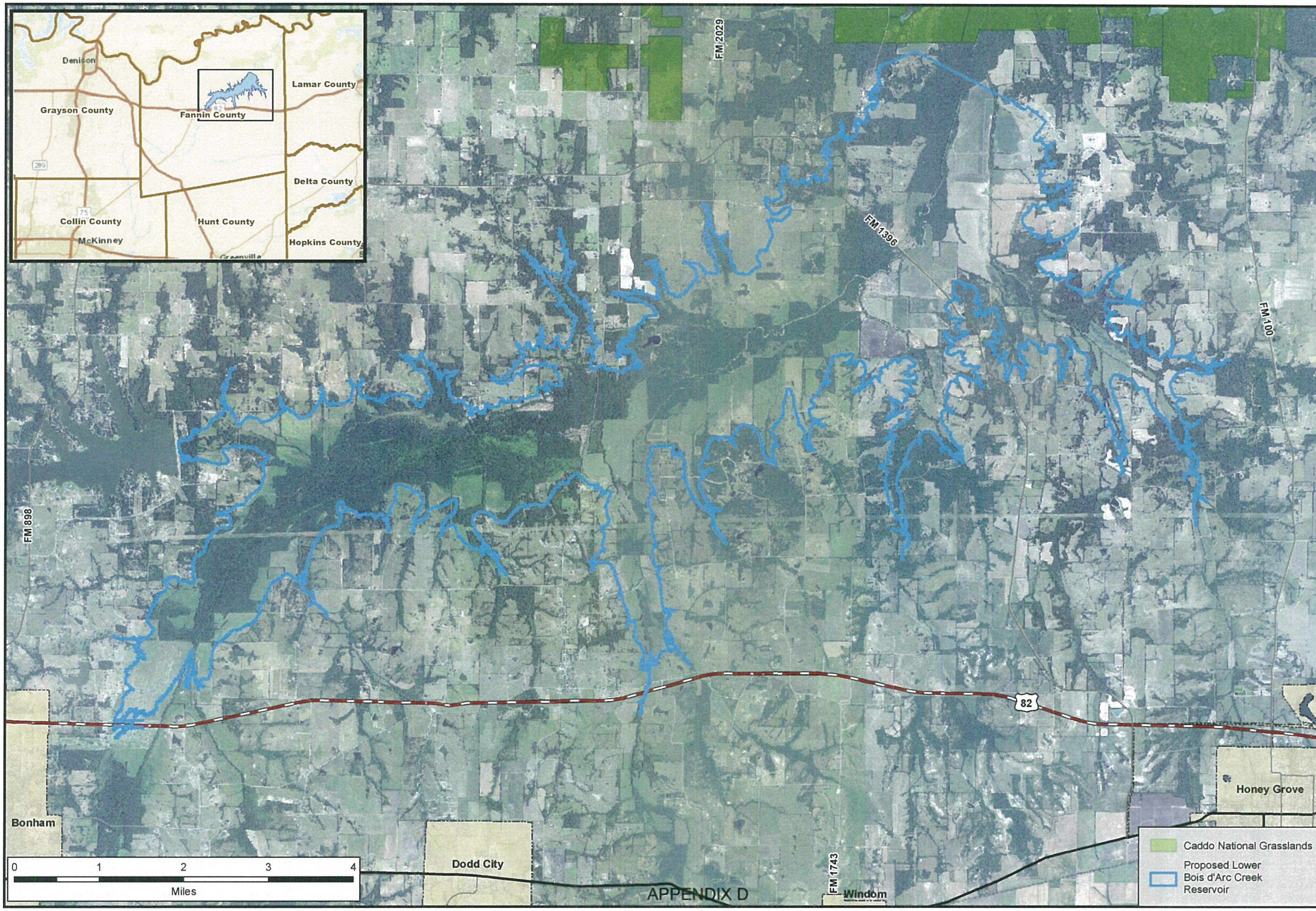
In the case of the proposed reservoir site, the WAA was determined to be the total acreage of forested wetlands within the footprint of the reservoir, which was 4,602 acres (1,862 hectares). The FCI values and resulting FCU's for each function are summarized in Table 2. Output from the modified East TX HGM calculator, including the FCI calculator and Data Summary by Plot tabs, are located in Attachment B.

Table 1. Average Measure and Sub-Index Values of the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Variable	Name	Average Measure	Sub-Index
V_{PATCH}	Forest Patch Size (ha)	2,500	1.00
V_{FREQ}	Change in Frequency of Flooding (years change)	0	1.00
V_{DUR}	Change in Growing Season Flood Duration (weeks change)	0	1.00
V_{POND}	Total Ponded Area (%)	30	1.00
V_{STRATA}	Number of Vegetation Strata	4	1.00
V_{SOIL}	Soil Integrity (%)	0	1.00
V_{TBA}	Tree Basal Area (m^3/ha)	29	1.00
V_{TDEN}	Tree Density (stems/ha)	690	0.81
V_{SNAG}	Snag Density (stems/ha)	79	1.00
V_{OHOR}	O Horizon Accumulation (cm)	0	0.20
V_{COMP}	Composition of Tallest Woody Stratum (%)	0.70	0.70
V_{TCOMP}	Tree Composition (%)	0.70	0.70
V_{SSD}	Shrub-Sapling Density (stems/ha)	875	0.88
V_{GVC}	Ground Vegetation Cover (%)	29	1.00
V_{LITTER}	Litter Cover (%)	57	0.92
V_{LOG}	Log Biomass (m^3/ha)	29	1.00
V_{WD}	Woody Debris Biomass (m^3/ha)	51	1.00

Table 2. Functional Capacity Index (FCI) Values and Functional Capacity Units (FCU) of the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Function	Functional Capacity Index (FCI)	Functional Capacity Units (FCU)
Detain Floodwater	0.92	1,713.04
Detain Precipitation	0.78	1,452.36
Cycle Nutrients	0.85	1,582.70
Export Organic Carbon	0.87	1,619.94
Maintain Plant Communities	0.90	1,675.80
Provide Habitat for Fish and Wildlife	0.86	1,601.32



APPENDIX D

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site

Location Map

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FIGURE 1

F&N JOB NO	NTD06128
DATE	June, 2016
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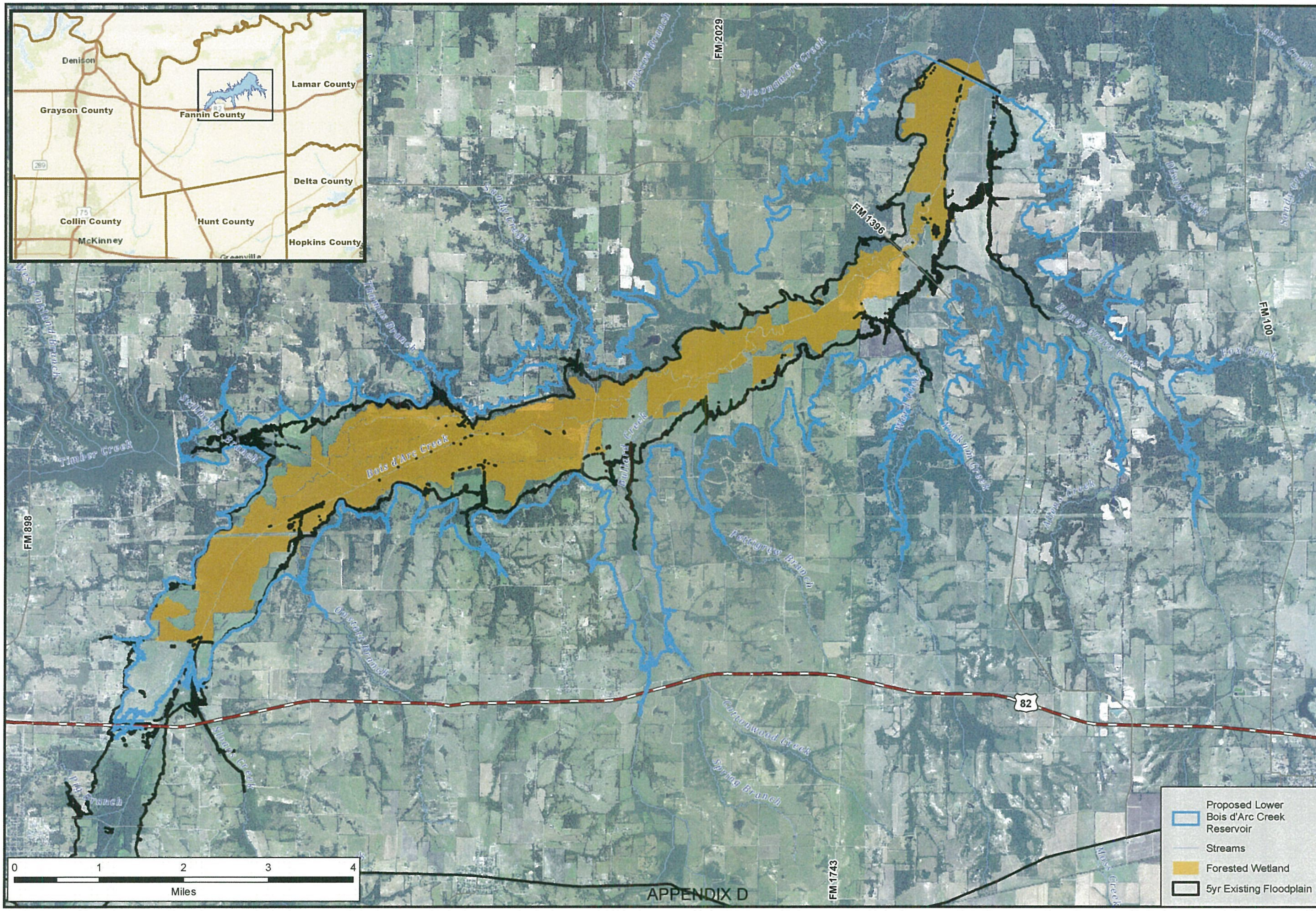

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site
Existing 5-Yr Floodplain

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DATE	June, 2016
SCALE	1:65,000
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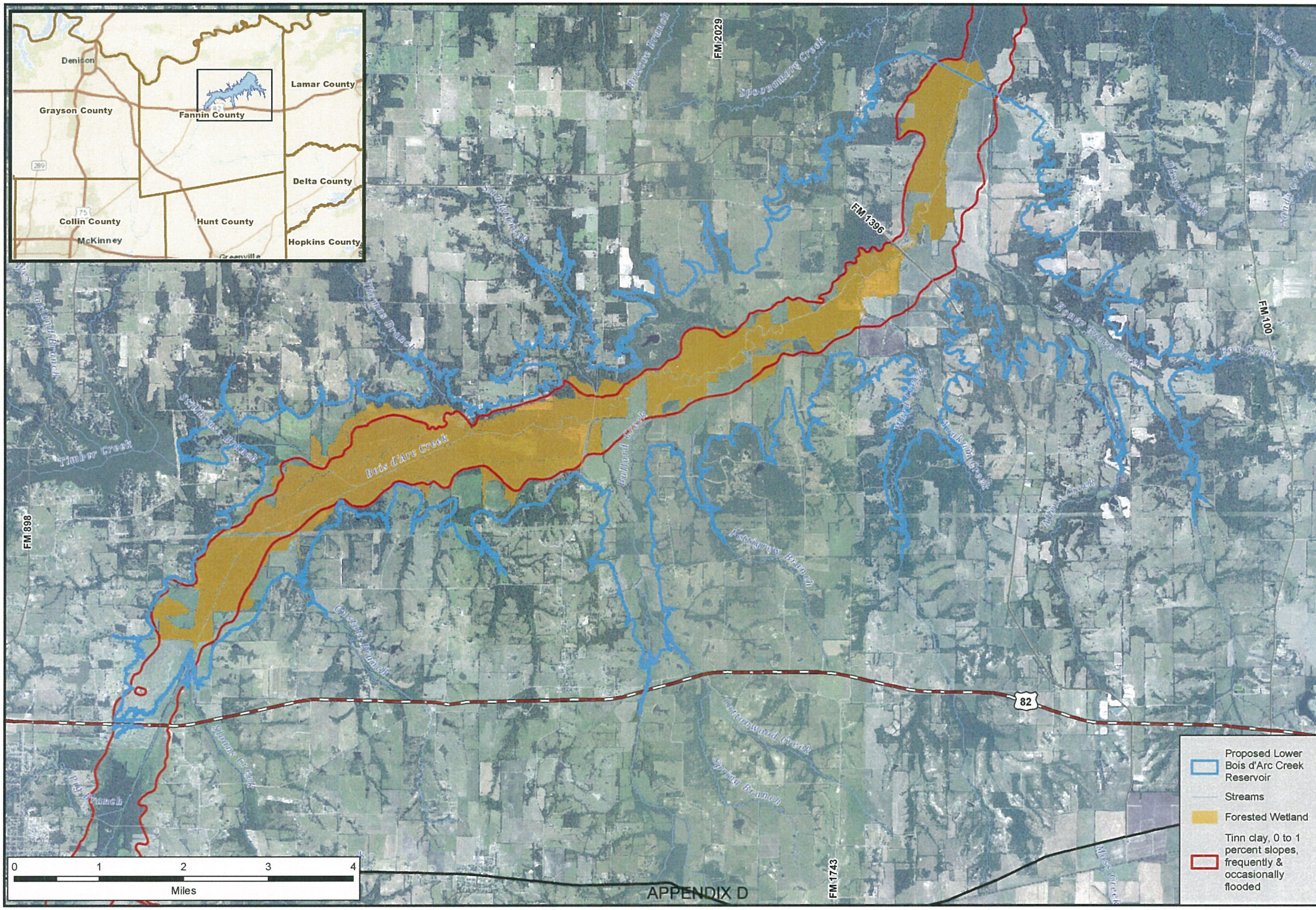
FIGURE 2

APPENDIX D



North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site
Hydric Soils

F&N JOB NO	NTD06128
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SCALE	1:65,000
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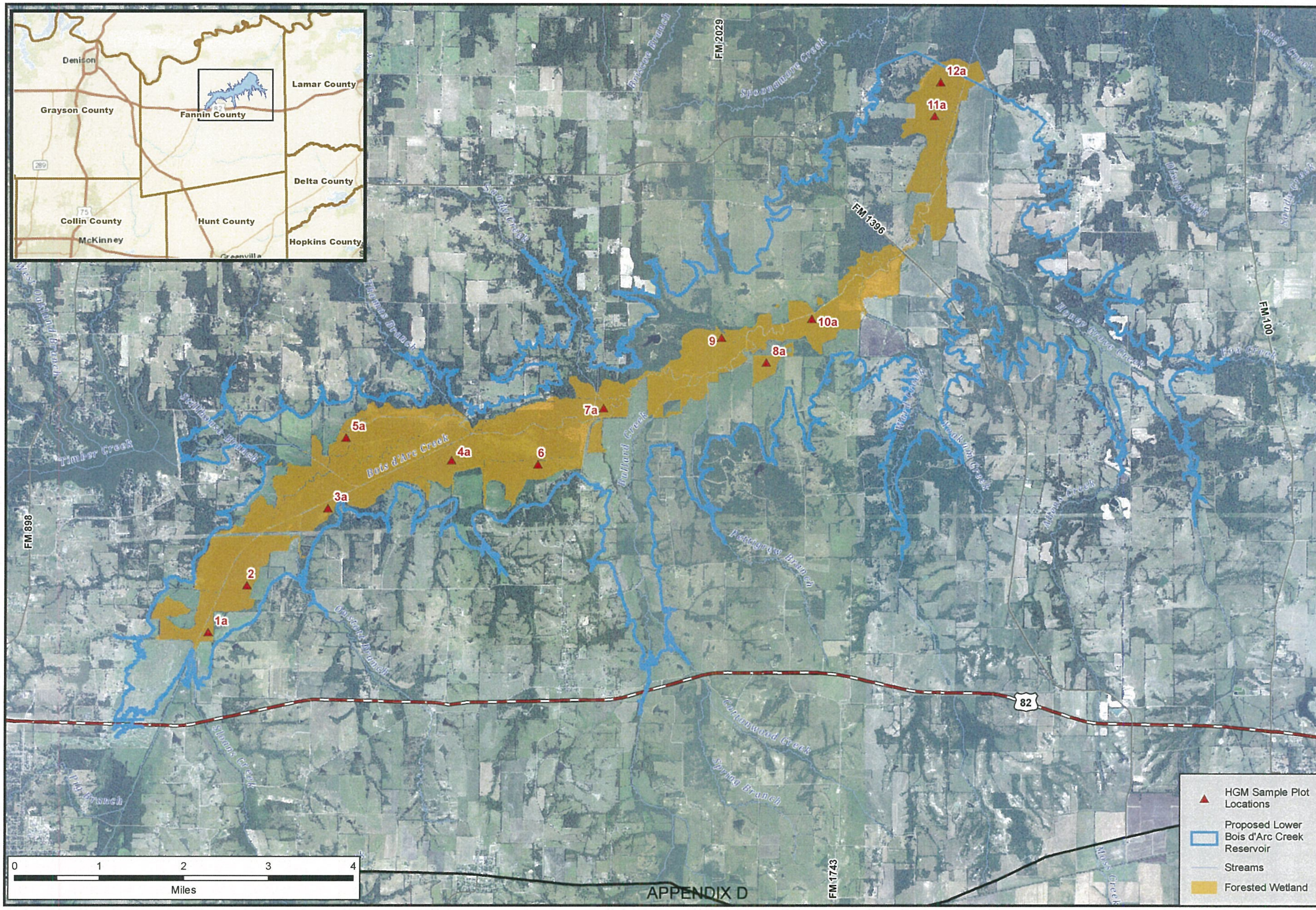
3
FIGURE

APPENDIX D



APPENDIX D

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site
HGM Sample Plot Locations

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FIGURE 4

FN JOB NO	NTD06128
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ATTACHMENT A
Photographs

Photo 1. Site 1A, view looking north

Photo 2. Site 1A, view looking south

APPENDIX D

Photo 3. Site 1A, view looking east

Photo 4. Site 1A, view looking west

APPENDIX D

Photo 5. Site 2, view looking north

Photo 6. Site 2, view looking south

APPENDIX D

Photo 7. Site 2, view looking east

Photo 8. Site 2, view looking west

Photo 9. Site 3A, view looking north

Photo 10. Site 3A, view looking south

APPENDIX D

Photo 11. Site 3A, view looking east

Photo 12. Site 3A, view looking west

APPENDIX D

Photo 13. Site 4A, view looking north

Photo 14. Site 4A, view looking south

APPENDIX D

Photo 15. Site 4A, view looking east

Photo 16. Site 4A, view looking west

APPENDIX D

Photo 17. Site 5A, view looking north

Photo 18. Site 5A, view looking south

Photo 19. Site 5A, view looking east

Photo 20. Site 5A, view looking west

APPENDIX D

Photo 21. Site 6, view looking north

Photo 22. Site 6, view looking south

APPENDIX D

Photo 23. Site 6, view looking east

APPENDIX D

Photo 24. Site 6, view looking west

Photo 25. Site 7A, view looking north

Photo 26. Site 7A, view looking south

APPENDIX D

Photo 27. Site 7A, view looking east

Photo 28. Site 7A, view looking west

Photo 29. Site 8A, view looking north

Photo 30. Site 8A, view looking south

Photo 31. Site 8A, view looking east

Photo 32. Site 8A, view looking west

Photo 33. Site 9, view looking north

Photo 34. Site 9, view looking south

Photo 35. Site 9, view looking east

Photo 36. Site 9, view looking west

APPENDIX D

Photo 37. Site 10A, view looking north

Photo 38. Site 10A, view looking south

APPENDIX D

Photo 39. Site 10A, view looking east

Photo 40. Site 10A, view looking west

Photo 41. Site 11A, view looking north

Photo 42. Site 11A, view looking south

APPENDIX D

Photo 43. Site 11A, view looking east

Photo 44. Site 11A, view looking west

APPENDIX D

Photo 45. Site 12A, view looking north

Photo 46. Site 12A, view looking south

APPENDIX D

Photo 47. Site 12A, view looking east

Photo 48. Site 12A, view looking west

ATTACHMENT B
Modified East TX HGM Calculator Output

FCI/FCU Calculator for the Fannin County, Texas Adaptation of the East Texas HGM Guidebook

Start with the Project Level Data Entry below. Enter in the yellow cells the number and size of the Wetland Assessment Area (WAA) being sampled, the project name, and location. Use the drop down menus to indicate whether this WAA represents the Project Site or Mitigation Site, before project or after project. Then go to the Data Entry tabs to enter individual field measurements for the tract and each plot. For information on determining how to split a project into WAAs, see A Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas (Williams *et al.* 2010). This spreadsheet calculator only allows for ten plots per WAA. If the WAA merits more plots, it must be subdivided to use this tool. Functional Results are automatically calculated based on the data entered into the Data Entry sheets. If the analysis includes mitigation sufficiency assessment, you may enter the functional results into the sufficiency calculator at http://el.erdc.usace.army.mil/wetlands/datanal.html.

Project Level Data Entry

Enter information in yellow cells, and select HGM Subclass and Site information from dropdown menus. A Subclass must be selected prior to printing out data sheets.

Project Name: Lower Bois d'Arc Creek Modified HGM Functional Assessment
Location: Proposed Lower Bois d'Arc Creek Reservoir Site
Sampling Dates: 4/28/16 through 4/29/16

HGM Subclass present at this WAA: Low Gradient Riverine **WAA number: 1**

Project Site: Project Site **Project Timing:** Before Project **WAA size (ha): 1862**

Final Summaries

All summaries of results are automatically calculated based on data entered into the individual plot entry data sheets.

Functional Results Summary: **Enter Results in Section A of the Mitigation Sufficiency Calculator**

Function	Functional Capacity Index	Functional Capacity Units
Detain Floodwater	0.92	1713.04
Detain Precipitation	0.78	1452.36
Cycle Nutrients	0.85	1582.70
Export Organic Carbon	0.87	1619.94
Maintain Plant Communities	0.90	1675.80
Provide Habitat for Fish and Wildlife	0.86	1601.32

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
V_{PATCH}	Forested Patch Size (ha)	2500	1.00
V_{FREQ}	Change in Frequency of Flooding (years change)	0	1.00
V_{DUR}	Change in Growing Season Flood Duration (weeks change)	0	1.00
V_{POND}	Total Ponded Area (%)	30	1.00
V_{STRATA}	Number of Vegetation Strata	4	1.00
V_{SOIL}	Soil Integrity (%)	0	1.00
V_{TBA}	Tree Basal Area (m^3/ha)	29	1.00
V_{TDEN}	Tree Density (stems/ha)	690	0.81
V_{SNAG}	Snag Density (stems/ha)	79	1.00
V_{OHOR}	O Horizon Organic Accumulation (cm)	0	0.20
V_{COMP}	Composition of Tallest Woody Vegetation Stratum (%)	0.70	0.70
V_{TCOMP}	Tree Composition (%)	0.70	0.70
V_{SSD}	Shrub-Sapling Density (stems/ha)	875	0.88
V_{GVC}	Ground Vegetation Cover (%)	29	1.00
V_{LITTER}	Litter Cover (%)	57	0.92
V_{LOG}	Log Biomass (m^3/ha)	29	1.00
V_{WD}	Woody Debris Biomass (m^3/ha)	51	1.00

WAA Data Summary: **WAA Number : 1** **Low-Gradient Riverine**

	Variable	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Number of Plots Used	Average Measure
1	V_{PATCH}	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	12	2500
2	V_{FREQ}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
3	V_{DUR}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
4	V_{POND}	30	30	30	30	30	30	30	30	30	30	30	30	12	30
5	V_{STRATA}	4	4	4	4	4	4	4	4	4	4	4	4	12	4
6	V_{SOIL}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
7	V_{TBA}	36.8	20.7	25.3	36.8	23.0	23.0	25.3	23.0	23.0	36.8	37	32	12	28.6
8	V_{TDEN}	550	725	1075	675	550	700	625	850	650	575	625	675	12	690
9	V_{SNAG}	50	100	125	75	25	100	50	75	100	75	125	50	12	79
10	V_{OHOR}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
11	V_{COMP}	0.51	0.66	0.55	1.00	0.72	0.66	1.00	0.51	1.00	0.44	1	1	12	0.70
12	V_{TCOMP}	0.51	0.66	0.55	1.00	0.72	0.66	1.00	0.51	1.00	0.44	1	1	12	0.70
13	V_{SSD}	625.0	750.0	1375.0	875.0	2875.0	375.0	875.0	375.0	750.0	750.0	625	250	12	875.0
14	V_{GVC}	42.5	22.5	18.8	52.5	3.8	27.5	17.5	37.5	53.8	33.8	13	21	12	28.6
15	V_{LITTER}	61.3	57.5	15.0	60.0	70.0	20.0	67.5	47.5	83.8	22.5	89	90	12	57.0
16	V_{LOG}	21.9	20.9	0.0	0.0	2.9	47.7	10.9	92.7	13.3	6.5	62	71	12	29.2
17	V_{WD}	72.3	83.3	17.3	24.9	13.3	56.8	63.6	96.1	35.4	10.7	64	78	12	51.3

Technical Memorandum on Lower Bois d'Arc Creek Reservoir – Additional Forested Wetland Mitigation Proposal Based on the Modified East TX HGM Functional Assessment

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TO: Robert McCarthy, North Texas Municipal Water District

CC: Simone Kiel, P.E., Steve Watters, PWS

FROM: Michael Votaw, PWS, CWB

SUBJECT: Lower Bois d'Arc Creek Reservoir – Additional Forested Wetland Mitigation Proposal Based on the Modified East TX HGM Functional Assessment

DATE: 9/30/2016

PROJECT: NTD06128 - Lower Bois d'Arc Creek Reservoir

BACKGROUND

In 2007, the North Texas Municipal Water District (NTMWD) assessed the wildlife habitat value of the cover types, including forested wetlands, within the proposed Lower Bois d'Arc Creek Reservoir site utilizing the Habitat Evaluation Procedures (HEP), developed by the U.S. Fish and Wildlife Service (USFWS). This study was conducted by an interagency team that included personnel from USFWS, U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TWDB), Texas Commission on Environmental Quality (TCEQ), NTMWD, and Freese and Nichols, Inc. (FNI). The results of this study showed that the forested wetlands within the footprint of the proposed reservoir obtained a habitat suitability index (HSI) score of 0.25 on a scale that ranges between 0.0 (poorest quality habitat) and 1.0 (highest quality habitat). Following the HEP protocol, the HSI score was multiplied by the number of acres (4,602) (1,862 hectares) of affected forested wetlands to quantify impacts to the forested wetlands, in terms of HEP habitat units (HU) and to determine what would be required as mitigation to offset those impacts. Results of the HEP evaluation for forested wetlands show that 1,150.5 HUs (0.25 HSI x 4,602 acres) would be impacted.

In February 2010, NTMWD purchased the approximately 15,000-acre Riverby Land and Cattle Company, LLC property (Riverby Ranch) located downstream of the proposed reservoir site to serve as a mitigation site. A separate interagency HEP study was conducted at Riverby Ranch in October 2010 to establish baseline conditions for the forested wetlands and other cover types located on the ranch. A subsequent HEP analysis was conducted to determine the number of habitat units that could be generated from the enhancement of existing forested wetlands and restoration of forested wetlands from existing grassland and cropland areas on the ranch. Results of this analysis showed that by enhancing 452 acres (182.9 hectares) of existing forested wetlands and restoring an additional 3,500 acres (1,416 hectares) of forested wetlands, the ranch could provide 2,266.1 HUs of forested wetland, resulting in an overall net gain of 1,115.6 HUs above what is expected to be impacted at the proposed reservoir site. This information was provided to the USACE in the December 2014 *Proposed Lower Bois d'Arc Creek Reservoir Mitigation Plan*.

In 2015, NTMWD was required to conduct an additional study utilizing the Hydrogeomorphic Methodology (HGM) to further assess the potential impacts to the forested wetlands within the footprint of the proposed reservoir site.

The functional assessment method utilized is a modification of the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams, et al., 2010). Documentation of how the guidebook was modified can be found in *Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016). As directed by the USACE, both impacts and mitigation would be determined using an average of the FCI scores from the HGM Calculator Tool for the modeled functions. The average FCI score for the forested wetland functions assessed within the footprint of the proposed reservoir was calculated to be 0.86 (Table 1). To estimate impacts, the average FCI score (0.86) is multiplied by the area (1,862 hectares) of forested wetlands located within the footprint of the proposed reservoir. This results in 1,601.32 functional capacity units (FCUs) of impacts to forested wetlands (Table 2).

Table 1. Average Functional Capacity Index (FCI) Value for the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Function	Functional Capacity Index (FCI)
Detain Floodwater	0.92
Detain Precipitation	0.78
Cycle Nutrients	0.85
Export Organic Carbon	0.87
Maintain Plant Communities	0.90
Provide Habitat for Fish and Wildlife	0.86
AVERAGE	**0.86**

Table 2. Average Functional Capacity Index (FCI) Value and Functional Capacity Units (FCU) of the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Average Functional Capacity Index (FCI)	Wetland Assessment Area (WAA) (hectares)	Functional Capacity Units (FCU)
0.86	1,862	1,601.32

In February of 2016, NTMWD conducted an HGM study on the forested wetlands located on Riverby Ranch to establish existing conditions. Four separate wetland assessment areas (WAAs) were identified and were evaluated independently. The average FCI score for the forested wetland functions assessed within each WAA were: 0.82 (WAA#1); 0.74 (WAA#2); 0.79 (WAA#3); and 0.74 (WAA#4). To determine existing FCUs, the average FCI score for each WAA is multiplied by the area of forested wetlands located within its respective WAA (Table 3).

Table 3. Average Functional Capacity Index (FCI) Value and Functional Capacity Units (FCU) of the Existing Forested Wetlands at the Proposed Mitigation Site (Riverby Ranch).

WAA	Average Functional Capacity Index (FCI)	Wetland Assessment Area (WAA) (hectares)	Functional Capacity Units (FCU)
WAA#1	0.82	33.3	27.2
WAA#2	0.74	81	59.81
WAA#3	0.79	49.3	38.86
WAA#4	0.74	19.3	14.25
TOTAL	**N/A**	**182.9**	**140.12**

In order to determine mitigation requirements utilizing the Modified East TX HGM approach and averaging FCI scores, the future functional conditions of the existing and proposed forested wetland mitigation areas on Riverby Ranch were predicted by evaluating each of the HGM sub-index variables to predict achievable values in 20 years. The assumptions made and resulting sub-index variable scores have been documented and are included as Attachment A. Once all future sub-index variable scores were predicted, the scores were entered into the Modified East TX HGM Calculator provided by ERDC. It was assumed that the existing FCI scores for the areas identified for restoration (existing grassland and cropland) have a baseline score of 0.0. Results of this evaluation show that the average FCI score for the proposed restored forested wetland areas located on Riverby Ranch would be 0.95 and the enhanced forested wetland areas would range between 0.95 and 0.93, for the four WAAs being analyzed. Following the establishment of the average FCI scores, a separate analysis was conducted using the Mitigation Sufficiency Calculator, also provided by ERDC, to determine if the proposed restored and enhanced forested wetlands on Riverby Ranch would provide sufficient mitigation to offset impacts to the forested wetlands at the proposed reservoir site. Table 4 summarizes the results of this analysis.

Table 4. Summary of Impacts at the Proposed Lower Bois d'Arc Creek Reservoir Site and Proposed Mitigation at Riverby Ranch.

Impacts					
	Hectares	**Average Baseline Functional Capacity Index (FCI)**	**Average Future Functional Capacity Index (FCI)**	**Baseline Functional Capacity Units (FCU)**	**Future Functional Capacity Units (FCU)**
Proposed Reservoir Site	(-)1,862	0.86	0.0	1,601.32	0.0
Mitigation					
	Hectares	**Average Baseline Functional Capacity Index (FCI)**	**Average Future Functional Capacity Index (FCI)**	**Baseline Functional Capacity Units (FCU)**	**Future Functional Capacity Units (FCU) Uplift**
Riverby Restoration	1,487.2	0.0	0.95	0.0	1,412.8
Riverby Enhancement (WAA#1)*	33.3	0.82	0.95	27.2	4.38
Riverby Enhancement (WAA#2)*	81	0.74	0.93	59.81	15.39
Riverby Enhancement (WAA#3)*	49.3	0.79	0.93	38.86	6.90
Riverby Enhancement (WAA#4)*	19.3	0.74	0.93	14.25	3.73
Total	(+)1,670.1	N/A	N/A	140.12	(+)1,443.2
Net Gain/Net Loss	**(-)191.9**	N/A	N/A	**140.12**	**-158.12**

**Note-Future functional capacity units for forested wetland enhancement areas only reflect predicted uplift above existing conditions.*

Use of the Modified East TX HGM methodology now shows that the proposed mitigation (as described in the December 2014 *Proposed Lower Bois d'Arc Creek Reservoir Mitigation Plan*) for forested wetlands at Riverby Ranch is not sufficient to offset the impacts at the proposed reservoir site. To address this, NTMWD has started investigations of additional lands located upstream of the proposed reservoir site that could be used to provide additional forested wetland mitigation. The following paragraphs describe the methods used to identify potential additional mitigation property and the estimated mitigation amount (area and FCUs) that could be added to NTMWD's mitigation proposal to fully compensate for the forested wetland impacts at the proposed reservoir site.

METHODS AND RESULTS

Recognizing the USACE mandate to compensate for impacts as close to the impact site as practicable, NTMWD's additional mitigation property search focused on lands located along Bois d'Arc Creek upstream of the proposed reservoir site. The search was specifically focused on areas located within the 5-year floodplain and that were mapped as having hydric soils. Once these areas were identified, recent aerial photographs were used to identify sites that had been cleared for agricultural purposes, as these areas have the potential to produce the highest uplift (i.e., gain in FCUs). An additional objective during this process was to avoid fragmentation of the additional mitigation property and to create an area of contiguous forest to increase patch size. The additional mitigation area identified as a result of this search is depicted on Figure 1. This area includes approximately 1,900 acres of bottomlands along Bois d'Arc Creek.

Following the identification of potential additional mitigation property, NTMWD, FNI, and the USACE conducted site visits to verify site conditions and collect HGM data using the Modified East TX HGM protocol within existing forested wetland areas. Data were collected in three additional forested wetland plots (Figure 2) resulting in average FCI score of 0.78 (Table 5). Information collected during the site visits were also used to create a preliminary cover type map of the area being proposed for additional forested wetland mitigation (Figure 3).

Table 5. Average Functional Capacity Index (FCI) Value for the Existing Forested Wetlands along Bois d'Arc Creek Upstream of the Proposed Reservoir Site.

Function	Functional Capacity Index (FCI)
Detain Floodwater	0.76
Detain Precipitation	0.67
Cycle Nutrients	0.78
Export Organic Carbon	0.74
Maintain Plant Communities	0.86
Provide Habitat for Fish and Wildlife	0.86
Average	**0.78**

The final analysis conducted within the proposed additional mitigation area involved the use of the Modified East TX HGM Calculator Tool and Mitigation Sufficiency Calculator. It was assumed for the purposes of this analysis that the same sub-index variable scores could be achieved for the restored forested wetlands upstream of the proposed reservoir as at Riverby Ranch. Based on this assumption, the average FCI score (as calculated by the Calculator Tool) for the proposed restored forested wetland areas located upstream of the proposed reservoir would be 0.93. It was also assumed that the functions of the existing forested wetlands located upstream of the proposed reservoir would increase (i.e., be enhanced) the same as they are expected to at Riverby Ranch, resulting in an average FCI score of

Table 6. Summary of Additional Forested Wetland Mitigation that Could Be Provided Upstream of the Proposed Lower Bois d'Arc Creek Reservoir.

Mitigation					
	Hectares	**Average Baseline Functional Capacity Index (FCI)**	**Average Future Functional Capacity Index (FCI)**	**Baseline Functional Capacity Units (FCU)**	**Future Functional Capacity Units (FCU) Uplift**
Upstream Restoration	445.1	0.0	0.93	0.0	413.94
Upstream Enhancement*	232.2	0.78	0.93	181.12	34.83
Total	**677.3**	**N/A**	**N/A**	**181.12**	**448.77**

**Note-Functional capacity units for forested wetland enhancement areas only reflect predicted uplift above existing conditions.*

0.93. Based on these assumptions, the 232.2 hectares of existing forested wetlands within the additional mitigation area could provide 34.83 FCUs of uplift credit through protection and enhancement activities. Additionally, the existing cropland, grassland, shrub and emergent wetlands (445.1 hectares) within the additional mitigation area could be restored to forested wetlands to generate an additional 413.94 FCUs above a baseline of 0.0 in these non-forested areas. This would result in a net total of 448.77 FCUs that could be gained from the additional upstream mitigation area (Table 6).

If the total FCUs from the upstream mitigation site are combined with the total FCUs that would be generated at the Riverby Ranch mitigation site, this would result in a net gain in both area (485.4 hectares) and functions (290.65 FCUs) compared to what would be impacted at the proposed reservoir site (Table 7).

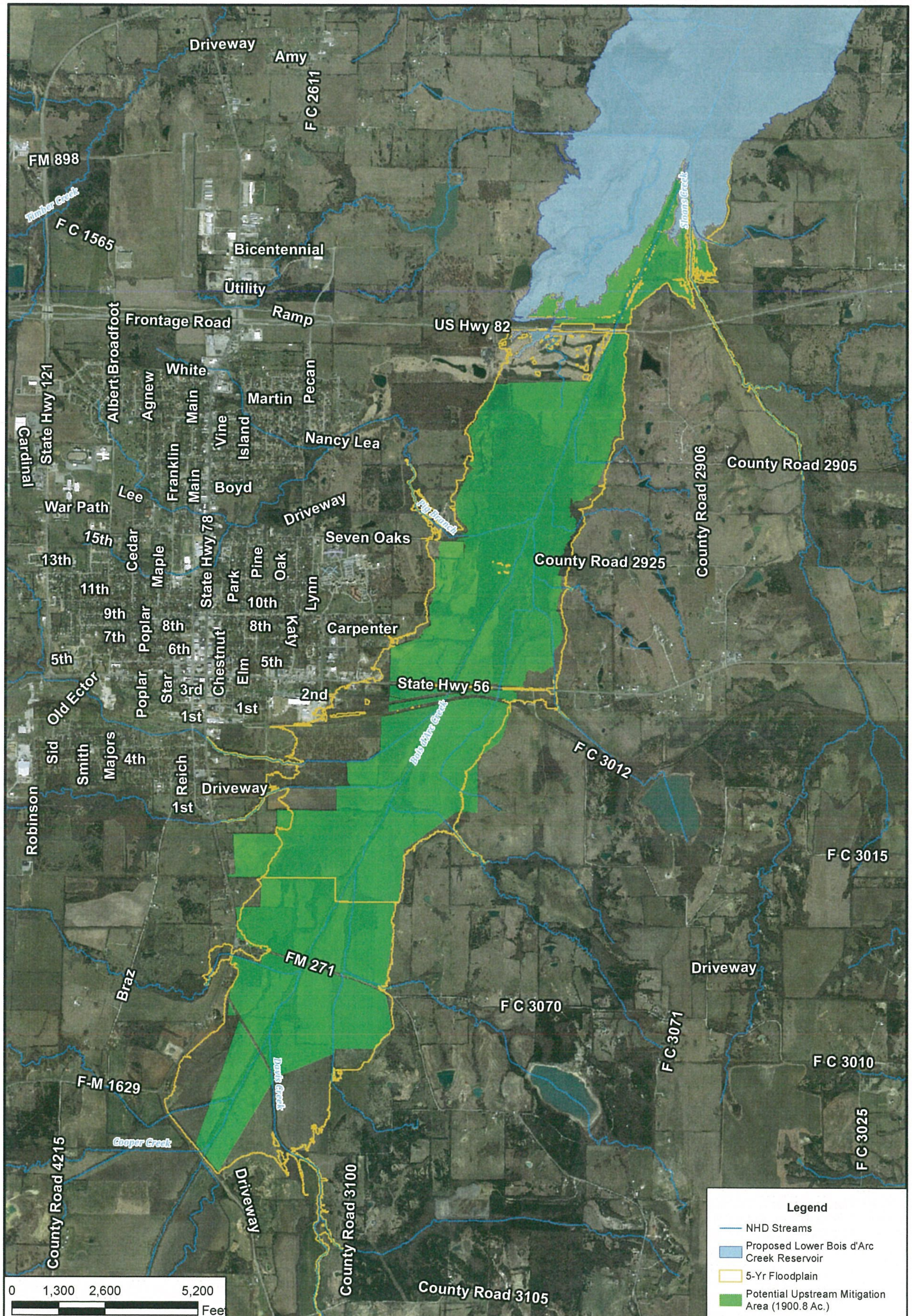
Table 7. Summary of Impacts at the Proposed Lower Bois d'Arc Creek Reservoir Site and Proposed Mitigation at Riverby Ranch and Upstream Mitigation Area.

Impacts			
	Hectares	**Average Functional Capacity Index (FCI)**	**Functional Capacity Units (FCU)**
Proposed Reservoir Site	(-)1,862	0.86	(-)1,601.32
Mitigation			
	Hectares	**Average Functional Capacity Index (FCI)**	**Functional Capacity Units (FCU) Uplift**
Riverby Restoration	1,487.2	0.95	1,412.8
Riverby Enhancement (WAA#1)*	33.3	0.95	4.38
Riverby Enhancement (WAA#2)*	81	0.93	15.39
Riverby Enhancement (WAA#3)*	49.3	0.93	6.90
Riverby Enhancement (WAA#4)*	19.3	0.93	3.73
Upstream Restoration	445.1	0.93	413.94
Upstream Enhancement	232.2	0.93	34.83
Total	2,347.4	N/A	1,891.97
Net Gain/Net Loss	**(+)485.4**	N/A	**(+)290.65**

REFERENCES CITED

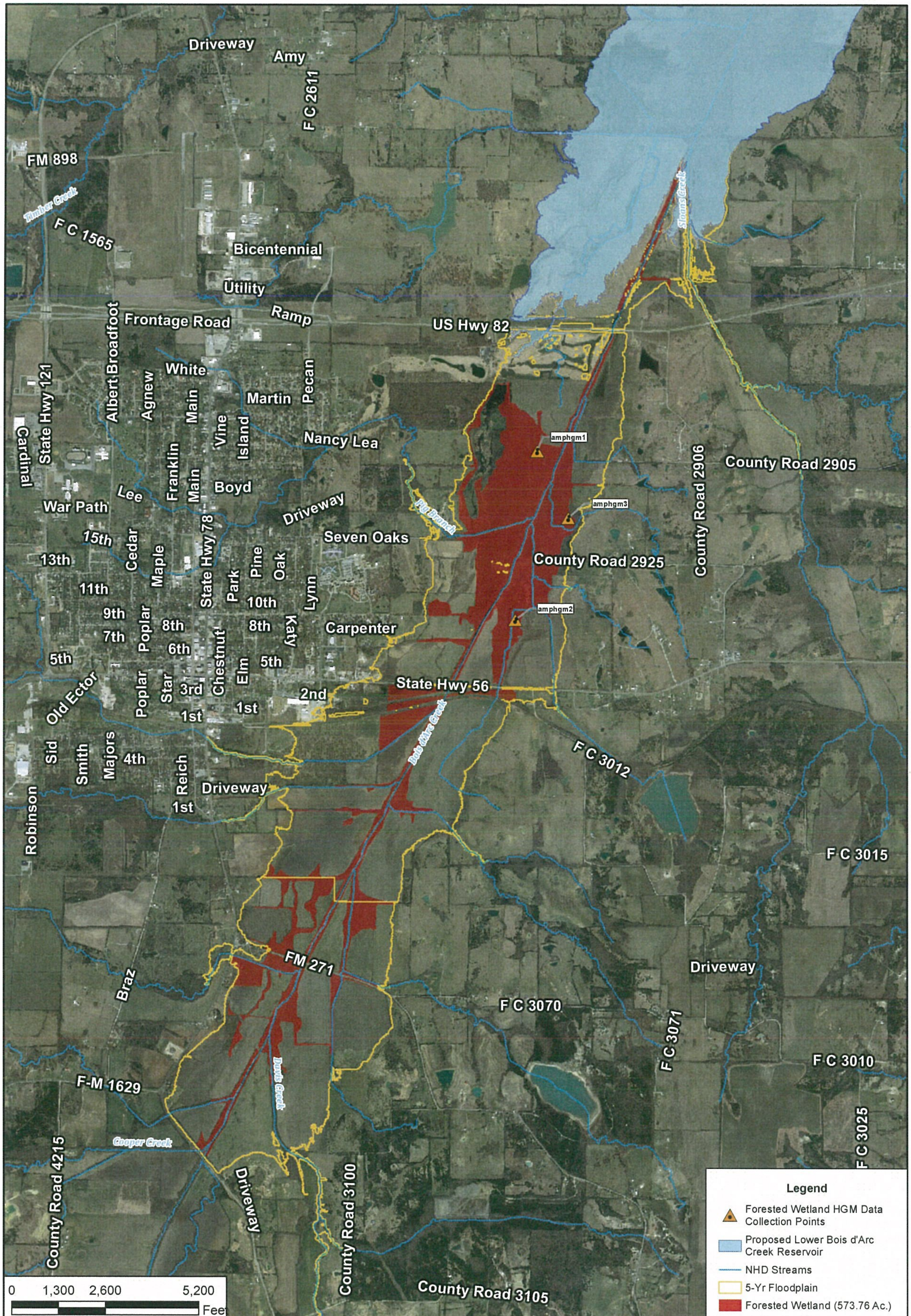
Camp, A., J. Grogan, A. Urbanovsky, and H. Williams. 2016. Draft Report - Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project. Prepared for the U.S. Army Corps of Engineers, Tulsa District, by the Arthur Temple College of Forestry and Agriculture.

Hans M. Williams, Adam J. Miller, Rachel S. McNamee, and Charles V. Klimas. 2010. A Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas. U.S. Army Engineer Research and Development Center.



Freese and Nichols 4055 International Plaza Suite 200 Fort Worth, Texas 76109-4895 817-735-7300	N W E S	*North Texas Municipal Water District* *Lower Bois d'Arc Creek Reservior* *Prospective Upstream Mitigation Land*	FN JOB NO NTD06128 FILE 1_Upstream_Mitigation_Area.mxd DATE June 28, 2016 SCALE 1:20,000 DESIGNED CJS DRAFTED HHM	1 Figure

APPENDIX D



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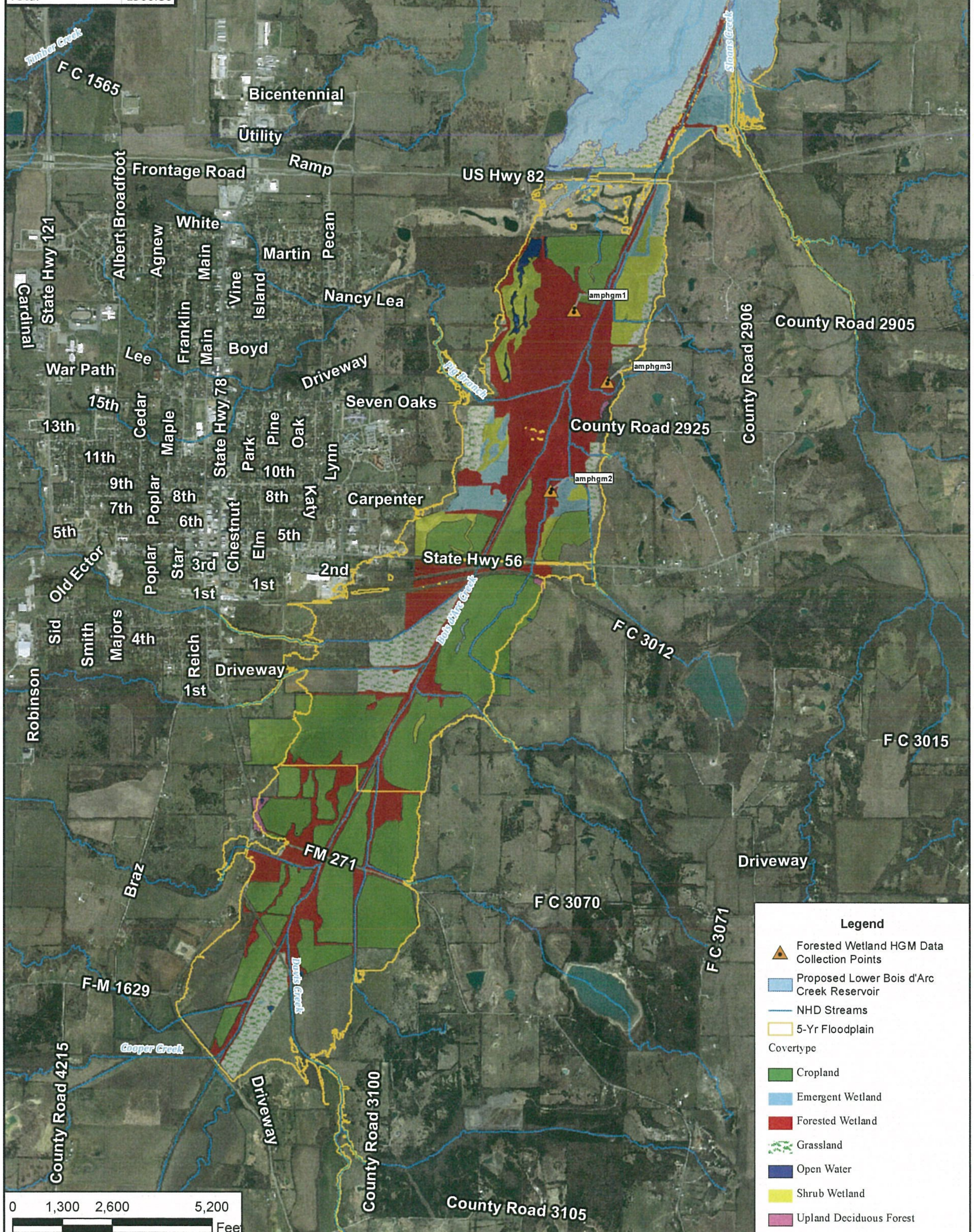
North Texas Municipal Water District
Lower Bois d'Arc Creek Reservior

Prospective Upstream Mitigation Land-
Forested Wetland HGM Data Collection Points

FN JOB NO	NTD06128
FILE	2_FW_HGM_Points.mxd
DATE	June 28, 2016
SCALE	1:20,000
DESIGNED	CJS
DRAFTED	HHM

2
Figure

Cropland	766.23
Emergent Wetland	117.07
Forested Wetland	573.76
Grassland	215.68
Open Water	12.64
Riparian	86.65
Shrub Wetland	119.74
Upland Deciduous	9.04
Total	1900.80



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N W E S

North Texas Municipal Water District
Lower Bois d'Arc Creek Reservior

Prospective Upstream Mitigation Land-
Existing Cover Types

FN JOB NO	NTD06128
FILE	3_Exist_CoverTypes.mxd
DATE	June 28, 2016
SCALE	1:20,000
DESIGNED	CJS
DRAFTED	HHM

3
Figure

ATTACHMENT A

Projected Values of Forested Wetlands Sub-index Variables at Mitigation Sites for the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

Technical Memorandum on Projected Values of Forested Wetlands Sub-index Variables at Mitigation Sites for the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

MEMORANDUM

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TO: Robert McCarthy, North Texas Municipal Water District

CC: Simone Kiel, P.E.

FROM: Steve Watters, PWS, and Michael Votaw, PWS, CWB

SUBJECT: Projected Values of Forested Wetlands Sub-index Variables at Mitigation Sites for the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

DATE: 6/24/2016

PROJECT: NTD06128 - Lower Bois d'Arc Creek Reservoir

INTRODUCTION

In order to predict future functional conditions of forested wetland mitigation areas using the Modified East Texas HGM (the "Modified HGM") calculator, FNI wetland scientists evaluated each of the HGM sub-index variables to predict achievable values in 20 years. It was assumed that restored forested wetland areas would grow into a forest stand by year 20 with the majority of dominant trees reaching a diameter at breast height (dbh) of at least 4 inches. The results of our evaluation of future sub-index variable scores are summarized in Table 1 (attached).

The first column of Table 1 lists the sub-index variables of the Modified HGM method developed by Camp et al. (2016). The second column describes the measurement thresholds within which each variable would be scored a value of 1.0 based on the revised sub-index variable curves for the Modified HGM (see Attachment A). For example, for the variable Total Ponded Area (VPOND), the revised curve indicates that VPOND would score a 1.0 in areas where the total ponded area is between 20 and 60 percent. The third column of Table 1 indicates whether or not each variable may be manipulated or controlled by mitigation construction, and if so, it provides a description as to how the variable might be manipulated. Finally, the fourth column of Table 1 identifies our projected value of each sub-index variable at 20 years, the age when restored forested areas are expected to develop into a forest stand. These projected sub-index values are proposed to be used in the Modified HGM models to calculate the expected value of each function for the forested wetland mitigation areas 20 years following planting.

Reference

Camp, A., J. Grogan, A. Urbanovsky, and H. Williams. 2016. Draft Report - Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project. Prepared for the U.S. Army Corps of Engineers, Tulsa District, by the Arthur Temple College of Forestry and Agriculture.

Table 1. Projected Values of Sub-index Variables for the Lower Bois d'Arc Creek Reservoir Forested Wetland Mitigation Areas 20 Years Following Planting

Sub-index Variables in the Modified East TX HGM Model	Index Curve Score of 1.0	Controllable/Constructible	Projected Score at 20 Years Post-Planting
Change in Growing Season Flood Duration (VDUR)	No change in growing season flood duration	This should automatically score 1.0 after construction.	1.00
Change in Frequency of Flooding (VFREQ)	No change in frequency of flooding	This should automatically score 1.0 after construction.	1.00
Total Ponded Area (VPOND)	20-60% of site capable of ponding	Yes - grade site to pond between 20-60% after heavy rain.	1.00
Composition of Overstory Vegetation (VTCOMP)	100% concurrence of overstory stratum	Yes - plant to achieve dominant spp. from Group 1. Non-dominant spp. planted from Group 2 or 3 to increase VTBA, VLOG, VSNAG, and VWD, e.g. cottonwood, black willow.	1.00
Number of Vegetation Strata (VSTRATA)	Site has all 4 vegetation strata	Yes - plant super-canopy species such as cottonwood, sub-canopy species such as ash, elm, sugarberry. It is expected that shrubs/groundcover will develop over time. ETx HGM Guidebook indicates 4 strata at 20 yr. Will plant cover crop - wheat, annual rye	1.00
Snag Density (VSNAG)	20-100 snags/ha (8-40 snags/ac)	Yes - plant species which grow quickly and are short lived. Examples include sugarberry, cottonwood, green ash, and black willow. Snags (min 6 ft. tall, 4 in dbh) installed min 4.5 ft. above ground, 18 in below ground at rate of min 10/acre.	1.00
Tree Basal Area (VTBA)	Anything above 18 square meters/ha (78 sq. ft./ac)	Yes - plant species which grow quickly. Examples include cottonwood, green ash, sugarberry. With proposed planting rate and species selected for planting, we anticipate a minimum of 100 sq. ft./ac. At 20-years. Reference young wetland sites within reservoir.	1.00

Table 1. Projected Values of Sub-index Variables for the Lower Bois d'Arc Creek Reservoir Forested Wetland Mitigation Areas 20 Years Following Planting (Continued)

Sub-index Variables in the Modified East TX HGM Model	Index Curve Score of 1.0	Controllable/Constructible	Projected Score at 20 Years Post-Planting
Log Volume (VLOG)	5-60 cubic meters/ha	Yes - plant species which grow quickly, short lived, and that are prone to producing dead fall. Examples include sugarberry, cottonwood, and black willow. ETx HGM Guidebook indicates 5 cubic meters at year 20 for typical hardwoods.	1.00
Forest Patch Size (VPATCH)	Anything greater than 6,178 ac	Yes - plant larger blocks/patches of forested wetlands and/or plant adjacent to existing forested areas. Plant wildlife corridors to connect to other patches of forested areas.	1.00
Ground Vegetation Cover (VGVC)	Ground vegetation cover (herbaceous and woody) less than or equal to 4.5-ft. in height between 0-40%.	ETx HGM Guidebook indicates 100% cover at year 20 for typical hardwoods.	0.50
Shrub-Sapling Density (VSSD)	Woody stems less than 4 inches dbh and greater than 4.5-ft. in height between 1000-4000 stems per hectare (405-1,620 stems per acre).	This should occur naturally over time. ETx HGM Guidebook indicates 5,000 stems/ha at year 20 for typical hardwoods. However, VSSD will be managed to maintain density to obtain 1,000-4,000 stems/ha.	1.00
Tree Density (VTDEN)	Density of the trees between 200-500 stems per hectare (81-202 stems per acre).	Yes - we are proposing to plant 435 trees/acre and anticipating with mortality at year 20, the tree density will be in the range of 100-200 trees/ac. This would achieve a score of 1.0.	1.00

Table 1. Projected Values of Sub-index Variables for the Lower Bois d'Arc Creek Reservoir Forested Wetland Mitigation Areas 20 Years Following Planting (Continued)

Sub-index Variables in the Modified East TX HGM Model	Index Curve Score of 1.0	Controllable/Constructible	Projected Score at 20 Years Post-Planting
O-Horizon Organic Accumulation (VOHOR)	Partially decomposed organic matter such as leaves, twigs, needles, or sticks less than 1/4-inch in diameter, flowers, fruits, insect frass, dead moss, or detached lichens on or near the surface of the ground. Anything over 1.25 cm (1/2-inch) thick.	No. This would occur/develop naturally over time. ETx HGM Guidebook indicates 1 cm O-horizon at year 20 for typical hardwoods.	0.84
Litter Cover (VLITTER)	Average percent of the ground surface covered by recognizable dead plant material between 60-100%.	ETx HGM Guidebook indicates approximately 80% litter cover at year 20 for typical hardwoods. Planting of cover crop will also contribute to litter cover.	1.00
Woody Debris Biomass (VWD)	20-90 cubic meters per hectare (706-3178 cubic feet per hectare).	Yes - plant species which grow quickly, short lived, and that are prone to producing dead fall. Examples include sugarberry, cottonwood, and black willow. ETx HGM Guidebook indicates 72 cubic meters/ha at year 20 for typical hardwoods.	1.00
Composition of Tallest Woody Stratum (VCOMP)	Composition and diversity concurrence of dominant woody stratum. 100% concurrence = 1.0.	Yes - plant to achieve dominant spp. from Group 1. Non-dominant spp. planted from Group 2 or 3 to increase VTBA, VLOG, VSNAG, and VWD, e.g. cottonwood, black willow.	1.00
Soil Integrity (VSOIL)	Percent of site with altered soils. 0% alteration = 1.0.	Yes - do not manipulate soils following initial restoration.	1.00

*A-horizon variable was omitted from the Modified East Texas HGM Model by Williams et al. (2016)

ATTACHMENT A

Modified East Texas HGM Models and Revised Sub-index Curves Developed by Camp et al. (2016)

APPENDIX D

Revised models for Fannin County application of East Texas HGM Low Gradient Riverine Models

a. Detain Floodwater.

$$FCI = V_{FREQ} \times \left[\frac{(V_{LOG} + V_{GVC} + V_{SSD} + V_{TDEN})}{4}\right]$$

b. Detain Precipitation.

$$FCI = \frac{\left[V_{POND} + \frac{(V_{OHOR} + V_{LITTER})}{2}\right]}{2}$$

c. Cycle Nutrients.

$$FCI = \frac{\left[\frac{(V_{TBA} + V_{SSD} + V_{GCV})}{3} + \frac{(V_{OHOR} + V_{WD} + V_{SNAG})}{3}\right]}{2}$$

d. Export Organic Carbon.

$$FCI = V_{FREQ} \times \frac{\left[\frac{(V_{LITTER} + V_{OHOR} + V_{WD} + V_{SNAG})}{4} + \frac{(V_{TBA} + V_{SSD} + V_{GVC})}{3}\right]}{2}$$

e. Maintain Plant Communities.

$$FCI = \left[\left\{\frac{\frac{[V_{TBA} + V_{TDEN}]}{2} + V_{COMP}}{2}\right\} \times \left[\frac{(V_{SOIL} + V_{DUR} + V_{POND})}{3}\right]\right]^{1/2}$$

f. Provide Habitat for Fish and Wildlife.

$$FCI = \left\{\left[\frac{(V_{FREQ} + V_{DUR} + V_{POND})}{3}\right] \times \left[\frac{(V_{TCOMP} + V_{STRATA} + V_{SNAG} + V_{TBA})}{4}\right] \times \left[\frac{(V_{LOG} + V_{OHOR})}{2}\right] \times V_{PATCH}\right\}^{1/4}$$

APPENDIX D

Revised models for Fannin County application of East Texas HGM in Mitigation Flats Wetlands

a. Detain Floodwater. **Not Assessed.**

b. Detain Precipitation.

$$FCI = \frac{\left[V_{POND} + \frac{(V_{OHOR} + V_{LITTER})}{2}\right]}{2}$$

c. Cycle Nutrients.

$$FCI = \frac{\left[\frac{(V_{TBA} + V_{SSD} + V_{GCV})}{3} + \frac{(V_{OHOR} + V_{WD} + V_{SNAG})}{3}\right]}{2}$$

d. Export Organic Carbon. **Not Assessed.**

e. Maintain Plant Communities.

$$FCI = \left[\left\{\frac{\frac{[V_{TBA} + V_{TDEN}]}{2} + V_{COMP}}{2}\right\} \times \left[\frac{(V_{SOIL} + V_{POND})}{2}\right]\right]^{1/2}$$

f. Provide Habitat for Fish and Wildlife.

$$FCI = \left\{ V_{POND} \times \left[\frac{(V_{TCOMP} + V_{STRATA} + V_{SNAG} + V_{TBA})}{4}\right] \times \left[\frac{(V_{LOG} + V_{OHOR})}{2}\right] \times V_{PATCH} \right\}^{1/4}$$

Revised V_{COMP} for Fannin County application of East Texas HGM Low Gradient Riverine Models (including diversity factor).

Table 5A Suggested HGM calculator tree species grouping based on field data and research on the reference domain.

Group 1		Group 2		Group 3	
Ash	*Fraxinus spp.*	Black Walnut	*Juglans nigra*	Black Willow	*Salix nigra*
Bur Oak	*Quercus macrocarpa*	Box Elder	*Acer negundo*	Bois D'Arc	*Maclura pomifera*
Chinkapin Oak	*Quercus muehlenbergii*	Cherrybark Oak	*Quercus pagoda*	Eastern Cottonwood	*Populus deltoides*
Elm	*Ulmus spp.*	Dogwood	*Cornus spp.*	Eastern Redbud	*Cercis canadensis*
Pecan	*Carya illinoinensis*	Honey Locust	*Gleditsia triacanthos*	Hawthorn	*Crataegus spp.*
Shumard Oak	*Quercus shumardii*	Persimmon	*Diospyros spp.*	Soapberry	*Sapindus spp.*
Sugarberry	*Celtis laevigata*	Red Maple	*Acer rubrum*		
Water Oak	*Quercus nigra*	Sycamore	*Platanus occidentalis*		
Willow Oak	*Quercus phellos*	Hickory Spp.	*Carya spp.*		

Group 1 = Common dominants in reference standard sites
Group 2 = Species commonly present in reference standard sites, but dominance generally indicates man-made or natural disturbance
Group 3 = Uncommon, minor or shrub species in reference standard sites, but may dominate in degraded systems

$$\textit{Initial Quality Index} = \frac{\left[\begin{array}{c}(\#\ of\ dominants\ from\ Group\ 1\ \times 1.0) + (\#\ of\ dominants\ from\ Group\ 2\ \times 0.66) + \\ (\#of\ dominants\ from\ Group\ 3\ \times 0.33)\end{array}\right]}{\#\ of\ dominants\ from\ Groups\ 1, 2, and\ 3}$$

$$VSI = Adjusted\ Quality\ Index$$

Where if there are 3 or more dominants from Groups 1 and 2:

$$Adjusted\ Quality\ Index = 1.0\ \times Initial\ Quality\ Index$$

Where if there are 2 dominants from Groups 1 and 2:

$$Adjusted\ Quality\ Index = 0.66\ \times Initial\ Quality\ Index$$

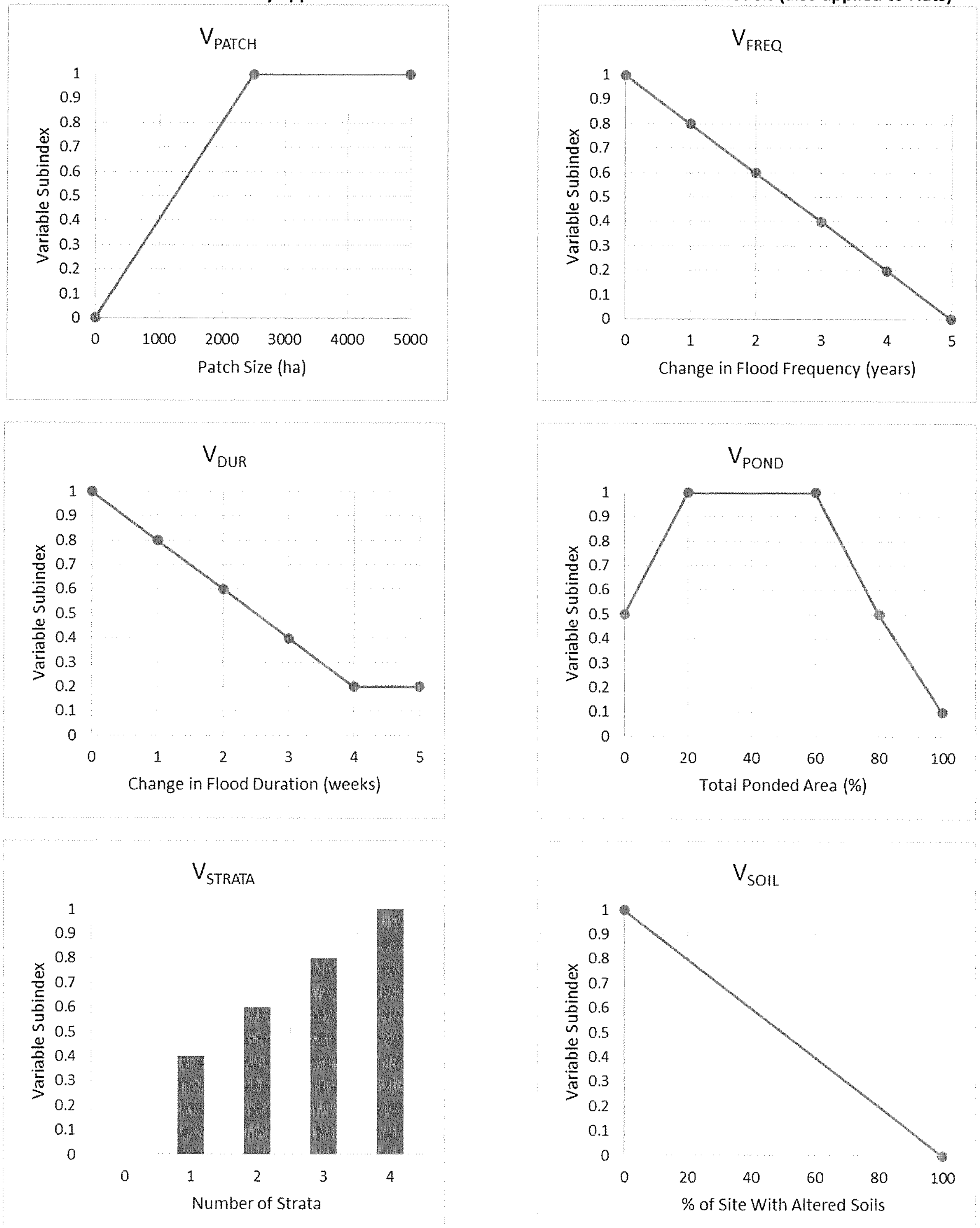
Where if there is 1 dominant from Groups 1 and 2:

$$Adjusted\ Quality\ Index = 0.33\ \times Initial\ Quality\ Index$$

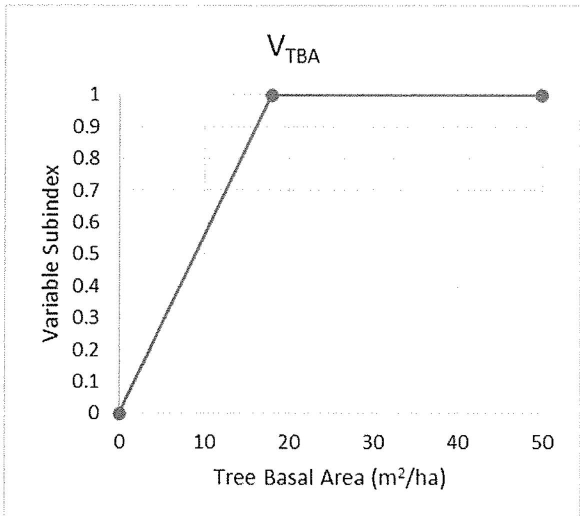
And if there are 0 dominants from Groups 1 and 2:

$$Adjusted\ Quality\ Index = 0.10\ \times Initial\ Quality\ Index$$

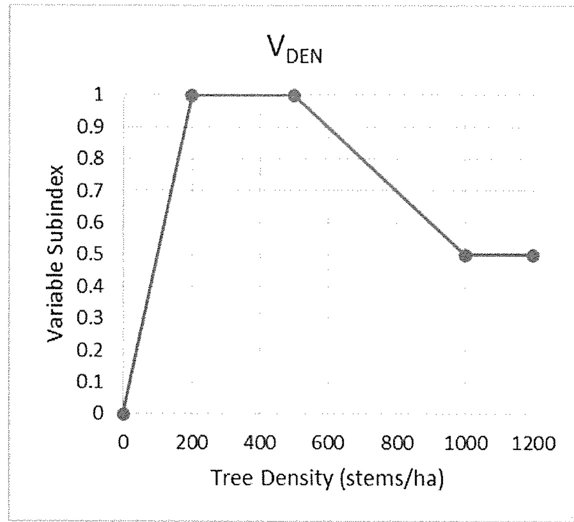
Revised curves for Fannin County application of East Texas HGM Low Gradient Riverine Models (also applied to Flats)



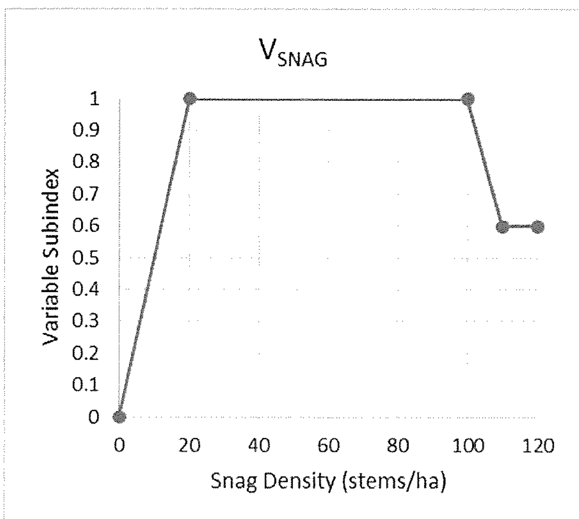
APPENDIX D



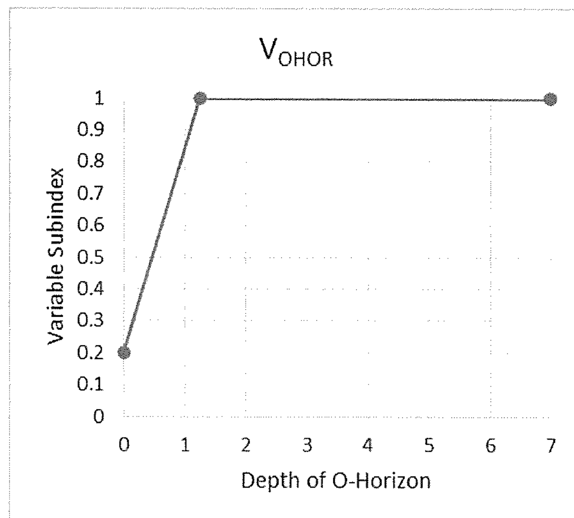
V_{TBA}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
Tree Basal Area (m²/ha)



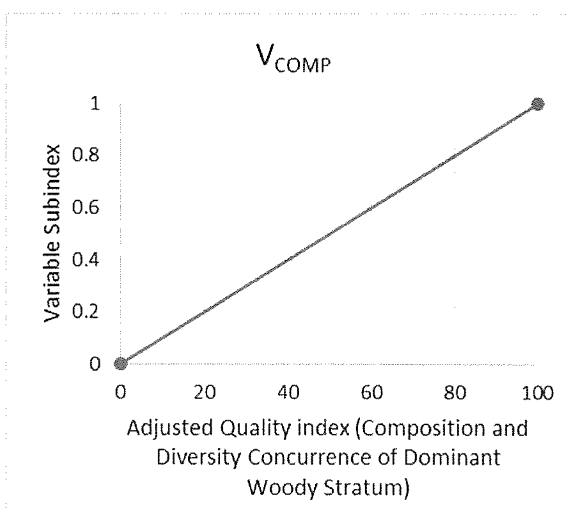
V_{DEN}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000
1200
Tree Density (stems/ha)



V_{SNAG}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
Snag Density (stems/ha)

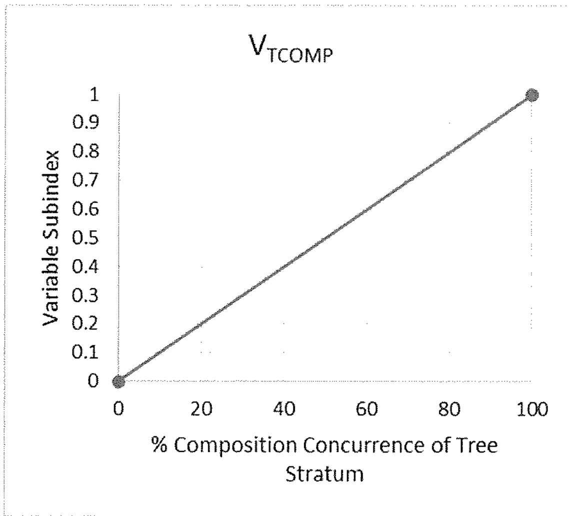


V_{OHOR}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
Depth of O-Horizon

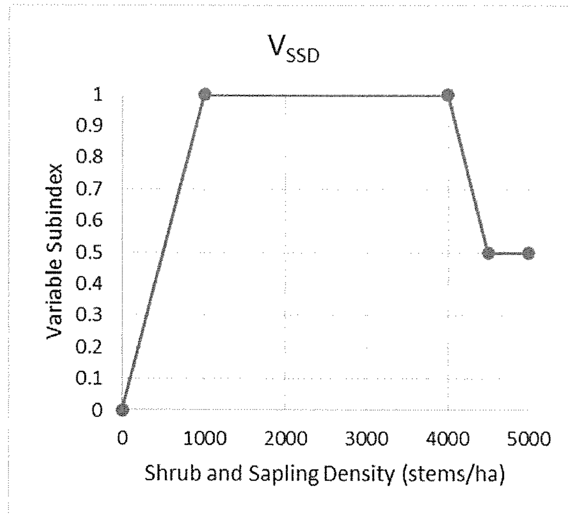


V_{COMP}
Variable Subindex
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Adjusted Quality index (Composition and Diversity Concurrence of Dominant Woody Stratum)

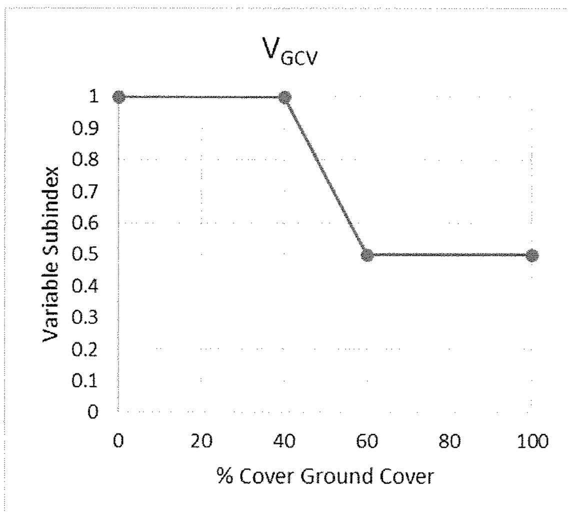
APPENDIX D



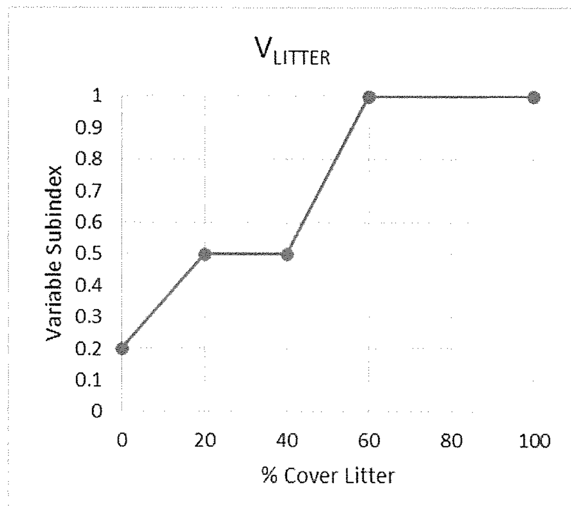
V_{TCOMP}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
% Composition Concurrence of Tree Stratum



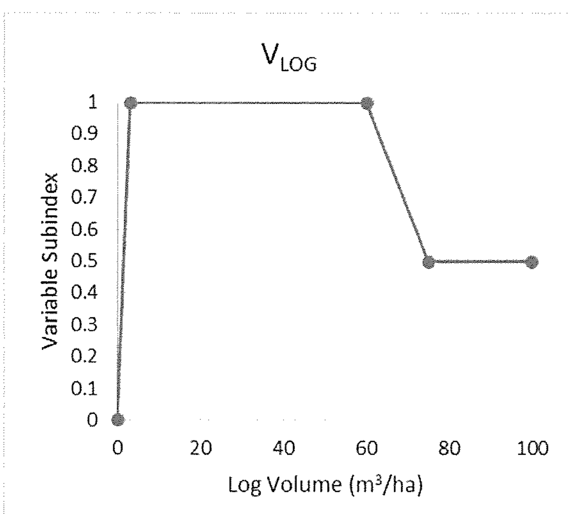
V_{SSD}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1000
2000
3000
4000
5000
Shrub and Sapling Density (stems/ha)



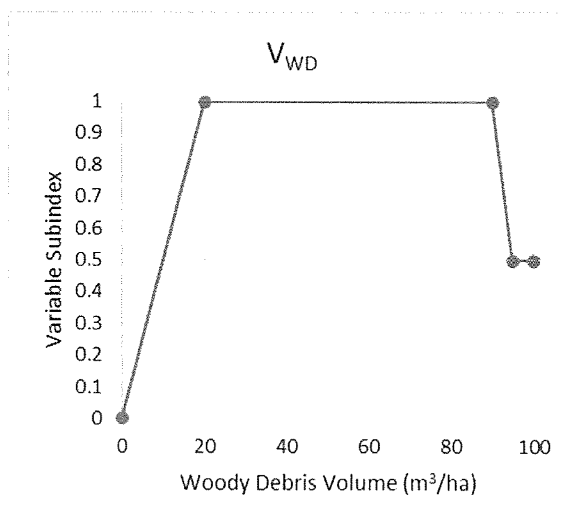
V_{GCV}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
% Cover Ground Cover



V_{LITTER}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
% Cover Litter



V_{LOG}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
Log Volume (m^3/ha)



V_{WD}
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
Woody Debris Volume (m^3/ha)

APPENDIX D

Appendix E

Streams and Rapid Geomorphic Method (RGA)

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

December 9, 2016

Martin C. Rochelle
Lloyd Gosselink Rochelle & Townsend, P.C.
816 Congress Avenue, Suite 1900
Austin, Texas 78701

Re: Request for Change in Flow Status Assigned to Bois d' Arc Creek

Dear Mr. Rochelle:

We have received your letter dated November 11, 2016, requesting that TCEQ review and reconsider the flow status of Bois d' Arc Creek. In your letter you suggested that TCEQ consider changing the flow status of Bois d' Arc Creek from perennial to intermittent in the Texas Surface Water Quality Standards (TSWQS). We are writing to let you know that we have considered this request, as well as the information provided during our meeting at TCEQ headquarters on December 1, 2016. As a part of our technical analysis of your request we have also reviewed available information collected by the United States Geological Survey, TCEQ, and our partners in the Clean Rivers Program.

We have developed preliminary changes to propose in the 2017 revisions to the TSWQS in response to your request. Our preliminary proposals for two reaches of Bois d' Arc Creek are described below. New language to be included in the 2017 revisions to the TSWQS is underlined; language to be removed is indicated with brackets:

- Revision of Existing Entry in Appendix D of the TSWQS for Bois d' Arc Creek in Fannin County (0202): <u>Intermittent stream with perennial pools</u> [Perennial stream] from the confluence with Sandy Creek <u>north of Dodd City</u> upstream to the confluence with Pace Creek. This portion of Bois d' Arc Creek will retain the currently assigned Intermediate aquatic life use and corresponding dissolved oxygen criteria of 4.0 mg/L for the 24-hour average, and 3.0 mg/L for the 24-hour minimum.
- New Entry in Appendix D of the TSWQS for Bois d' Arc Creek in Fannin County (0202): <u>Intermittent stream with perennial pools from the confluence with Sandy Creek near Davy Crocket Lake upstream to the confluence with Sandy Creek north of Dodd City</u>. This portion of Bois d' Arc Creek will be assigned a High aquatic life use and corresponding dissolved oxygen criteria of 5.0 mg/L for the 24-hour average, and 3.0 mg/L for the 24-hour minimum.

The review process for the TSWQS includes public notice and comment periods, as well as a public hearing, in accordance with federal and state requirements. We will consider additional information that may be submitted as a result of public comment. Revisions to the TSWQS must be approved by the Environmental Protection Agency prior to use in Clean Water Act activities such as assessments to develop the Texas Integrated Report of Surface Water Quality, wastewater permitting, and development of Total Maximum Daily Loads.

We are available to continue discussions regarding your request and the preliminary changes presented above. In addition, the staff of the Office of Water and I will be available for further coordination and discussion. Please contact Mr. Kelly Holligan at 512-239-2369 or by email at Kelly.Holligan@tceq.texas.gov regarding this matter.

Sincerely,

L'Oreal W. Stepney, P.E.
Deputy Director, Office of Water
Texas Commission on Environmental Quality

Technical Memorandum on Rapid Geomorphic Assessment (RGA) for the Proposed Lower Bois d'Arc Creek Reservoir Site and Proposed Stream Mitigation

4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7492 www.freese.com

TO: Robert McCarthy, NTMWD

CC: Simone Kiel, P.E.; Michael Votaw, P.W.S; Steve Watters, P.W.S

FROM: David Coffman, P.G., C.F.M.

SUBJECT: Rapid Geomorphic Assessment (RGA) for the Proposed Lower Bois d'Arc Creek Reservoir Site and Proposed Stream Mitigation

DATE: November 4, 2016, Updated January 27, 2017

PROJECT: NTD06128

1.0 INTRODUCTION

The North Texas Municipal Water District (NTMWD) is proposing to construct the Lower Bois d'Arc Creek Reservoir (LBCR) in Fannin County, TX. A rapid geomorphic assessment (RGA) of Bois d'Arc Creek and its four major tributaries within the footprint of the proposed LBCR was performed in 2008 to provide an estimate of baseline stream conditions (Freese and Nichols, 2008). At the time of this stream assessment, no functional or conditional stream assessment methods had been proposed, adopted, endorsed, or required by the U.S. Army Corps of Engineers (USACE) or other resource agencies having jurisdiction within the state of Texas. Applicants were encouraged to use best scientific judgement in employing tools to assess the function or condition of streams to be affected by the applicant's proposed project, LBCR. In March 2011 a draft methodology for stream (and wetland) condition assessment, Texas Rapid Assessment Method, Version 1.0 (TXRAM), was first published for use, testing, and public comment (USACE, 2011). The final TXRAM guidebook, Version 2.0, was issued by public notice published in October 2015 (USACE, 2015), seven years after fieldwork at the LBCR site was completed.

The data collection method and subsequent analysis used to assess the proposed LBCR site was also used to assess the streams on the proposed mitigation site, Riverby Ranch, in June 2014. A technical memorandum titled, Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment was submitted to NTMWD on November 12, 2014 ("the 2014 RGA memo"). It described how RGA scores were calculated to characterize baseline condition of streams at both the LBCR site and at Riverby Ranch. The memo also outlined how the proposed stream mitigation would compensate for the stream impacts caused by the proposed LBCR (Freese and Nichols, 2014).

NTMWD submitted the 2014 RGA memo to the USACE, who subsequently distributed it to the Cooperating Agencies working with the USACE on the Clean Water Act, Section 404 permit for the proposed LBCR. These agencies include the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), the Texas Commission on Environmental Quality (TCEQ), and Texas Parks and Wildlife Department (TPWD). A workshop was held on October 13, 2015 to discuss the RGA method and its application at the proposed reservoir site and the proposed mitigation site. The workshop was attended by representatives from USACE, EPA, USFWS, TCEQ, TPWD, NTMWD, and Freese and Nichols (See Attachment A).

During the workshop, the USACE and Cooperating Agencies requested additional RGA data be collected at the proposed reservoir site to supplement the 2008 data collection effort and assessment. In 2008, the RGA data collected on the main stem of Bois d'Arc Creek and four tributaries (Honey Grove Creek, Bullard Creek, Ward Creek, and Sandy Creek) were extrapolated to characterize all of the stream reaches in the proposed reservoir site. At the request of the resource agencies, the requested additional RGA data would be used to confirm the methodology used to characterize streams that were not directly measured in 2008.

The USACE worked with the Cooperating Agencies and NTMWD to identify 10 additional tributaries within the footprint of the proposed reservoir for additional RGA data collection. These tributaries included Allen's Creek, Burns Branch, Fox Creek, Onstott Creek, Pettigrew Branch, Sandy Branch, Stillhouse Branch, Timber Creek, Thomas Branch, and Yoakum Creek, with additional points on Honey Grove Creek, Sandy Creek, and Ward Creek. USACE approved the final locations of the additional RGA data collection sites via email to NTMWD and the Cooperating Agencies on December 7, 2015 (see Exhibit A and Attachment B).

The fieldwork to collect the supplemental RGA data took place during the week of January 11, 2016. Cooperating Agency members were invited to participate in the field data collection effort. In attendance during field work were Ed Parisotto and Robert Hoffman from USACE, Ryan McGillicuddy from TPWD, Robert McCarthy from NTMWD and Freese and Nichols staff.

The supplemental RGA data were collected using the same RGA methods as the previous investigations at the proposed reservoir site (2008) and the proposed mitigation site (2014). The findings of the supplemental data collection were presented in a technical memorandum entitled, Supplemental Rapid Geomorphic Assessment (RGA) Data Collection at the Proposed Lower Bois d'Arc Creek Reservoir Site. This memo was submitted to NTMWD on March 1, 2016. NTMWD subsequently submitted the memo to the USACE.

The USACE published an Approved Jurisdictional Determination (AJD) for the proposed reservoir site in August 2015. The AJD states that the proposed impact area contains 286,139 linear feet of Relatively Permanent Waters (RPWs) and 365,001 linear feet of non-relatively permanent waters (Non-RPWs), for a total of 651,140 linear feet of stream impacts.

Through additional communications with the USACE and cooperating agencies, NTMWD has revised the components of the stream mitigation plan and proposes the following five stream mitigation components to compensate for the impacts of the proposed reservoir:

- Riverby Ranch Existing Stream Restoration and Enhancement
- Riverby Ranch Stream Creation
- On-site Tributaries to Littoral Zone Wetlands
- Riverby Ranch WRP
- Upper Bois d'Arc Creek Mitigation Site Stream Enhancement

This memo summarizes all RGA assessments to date, and the results presented herein supersede those contained in all previous RGA memoranda. Specifically, this memorandum covers the following topics:

- The Lower Bois d'Arc Creek Reservoir Project RGA method and the calculation of Stream Quality Factor and Stream Quality Units
- RGA evaluation of the impacted streams at the proposed reservoir site, including the supplemental data collection effort (FNI, 2016) and the stream length presented in the AJD (USACE, 2015)
- Baseline condition assessment of five proposed stream mitigation opportunities in the Bois d'Arc Creek watershed
- The potential for ecological uplift in the mitigation streams generated through restoration and enhancement
- Proposed stream mitigation components to compensate for the impacts of the proposed reservoir

2.0 APPROACH AND METHODOLOGY

The following sub-sections provide descriptions of the RGA approach and how the RGA scores were used to derive Stream Quality Factor (SQF) and Stream Quality Unit (SQU) values for the proposed impact streams and mitigation streams. The rapid assessments were based on both anthropogenic and natural factors observed in the field and through comparison of the existing and historic channel pattern and geometry. The major factors evaluated were channel stability, vegetation/armoring, and potential in-stream habitat features. A description of the components used to develop the rapid stream assessments is presented below.

2.1 Rapid Geomorphic Assessment (RGA) Approach

The RGA approach integrates data from field and desktop sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features (Freese and Nichols, 2008). The RGA method is based on a rapid field assessment of stream properties and characteristics at representative field sites along the stream reaches being evaluated. Three forms are used to record data at each field point. The Data Collection sheet includes general stream information related to channel size and location. The Bank Stability form is used to record general bank geometry, information regarding riparian vegetation and rooting depths, and general bank armoring. The Channel Stability form is used to collect a variety of information related to the condition of the upper slopes, lower slopes, and channel bed. For each field point, data collected in the field forms are consolidated into a Channel Stability Rating System form. Examples of the four data forms are included in Attachment C. The following six categories are scored and summed to calculate a final RGA score for each field point out of a maximum possible 60 points, with higher values indicating more optimal stream conditions:

- Evidence of Bank Erosion
- Bank Root Zone
- Vegetative Bank Cover
- Bank Angle
- Sediment Transport
- Channel Alteration

2.2 Channel Stability Variables

Qualitative analysis of channel stability was the primary focus of the Rapid Geomorphic Assessment. The adverse consequences of stream channel instability are increased sediment supply, land loss, habitat deterioration, changes in long-term and short-term channel evolution, and loss of both physical and biological function of the stream.

Channel stability was inferred from field inspections, measurements of stream channel characteristics, and by comparing existing stream conditions to historic maps and aerial photography. Specific categories and variables included in the assessment were streambank erosion and angle, riparian and streambank vegetation, overall channel stability, sediment transport, and man-made channel alteration.

Streambank Erosion and Angle

The Bank Stability parameters included several related to the riparian vegetation and the bank angle. Although the Bank Erosion Hazard Index (BEHI) scoring system was not used, the method was referenced for help in determining the key parameters to be evaluated in relation to the channel erosion potential (Rosgen, 2006). Riparian vegetation plays a key role in bank stabilization. Banks with dense, deep rooting zones and in-channel vegetative cover in alluvium generally have stable banks while shallow, sparse roots and no in-stream vegetation result in unstable banks that are subject to mass wasting. Erosion potential related to bank angle (slope steepness) generally ranges from very low for flat slopes to extreme for steep slopes; however, there is a correction factor associated with bank angle to take into consideration the bank material (i.e. bedrock can be very stable at steep angles while sand and clay are not).

Riparian and Streambank Vegetation

Riparian vegetation performs several functions in a stream system including bank stabilization water quality protection, fish and wildlife habitat, and thermal cover for the stream. Bank stabilization and water quality are improved with good riparian buffers because the roots of trees and shrubs help hold stream banks in place, preventing erosion. Riparian vegetation also traps sediment and pollutants in land runoff before it reached the stream channel. The field data collected included information on the general type and condition of the riparian vegetation including an estimate of the percentage of the riparian vegetation that was trees, shrubs, and grasses. Rooting depth, root density and the percentage of the bank protected by vegetation are specific measurements that were taken at each data point. This information was used in both the preliminary bank stability and channel stability classifications.

Channel Stability

The channel stability rating system utilized for this assessment is based on the measurement of up to 15 variables that are specific to the channel bottom, the lower banks within the channel, and the upper banks of the channel. Although the Rosgen-Pfankuch rating system was not used, the method was referenced for help in determining the key parameters to be evaluated in relation to channel stability (Rosgen, 2006). The channel stability rating process evaluates the upper banks, lower banks, and streambed for evidence of excessive erosion or deposition, which are indicative of disequilibrium and can be used to identify potential aquatic habitat within a stream. The system quantitatively evaluates the potential for mass wasting of the stream banks, the detachability of bank and bed materials, channel capacity, and evidence of excessive erosion or deposition. The process provides a means for estimating general channel stability.

Sediment Transport

The description of depositional features utilized for this study is from Mollard (1973) and Galay et al. (1973) as modified by Rosgen (2006). Depositional features, or lack thereof, can be an indicator of channel aggradation or degradation and signal that the channel is experiencing instabilities. Field observations and interpretations of the depositional patterns were used in estimating the sediment transport competency of the channel. Depositional patterns in altered or degraded channel reaches aided in estimating the long-term stability of the channel reach under existing flow conditions.

Man-Made Channel Alterations

Man-made alterations consider man-induced changes to the natural stream system. These may include direct changes to the stream alignment (such as straightening of channels), use of culverts, construction of levees or dikes that alter connectivity with the floodplain, etc.

Photographs

In addition to the data discussed above, GPS-tagged photographs were taken at each data collection point to record visual observations. Photographs looking upstream and downstream were taken at each data point and, at some locations, photographs of the right and left banks were also taken.

Historical Aerial Photography

Current and historical aerial photographs of potential mitigation areas were used to evaluate changes in stream patterns, land use practices, and riparian vegetation over time. The impacts of these changes on the channel pattern and profile were evaluated and documented.

2.3 Channel Stability Rating System

All the variables discussed in Section 2.2 were assessed for each data point and consolidated into a Channel Stability Rating System form (Attachment C). The data were then used to determine a general RGA score (ranging from zero (0) to 60) for that portion of the creek. These classification sheets were then used in conjunction with field notes, aerial photographs, one-foot LIDAR generated topography and two-foot aerial topography to relate the measured and observed sections of the study reaches to other sections of the creeks to determine their RGA score. The stability rating system was developed by Freese and Nichols to provide an objective means for assigning values to the six major parameters identified on the Channel Stability Rating System form. To provide a quantitative measurement of the six evaluation factors, the system relies on the physical parameters measured and recorded on the data collection sheet, bank stability form, and channel stability form. Data are first recorded in the field on those forms and select photographs are attached for future reference. Finally, the information on those three forms is used to complete the Channel Stability Rating System form and subsequently calculate the RGA score. The weighting and scoring system was developed to provide an objective means for interpreting the data and classifying the stream reaches.

2.4 Stream Quality Factor

The RGA score (a number between zero (0) and 60) for a study site is normalized into a Stream Quality Factor (SQF) value by dividing the calculated RGA score by the maximum possible score of 60 points. SQF values are a quality weighting factor that are used to quantify the comparison between baseline stream characteristics of the study site to the stream conditions that are ecologically optimal. This SQF value is used to place a value on the impacted streams and to evaluate the success of the proposed stream mitigation. As with the RGA score, the higher the SQF, the higher the stream quality as based on geomorphic stream equilibrium.

2.5 Stream Quality Unit

The calculated SQF score for a study reach is multiplied by the length of the respective study reach to calculate the number of Stream Quality Units (SQUs) provided by the reach. SQUs quantify the relationship between stream characteristics and the length of stream with those characteristics. SQUs are essentially the mitigation currency for the LBCR RGA stream evaluation method.

3.0 EVALUATION OF PROPOSED STREAM IMPACTS FOR LOWER BOIS D'ARC RESERVOIR

Freese and Nichols (2008) provided RGA scores for Bois d'Arc Creek and its larger tributaries (Honey Grove Creek, Ward Creek, Sandy Creek and Bullard Creek) within the proposed reservoir pool. The 2016 supplemental data collection effort expanded the observed and recorded stream conditions to include 10 additional tributaries of Bois d'Arc Creek. In total, data were collected along the main stem of Bois d'Arc Creek and 14 tributaries within the footprint of the reservoir (Exhibit A).

The RGA scores for these assessed streams were converted to SQF values, and subsequently, the number of SQUs were calculated using the SQF value and the associated reach length. SQF values from the assessed streams were extrapolated to the tributaries upstream of the assessed reaches based on the location of the tributary confluence. For example, if a study reach of Honey Grove Creek had an SQF value calculated to be 0.25, then an unscored stream tributary to that study reach was assumed to also have an SQF value of 0.25. The total SQUs of Bois d'Arc Creek and its tributaries within the proposed reservoir pool, designated by the summed product of the SQU scores for all proposed impact streams and the respective lengths of proposed impacted stream, is 192,377. Table 1 shows the length of stream within the Lower Bois d'Arc Creek footprint by SQF and the corresponding calculated SQUs.

Table 1. Summary of Proposed Reservoir Site SQUs Incorporating 2016 RGA Field Data

Stream Quality Factor (SQF)	Existing Length (ft)	Stream Quality Unit (SQU)
0 - .09	35,261	2,368
.1 - .19	118,020	15,648
.2 - .29	163,585	37,261
.3 - .39	132,662	42,877
.4 - .49	144,541	63,635
.5 - .59	57,071	30,588
.6 - .69	0	0
.7 - .79	0	0
.8 - .89	0	0
.9 - .99	0	0
1.0	0	0
Total	651,140	192,377

4.0 DESCRIPTIONS OF POTENTIAL STREAM MITIGATION OPPORTUNITIES

Several opportunities have been identified that would provide compensatory stream mitigation for the impacts to streams caused by the construction of the proposed Lower Bois d'Arc Creek Reservoir. The five identified potential opportunities are as follows:

- Riverby Ranch existing stream restoration and enhancement
- Riverby Ranch stream creation by restoring meanders on straightened/channelized streams
- On-site tributaries to littoral zone wetlands
- Riverby Ranch Wetlands Reserve Program (WRP) area stream enhancement
- Upper Bois d'Arc Creek Mitigation Site stream enhancement

The following subsections briefly describe the six stream mitigation opportunities and how they were individually assessed using the RGA methodology.

4.1 Riverby Ranch Existing Stream Restoration and Enhancement

Riverby Ranch (excluding areas enrolled in the Wetlands Reserve Program (WRP)) contains 179,353 linear feet of RPWs and Non-RPWs that have been degraded over time by agricultural practices. During the RGA study of Riverby Ranch, 36 field points were evaluated to quantify characteristics of the existing streams on the ranch outside the WRP area (Exhibit B). The streams were each given a unique identifier/name and were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score (Exhibit C).

4.2 Riverby Ranch Stream Creation

The NTMWD is proposing to restore meanders to several first and second-order streams located on the ranch that have been historically straightened/channelized. Field observations and evaluation of current and historical aerial photographs were used to select existing streams on the ranch that would be suitable for meander creation and to calculate an appropriate sinuosity ratio for the created meanders. Through a desktop analysis of nearby reference reaches, it was determined that a sinuosity ratio of approximately 1.3 would be a reasonable ratio for the restored channels. Application of the 1.3 sinuosity ratio to streams suitable for meander creation results in approximately 32,597 additional linear feet of meandering stream on the ranch. The additional linear feet are only considered during the future conditions analysis because there are no baseline conditions present prior to the construction of the created meanders.

4.3 On-site Tributaries to Littoral Zone Wetlands

The RGA method was used to evaluate the baseline condition and potential future conditions of the tributary streams of the littoral zone wetlands that will form between elevations 534 and 541 ft. msl resulting from the proposed impoundment of Bois d'Arc Creek. The baseline RGA scores of the littoral zone tributary streams were extrapolated from the downstream stream reaches within the conservation pool of the proposed reservoir.

4.4 Riverby Ranch WRP

There are approximately 94,596 linear feet of stream within the WRP area on Riverby Ranch, including the channel of Bois d'Arc Creek. During the RGA study of Riverby Ranch, eight (8) field points were evaluated to quantify characteristics of the existing streams in the WRP area (Exhibit C). The study area within the WRP was divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score.

4.5 Upper Bois d'Arc Creek Mitigation Site Stream Enhancement

The proposed Upper Bois d' Arc Creek (BDC) Mitigation Site is located along Bois d'Arc Creek upstream of the proposed LBCR in Fannin County, TX (Exhibit D). The approximately 1,900-acre site contains approximately 62,535 linear feet of RPW and Non-RPW, including the main channel of Bois d'Arc Creek. Eleven field points were evaluated using RGA to describe the existing condition of streams in the Upper BDC Mitigation Site. Most of the streams, including Bois d'Arc Creek, have bene heavily impacted by past and current agricultural actives, including channelization, straightening, and removal of riparian vegetation. During the RGA study of the Upper BDC Mitigation Site, 11 field points were evaluated to quantify characteristics of the existing streams within the proposed mitigation site. The streams were each were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score.

5.0 BASELINE CONDITIONS OF PROPOSED MITIGATION STREAMS

The following section discusses the calculations and results for baseline conditions of the potential mitigation opportunities. Table 2 presents a summary of the baseline conditions for the potential stream mitigation opportunities.

5.1 Riverby Ranch Existing Stream Restoration and Enhancement

RGA scores were applied to reaches based on the score of the most representative nearby field data point. The RGA score for reaches with two field data points was calculated as the average of the two field data points. The RGA scores for stream reaches that did not contain field data points were extrapolated from reaches with similar characteristics. Exhibit C illustrates the locations of the field data points and stream reaches on Riverby Ranch. The RGA score for each reach was converted to an SQF value, which was then multiplied by the length of the respective reach to calculate the SQU. The total baseline SQU value for Riverby Ranch, defined as the sum of the SQUs for each reach, was calculated to be 64,140. This total does not include streams within the WRP area.

5.2 Riverby Ranch Stream Creation

The restoration of meanders for historically straightened/channelized streams will create additional stream length that does not currently exist. For mitigation accounting purposes, the additional created stream length was designated a baseline RGA score and SQF of zero. Total number of baseline SQUs for this component was assumed to be zero due to the absence of preexisting stream length and the RGA score and SQF value of zero.

5.3 On-site Tributaries to Littoral Zone Wetlands

RGA scores for stream reaches within the pool of the proposed reservoir were extrapolated to the streams tributaries to the littoral zone wetlands between elevations 534 and 541 ft. msl. The RGA scores for the tributaries of the littoral zone wetlands were converted into SQF values, then multiplied by the stream length to calculate the total number of SQUs for each reach. The total baseline SQU value for the on-site littoral zone wetlands tributary streams was calculated to be 3,745.

5.4 Riverby Ranch WRP

RGA scores for the tributary streams in the WRP area were calculated the same way as the reaches throughout Riverby Ranch. For the segment of Bois d'Arc Creek within the WRP area, reach RGA scores were designated based on their respective field points within the WRP. The RGA scores were converted into SQF values, which were then multiplied by the lengths of the respective reaches to calculate the SQUs for each reach within the WRP area. The total number of baseline SQUs for streams within the WRP area, defined as the sum of the SQUs for each reach within the WRP area, was calculated to be 40,990.

5.5 Upper Bois d'Arc Creek Mitigation Site Stream Enhancement

RGA scores for the streams in the Upper BDC Mitigation Site were calculated the same way as the reached throughout Riverby Ranch and the WRP. The RGA scores were converted into SQF values, which were then multiplied by the lengths of the respective reaches to calculate the SQUs for each reach within the mitigation site. The total number of baseline SQUs for streams within the Upper BDC Mitigation Site, defined as the sum of the SQUs for each reach within the site, was calculated to be 17,119.

Table 2. Summary of the Baseline Conditions for the Potential Mitigation Opportunities

SQF	Riverby Ranch, Excluding WRP		Tributaries of Littoral Zone		Riverby Ranch WRP Area		Upper BDC Mitigation Site	
	Existing Length (ft)	SQU	Existing Length (ft)	SQU	Existing Length (ft)	SQU	Existing Length (ft)	SQU
0 - .09	8,507	457	11,447	954	7,649	382	15,032	1,253
.1 - .19	26,967	4,253	0	0	887	163	3,800	633
.2 - .29	47,789	10,764	10,022	2,098	0	0	14,641	3,684
.3 - .39	14,086	4,991	1,075	341	16,026	5,342	20,763	6,575
.4 - .49	37,838	17,395	0	0	46,721	21,504	1,483	692
.5 - .59	29,393	15,818	640	352	23,313	13,599	1,962	1,046
.6 - .69	10,905	7,239	0	0	0	0	4,854	3,236
.7 - .79	0	0	0	0	0	0	0	0
.8 - .89	3,868	3,223	0	0	0	0	0	0
.9 - .99	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
Total	179,353	64,140	23,184	3,745	94,596	40,990	62,535	17,119

1. Stream Creation is not shown because the baseline conditions are "0".

6.0 EVALUATION OF POTENTIAL MITIGATION STREAM IMPROVEMENTS

The following section discusses the calculations and results for the potential future conditions of the identified mitigation opportunities. Stream quality improvement potential was estimated assuming appropriate application of potential stream improvement practices. Measures to attain the intended ecological uplift vary from site to site and may include one or more of the following practices:

- Laying back stream banks to reduce erosion and allow for vegetation establishment
- Removal of cattle and other negative anthropogenic influences
- Plugging or diverting drainage ditches
- Restoring meanders to stream channels which were previously straightened
- Establishing a balanced sediment supply
- Re-establishing hydrology by breaching existing dikes

The potential improvement practices directly correspond with the variables on the Channel Stability Rating System form, shown in Attachment C. For example, Table 3 shows that the calculated baseline RGA score for Bois d'Arc Tributary 2, Reach 1 (Figure 1) on Riverby Ranch was determined to be 3 out of 60 possible points, and the improved RGA score due to the application of improvement practices was 50 out of 60 possible points. The stream improvement practices and their expected results that provide the anticipated ecological uplift for this reach are shown in Table 4. Table 5 presents a summary of the mitigated conditions for the potential stream mitigation opportunities.

Table 3. Calculated baseline and potential improved RGA scores for Bois d'Arc Creek Tributary 2, Reach 1

Evaluation Category	Baseline RGA Score	Mitigated RGA Score
Evidence of Bank Erosion	0	8
Bank Root Zone	1	8
Vegetative Cover	2	8
Bank Angle	0	8
Sediment Transport	0	8
Channel Alteration	0	10
Total	3	50

Figure 1. Photograph looking upstream at reach of Bois d'Arc Creek Tributary 2, Reach 1

Table 4. Stream improvement practices and anticipated results for Bois d'Arc Creek Tributary 2, Reach 1

Improvement Practice	Post-Restoration Condition
Decrease streambank angle	Reduces the steepness of the streambank, allows for streambank vegetation to become established, reduces sediment supply from eroding streambanks, and increases floodplain connectivity
Reconnect the stream to the floodplain and reshape the channel	Energy dissipation during high-flow events, reduces sediment supply from eroding streambanks, improves groundwater/surface water exchange, establishes vertical and lateral stability, improves sediment transport capacity, improves bed form diversity, generates habitat, and improves water quality
Establish streambank vegetation and plant riparian buffer	Provides streambank stability, improves vegetated bank cover and bank root zone, provides shade and generates wood debris storage/habitat, reduces bank erosion, and improves water quality
Channelized stream converted to meandering systems	Provides adequate flow duration, increases floodplain connectivity, improves groundwater/surface water exchange, reduces sediment supply from eroding streambanks, establishes vertical and lateral stability, improves sediment transport capacity, improves bed form diversity, generates habitat and biodiversity, and improves water quality
Add bed form structure and complexity, e.g. instream structures	Energy dissipation during flow events, locally reduce shear stresses, generates wood debris storage, habitat and biodiversity, reduces bed and bank erosion, reduced sediment supply from eroding streambanks, improves bed form diversity and improves water quality
Remove Livestock and terminate agricultural practices	Improves vegetated bank cover and bank root zone, provides shade and generates wood debris storage, habitat and biodiversity, reduces bank erosion, reduces sediment supply from eroding streambanks and improves bed form diversity and improves water quality

6.1 Riverby Ranch Existing Stream Restoration and Enhancement

Mitigated SQUs for the reaches were calculated by estimating the uplift potential for each reach on the ranch and designating an uplift RGA score and SQF for the reach. Uplift potential was estimated assuming appropriate application of potential stream improvement practices. The mitigated SQUs for the reaches were calculated as a product of reach length and reach mitigated SQF. Reach mitigated SQUs were summed to calculate the total number of mitigated SQUs for the Riverby Ranch Property of 120,506, excluding streams in the WRP area.

6.2 Riverby Ranch Stream Creation

Mitigated RGA scores for the additional created stream length were extrapolated from the mitigated RGA scores of the associated stream. For example, if a straightened stream channel was estimated to receive a mitigated RGA score of 40, the additional stream length associated with that stream (calculated using a sinuosity ratio of 1.3) was also given a RGA score of 40. The RGA scores of the additional created stream length were converted to SQF values. The SQUs of the created stream length for each reach were calculated as the product of the mitigated SQF values and the anticipated additional created stream length for each reach. The total number of SQUs for created stream length on Riverby Ranch was calculated as the sum of the SQUs of the created stream length for each reach in which meanders were developed. The total number of SQUs for the created stream length resulting from the restoration of meanders was calculated to be 26,488. Stream reaches in the WRP were not considered suitable for meander creation.

6.3 On-site Tributaries to Littoral Zone Wetlands

The proposed mitigation plan intends to offer protection from future development and other non-compatible uses by establishing a site protection instrument up to elevation 541 ft. msl. at the proposed reservoir site. The cessation of farming practices such as the application of fertilizers and pesticides, removing cattle and other negative anthropogenic influences will benefit the littoral zone tributary streams and provide ecological uplift. The uplift due to the establishment of a site protection instrument and the removal of human influences is expected to be at least five (5) RGA points. Five RGA points were added to the baseline RGA score for each tributary stream to establish the mitigated RGA scores within the littoral zone wetlands. The mitigated RGA scores were converted to SQF values, which were used to calculate the SQUs, defined as the product of the SQF and the length of littoral zone tributary streams. The total number of mitigated SQUs for tributaries of the littoral zone wetlands, defined as the sum of all mitigated SQUs for the littoral zone tributary streams, was calculated to be 5,677.

6.4 Riverby Ranch WRP

Enhancement of streams within the WRP would include restoration of hydrology through modifications to the existing dike and drainage ditch that borders the east and west sides of the WRP area, and the creation of treed riparian corridors along selected existing stream alignments. The restoration of hydrology reconnects the watershed with its streams and floodplain. The uplift is reflected through a reduction in man-made influences on the stream and improved sediment transport. Establishing a treed riparian buffer will improve streambank stability, reduce bank erosion, provide shade to the stream, and generate wood debris storage/habitat.

Fluvial geomorphic principles support the hypothesis that as upstream reaches of streams are improved and become stabilized, the downstream reaches of the channel can experience indirect ecological uplift resulting from the upstream improvements, even with no direct channel work performed in the downstream reaches. For example, removing cattle and other agricultural practices, restoring meanders, modifying channel geometry to stable dimensions, and re-connecting the upstream channel to a floodplain would promote stability and provide uplift to the downstream reach by reducing the volume and velocity of incoming stream flow (thereby reducing channel erosion and bank failures), reducing incoming sediment and nutrient loads (that promote channel infilling and eutrophication), and providing a seed source for channel vegetation.

Additionally, changes in the hydrologic regime of Bois d'Arc Creek downstream of the proposed dam are expected to provide sufficient flows to benefit and maintain habitat and not cause erosion and channel degradation. Based on this assumption, RGA scores are expected to improve for the reaches of Bois d'Arc Creek downstream of the proposed dam.

Mitigated RGA scores for the streams in the WRP that were directly connected to upstream tributaries outside the WRP area were assigned based on the existing condition of the WRP streams and the anticipated future condition that would result from indirect uplift caused by upstream channel restoration efforts, modifications to the existing dike surrounding this area, and the establishment of treed riparian buffers. Mitigated RGA scores for Bois d'Arc Creek within the WRP were assigned based on the anticipated future condition that would result from the stabilized hydraulic regime downstream of the proposed dam and the re-establishment of hydrology to its tributaries. Mitigated RGA scores were converted to mitigated SQF values, and the mitigated SQUs for the WRP stream reaches were calculated as the product of length of the stream reach within the WRP area and the reach mitigated SQUs. Reach mitigated SQUs were summed to calculate the total number of mitigated SQUs for the streams in the WRP area on Riverby Ranch of 47,142.

6.5 Upper Bois d'Arc Creek Mitigation Site Stream Enhancement

The primary purpose of the Upper BDC Mitigation Site is to provide forested wetland mitigation to offset forested wetland impacts caused by the proposed reservoir. NTMWD is proposing to enhance streams in the Upper BDC Mitigation Site area by through planting of treed riparian buffers along the main stem of Bois d'Arc creek and tributaries. Establishing a treed riparian buffer will improve streambank stability, reduce bank erosion, provide shade to the stream, and generate wood debris storage/habitat.

The uplift due to the establishment of a site protection instrument and the removal of human influences is expected to be at least five (5) RGA points. Therefore, five RGA points were added to the baseline RGA score for each stream to establish the mitigated RGA scores within the Upper BDC Mitigation Site. The establishment of new treed riparian buffers and the enhancement of existing treed buffers is expected to generate additional uplift, but NTMWD is not proposing to take credit for this uplift. The mitigated RGA scores were converted to SQF values, which were used to calculate the SQUs, defined as the product of the SQF and the length of littoral zone tributary streams. The total number of mitigated SQUs for streams in the Upper BDC Mitigation Site, defined as the sum of all mitigated SQUs for the streams at the site, was calculated to be 22,330.

Table 5. Summary of the Mitigated Conditions for the Potential Mitigation Opportunities

SQF	Riverby Ranch, Excluding WRP		Riverby Ranch Stream Creation		Tributaries of Littoral Zone		Riverby Ranch WRP Area		Upper BDC Mitigation Site	
	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU
0 - .09	0	0	0	0	0	0	0	0	0	0
.1 - .19	1,907	286	0	0	11,447	1,908	4,502	825	15,032	2,505
.2 - .29	10,584	2,486	0	0	4,399	1,246	3,045	791	3,800	950
.3 - .39	18,167	6,457	0	0	5,623	1,687	0	0	14,641	4,904
.4 - .49	10,517	4,381	0	0	1,075	430	23,048	9,637	20,763	8,305
.5 - .59	6,762	3,719	0	0	0	0	40,688	21,025	1,483	816
.6 - .69	27,288	16,505	2,852	1,711	640	406	23,313	14,864	1,962	1,210
.7 - .79	1,215	911	0	0	0	0	0	0	4,854	3,640
.8 - .89	102,913	85,761	29,745	24,777	0	0	0	0	0	0
.9 - .99	0	0	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0	0	0
Total	179,353	120,506	32,597	26,488	23,184	5,677	94,596	47,142	62,535	22,330

7.0 COMPENSATORY MITIGATION SUMMARY AND PROPOSED MITIGATION PLAN COMPONENTS

The total number of SQUs of Bois d'Arc Creek and its tributaries within the proposed reservoir pool is 192,377. Mitigation for the impacted streams would be achieved through the five (5) mitigation components listed in Table 6.

As shown in Table 6, only the uplift that will be generated by stream enhancement in the Riverby Ranch WRP area are included in the total proposed mitigation. This is because the streams located within the WRP area are currently protected in perpetuity under the NRCS WRP instrument. The total number of SQUs generated by the five mitigation components compensate for the stream losses in the proposed reservoir pool with a total of 181,153 SQU mitigation credits, resulting in a deficit of 11,224 SQUs. Table 6 summarizes the total number of baseline and mitigated condition SQUs for the five proposed mitigation components.

Table 6 Baseline, mitigated, and uplift SQUs for proposed stream mitigation components

Mitigation Component	Baseline SQU	Mitigated SQU	SQU Uplift
Riverby Ranch Restoration and Enhancement	64,140	120,506	56,366
Riverby Ranch Creation	0	26,488	26,488
Riverby Ranch WRP Area	40,990	47,142	6,152
On-Site Tributaries to Littoral Zone Wetlands	3,745	5,677	1,932
Upper BDC Mitigation Site	17,119	22,330	5,211
Total	125,994	222,143	96,149
Total Stream Impacts	192,377		
Total Stream SQU Mitigation Credits		181,153*	

*Total stream SQU mitigation credits is the sum of the total (baseline plus uplift) mitigated SQUs for each mitigation component less the baseline SQUs for the for Riverby Ranch WRP Area. The baseline SQUs for the WRP Area are excluded from the credit calculation because this area is currently protected through the WRP.

8.0 REFERENCES

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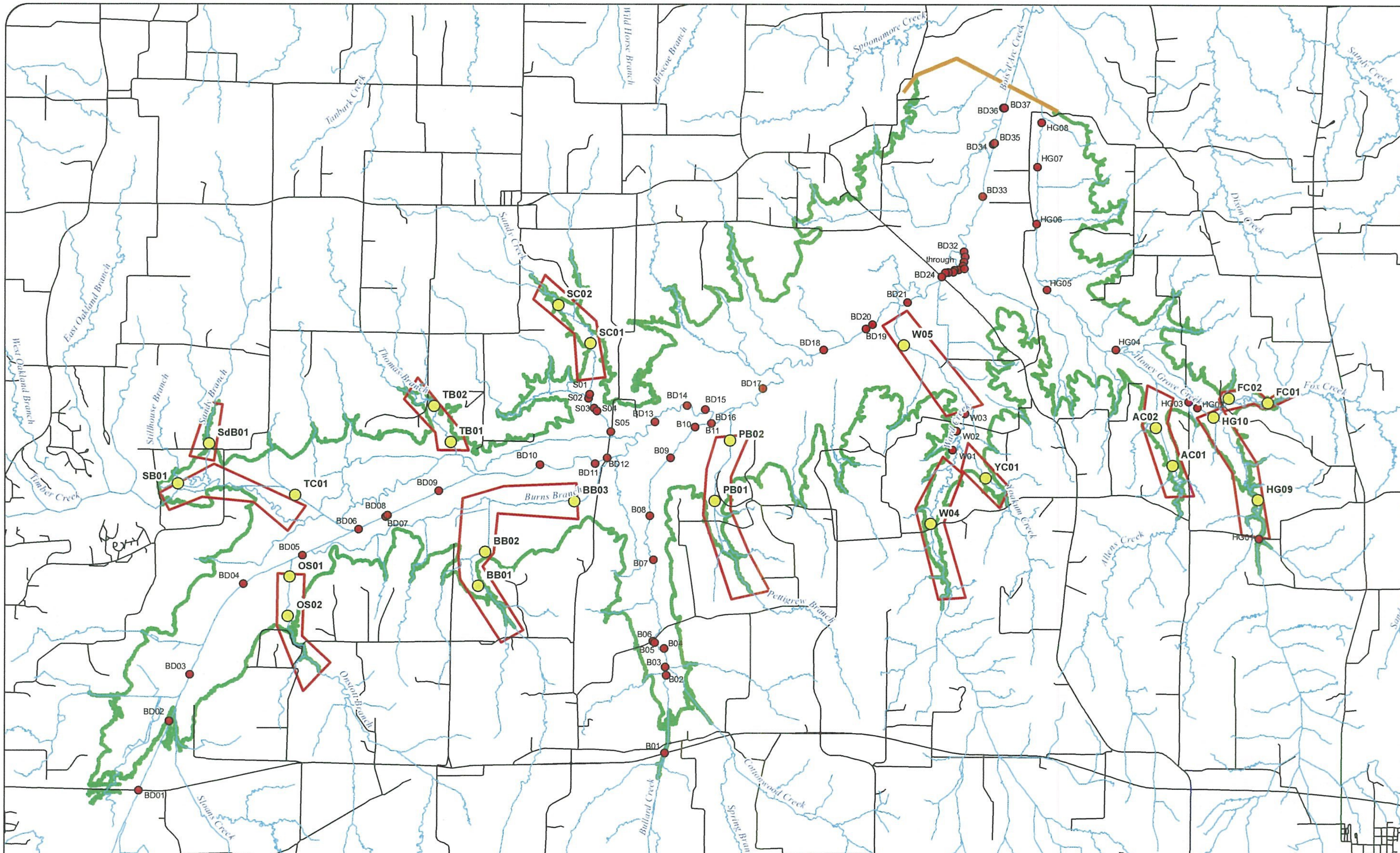
EXHIBITS

APPENDIX E



Road
Stream
Proposed Dam
Proposed Reservoir
2015 Proposed RGA Refinement
2007 Rapid Assessment Reach Field Data Points
USACE Requested 2015 RGA Refinement

0 1 2 4 Miles

North Texas Municipal Water District

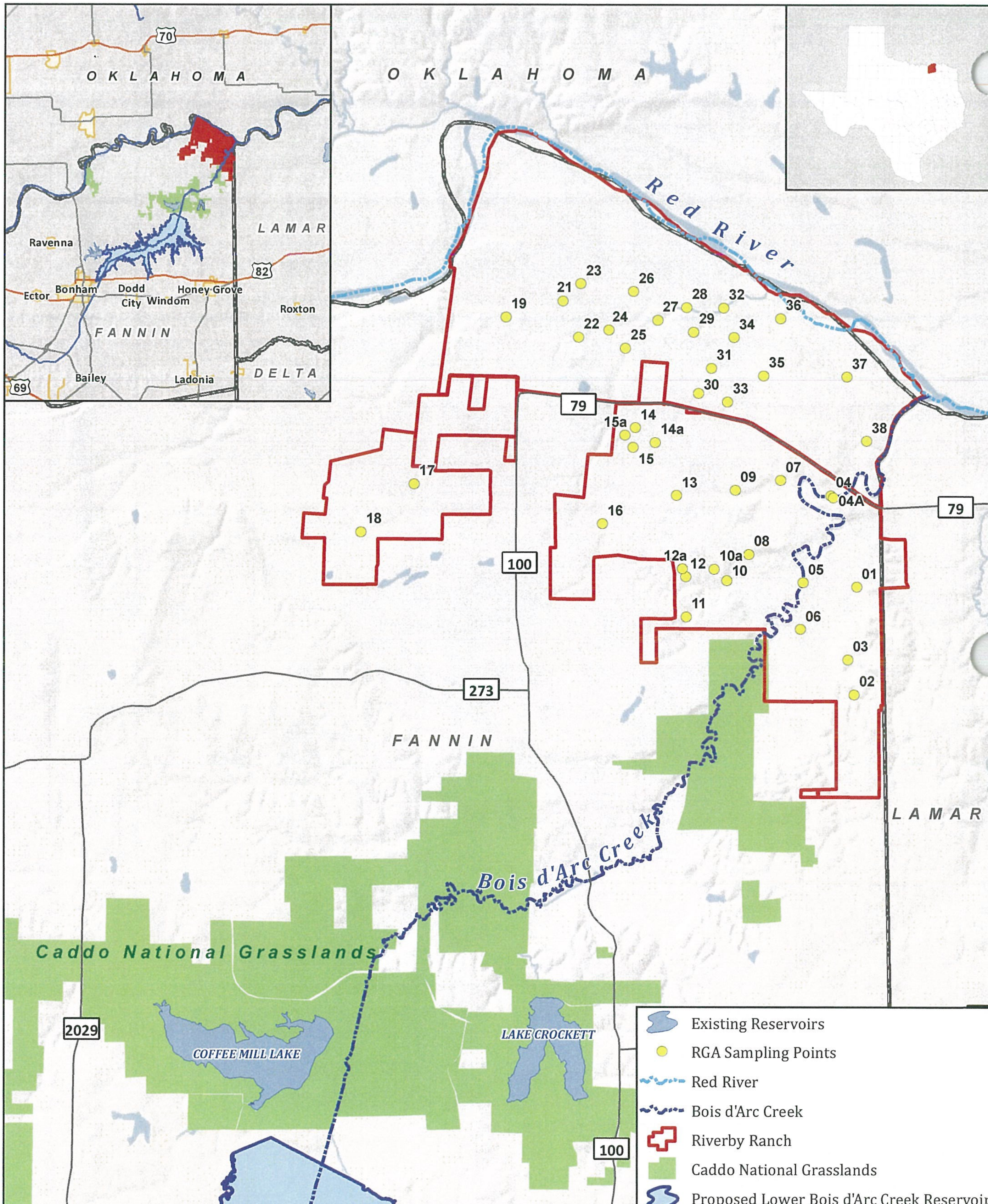
Proposed Lower Bois d'Arc Reservoir Project

2015 RGA Data Collection Points

FN PROJECT NO	NTD06128
DATE	December 4, 2015
DATUM & COORDINATE SYSTEM	NAD83 State Plane TX Central
FILE	RGA_2015.mxd
PREPARED BY	VMC

Freese and Nichols
4055 International Plaza
Ste. 200
Fort Worth, TX 76109
Phone: (817) 735-7300
Fax: (817) 735-7491

EXHIBIT
A



FREESE AND NICHOLS

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

N W E S

NORTH TEXAS MUNICPAL WATER DISTRICT

Riverby Ranch

Location Map

0 2 4 Miles

FN JOB NO	NTD06128
FILE NAME	Location.mxd
DATE	11/4/2016
SCALE	1:96,411
DESIGNED	SSJ
DRAFTED	dkc

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EXHIBIT

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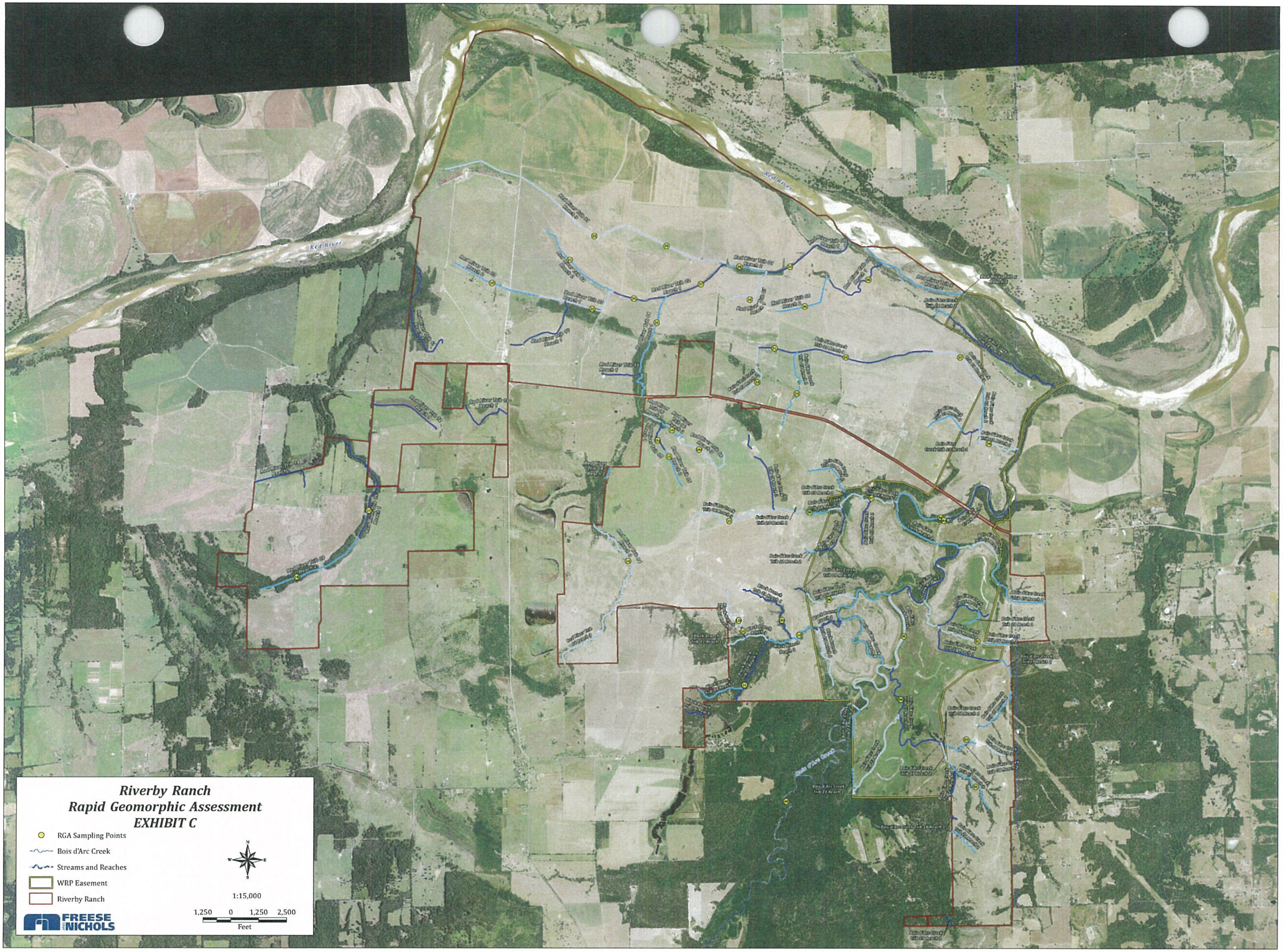
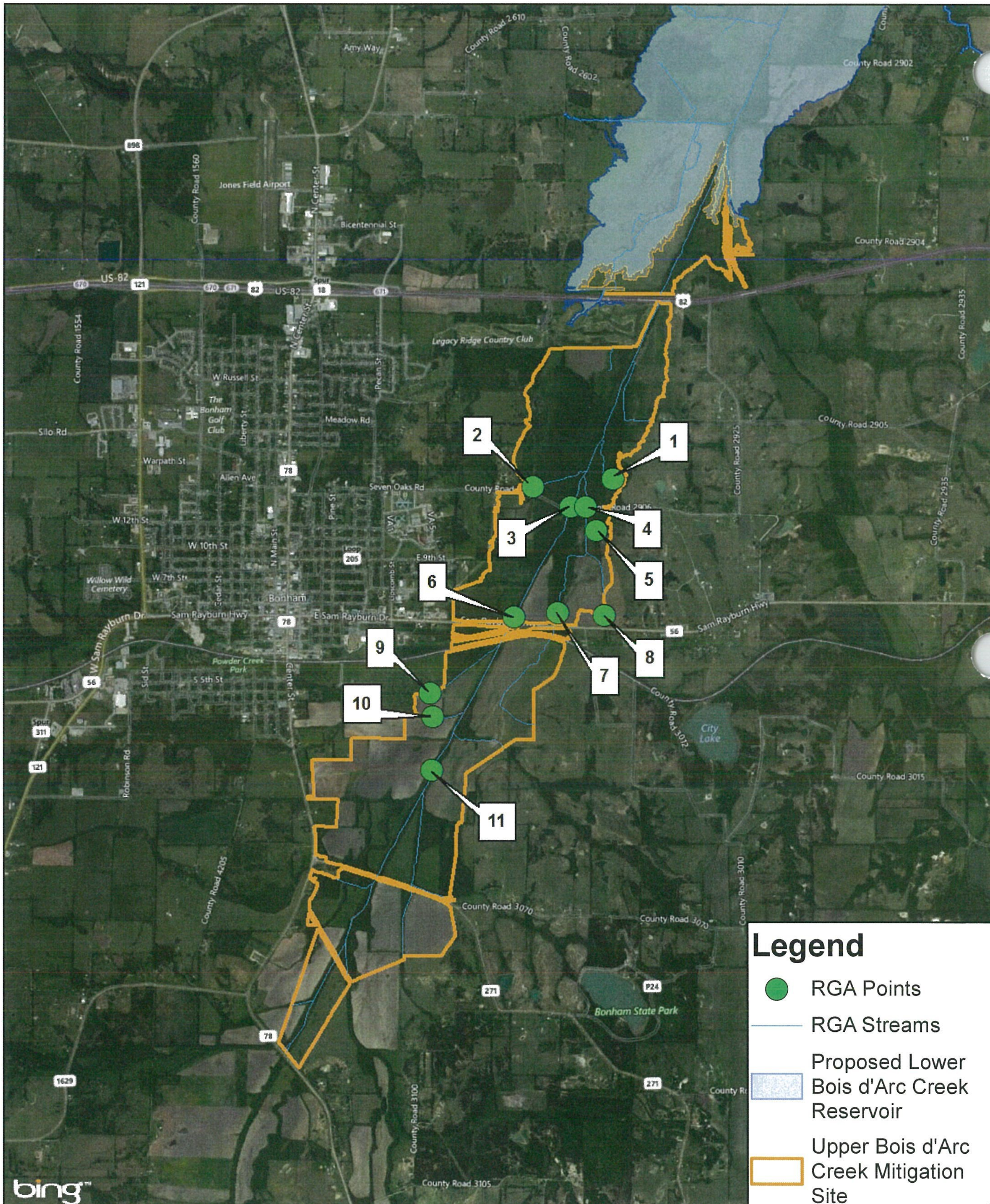
APPENDIX E

NAD 1983 StatePlane Texas North Central FIPS 4202 Feet


Riverby Ranch
Rapid Geomorphic Assessment
EXHIBIT C
RGA Sampling Points
Bois d'Arc Creek
Streams and Reaches
WRP Easement
Riverby Ranch
1:15,000
1,250 0 1,250 2,500
Feet
FREESE NICHOLS
Red River



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

N W E S

NORTH TEXAS MUNICPAL WATER DISTRICT

Upper Bois d'Arc Creek Mitigation Site

RGA Locations

0 4,000 8,000 Feet

FN JOB NO	NTD06128
FILE NAME	Upper_BDC_Mitigation_Area_RGA_8x11.mxd
DATE	11/4/2016
SCALE	1:48,000
DESIGNED	SSJ
DRAFTED	02405

D

EXHIBIT

APPENDIX E

Path: H:\ENVIRONMENTAL\FINAL_EXHIBITS\Mitigation\Revisions\RGA\Upper_BDC_Mitigation_Area_RGA_8x11.mxd

NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

Attachment A

October 2015 RGA Workshop Attendees

1. USACE
    a. Andy Commer
    b. Ed Parisotto

2. USEPA
    a. Maria Martinez
    b. Keith Hayden
    c. Alison Kitto

3. USFWS
    a. Sid Puder

4. TPWD
    a. Tom Heger
    b. Ryan McGillicuddy

5. TCEQ
    a. Peter Schaffer

6. Solv
    a. Leon Kolankiewicz

7. NTMWD
    a. Robert McCarthy
    b. Ashley Burt

8. FNI
    a. Simone Kiel
    b. Steve Watters
    c. David Coffman
    d. Stephanie Coffman
    e. Velita Cardenas
    f. Michael Votaw
    g. Randall Howard

9. Lloyd Gosselink
    a. Sara Thornton

10. Baylor University
    a. Dr. Peter Allen

Attachment B

Email: LBRC RGA “ground truthing” of data

From:	Robert McCarthy
To:	Mike Rickman; Billy George; Sara Thornton; Steve Watters; Michael Votaw; Randall Howard; Simone Kiel
Subject:	Fwd: LBCR RGA "ground truthing" of data
Date:	Monday, December 07, 2015 10:42:07 AM
Attachments:	RGA 2015.pdf RGA 2015 DataPoints 20151204.zip FW LBCR RGA ground truthing of data (UNCLASSIFIED).msg

Fyi

RM:
Sent via the Samsung GALAXY S5

-------- Original message --------
From: "Parisotto, Edward SWT" <Edward.Parisotto@usace.army.mil>
Date: 12/7/2015 9:00 AM (GMT-06:00)
To: "Crawford, Dorothy" <Crawford.Dorothy@epa.gov>, "Kitto, Alison" <Kitto.Alison@epa.gov>, "Hayden, Keith" <Hayden.Keith@epa.gov>, "'sidney_puder@fws.gov'" <sidney_puder@fws.gov>, 'Ryan McGillicuddy' <Ryan.McGillicuddy@tpwd.texas.gov>, 'Tom Heger' <Tom.Heger@tpwd.texas.gov>, 'Peter Schaefer' <peter.schaefer@tceq.texas.gov>, "'robertpotts@fs.fed.us'" <robertpotts@fs.fed.us>, 'H M Williams' <hwilliams@sfasu.edu>, "Commer, Andrew SWT" <Andrew.Commer@usace.army.mil>, Robert McCarthy <rmccarthy@NTMWD.COM>, 'Leon Kolankiewicz' <Leon.Kolankiewicz@solvllc.com>, "Hoffmann, Robert SWT" <Robert.B.Hoffmann@usace.army.mil>, "Poulos, Lauren" <poulos.lauren@epa.gov>
Subject: FW: LBCR RGA "ground truthing" of data

Team,

Please reference my November 13th email regarding RGA "truthing". The Corps received valuable comments from some of you and appreciate the time you have taken to provide that input. The Corps has finalized the required additional field work with the applicant.

Attached is a map and data points that the applicant is required to assess utilizing the same RGA method used previously for this project. The field work is tentatively scheduled for the week of 11 January 2016. Field contacts numbers are Michael Votaw, 817-676-3610 or Steve Watters, 817-706-5733.

I will still be the POC for coordination if you plan on monitoring the field work OR schedule changes need to be made (due to weather). If for some reason I am not available, feel free to contact Robert McCarthy at 469-626-4635.

I want to thank each of you again for all of you time and assistance with the evaluation of this field work.

Respectfully,
Ed

Ed Parisotto
Supervisory Regulatory Project Manager
Tulsa District U.S. Army Corps of Engineers
(918) 669-7549 / Fax: (918) 669-4306
http://www.swt.usace.army.mil/Missions/Regulatory.aspx
You are invited to complete our Regulatory Service Survey at:

http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0

-----Original Message-----
From: Robert McCarthy [mailto:rmccarthy@NTMWD.COM]
Sent: Friday, December 04, 2015 3:42 PM
To: Parisotto, Edward SWT <Edward.Parisotto@usace.army.mil>
Cc: spw@freese.com; Mike Rickman <mrickman@NTMWD.COM>; Billy George <bgeorge@NTMWD.COM>; mpv@freese.com
Subject: [EXTERNAL] LBCR RGA "ground truthing" of data

Ed,

Pease see attached a revised RGA "ground truthing" map (and associated shapefiles) on which we relocated the following stream assessment points in response to EPA's November 20, 2015 comment.

- Relocated site TC01 to Stillhouse Branch and renamed it SB01.
While reviewing the stream assessment site placement on Timber Creek, it became apparent that the site that had been labeled SB01 (in the November 2, 2015 email) was actually on an inactive, historic channel of Timber Creek. The name of the point was changed to TC01 and the point was moved northeast, out of the USACE proposed 2015 RGA ground truthing site box, onto the active channel of Timber Creek, which is a previously straightened reach.

With regard to schedule, we are tentatively planning to conduct the RGA ground truthing field study during the week of January 11, 2016. This field schedule is dependent on USACE concurrence with our proposed stream assessment locations as well as weather/field conditions. We'll firm up the field logistics as we get closer to January 11.

Please let me know if you have any questions.

Robert McCarthy
Permit Manager
North Texas Municipal Water District
505 E. Brown St.
P.O. Box 2408
Wylie, Texas 75098
Telephone (469) 626-4633
Email: rmccarthy@ntmwd.com

Attachment C

Example RGA Field Forms and Channel Stability Rating System Form

Data Collection Sheet

Sheet No.

Date:		Stream Name:	
Project Name:	Lower Bois d'Arc Creek Reservoir Phase II	Coordinates:	
Project Number:	NTD06128	Field Crew:	

Channel Characteristics:				Stream Size: Category (Bankfull Width, ft)					
Average Bank Width:		OHWM Width:		S-1 (<1)	❑	S-6 (50-75)	❑	S-11 (350-500)	❑
Average Bank Depth:		Circle: Perennial, Intermittent, or Ephemeral		S-2 (1-5)	❑	S-7 (75-100)	❑	S-12 (500-1000)	❑
Average Stream Bed Depth:				S-3 (5-15)	❑	S-8 (100-150)	❑	S-13 (>1000)	❑
Average Water Width:		Circle: Clear or Turbid		S-4 (15-30)	❑	S-9 (150-250)	❑		
Average Water Depth:		Water Color:		S-5 (30-50)	❑	S-10 (250-350)	❑		
Maximum Water Depth:									

Substrate:				Debris/Blockages:		*B.D.= Beaver Dams			
Silt/Clay	❑	Boulder (>10")	❑	D1: None	❑	D5: Extensive	❑	D9: B.D. - Abandoned	❑
Sand	❑	Bedrock	❑	D2: Infrequent	❑	D6: Dominating	❑		
Gravel (.25"-2.5")	❑	Concrete	❑	D3: Moderate	❑	D7: B.D. - Few	❑	D10 - Human Influences	❑
Cobble (2.5"-10")	❑	Organic	❑	D4: Numerous	❑	D8: B.D. - Frequent	❑		

Instream Cover:				Riparian Zone:			
Undercut Banks	❑	Deep Pools	❑	Forest	❑	Scrub/Shrub	❑
Shallows	❑	Overhanging Vegetation	❑	Pasture	❑	Row-Crop	❑
Boulders	❑	Emergent/Submergent Vegetation	❑	Paved	❑	Residential	❑
Oxbows	❑	Logs/Brush	❑	Old-Field/ROW	❑	Width of Riparian Zone	

Riparian Vegetation:

Category	Percent Aerial Cover	Percent Site Coverage	Species Composition	Percent of Total
Canopy Layer				
Shrub Layer				
Herbaceous				
Leaf or Needle Litter				
Bare Ground				

Photos:	Additional Notes:

APPENDIX E

BEHI Variable Worksheet

Stream: Reach: Cross Section:

Observers: Date:

						BEHI Score
Bank Height/Max Depth Bankfull (C)						
Study Bank Height (ft)	(A)	Bankfull Height (ft)	(B)	(A)/(B) =	(C)	
Root Depth/Bank Height (E)						
Root Depth (ft)	(D)	Study Bank Height (ft)	(A)	(D)/(A) =	(E)	
Weighted Root Density (F)						
				Root Density (%)	(F)	
Bank Angle (G)						
				Bank Angle (Degrees)	(G)	
Surface Protection (H)						
				Surface Protection (%)	(H)	

Bank Material Adjustment

- Bedrock (Overall Very Low BEHI)
- Boulders (Overall Low BEHI)
- Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust
- Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)
- Sand (Add 10 points)
- Silt Clay (no adjustment)

⇨ **Bank Materials Adjustment**

Stratification Adjustment

Add 5-10 points, depending on position of unstable layers in relation to bankfull stage

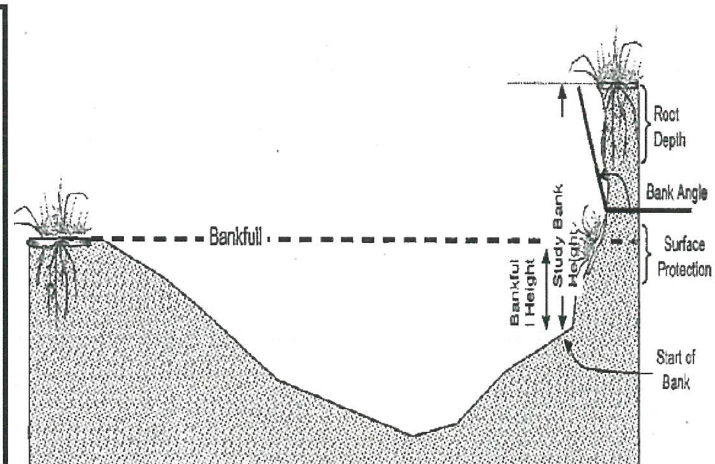
VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5 - 9.5	10 - 19.5	20 - 29.5	30 - 39.5	40 - 45	46 - 50

⇨ **ADJECTIVE RATING and TOTAL SCORE**

Bank Sketch

Vertical Distance (ft)

Horizontal Distance (ft)



APPENDIX E

Pfankuch Channel Stability Form

Stream: ____________ Reach: ____________ Date: ________ Observers: ____________ Comments: ____________

Location	Key	Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating
Upper Banks	1	Landform Slope	Bank slope gradient <30%.	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient 60%+.	8
	2	Mass Wasting	No evidence of past or future mass wasting.	3	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly year long.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
	3	Debris Jam Potential	Essentially absent from immediate channel area.	2	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8
	4	Vegetative Bank Protection	90%+ plant density. Vigor and variety suggest a deep, dense soil binding root mass.	3	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species & less vigor indicating poor, discontinuous, and shallow root mass.	12
Lower Banks	5	Channel Capacity	Ample for present plus some increases. Peak flows contained. (W/D)/(W/Dref) < 1.1, BHR = 1.0 - 1.1	1	Adequate. Bank overflows are rare. (W/D)/(W/Dref) = 1.1 - 1.2, BHR = 1.1 - 1.3	2	Barely contains present peaks. Occasional overbank floods. (W/D)/(W/Dref) = 1.2 - 1.6, BHR = 1.3 - 1.5	3	Inadequate. Overbank flows common. (W/D)/(W/Dref) > 1.6, BHR > 1.5	4
	6	Bank Rock Content	65%+ w/ large angular boulders. 12"+ common.	2	40-65%. Mostly boulders and small cobbles 6-12".	4	20-40%. With most in the 3-6" diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	8
	7	Obstructions to Flow	Rocks and logs firmly embedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8
	8	Cutting	Little or none. Infrequent raw banks <6".	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges, surfaces smooth, flat.	2	Corners and edges well rounded in 2 dimensions.	3	Well rounded in all dimensions, surfaces smooth.	4
	11	Brightness	Surfaces dull, dark or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	2	Mixture dull and bright, i.e. 35-65% mixture range.	3	Predominantly bright, 65%+, exposed or scoured surfaces.	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	4	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%.	4	Distribution shift light. Stable material 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.	12	Marked distribution change. Stable materials 0-20%.	16
	14	Scouring and Deposition	<5% of bottom affected by scour or deposition.	6	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too.	1	Common. Algae forms in low velocity and pool areas. Moss here, too.	2	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
			Excellent Total =		Good Total =		Fair Total =		Poor Total =	

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98
Fair (Mod. Unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+

Stream Type	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6
Good (Stable)	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
Poor (Unstable)	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

Grand Total =	
Existing Stream Type =	
Potential Stream Type* =	
Modified Channel Stability Rating =	

* Rating should be adjusted to Potential Stream Type, not existing.

Riverby Ranch Streams
Channel Stability Rating System

Reach: ____________________

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		0		0		0

Description:

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	0

APPENDIX E

Attachment D

RGA Calculations Tables

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
Allens Creek	12	2,785	0.20	557	Intermittent
Allens Creek	8	4,327	0.13	577	Intermittent
Allens Creek	8	1,498	0.13	200	Intermittent
Allens Creek	12	2,909	0.20	582	Intermittent
Allens Creek	8	262	0.13	35	Intermittent
UT of Allens Creek	12	924	0.20	185	Intermittent/Ephemeral
UT of Allens Creek	8	629	0.13	84	Intermittent/Ephemeral
UT of Allens Creek	8	290	0.13	39	Intermittent/Ephemeral
Bois d'Arc Creek	14	1,895	0.23	442	Intermittent
Bois d'Arc Creek	13	1,950	0.22	422	Intermittent
Bois d'Arc Creek	5	1,614	0.08	135	Intermittent
Bois d'Arc Creek	13	1,426	0.22	309	Intermittent
Bois d'Arc Creek	14	2,093	0.23	488	Intermittent
Bois d'Arc Creek	18	548	0.30	164	Intermittent
Bois d'Arc Creek	18	3,128	0.30	938	Intermittent
Bois d'Arc Creek	25	3,373	0.42	1,406	Intermittent
Bois d'Arc Creek	14	1,518	0.23	354	Intermittent
Bois d'Arc Creek	13	1,046	0.22	227	Intermittent
Bois d'Arc Creek	19	2,412	0.32	764	Intermittent
Bois d'Arc Creek	7	5,727	0.12	668	Intermittent
Bois d'Arc Creek	13	177	0.22	38	Intermittent
Bois d'Arc Creek	28	4,191	0.47	1,956	Intermittent
Bois d'Arc Creek	25	1,148	0.42	478	Intermittent
Bois d'Arc Creek	33	2,220	0.55	1,221	Intermittent
Bois d'Arc Creek	33	455	0.55	251	Intermittent
Bois d'Arc Creek	33	285	0.55	157	Intermittent
Bois d'Arc Creek	28	4,402	0.47	2,054	Intermittent
Bois d'Arc Creek	14	2,670	0.23	623	Intermittent
Bois d'Arc Creek	27	4,062	0.45	1,828	Intermittent
Bois d'Arc Creek	18	4,200	0.30	1,260	Intermittent
Bois d'Arc Creek	18	661	0.30	198	Intermittent
Bois d'Arc Creek	33	4,798	0.55	2,639	Intermittent
Bois d'Arc Creek	18	2,768	0.30	830	Intermittent
Bois d'Arc Creek	24	463	0.40	185	Intermittent
Bois d'Arc Creek	33	598	0.55	329	Intermittent
Bois d'Arc Creek	33	2,160	0.55	1,188	Intermittent
Bois d'Arc Creek	7	3,062	0.12	357	Intermittent
Bois d'Arc Creek	33	1,078	0.55	593	Intermittent
Bois d'Arc Creek	33	9	0.55	5	Intermittent
Bois d'Arc Creek	19	3,297	0.32	1,044	Intermittent
Bois d'Arc Creek	17	697	0.28	198	Intermittent
Bois d'Arc Creek	17	1,001	0.28	284	Intermittent
Bois d'Arc Creek	25	1,640	0.42	683	Intermittent
Bois d'Arc Creek	28	225	0.47	105	Intermittent
Bois d'Arc Creek	14	151	0.23	35	Intermittent
Bois d'Arc Creek	14	1,394	0.23	325	Intermittent
Bois d'Arc Creek	18	350	0.30	105	Intermittent

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
Bois d'Arc Creek	8	303	0.13	40	Intermittent
Bois d'Arc Creek	13	70	0.22	15	Intermittent
Bois d'Arc Creek	27	1,019	0.45	459	Intermittent
Bois d'Arc Creek	28	2,724	0.47	1,271	Intermittent
Bois d'Arc Creek	14	502	0.23	117	Intermittent
Bois d'Arc Creek	23	261	0.38	100	Intermittent
Bois d'Arc Creek	14	186	0.23	44	Intermittent
Bois d'Arc Creek	18	732	0.30	220	Intermittent
UT of Bois d'Arc Creek	5	2,219	0.08	185	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	1,594	0.08	133	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	9,928	0.30	2,978	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	233	0.30	70	Intermittent/Ephemeral
UT of Bois d'Arc Creek	13	4,629	0.22	1,003	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	705	0.30	212	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	96	0.45	43	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	2,035	0.45	916	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	30	0.08	2	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	2,271	0.23	530	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	2,163	0.23	505	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	479	0.08	40	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	3,939	0.30	1,182	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	2,404	0.23	561	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	1,122	0.23	262	Intermittent/Ephemeral
UT of Bois d'Arc Creek	19	9,904	0.32	3,136	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	634	0.45	285	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	535	0.30	161	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	2,814	0.45	1,266	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	67	0.08	6	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	5,664	0.23	1,322	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	136	0.30	41	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	381	0.08	32	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	4,550	0.30	1,365	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	56	0.08	5	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	555	0.30	166	Intermittent/Ephemeral
UT of Bois d'Arc Creek	23	466	0.38	179	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	906	0.08	76	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	5,659	0.23	1,320	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	2,472	0.23	577	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	10	0.30	3	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	212	0.08	18	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	2,034	0.08	170	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	912	0.30	274	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	32	0.30	10	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	219	0.08	18	Intermittent/Ephemeral
UT of Bois d'Arc Creek	13	1,886	0.22	409	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	4,933	0.47	2,302	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	999	0.47	466	Intermittent/Ephemeral

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
UT of Bois d'Arc Creek	27	2,577	0.45	1,160	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	2,443	0.08	204	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	600	0.47	280	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	6,454	0.47	3,012	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	2,272	0.45	1,022	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	5,391	0.47	2,516	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	338	0.47	158	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	1,867	0.47	871	Intermittent/Ephemeral
UT of Bois d'Arc Creek	13	2,835	0.22	614	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	2,973	0.23	694	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	2,631	0.08	219	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	3,645	0.45	1,640	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	4,141	0.23	966	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	11,142	0.23	2,600	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	4,796	0.45	2,158	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	307	0.30	92	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	1,898	0.08	158	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	538	0.08	45	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	5,819	0.23	1,358	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	4,336	0.30	1,301	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	7,210	0.45	3,244	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	5,612	0.23	1,309	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	603	0.30	181	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	1,098	0.08	92	Intermittent/Ephemeral
UT of Bois d'Arc Creek	18	1,380	0.30	414	Intermittent/Ephemeral
UT of Bois d'Arc Creek	27	4,911	0.45	2,210	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	4,412	0.47	2,059	Intermittent/Ephemeral
UT of Bois d'Arc Creek	5	80	0.08	7	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	275	0.23	64	Intermittent/Ephemeral
UT of Bois d'Arc Creek	28	126	0.47	59	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	264	0.23	62	Intermittent/Ephemeral
UT of Bois d'Arc Creek	14	53	0.23	12	Intermittent/Ephemeral
Bullard Creek	19	4,893	0.32	1,549	Intermittent
Bullard Creek	19	2,612	0.32	827	Intermittent
Bullard Creek	11	2,032	0.18	372	Intermittent
Bullard Creek	33	305	0.55	168	Intermittent
Bullard Creek	13	1,057	0.22	229	Intermittent
Bullard Creek	13	2,133	0.22	462	Intermittent
Bullard Creek	33	946	0.55	520	Intermittent
Bullard Creek	12	1,198	0.20	240	Intermittent
Bullard Creek	15	928	0.25	232	Intermittent
Bullard Creek	12	1,127	0.20	225	Intermittent
Bullard Creek	11	4,631	0.18	849	Intermittent
Bullard Creek	25	3,359	0.42	1,400	Intermittent
UT of Bullard Creek	13	23	0.22	5	Intermittent/Ephemeral
UT of Bullard Creek	12	1,702	0.20	340	Intermittent/Ephemeral
UT of Bullard Creek	11	3,121	0.18	572	Intermittent/Ephemeral

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
UT of Bullard Creek	13	346	0.22	75	Intermittent/Ephemeral
UT of Bullard Creek	13	1,429	0.22	310	Intermittent/Ephemeral
Burns Branch	9	903	0.15	135	Intermittent
Burns Branch	31	9,077	0.52	4,690	Intermittent
Burns Branch	12	4,080	0.20	816	Intermittent
Burns Branch	9	3,680	0.15	552	Intermittent
Burns Branch	9	847	0.15	127	Intermittent
UT of Burns Branch	7	3,203	0.12	374	Intermittent/Ephemeral
UT of Burns Branch	9	630	0.15	95	Intermittent/Ephemeral
UT of Burns Branch	9	480	0.15	72	Intermittent/Ephemeral
UT of Burns Branch	33	4,129	0.55	2,271	Intermittent/Ephemeral
UT of Burns Branch	7	4,693	0.12	548	Intermittent/Ephemeral
UT of Burns Branch	7	2,738	0.12	319	Intermittent/Ephemeral
UT of Burns Branch	33	798	0.55	439	Intermittent/Ephemeral
UT of Burns Branch	7	4,652	0.12	543	Intermittent/Ephemeral
UT of Burns Branch	12	2,803	0.20	561	Intermittent/Ephemeral
Cottonwood Creek	12	182	0.20	36	Intermittent
Cottonwood Creek	12	3,897	0.20	779	Intermittent
Fox Creek	12	1,391	0.20	278	Intermittent
Fox Creek	22	1,299	0.37	476	Intermittent
Fox Creek	12	126	0.20	25	Intermittent
Fox Creek	12	961	0.20	192	Intermittent
Fox Creek	22	522	0.37	192	Intermittent
Fox Creek	12	366	0.20	73	Intermittent
Fox Creek	12	972	0.20	194	Intermittent
Fox Creek	12	1,476	0.20	295	Intermittent
Fox Creek	22	481	0.37	176	Intermittent
UT of Fox Creek	22	79	0.37	29	Intermittent/Ephemeral
UT of Fox Creek	12	2,896	0.20	579	Intermittent/Ephemeral
UT of Fox Creek	22	417	0.37	153	Intermittent/Ephemeral
UT of Fox Creek	12	1,968	0.20	394	Intermittent/Ephemeral
UT of Fox Creek	12	764	0.20	153	Intermittent/Ephemeral
Honey Grove Creek	1	328	0.02	5	Intermittent
Honey Grove Creek	1	2,416	0.02	40	Intermittent
Honey Grove Creek	34	1,625	0.57	921	Intermittent
Honey Grove Creek	10	967	0.17	161	Intermittent
Honey Grove Creek	31	1,800	0.52	930	Intermittent
Honey Grove Creek	34	1,619	0.57	918	Intermittent
Honey Grove Creek	24	666	0.40	266	Intermittent
Honey Grove Creek	6	2,140	0.10	214	Intermittent
Honey Grove Creek	24	1,510	0.40	604	Intermittent
Honey Grove Creek	31	3,674	0.52	1,898	Intermittent
Honey Grove Creek	6	1,549	0.10	155	Intermittent
Honey Grove Creek	6	1,170	0.10	117	Intermittent
Honey Grove Creek	6	1,635	0.10	163	Intermittent
Honey Grove Creek	34	2,398	0.57	1,359	Intermittent
Honey Grove Creek	24	2,556	0.40	1,022	Intermittent

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
Honey Grove Creek	24	1,526	0.40	610	Intermittent
Honey Grove Creek	23	2,965	0.38	1,137	Intermittent
Honey Grove Creek	6	53	0.10	5	Intermittent
Honey Grove Creek	6	57	0.10	6	Intermittent
Honey Grove Creek	6	546	0.10	55	Intermittent
Honey Grove Creek	1	65	0.02	1	Intermittent
Honey Grove Creek	1	1,451	0.02	24	Intermittent
Honey Grove Creek	24	1,379	0.40	552	Intermittent
Honey Grove Creek	31	840	0.52	434	Intermittent
Honey Grove Creek	23	231	0.38	88	Intermittent
Honey Grove Creek	10	1,370	0.17	228	Intermittent
Honey Grove Creek	1	116	0.02	2	Intermittent
Honey Grove Creek	1	782	0.02	13	Intermittent
UT of Honey Grove Creek	10	3,257	0.17	543	Intermittent/Ephemeral
UT of Honey Grove Creek	24	2,229	0.40	891	Intermittent/Ephemeral
UT of Honey Grove Creek	24	58	0.40	23	Intermittent/Ephemeral
UT of Honey Grove Creek	24	2,521	0.40	1,008	Intermittent/Ephemeral
UT of Honey Grove Creek	24	195	0.40	78	Intermittent/Ephemeral
UT of Honey Grove Creek	24	4,333	0.40	1,733	Intermittent/Ephemeral
UT of Honey Grove Creek	23	4,687	0.38	1,797	Intermittent/Ephemeral
UT of Honey Grove Creek	6	1,507	0.10	151	Intermittent/Ephemeral
UT of Honey Grove Creek	1	1,855	0.02	31	Intermittent/Ephemeral
UT of Honey Grove Creek	24	3,127	0.40	1,251	Intermittent/Ephemeral
UT of Honey Grove Creek	24	418	0.40	167	Intermittent/Ephemeral
UT of Honey Grove Creek	31	6,715	0.52	3,469	Intermittent/Ephemeral
UT of Honey Grove Creek	24	2,962	0.40	1,185	Intermittent/Ephemeral
UT of Honey Grove Creek	6	272	0.10	27	Intermittent/Ephemeral
UT of Honey Grove Creek	24	1,981	0.40	792	Intermittent/Ephemeral
UT of Honey Grove Creek	31	5,486	0.52	2,834	Intermittent/Ephemeral
UT of Honey Grove Creek	6	942	0.10	94	Intermittent/Ephemeral
UT of Honey Grove Creek	24	4,851	0.40	1,940	Intermittent/Ephemeral
UT of Honey Grove Creek	1	1,546	0.02	26	Intermittent/Ephemeral
UT of Honey Grove Creek	24	63	0.40	25	Intermittent/Ephemeral
UT of Honey Grove Creek	24	2,695	0.40	1,078	Intermittent/Ephemeral
UT of Honey Grove Creek	24	715	0.40	286	Intermittent/Ephemeral
UT of Honey Grove Creek	6	1,198	0.10	120	Intermittent/Ephemeral
UT of Honey Grove Creek	24	6,861	0.40	2,744	Intermittent/Ephemeral
UT of Honey Grove Creek	34	1,494	0.57	847	Intermittent/Ephemeral
Onstott Branch	19	1,327	0.32	420	Intermittent
Onstott Branch	20	3,307	0.33	1,102	Intermittent
Onstott Branch	19	3,173	0.32	1,005	Intermittent
UT of Onstott Branch	19	351	0.32	111	Intermittent/Ephemeral
Pettigrew Branch	11	887	0.18	163	Intermittent
Pettigrew Branch	8	5,854	0.13	781	Intermittent
Pettigrew Branch	11	3,211	0.18	589	Intermittent
Pettigrew Branch	11	1,687	0.18	309	Intermittent
Pettigrew Branch	11	589	0.18	108	Intermittent

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
UT of Pettigrew Branch	11	2,230	0.18	409	Intermittent/Ephemeral
UT of Pettigrew Branch	11	130	0.18	24	Intermittent/Ephemeral
UT of Pettigrew Branch	11	1,680	0.18	308	Intermittent/Ephemeral
Sandy Branch	17	878	0.28	249	Intermittent
Sandy Branch	17	1,270	0.28	360	Intermittent
Sandy Branch	17	2,835	0.28	803	Intermittent
UT of Sandy Branch	17	205	0.28	58	Intermittent/Ephemeral
UT of Sandy Branch	17	3,373	0.28	956	Intermittent/Ephemeral
Sandy Creek	19	3,236	0.32	1,025	Intermittent
Sandy Creek	7	938	0.12	109	Intermittent
Sandy Creek	7	1,383	0.12	161	Intermittent
Sandy Creek	13	1,388	0.22	301	Intermittent
Sandy Creek	13	2,148	0.22	465	Intermittent
Sandy Creek	7	470	0.12	55	Intermittent
Sandy Creek	7	129	0.12	15	Intermittent
Sandy Creek	7	725	0.12	85	Intermittent
Sandy Creek	7	983	0.12	115	Intermittent
Sandy Creek	19	1,098	0.32	348	Intermittent
Sandy Creek	18	599	0.30	180	Intermittent
Sandy Creek	13	211	0.22	46	Intermittent
Sandy Creek	13	2,109	0.22	457	Intermittent
UT of Sandy Creek	7	319	0.12	37	Intermittent/Ephemeral
UT of Sandy Creek	13	1,521	0.22	330	Intermittent/Ephemeral
UT of Sandy Creek	7	4,325	0.12	505	Intermittent/Ephemeral
UT of Sandy Creek	13	1,912	0.22	414	Intermittent/Ephemeral
UT of Sandy Creek	13	889	0.22	193	Intermittent/Ephemeral
UT of Sandy Creek	13	5,003	0.22	1,084	Intermittent/Ephemeral
UT of Sandy Creek	13	1,296	0.22	281	Intermittent/Ephemeral
Sloans Creek	5	1,468	0.08	122	Intermittent
Sloans Creek	5	230	0.08	19	Intermittent
UT of Sloans Creek	5	655	0.08	55	Intermittent/Ephemeral
Stillhouse Branch	19	1,859	0.32	589	Intermittent
Stillhouse Branch	19	80	0.32	25	Intermittent
Stillhouse Branch	19	1,507	0.32	477	Intermittent
UT of Stillhouse Branch	19	1,163	0.32	368	Intermittent/Ephemeral
Thomas Branch	21	2,032	0.35	711	Intermittent
Thomas Branch	21	3,267	0.35	1,144	Intermittent
Thomas Branch	15	280	0.25	70	Intermittent
Thomas Branch	7	340	0.12	40	Intermittent
Thomas Branch	21	589	0.35	206	Intermittent
Thomas Branch	7	496	0.12	58	Intermittent
Thomas Branch	7	1,243	0.12	145	Intermittent
Thomas Branch	15	1,319	0.25	330	Intermittent
UT of Thomas Branch	7	605	0.12	71	Intermittent/Ephemeral
UT of Thomas Branch	7	1,679	0.12	196	Intermittent/Ephemeral
UT of Thomas Branch	33	1,748	0.55	961	Intermittent/Ephemeral
UT of Thomas Branch	7	6,640	0.12	775	Intermittent/Ephemeral

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
UT of Thomas Branch	33	2,815	0.55	1,548	Intermittent/Ephemeral
UT of Thomas Branch	7	4,825	0.12	563	Intermittent/Ephemeral
UT of Thomas Branch	21	102	0.35	36	Intermittent/Ephemeral
UT of Thomas Branch	7	1,084	0.12	126	Intermittent/Ephemeral
UT of Thomas Branch	7	1,581	0.12	184	Intermittent/Ephemeral
UT of Thomas Branch	21	1,141	0.35	399	Intermittent/Ephemeral
UT of Thomas Branch	7	1,011	0.12	118	Intermittent/Ephemeral
UT of Thomas Branch	7	3,523	0.12	411	Intermittent/Ephemeral
UT of Thomas Branch	7	5,084	0.12	593	Intermittent/Ephemeral
Timber Creek	20	70	0.33	23	Intermittent
Timber Creek	20	774	0.33	258	Intermittent
Timber Creek	20	384	0.33	128	Intermittent
Timber Creek	20	2,272	0.33	757	Intermittent
Timber Creek	20	1,218	0.33	406	Intermittent
Timber Creek	20	221	0.33	74	Intermittent
Timber Creek	20	751	0.33	250	Intermittent
Timber Creek	20	56	0.33	19	Intermittent
Timber Creek	20	1,951	0.33	650	Intermittent
Timber Creek	20	2,378	0.33	793	Intermittent
Timber Creek	20	3,235	0.33	1,078	Intermittent
UT of Timber Creek	20	7,742	0.33	2,581	Intermittent/Ephemeral
UT of Timber Creek	20	3,356	0.33	1,119	Intermittent/Ephemeral
UT of Timber Creek	20	880	0.33	293	Intermittent/Ephemeral
UT of Timber Creek	20	1,416	0.33	472	Intermittent/Ephemeral
UT of Timber Creek	20	6,055	0.33	2,018	Intermittent/Ephemeral
Ward Creek	28	2,191	0.47	1,022	Intermittent
Ward Creek	28	5,089	0.47	2,375	Intermittent
Ward Creek	14	1,268	0.23	296	Intermittent
Ward Creek	28	2,098	0.47	979	Intermittent
Ward Creek	15	3,995	0.25	999	Intermittent
Ward Creek	28	1,018	0.47	475	Intermittent
Ward Creek	14	862	0.23	201	Intermittent
Ward Creek	15	3,119	0.25	780	Intermittent
Ward Creek	14	905	0.23	211	Intermittent
Ward Creek	14	879	0.23	205	Intermittent
Ward Creek	14	659	0.23	154	Intermittent
Ward Creek	14	400	0.23	93	Intermittent
Ward Creek	14	97	0.23	23	Intermittent
Ward Creek	14	36	0.23	8	Intermittent
Ward Creek	14	194	0.23	45	Intermittent
Ward Creek	14	114	0.23	27	Intermittent
Ward Creek	14	41	0.23	10	Intermittent
Ward Creek	14	39	0.23	9	Intermittent
Ward Creek	14	400	0.23	93	Intermittent
Ward Creek	14	163	0.23	38	Intermittent
Ward Creek	28	2,145	0.47	1,001	Intermittent
Ward Creek	28	888	0.47	414	Intermittent

Proposed Lower Bois d'Arc Creek Reservoir Site

GNIS_Name	RGA Score	Length (ft)	SQF	SQU	Flow Type
UT of Ward Creek	15	5,617	0.25	1,404	Intermittent/Ephemeral
UT of Ward Creek	14	699	0.23	163	Intermittent/Ephemeral
UT of Ward Creek	28	1,625	0.47	758	Intermittent/Ephemeral
UT of Ward Creek	28	1,415	0.47	660	Intermittent/Ephemeral
UT of Ward Creek	28	822	0.47	383	Intermittent/Ephemeral
UT of Ward Creek	14	60	0.23	14	Intermittent/Ephemeral
UT of Ward Creek	28	2,865	0.47	1,337	Intermittent/Ephemeral
UT of Ward Creek	28	1,026	0.47	479	Intermittent/Ephemeral
UT of Ward Creek	14	575	0.23	134	Intermittent/Ephemeral
UT of Ward Creek	14	223	0.23	52	Intermittent/Ephemeral
Yoakum Creek	5	1,006	0.08	84	Intermittent
Yoakum Creek	5	4,694	0.08	391	Intermittent
UT of Yoakum Creek	5	151	0.08	13	Intermittent/Ephemeral

		Existing					Mitigation 2016		
Label	**Reach**	**Length (ft)**	**Field Type**	**RGA Score**	**SQF**	**Stream Quality Unit (SQU)**	**RGA Score**	**SQF**	**Stream Quality Unit (SQU)**
Black Branch	2	2,787	Perennial	26	0.43	1,208	36	0.6	1,672
Black Branch	3	2,105	Perennial	7	0.12	246	17	0.3	596
Black Branch Trib 01	1	600	Ephemeral	7	0.12	70	36	0.6	360
Black Branch Trib 01	2	2,186	Ephemeral	31	0.52	1,130	50	0.83	1,822
Black Branch Trib 02	1	3,506	Intermittent	23	0.38	1,344	33	0.6	1,929
Black Branch Trib 03	1	3,868	Ephemeral	50	0.83	3,223	50	0.8	3,223
Black Branch Trib 04	1	1,350	Ephemeral	23	0.38	518	33	0.6	743
Black Branch Trib 06	1	956	Ephemeral	23	0.38	367	33	0.6	526
Bois d'Arc Creek Trib 01	3	3,040	Ephemeral	3	0.05	152	50	0.8	2,533
Bois d'Arc Creek Trib 01	4	8,066	Ephemeral	28	0.47	3,764	50	0.8	6,722
Bois d'Arc Creek Trib 02	1	2,970	Ephemeral	3	0.05	149	50	0.8	2,475
Bois d'Arc Creek Trib 04	2	1,430	Intermittent	13	0.22	310	50	0.8	1,192
Bois d'Arc Creek Trib 04	3	3,038	Ephemeral	40	0.67	2,025	50	0.8	2,532
Bois d'Arc Creek Trib 06	2	1,215	Intermittent	35	0.58	709	45	0.8	911
Bois d'Arc Creek Trib 07	3	3,163	Intermittent	11	0.18	580	21	0.4	1,107
Bois d'Arc Creek Trib 08	2	1,718	Intermittent	12	0.20	344	22	0.4	630
Bois d'Arc Creek Trib 08	3	921	Intermittent	11	0.18	169	21	0.4	322
Bois d'Arc Creek Trib 09	1	3,417	Ephemeral	40	0.67	2,278	50	0.8	2,848
Bois d'Arc Creek Trib 10	2	2,343	Ephemeral	13	0.22	508	50	0.8	1,953
Bois d'Arc Creek Trib 12	2	586	Ephemeral	13	0.22	127	50	0.8	488
Bois d'Arc Creek Trib 13	2	2,006	Ephemeral	31	0.52	1,036	50	0.8	1,671
Bois d'Arc Creek Trib 14	2	1,012	Ephemeral	28	0.47	472	38	0.6	641
Bois d'Arc Creek Trib 15	2	1,973	Ephemeral	11	0.18	362	50	0.8	1,644
Bois d'Arc Creek Trib 19	1	602	Intermittent	11	0.18	110	21	0.4	211
Bois d'Arc Creek Trib 20	1	193	Ephemeral	40	0.67	128	50	0.8	160
Bois d'Arc Creek Trib 21	1	1,169	Intermittent	11	0.18	214	21	0.4	409
Bois d'Arc Creek Trib 21	2	1,551	Ephemeral	11	0.18	284	21	0.4	543
Bois d'Arc Creek Trib 18	1	258	Ephemeral	11	0.18	47	21	0.4	90
Red River Trib 01	1	4,582	Perennial	16	0.27	1,222	21	0.4	1,604
Red River Trib 01	2	1,907	Perennial	4	0.07	127	9	0.2	286
Red River Trib 01	3	12,707	Ephemeral	32	0.53	6,777	50	0.8	10,589
Red River Trib 02	1	3,156	Perennial	9	0.15	473	14	0.2	736
Red River Trib 02	2	4,298	Ephemeral	18	0.30	1,289	50	0.8	3,582
Red River Trib 03	1	3,937	Intermittent	28	0.47	1,837	50	0.8	3,281
Red River Trib 03	2	4,090	Ephemeral	28	0.47	1,908	50	0.8	3,408
Red River Trib 04	1	3,107	Perennial	8	0.13	414	13	0.2	673
Red River Trib 04	2	559	Intermittent	12	0.20	112	22	0.4	205
Red River Trib 04	3	3,420	Intermittent	12	0.20	684	36	0.6	2,052
Red River Trib 05	2	1,861	Ephemeral	39	0.65	1,209	50	0.8	1,551
Red River Trib 06	1	902	Ephemeral	14	0.23	210	50	0.8	751
Red River Trib 06	3	2,778	Ephemeral	22	0.37	1,018	50	0.8	2,315
Red River Trib 07	1	1,482	Ephemeral	34	0.57	840	50	0.8	1,235
Red River Trib 08	1	3,703	Ephemeral	12	0.20	741	50	0.8	3,086
Red River Trib 08	2	3,308	Ephemeral	34	0.57	1,875	50	0.8	2,757
Red River Trib 09	1	5,333	Intermittent	14	0.23	1,244	36	0.6	3,200
Red River Trib 09	2	3,980	Ephemeral	26	0.43	1,725	36	0.6	2,388
Red River Trib 10	1	3,703	Ephemeral	28	0.47	1,728	50	0.8	3,086
Red River Trib 11	1	1,895	Intermittent	14	0.23	442	24	0.4	758
Red River Trib 11	1	2,061	Ephemeral	14	0.23	481	24	0.4	824
Red River Trib 12	1	3,273	Ephemeral	28	0.47	1,528	50	0.8	2,728
Red River Trib 13	1	1,876	Ephemeral	28	0.47	876	50	0.8	1,564
Red River Trib 14	1	2,947	Ephemeral	28	0.47	1,375	38	0.6	1,867
Red River Trib 15	1	848	Ephemeral	9	0.15	127	50	0.8	706
Red River Trib x	2	5,219	Perennial	16	0.27	1,392	26	0.4	2,261
Bois d'Arc Creek Trib 05	2	590	Ephemeral	3	0.05	29	50	0.8	492
Bois d'Arc Creek Trib 17	2	3,644	Intermittent	12	0.20	729	22	0.4	1,336
Red River Trib 05	1	1,500	Ephemeral	14	0.23	350	50	0.8	1,250
Red River Trib 02	1.1	2,492	Intermittent	9	0.15	374	50	0.8	2,077
Red River Trib 04	1.1	2,216	Perennial	8	0.13	295	13	0.2	480
Red River Trib 04	3	4,217	Ephemeral	12	0.20	843	36	0.6	2,530
Bois d'Arc Creek Trib 04	3	2,094	Ephemeral	40	0.67	1,396	50	0.8	1,745
Red River Trib 09	2	1,123	Intermittent	26	0.43	487	36	0.6	674
Red River Trib 11	1	1,173	Intermittent	14	0.23	274	24	0.4	469
Red River Trib 01	3	1,650	Intermittent	32	0.53	880	50	0.8	1,375
Red River Trib 07	1	1,444	Intermittent	34	0.57	818	50	0.8	1,203
Black Branch Trib 04	1	949	Intermittent	23	0.38	364	33	0.6	522
Bois d'Arc Creek Trib 15	2	1,832	Intermittent	11	0.18	336	50	0.8	1,527
Red River Trib 03	1	63	Ephemeral	28	0.47	30	50	0.8	53
Bois d'Arc Creek Trib 04	3	163	Intermittent	40	0.67	109	50	0.8	136
Red River Trib 06	2	33	Ephemeral	14	0.23	8	50	0.8	27
Red River Trib 06	2	1,272	Ephemeral	14	0.23	297	50	0.8	1,060
Red River Trib 15	1	689	Ephemeral	9	0.15	103	50	0.8	574

Riverby Ranch Existing Stream Restoration and Enhancement

		Existing					Mitigation 2016		
Label	Reach	Length (ft)	Field Type	RGA Score	SQF	Stream Quality Unit (SQU)	RGA Score	SQF	Stream Quality Unit (SQU)
Red River Trib 13	1	855	Ephemeral	28	0.47	399	50	0.8	712
Red River Trib 04	3	1,240	Intermittent	12	0.20	248	36	0.6	744
Red River Trib 04	3	499	Intermittent	12	0.20	100	36	0.6	299
Bois d'Arc Creek Trib 03	1	989	Ephemeral	31	0.52	511	50	0.8	824
Bois d'Arc Creek Trib 03	1	734	Ephemeral	31	0.52	379	50	0.8	612
Bois d'Arc Creek Trib 03	1	1,565	Ephemeral	31	0.52	809	50	0.8	1,304
Bois d'Arc Creek Trib 15	2	137	Intermittent	11	0.18	25	50	0.8	114
Bois d'Arc Creek Trib 12	2	23	Ephemeral	13	0.22	5	50	0.8	19
Bois d'Arc Creek Trib 04	3	102	Ephemeral	40	0.67	68	50	0.8	85
Bois d'Arc Creek Trib 04	3	38	Ephemeral	40	0.67	25	50	0.8	32
Red River Trib 06	3	249	Ephemeral	22	0.37	91	50	0.8	207
Red River Trib 06	2	42	Ephemeral	14	0.23	10	50	0.8	35
Red River Trib 15	1	147	Ephemeral	9	0.15	22	50	0.8	123
Red River Trib 11	1	169	Ephemeral	14	0.23	39	24	0.4	68
Red River Trib 13	1	126	Ephemeral	28	0.47	59	50	0.8	105
Red River Trib 04	3	63	Intermittent	12	0.20	13	36	0.6	38
Red River Trib 04	3	68	Intermittent	12	0.20	14	36	0.6	41
Bois d'Arc Creek Trib 03	1	106	Ephemeral	31	0.52	55	50	0.8	88
Red River Trib 08	1	97	Ephemeral	12	0.20	19	50	0.8	81

Riverby Ranch Stream Creation

Label	Reach	Field Type	Additional Length (ft)	RGA Score	SQF	Stream Quality Unit (SQU)
Bois d'Arc Creek Trib 01	3	E	912	50	0.83	760
Bois d'Arc Creek Trib 01	4	E	2420	50	0.83	2,016
Bois d'Arc Creek Trib 02	1	E	891	50	0.83	743
Bois d'Arc Creek Trib 03	1	E	1018	50	0.83	849
Bois d'Arc Creek Trib 04	3	E	923	50	0.83	769
Bois d'Arc Creek Trib 04	3	I	707	50	0.83	590
Bois d'Arc Creek Trib 09	1	E	1025	50	0.83	854
Bois d'Arc Creek Trib 10	2	E	703	50	0.83	586
Bois d'Arc Creek Trib 13	2	E	602	50	0.83	501
Red River Trib 01	3	E	6,498	50	0.83	5,415
Red River Trib 01	3	I	844	50	0.83	703
Red River Trib 02	1.1	I	1,135	50	0.83	946
Red River Trib 02	2	E	822	50	0.83	685
Red River Trib 03	1	I	1,821	50	0.83	1,518
Red River Trib 03	2	E	1,862	50	0.83	1,552
Red River Trib 04	3	I	1587	36	0.60	952
Red River Trib 04	3	E	1265	36	0.60	759
Red River Trib 05	1	E	450	50	0.83	375
Red River Trib 05	2	E	558	50	0.83	465
Red River Trib 06	2	E	258	50	0.83	215
Red River Trib 06	3	E	908	50	0.83	757
Red River Trib 07	1	E	445	50	0.83	370
Red River Trib 07	1	I	433	50	0.83	361
Red River Trib 08	1	E	1140	50	0.83	950
Red River Trib 08	2	E	992	50	0.83	827
Red River Trib 10	1	E	1,197	50	0.83	998
Red River Trib 13	1	E	857	50	0.83	714
Red River Trib 15	1	E	323	48	0.80	258

On-site Tributaries to Littoral Zone Wetlands

	Existing					Mitigation		
GNIS_Name	Length	RGA Score	Type 2	SQF	Stream Quality Unit (SQU)	RGA Score	SQF	Stream Quality Unit (SQU)
Unnamed	194	5	Intermittent/Ephemeral	0.08	16	10	0.17	32
Unnamed	550	33	Intermittent/Ephemeral	0.55	302	38	0.63	348
Sloans Creek	5,201	5	Intermittent	0.08	433	10	0.17	867
Unnamed	1,685	13	Intermittent/Ephemeral	0.22	365	18	0.30	506
Timber Creek	90	33	Intermittent	0.55	50	38	0.63	57
Bullard Creek	1,047	13	Intermittent	0.22	227	18	0.30	314
Unnamed	584	5	Intermittent/Ephemeral	0.08	49	10	0.17	97
Unnamed	770	5	Intermittent/Ephemeral	0.08	64	10	0.17	128
Sloans Creek	15	5	Intermittent	0.08	1	10	0.17	3
Sloans Creek	85	5	Intermittent	0.08	7	10	0.17	14
Unnamed	1,235	5	Intermittent/Ephemeral	0.08	103	10	0.17	206
Unnamed	144	5	Intermittent/Ephemeral	0.08	12	10	0.17	24
Spring Branch	122	12	Intermittent	0.20	24	17	0.28	35
Unnamed	64	5	Intermittent/Ephemeral	0.08	5	10	0.17	11
Unnamed	95	5	Intermittent/Ephemeral	0.08	8	10	0.17	16
Unnamed	48	5	Intermittent/Ephemeral	0.08	4	10	0.17	8
Unnamed	10	5	Intermittent/Ephemeral	0.08	1	10	0.17	2
Unnamed	5	5	Intermittent/Ephemeral	0.08	0	10	0.17	1
Unnamed	2,438	5	Intermittent/Ephemeral	0.08	203	10	0.17	406
Bullard Creek	104	13	Intermittent	0.22	23	18	0.30	31
Bullard Creek	1,456	13	Intermittent	0.22	315	18	0.30	437
Unnamed	53	13	Intermittent/Ephemeral	0.22	11	18	0.30	16
Unnamed	103	13	Intermittent/Ephemeral	0.22	22	18	0.30	31
Unnamed	468	13	Intermittent/Ephemeral	0.22	101	18	0.30	140
Unnamed	464	13	Intermittent/Ephemeral	0.22	100	18	0.30	139
Unnamed	191	13	Intermittent/Ephemeral	0.22	41	18	0.30	57
Cottonwood Creek	406	12	Intermittent	0.20	81	17	0.28	115
Cottonwood Creek	25	12	Intermittent	0.20	5	17	0.28	7
Cottonwood Creek	1,613	12	Intermittent	0.20	323	17	0.28	457
Cottonwood Creek	516	12	Intermittent	0.20	103	17	0.28	146
Cottonwood Creek	18	12	Intermittent	0.20	4	17	0.28	5
Unnamed	23	5	Intermittent/Ephemeral	0.08	2	10	0.17	4
Unnamed	124	5	Intermittent/Ephemeral	0.08	10	10	0.17	21
Unnamed	165	5	Intermittent/Ephemeral	0.08	14	10	0.17	28
Unnamed	248	5	Intermittent/Ephemeral	0.08	21	10	0.17	41
Unnamed	876	12	Intermittent/Ephemeral	0.20	175	17	0.28	248
Unnamed	77	12	Intermittent/Ephemeral	0.20	15	17	0.28	22
Unnamed	678	12	Intermittent/Ephemeral	0.20	136	17	0.28	192
Unnamed	5	12	Intermittent/Ephemeral	0.20	1	17	0.28	1
Unnamed	39	13	Intermittent/Ephemeral	0.22	9	18	0.30	12
Unnamed	12	13	Intermittent/Ephemeral	0.22	3	18	0.30	4
Stillhouse Branch	119	19	Intermittent	0.32	38	24	0.40	48
Stillhouse Branch	956	19	Intermittent	0.32	303	24	0.40	382
Cottonwood Creek	62	12	Intermittent	0.20	12	17	0.28	18

Riverby Ranch WRP Area

		Existing					Mitigation		
Label	Reach	Length (ft)	Field Stream Type	RGA Score	SQF	Stream Quality Unit (SQU)	RGA Score	SQF	Stream Quality Unit (SQU)
Black Branch	1	2,524	P	26	0.43	1,094	34	0.57	1,430
Black Branch Trib 05	1	3,251	I	35	0.58	1,896	37	0.62	2,005
Bois d'Arc Creek	4	8,334	P	29	0.48	4,028	32	0.53	4,445
Bois d'Arc Creek	1	10,574	P	27	0.45	4,758	30	0.50	5,287
Bois d'Arc Creek	2	7,021	P	29	0.48	3,394	32	0.53	3,745
Bois d'Arc Creek	3	9,505	P	27	0.45	4,277	30	0.50	4,753
Bois d'Arc Creek Trib 01	2	2,158	E	3	0.05	108	15	0.25	539
Bois d'Arc Creek Trib 01	1	2,730	E	25	0.42	1,137	30	0.50	1,365
Bois d'Arc Creek Trib 04	1	4,170	I	3	0.05	209	11	0.18	765
Bois d'Arc Creek Trib 05	1	2,703	I	35	0.58	1,577	37	0.62	1,667
Bois d'Arc Creek Trib 06	1	4,292	I	35	0.58	2,504	39	0.65	2,790
Bois d'Arc Creek Trib 07	1	6,800	I	20	0.33	2,267	24	0.40	2,720
Bois d'Arc Creek Trib 07	2	888	I	11	0.18	163	17	0.28	252
Bois d'Arc Creek Trib 08	1	211	I	20	0.33	70	24	0.40	84
Bois d'Arc Creek Trib 10	1	332	I	3	0.05	17	11	0.18	61
Bois d'Arc Creek Trib 11	1	2,113	E	20	0.33	704	24	0.40	845
Bois d'Arc Creek Trib 12	1	2,727	E	35	0.58	1,591	37	0.62	1,682
Bois d'Arc Creek Trib 13	1	989	E	3	0.05	49	25	0.42	412
Bois d'Arc Creek Trib 14	1	6,033	E	28	0.47	2,815	28	0.47	2,815
Bois d'Arc Creek Trib 15	1	2,707	I	35	0.58	1,579	39	0.65	1,759
Bois d'Arc Creek Trib 16	1	3,017	I	35	0.58	1,760	39	0.65	1,961
Bois d'Arc Creek Trib 17	1	3,807	E	35	0.58	2,221	39	0.65	2,474
Bois d'Arc Creek Trib 22	1	4,657	E	20	0.33	1,552	24	0.40	1,863
Bois d'Arc Creek Trib 23	1	843	I	20	0.33	281	24	0.40	337
Bois d'Arc Creek Trib 23	2	1,401	P	20	0.33	467	24	0.40	561
Bois d'Arc Creek Trib 24	1	809	P	35	0.58	472	39	0.65	526

Upper Bois d'Arc Creek Mitigation Site Stream Enhancement

	Existing					Mitigation		
GNIS Name	Length	RGA Score	Type	SQF	Stream Quality Unit (SQU)	RGA Score	SQF	Stream Quality Unit (SQU)
Pig Branch	1,913	19	Intermittent	0.32	606	24	0.40	765
Pig Branch	26	5	Intermittent	0.08	2	10	0.17	4
Davis Creek	972	19	Intermittent	0.32	308	24	0.40	389
Cooper Creek	324	19	Intermittent	0.32	103	24	0.40	130
Bois d'Arc Creek	2,027	19	Intermittent	0.32	642	24	0.40	811
Bois d'Arc Creek	6,303	5	Intermittent	0.08	525	10	0.17	1,050
Bois d'Arc Creek	1,332	15	Intermittent	0.25	333	20	0.33	444
Bois d'Arc Creek	1,058	5	Intermittent	0.08	88	10	0.17	176
Bois d'Arc Creek	3,152	19	Intermittent	0.32	998	24	0.40	1,261
Bois d'Arc Creek	174	5	Intermittent	0.08	15	10	0.17	29
Bois d'Arc Creek	1,935	19	Intermittent	0.32	613	24	0.40	774
Bois d'Arc Creek	2,623	5	Intermittent	0.08	219	10	0.17	437
Bois d'Arc Creek	737	19	Intermittent	0.32	233	24	0.40	295
Bois d'Arc Creek	1,419	19	Intermittent	0.32	449	24	0.40	568
Bois d'Arc Creek	665	15	Intermittent	0.25	166	20	0.33	222
Bois d'Arc Creek	3,800	10	Intermittent	0.17	633	15	0.25	950
Bois d'Arc Creek	345	19	Intermittent	0.32	109	24	0.40	138
Bois d'Arc Creek	2,370	15	Intermittent	0.25	593	20	0.33	790
Bois d'Arc Creek	160	15	Intermittent	0.25	40	20	0.33	53
Bois d'Arc Creek	77	15	Intermittent	0.25	19	20	0.33	26
Bois d'Arc Creek	133	15	Intermittent	0.25	33	20	0.33	44
Bois d'Arc Creek	147	15	Intermittent	0.25	37	20	0.33	49
Bois d'Arc Creek	1,050	5	Intermittent	0.08	87	10	0.17	175
Unnamed	34	15	Intermittent/Ephemeral	0.25	9	20	0.33	11
Unnamed	2,100	15	Intermittent/Ephemeral	0.25	525	20	0.33	700
Unnamed	1,064	5	Intermittent/Ephemeral	0.08	89	10	0.17	177
Unnamed	26	40	Intermittent/Ephemeral	0.67	18	45	0.75	20
Unnamed	1,962	32	Intermittent/Ephemeral	0.53	1,046	37	0.62	1,210
Unnamed	1,393	16	Intermittent/Ephemeral	0.27	372	21	0.35	488
Unnamed	1,212	19	Intermittent/Ephemeral	0.32	384	24	0.40	485
Unnamed	1,483	28	Intermittent/Ephemeral	0.47	692	33	0.55	815
Unnamed	892	40	Intermittent/Ephemeral	0.67	594	45	0.75	669
Unnamed	11	5	Intermittent/Ephemeral	0.08	1	10	0.17	2
Unnamed	123	5	Intermittent/Ephemeral	0.08	10	10	0.17	20
Unnamed	2,873	19	Intermittent/Ephemeral	0.32	910	24	0.40	1,149
Unnamed	971	40	Intermittent/Ephemeral	0.67	648	45	0.75	729
Unnamed	333	15	Intermittent/Ephemeral	0.25	83	20	0.33	111
Unnamed	692	19	Intermittent/Ephemeral	0.32	219	24	0.40	277
Unnamed	1,722	15	Intermittent/Ephemeral	0.25	430	20	0.33	574
Unnamed	454	5	Intermittent/Ephemeral	0.08	38	10	0.17	76
Unnamed	500	40	Intermittent/Ephemeral	0.67	334	45	0.75	375
Unnamed	17	5	Intermittent/Ephemeral	0.08	1	10	0.17	3
Unnamed	160	15	Intermittent/Ephemeral	0.25	40	20	0.33	53
Unnamed	1,042	19	Intermittent/Ephemeral	0.32	330	24	0.40	417
Unnamed	743	40	Intermittent/Ephemeral	0.67	495	45	0.75	557
Unnamed	28	15	Intermittent/Ephemeral	0.25	7	20	0.33	9
Unnamed	2,130	5	Intermittent/Ephemeral	0.08	177	10	0.17	355
Unnamed	2,120	19	Intermittent/Ephemeral	0.32	671	24	0.40	848
Unnamed	3,958	15	Intermittent/Ephemeral	0.25	989	20	0.33	1,319
Unnamed	1,240	40	Intermittent/Ephemeral	0.67	827	45	0.75	930
Unnamed	28	15	Intermittent/Ephemeral	0.25	7	20	0.33	9
Unnamed	482	40	Intermittent/Ephemeral	0.67	321	45	0.75	361

Appendix F

Downstream Impact Assessment

Technical Memorandum on Assessment of Potential Impacts of Wetlands Downstream of LBCR

MEMORANDUM

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

TO: Robert McCarthy, NTMWD

FROM: Steve Watters, Simone Kiel

SUBJECT: Assessment of Potential Impacts of Wetlands Downstream of LBCR

DATE: June 3, 2016

PROJECT: NTD06128

Executive Summary

Freese and Nichols, Inc. conducted a desktop analysis of the potential impacts to the riparian corridor downstream of the proposed Lower Bois d'Arc Creek Reservoir (LBCR) dam. This analysis expands upon the previous downstream habitat study that was incorporated in Appendix C of the Supplemental Instream Flow Study (Freese and Nichols, Inc., 2010), which is included in Attachment 1 of this memorandum.

The current study focused on the identification of potential wetlands downstream of the LBCR dam, expected changes to local hydrology, and potential impact to the associated forest community. The study found that there are approximately 2,000 acres of riparian bottomland hardwood forests, including potential forested wetlands, within the two-year floodplain downstream of the proposed LBCR dam. With the construction of the LBCR there will be some changes in overbanking flows, but the wetland community will continue to receive sufficient hydrology from direct precipitation, overbanking flows, and discharge of subsurface water from springs and seepage along the margins of the stream valley. Specifically, the downstream corridor is expected to continue to function as bottomland riparian forest after the construction of LBCR for the following reasons:

- Hydric soils will remain and continue to be supported by periods of saturation and inundation during the growing season.
- The existing riparian bottomland hardwood community is comprised of facultative species, which are "equally likely to occur in wetlands and non-wetlands." (Lichvar et al., 2012).
  - Existing species can tolerate hydrology changes.
  - There are no expected changes to plant communities or wildlife habitat.
- Multiple sources of hydrology will remain to support wetlands.

APPENDIX F

1.0 Introduction

As part of the Supplemental Instream Flow Study report (Freese and Nichols, 2010), FNI prepared an assessment of the potential impacts on the floodplain of Bois d'Arc Creek downstream of the proposed dam, specifically those effects that pertain to expected modification of overbanking flows that are associated with the construction of the LBCR, henceforth called "FNI 2010 study". This assessment addressed the potential impacts to hydrology and sedimentation, floodplain morphology, riparian vegetation, and wildlife. It included literature research and site-specific data collection for vegetative cover.

The conclusions of the FNI 2010 study noted that the potential impacts to the downstream floodplain of Bois d'Arc Creek would likely be limited due to several factors: (1) the existing community is not dependent upon overbank flow for reproduction and overall success; many of the species along Bois d'Arc Creek riparian corridor are equally as likely to occur in uplands as in wetlands; (2) the local site conditions (e.g., rainfall, soil type, and land cover) supplement floodplain hydrology; (3) the proposed release of base and pulse flows would result in stream bed saturation and channel connectivity and promote growth of streambank vegetation; (4) the reduction in magnitude and frequency of highly erosive flows would stop degradation and allow the stream to aggrade over time, thereby increasing the potential for floodplain connectivity; and (5) contributing downstream hydrology provides instream flow and supplements floodplain connectivity. The study also noted that certain aspects of the riparian corridor may even be improved as a result of the dam, including increased streambank stabilization, vegetation growth, and gain of hard mast producing woody species. A copy of this study is included in Attachment 1.

As a follow-on to the FNI 2010 study, the USACE requested that NTMWD provide information on the water sources for the potential wetlands located in the downstream floodplain corridor. This memorandum addresses that request. Please note that all maps (Figures) associated with this discussion are shown at the end of the memorandum.

1.1 <u>Data Sources</u>

Data sources for this study include field data collected in the downstream corridor for the Supplemental Instream Flow Study (FNI, 2010) and the Hydrogeomorphic Methodology (HGM) studies by Dr. Hans Williams (2011 and 2016 in-progress), site-specific topographic data, available desktop mapping resources, and project-specific hydrologic models. The data sources and tools are described below.

National Wetlands Inventory (NWI). This data, developed by the U.S. Fish and Wildlife Service (USFWS), was used in conjunction with hydric soils mapping and hydrologic modeling to identify potential wetlands in the downstream corridor.

Soil Survey Geographic Database (SSURGO). Soils data for Fannin County was downloaded from the USDA Geospatial Data Gateway. SSURGO is shown as map units which can then be joined with data tables to define various soil conditions. The two soil characteristics used in this analysis were hydric soils and texture.

LiDAR elevation data. Aerial photography of the Bois d'Arc Creek watershed was flown in 2007 and November 2010. The high resolution LiDAR with a vertical accuracy of 95% at 0.6-foot resolution was used to generate 1-foot elevation contours. These contours, along with hand surveyed stream cross-sections were used to develop the elevation mapping for the HEC-RAS (2D) model.

HEC-HMS. This is one of two hydrologic/hydraulic models developed by the USACE that were used to define the floodplain hydrology along Bois d'Arc Creek. This model applies specific rainfall events to the watershed and calculates the runoff hydrographs that are subsequently used in the HEC-RAS (2D) model.

HEC-RAS 2D. This is the second of the two hydrologic/hydraulic models developed by the USACE that were used to define the floodplain hydrology along Bois d'Arc Creek. HEC-RAS uses the runoff hydrographs generated by HEC-HMS to define the geographic boundaries of the floodplain associated with a specific rain event. The HEC-RAS 2D (Version 5.0) is an updated model that allows the user to better define floodplain hydrology over the entire watershed and better represents the hydraulic flows of the tributaries to Bois d'Arc Creek.

Downstream Study (FNI, 2010). In 2009 FNI staff collected vegetative data and evaluated flood tolerance of the species in the downstream corridor based on wetland indicator status (USDA-NRCS, Region 6) and anaerobic soil tolerance (USDA-NRCS 2010). The results of this data collection were incorporated into the FNI 2010 study.

Stephen F. Austin HGM Study (Dans and Williams, 2011). Under contract with the USEPA, Darinda Dans and Dr. Hans Williams of Stephen F. Austin State University conducted field testing of the R*egional Guidebook for Applying the Hydrogeomorphoric Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* to assess wetland functions of the Lower Bois d'Arc Creek Impoundment Project in Fannin County, Texas and to determine appropriate adjustments to apply to variables for use of the *Guidebook* in Fannin County.

Bonham Rain Gauge. Historical precipitation was obtained from the National Weather Service for rainfall recorded at the City of Bonham from 1903 to the present. The data was downloaded from http://www.srh.weather.gov/fwd/?n=bonhamclimatology.

2.0 Study Area

The study area addressed in this memorandum consisted of the corridor located within the two-year floodplain downstream of the proposed LBCR dam site to the Red River (Figure 1). Potential wetlands within this corridor were delineated using a desktop, GIS-based approach to identify the intersection of the existing two-year floodplain, NWI wetlands (emergent, shrub/ forested wetlands) and hydric soils. The definition of wetlands as used by the USACE are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. To better understand the potential wetlands in the downstream corridor from the LBCR dam, a review of these three characteristics was conducted. The resulting overlap of these three resource layers were assumed to represent the criteria that define a regulatory wetland: wetland hydrology, hydrophytic vegetation, and hydric soils.

2.1 Wetland Hydrology

The two-year floodplain was selected to define the study area because this is the area identified as being inundated at least 50 percent of the years. The existing floodplain was defined through hydraulic and hydrologic modeling of Bois d'Arc Creek. The length of the floodplain is approximately 20 river miles from the proposed LBCR dam to the Red River confluence. The hydraulic/hydrologic analyses are discussed in a technical memorandum in Attachment 2. Due to the nature of the local topography and historical modifications to Bois d'Arc Creek, the two-year floodplain varies from less than 0.5 mile to about 1 mile in width. It should be noted that the floodplains for less frequent storms (i.e., 5-year and 10-year floods) are similar in location and width. This is because the floodplain is bordered by steeper topography, which funnels the flood water through this corridor. The existing two-year floodplain (i.e., without the proposed dam) is shown on Figure 1.

2.2 Hydric Soils

The presence of hydric soils is a key indicator of potential wetland occurrence. The presence of hydric soils was estimated using the Soil Survey Geographic Database (SSURGO). Hydric soils are shown on Figure 2.

2.3 Hydrophytic Vegetation

For the purposes of this assessment, the National Wetlands Inventory (NWI) map data developed by the USFWS was used to identify the locations of potential wetlands by vegetation type downstream of the proposed LBCR dam (Figure 2). The NWI wetlands mapped within the study corridor included emergent and forested/shrub wetlands. The NWI relies on trained image analysts to identify and classify wetlands and deep water habitats from aerial imagery. The wetland areas are located along the riparian corridor of Bois d'Arc Creek downstream of the proposed dam and seem to closely follow the footprint of the existing 2-year floodplain (Figure 3).

2.4 Study Area Wetlands

Based on the overlap, i.e., intersection, of the two-year floodplain, NWI forested wetlands, and mapped hydric soils in the Bois d'Arc Creek corridor downstream of the proposed dam site, the estimated area of existing wetlands downstream of the dam is 2,001 acres. The desktop-delineated wetlands, which are the primary focus of the current study, are shown in Figure 4.

3.0 Characteristics of Downstream Wetlands

3.1 Vegetative Cover

As part of Dans and Williams (2011) study, data were collected at 13 NWI forested wetland sites (59 total plots) both within the proposed reservoir pool area and within the Caddo National Grasslands located downstream of the proposed dam site. In 2015, additional data were collected by Stephen F. Austin staff in the Caddo National Grasslands (Camp et al, 2016). In 2010, FNI conducted limited habitat evaluation studies in the downstream corridor (Attachment 1). To assess potential impacts of the construction of the LBCR dam to the study area wetlands, FNI used tree species identified in these studies to create a tree species list to represent the current tree community assemblage for Bois d'Arc Creek. This list is consistent with the tree species identified in the FNI 2010 study. Each species was then assigned its respective wetland indicator status according to the 2014 National Wetland Plant List (Lichvar, et al., 2014). These data are summarized in Table 1. Table 2 defines each wetland indicator status with comments on occurrence, and Table 3 defines the flood tolerance indices.

Table 1. Tree Species Identified in the Downstream Corridor

Scientific Name	Common Name	Indicator Status	Flood Tolerance
Acer negundo	Box elder	FAC	T
Celtis laevigata	Sugarberry	FAC	T
Cornus sp.	Dogwood sp.	FAC*	I
Fraxinus pennsylvanica	Green ash	FAC	VT
Gleditsia triacanthos	Honey locust	FACU	IT
Maclura pomifera	Bois d'Arc	FACU	No data
Populus deltoides	Cottonwood	FAC	VT
Quercus macrocarpa	Bur oak	FACU	T
Quercus pagoda	Cherrybark oak	FAC	No data
Quercus stellata	Post oak	FACU	I
Salix nigra	Black willow	FACW	VT
Ulmus spp.	Elm spp.	FAC**	T

*assumed *Cornus drummondii* (Roughleaf dogwood); **assumed *Ulmus crassifolia* (Cedar elm)

Table 2. Wetland Indicator Status Ratings with Definitions (Lichvar, et al. 2012).

Indicator Status	Abbreviation	Definitions
Obligate	OBL	Almost always occur in wetlands.
Facultative Wetland	FACW	Usually occur in wetlands, but may occur in non-wetlands.
Facultative	FAC	Occur in wetlands and non-wetlands.
Facultative Upland	FACU	Usually occur in non-wetlands, but may occur in wetlands.
Upland	UPL	Almost never occur in wetlands.

Table 3. Flood Tolerance Indicator Status Ratings with Definitions (Teskey, et al. 1978).

Indicator Status	Abbreviation	Definitions
Very Tolerant	VT	Can withstand flooding for two or more growing seasons.
Tolerant	T	Can withstand flooding for most of one growing season.
Intermediately Tolerant	IT	Able to survive flooding for periods between 1-3 months during growing season.
Intolerant	I	Cannot withstand flooding for short periods (1 month or less) during growing season.

In the Bois d'Arc Creek downstream riparian corridor, the riparian woodland community is currently most similar to the forest cover type described as Sugarberry-American Elm-Green Ash (Society of American Foresters; Smith et al., 2001). These woodlands are typically found at transitional elevations between poorly drained flats (e.g., overcup oak-water hickory stands) and well-drained ridges (e.g., sweetgum-willow oak stands).

The wetland community observed in the Bois d'Arc Creek watershed is commonly limited to one to three dominant tree species with green ash, a pioneer species that readily invades cutover sites in the project area, being the most prevalent. This is indicative of the maturity of the wetland forest (immature) and the nature of the logging activities that have been on-going for decades.

3.2 Wetland Hydrology. For an area to have sufficient hydrology to support wetlands, the area must be inundated or saturated for two weeks of the growing season for most years. The growing season for the study area is March through October. There are four potential sources of water for the wetlands in the Bois d'Arc Creek watershed. These include:

1. Overbank flows from tributaries and Bois d'Arc Creek
2. Direct precipitation
3. Overland flow
4. Discharge of subsurface water from springs and seeps along the margins of the stream valley or into wetland depressions

A brief description of these sources and the potential impacts of the proposed dam on the water source is discussed in the following sections.

4.0 Sources of Water

4.1 Overbank Flows

Bois d'Arc Creek is a highly altered stream system due to years of channelization and drainage improvements. As a result, there are parts of the creek that are deeply incised and have little connectivity with the adjacent floodplain. The existing floodplain identified in Figure 1 is partially the result of overbanking flows from local tributaries and the connectivity of Bois d'Arc Creek to the floodplain through drainage ditches and other depressional areas. During very high flows, Bois d'Arc Creek does overtop the existing channel.

Under existing conditions, the flood hydrograph in Bois d'Arc Creek at the LBCR dam location has a characteristic double peak that occurs over an approximate two-day period. After two days, the flows return very quickly to pre-rain event levels. When the reservoir spills, the flow from the reservoir continues for more than six days before returning to pre-rain event levels. The flashy nature of the existing stream system provides flood waters to the adjacent floodplain and wetlands, but overbank flows are only one source of hydrology necessary to meet the wetland hydrology criterion of two consecutive weeks of inundated or saturated conditions.

To better understand the connectivity of Bois d'Arc Creek to the floodplain and assess the potential impacts of the LBCR dam on overbank flows, a detailed hydrologic/hydraulic study was conducted.

This study evaluated the Bois d'Arc Creek floodplain under five conditions:

1. Two-year flood event without the LBCR dam (the existing condition)
2. Two-year flood event with the LBCR dam in place and no spills from the reservoir
3. Two-year flood event with the LBCR dam in place and spills from the reservoir
4. Five-year flood event with the LBCR dam in place and no spills from the reservoir
5. Five-year flood event with the LBCR dam in place and spills from the reservoir

The two-year rainfall event was selected because it represents the flood conditions in at least 50 percent of the years. The five-year rainfall event was also analyzed because the HGM functional assessment model for forested wetlands considers the five-year floodplain in the evaluation of riverine wetlands. For the conditions with no spills from the reservoir, it was assumed that the only water released through the dam would be the 3 cfs base flow required by the LBCR water right permit. The creek was modeled as if only the 3 cfs flow was in the creek before the two-year event was applied. This was a conservative assumption, especially during the rainy season in May and June. For the conditions with the reservoir spilling, it was assumed that the reservoir was full before the rain event and the upstream flood waters were routed through the reservoir prior to spilling downstream. This provided some attenuation of the flood hydrograph.

For the two-year flood rainfall event with the LBCR dam in place and no spills, flows in Bois d'Arc Creek and associated tributaries would continue to provide overbanking flows to the adjacent floodplain and wetland areas. As shown on Figure 5, overbanking flows would inundate the lower lying areas within the floodplain. The areas not being inundated tend to be immediately adjacent to the creek bank, which may be due to spoils that were placed next to the creek bank when it was channelized and/or sediment deposits from prior overbank floods. Additional areas may be flooded and/or retain water from direct precipitation but may not be differentiated in the model simply due to the one-foot resolution of the LiDAR data. When the dam spills, Figure 6 shows that additional areas within the two-year floodplain would be inundated.

For the five-year flood event with the LBCR dam in place and no spills, nearly all of the existing wetland areas within the floodplain would be inundated as shown on Figure 7. When the dam spills, Figure 8 shows that additional areas within the five-year floodplain would be inundated.

Figure 9 shows only the wetland area that is not inundated under a 5-year event with spills. After adjusting for very small out-areas (non-contiguous areas that are less than 0.25 acres), the total acreage of potential wetlands that is not inundated is 162 acres. [Note: this adjustment was made because the LiDAR tool did not include smoothing of the elevation data, which results in these small out-parcels. Also, if these areas are truly higher and not inundated, they are surrounded by inundated areas such that the underlying soils would likely be saturated. The total acreage of these out-parcels is 43 acres.]

A summary of the inundated areas and potential wetlands for the different scenarios is presented in Table 4.

Table 4: Summary of Inundated Areas under Different Flood Conditions[1]

Wetland Type	Study Area (Acres)	2 Year Flood With Dam No Spills (Acres)	2 Year Flood With Dam Spilling (Acres)	5 Year Flood With Dam No Spills (Acres)	5 Year Flood With Dam Spilling (Acres)
Freshwater Emergent Wetland	149	109	113	134	140
Freshwater Forested/ Shrub Wetland	1,852	954	1,224	1,495	1,657
Total	**2,001**	**1,063**	**1,336**	**1,629**	**1,796**

1. These values do not include the adjustment for out-parcels that are less than 0.25 acres. The total acreage of these out-parcels is 43 acres.

4.2 Direct Precipitation

One of the four sources of water for forested wetlands downstream of the proposed LBCR is direct precipitation. Fannin County receives over 41 inches of rainfall in most years. In 2015, the area received over 76 inches of rain. Most of the precipitation occurs during the early growing season in March through June with over 5 inches of rainfall occurring in May. Figure 10 shows the average monthly precipitation for Fannin County near Bonham.

Figure 10 Average Monthly Precipitation at Bonham, TX

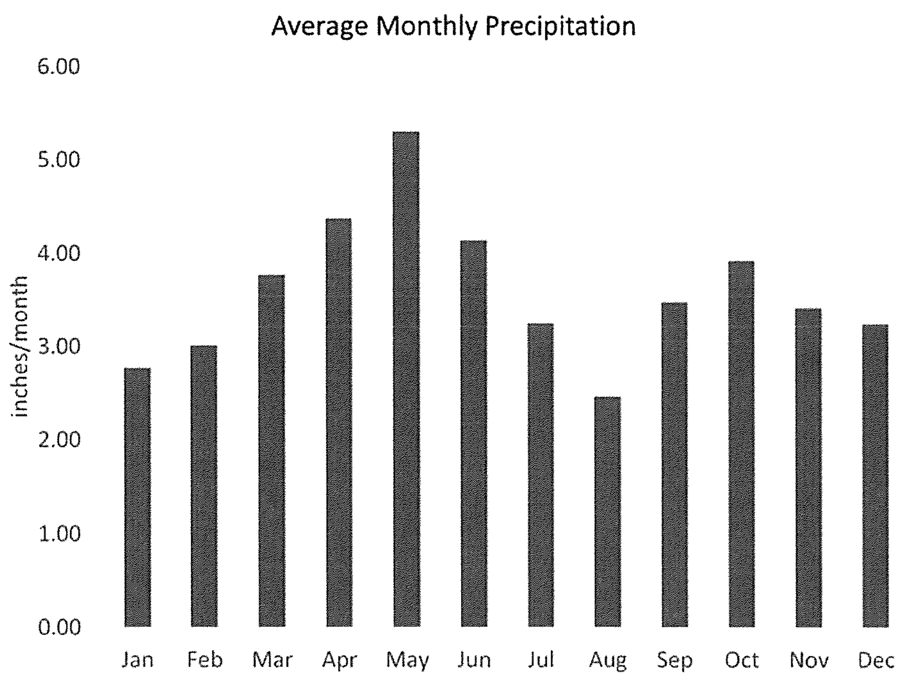


Figure 11 shows the median rainfall over two-week intervals, which relates to the wetland hydrology criterion (i.e., saturation or inundation for approximately two weeks during the growing season in most years). During the growing season the median rainfall is 1.63 inches over 14 days. As shown on Figure 6, the four highest consecutive rainfall periods are from the end of April through mid-June, with median rainfall levels ranging from 2.69 to 2.25 inches over 14 days. The total median rainfall over this 8-week period is 9.9 inches. Direct precipitation on wetlands is, by itself, a considerable source of water for saturation or inundation for a two-week period depending on antecedent soil moisture conditions and frequency of rainfall. Of course, precipitation doesn't just fall directly on wetlands, it also covers adjacent areas and finds its way to wetlands by other routes too. A summary of the local precipitation data is presented in Table 5.

Figure 11 Average 14-Day Precipitation at Bonham, TX

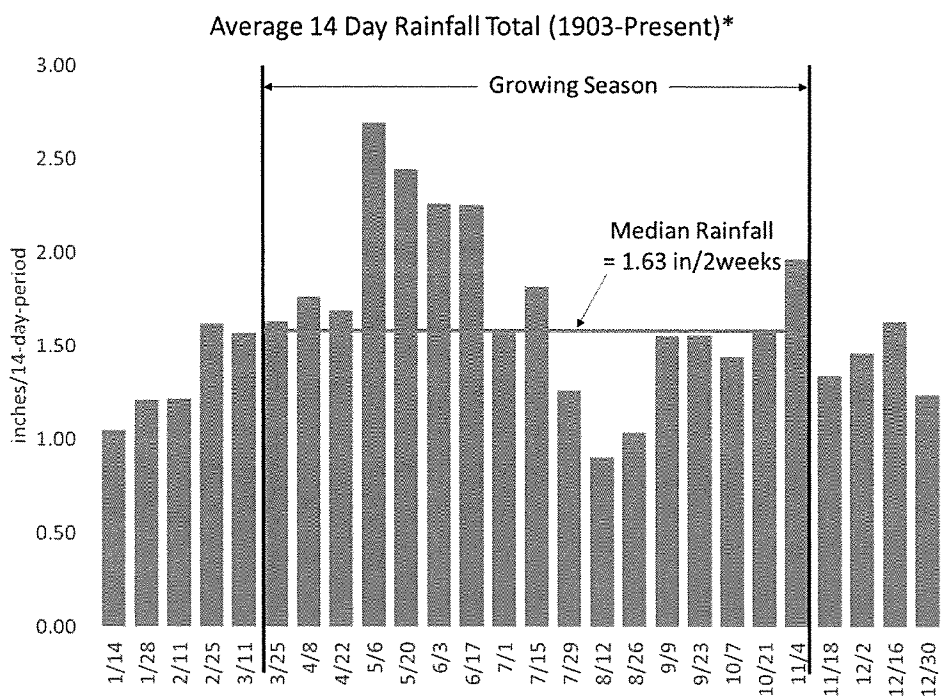


Table 5 Summary of Precipitation at Bonham, TX

	All Year			**Growing Season**		
	7-day Total	**14-day Total**	**Annual Total**	**7-day Total**	**14-day Total**	**Season Total**
Median	0.77	1.57	41.16	0.81	1.63	33.22
Average	0.80	1.61	41.77	0.87	1.74	33.55
Std Dev	0.22	0.44	10.20	0.25	0.49	9.39

4.3 Overland Flow

Overland flow is a result of precipitation that falls on the landscape and runs off. Such runoff occurs only after rainfall interception storage by vegetation, debris and other non-permeable objects is satisfied and when the precipitation rate exceeds the infiltration capacity of soils. Thus, overland flow, or runoff, is the excess precipitation that isn't retained by interception or infiltration. Overland flow from local areas surrounding wetlands, which are typically depressional features on the landscape, is another source of wetland hydrology. The magnitude of overland flow contribution to wetland hydrology for a given storm event increases with intensity and duration of the event, and it is greater when antecedent moisture conditions in soil and watershed micro-depressions are wetter.

4.4 Discharge of Subsurface Water from Springs and Seeps

Another source of water for the downstream wetland hydrology is local ponding. Both direct precipitation and ponded water can act as recharge to alluvial sediments. This water then travels through the near surface soils as interflow and is observed as seepage in the bottomland flats. Ponded water and interflow can sustain wetland hydrology over a longer period than overbanking flows, which deliver a lot of water in a short time frame and then recede, contributing to the saturation of these areas.

To assess the locations of ponded water and potential for interflow, the HEC-RAS 2D model was used to simulate a flood over the vicinity of the study area and then the flood waters were allowed to drain. Local ponding areas were identified where water remained after the drainage. These areas are shown in dark blue on Figure 12. As previously noted, ponded areas shown are a minimum of 12-inches deep due to the resolution of the LiDAR imagery and resulting elevation contours. There may be additional ponded areas that cannot be identified because the depth is less than 12 inches. Based on this analysis, there are approximately 160 acres of ponded areas within the study area and 135 acres of ponded areas within relatively permeable (coarse loamy and loamy) soils located within a mile of the floodplain that could act as potential recharge areas for interflow.

The potential for recharge and interflow is directly related to the permeability of the local soils. Permeable soils generally include coarser textured soils (loams and sands). Finer textured soils (clays) as identified along the Bois d'Arc Creek bottoms tend to have low permeability. As shown on Figure 11, there are coarse loamy and loamy soils bordering the floodplain on both the north and south banks of Bois d'Arc Creek. These areas would likely provide wetland hydrology through ponding and interflow from the alluvial sediments.

Groundwater seepage is similar to interflow but occurs due to the geologic and geomorphic characteristics of the watershed and can be realized as springs. Springs often are groundwater that travels through an alluvial aquifer and discharges along topographic breaks such as stream banks. Gunnar Brune, author of *Springs of Texas* (Brune, 1981), identified 11 springs in Fannin County. Some of these springs have stopped flowing or have reduced flow due to groundwater pumpage and declining groundwater levels. Several springs are still active, including Bois d'Arc Spring that is located about 2 kilometers northeast of Lake Coffee Mill dam. According to Brune (1981), the springs flow from the base cliff of Bonham sandstone on top of Eagle Ford shale toward Bois d'Arc Creek. Other springs were observed by FNI staff on property near Bois d'Arc Creek, located midway between FM 100 and FM 79.

The source of water for groundwater discharges that contribute to wetlands adjacent to Bois d'Arc Creek typically derives from precipitation that infiltrates the soil surface and flows underground by the force of gravity. It can be local or it can be recharge from outside the watershed. Figure 13 shows the local topography of the Bois d'Arc Creek downstream of the LBCR dam. The red areas depicted on Figure 13 are the surrounding elevated upland potential recharge areas, which occur all along the south side of the creek valley and along the western part of the northern creek valley. These uplands rise approximately 300 feet above the floodplain.

Local groundwater in the study area include the Red River Alluvium, Woodbine Aquifer and local alluvium (perched aquifer). The Red River Alluvium is a shallow aquifer along the Red River and consists of alluvial sediments. This aquifer is likely not a source for interflow through the bluffs, but it does contribute to wetland hydrology near the confluence with the Red River as the alluvium is recharged by precipitation and flows from the Red River. The Woodbine Aquifer is a minor aquifer, but provides considerable amounts of local groundwater. The Woodbine Formation is composed of water-bearing sandstones interbedded with shales and clays, outcropping along the Red River. Within the study area, the Woodbine can be found near the surface to more than 500 feet deep. This formation could be a source for springs along Bois d'Arc Creek. The most likely source for springs is perched groundwater, as described by Brune (1981). This is water that has infiltrated the overlying alluvial soils and travels along an impermeable layer, such as tight clays or shale. Water would flow along these layers until it is discharged at a break in the land surface, such as a stream or depressional area. This source of water would provide wetland hydrology over a sustained period of time since it is not directly related to flood waters.

5.0 Conclusions

As discussed, wetlands are identified based on the presence of hydric soils, wetland vegetation and wetland hydrology. Based on our previous evaluation of potential impacts within the downstream corridor and the current study, the wetlands downstream of the proposed LBCR dam are expected to be sustained after the dam is in place.

The hydric soils located in the floodplain will remain. No action is proposed that would displace or alter the existing hydric soils.

The wetland vegetation is not expected to change as a result of altered flows with the proposed dam in place. Of the 12 tree species identified in previous studies, 11 (92%) are classified as facultative or facultative upland, suggesting a community prone to temporary, or seasonal, rather than semi-permanent flooding. Because the tree vegetative community is dominated by facultative (equally likely to occur in wetlands or uplands) and facultative upland (usually occur in non-wetlands) species, potential reductions of overbanking events from Bois d'Arc Creek are not anticipated to result in a change, or shift, in the species composition.

As noted in the FNI 2010 study (Appendix C), the changes in hydrology with the proposed LBCR in place may allow for greater species diversity, including hard mast trees, which are important to wildlife habitat. The reduced frequency and magnitude of large floods and improved reliability of stream flow throughout the year due to required environmental flow releases is expected to create a more suitable habitat for riparian plant growth and development. Construction of the proposed LBCR will provide a more diverse and stable ecosystem in the downstream area.

There are multiple sources of hydrology to sustain the wetland community downstream of the proposed LBCR dam. Overbanking flows will continue with the LBCR dam in place, based on the results of modeling two-year flood hydrology. In most years, there will be inundation of much of the downstream wetlands solely from overbanking flows, and 84% of the downstream wetlands are expected to be inundated at least every five years. When the reservoir is spilling, inundation increases to 92% of the downstream wetlands. Three additional sources of wetland hydrology, including direct precipitation, overland flow, and subsurface discharge through springs and seeps, are not expected to change with the construction of the dam. These sources are important in providing the hydrology necessary to sustain inundation and/or saturation for two weeks during the growing season in most years. When all four sources of wetland hydrology are considered, there will be sufficient wetland hydrology for the downstream wetlands following the development of the proposed LBCR.

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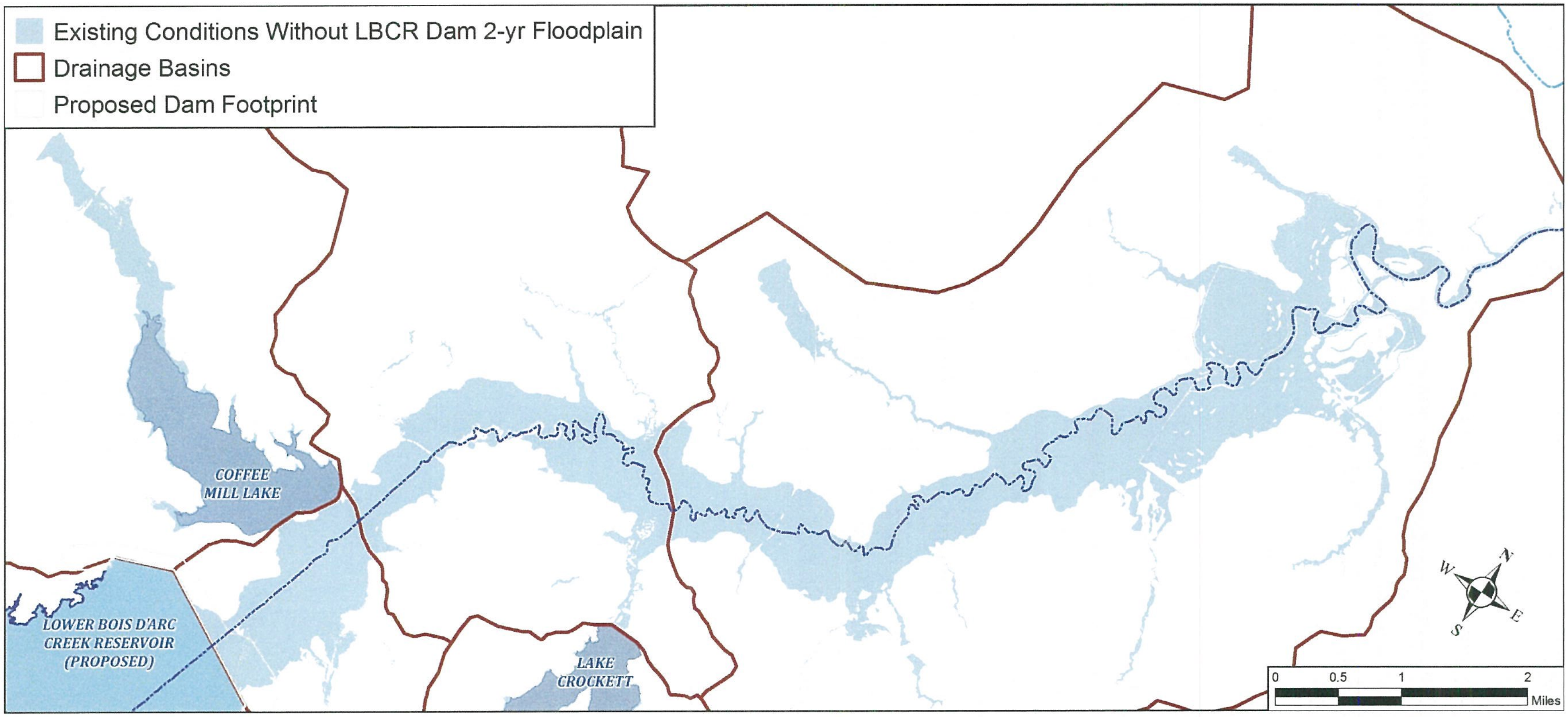


Figure 1 Existing 2-Year Floodplain on Bois d'Arc Creek

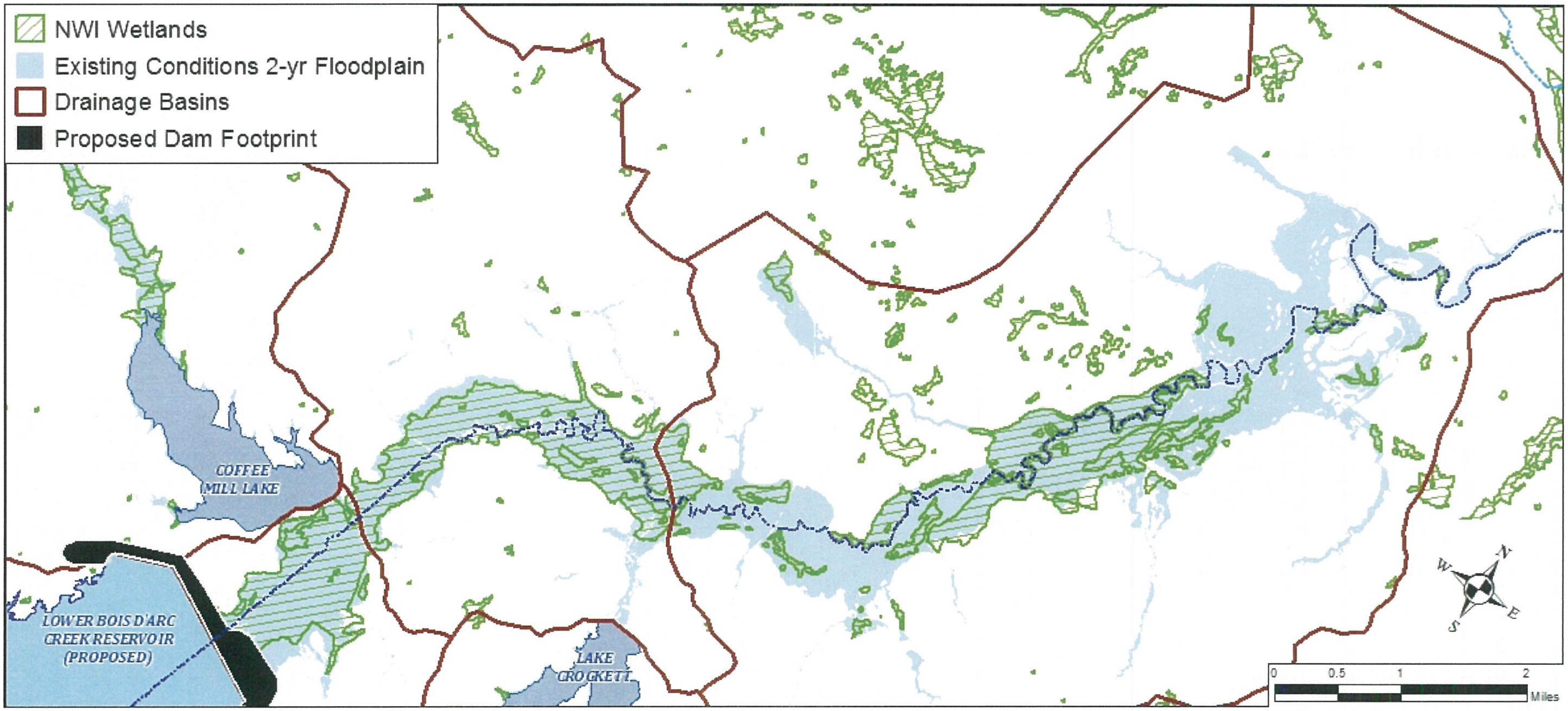


Figure 2 NWI Wetlands Downstream of LBCR Dam

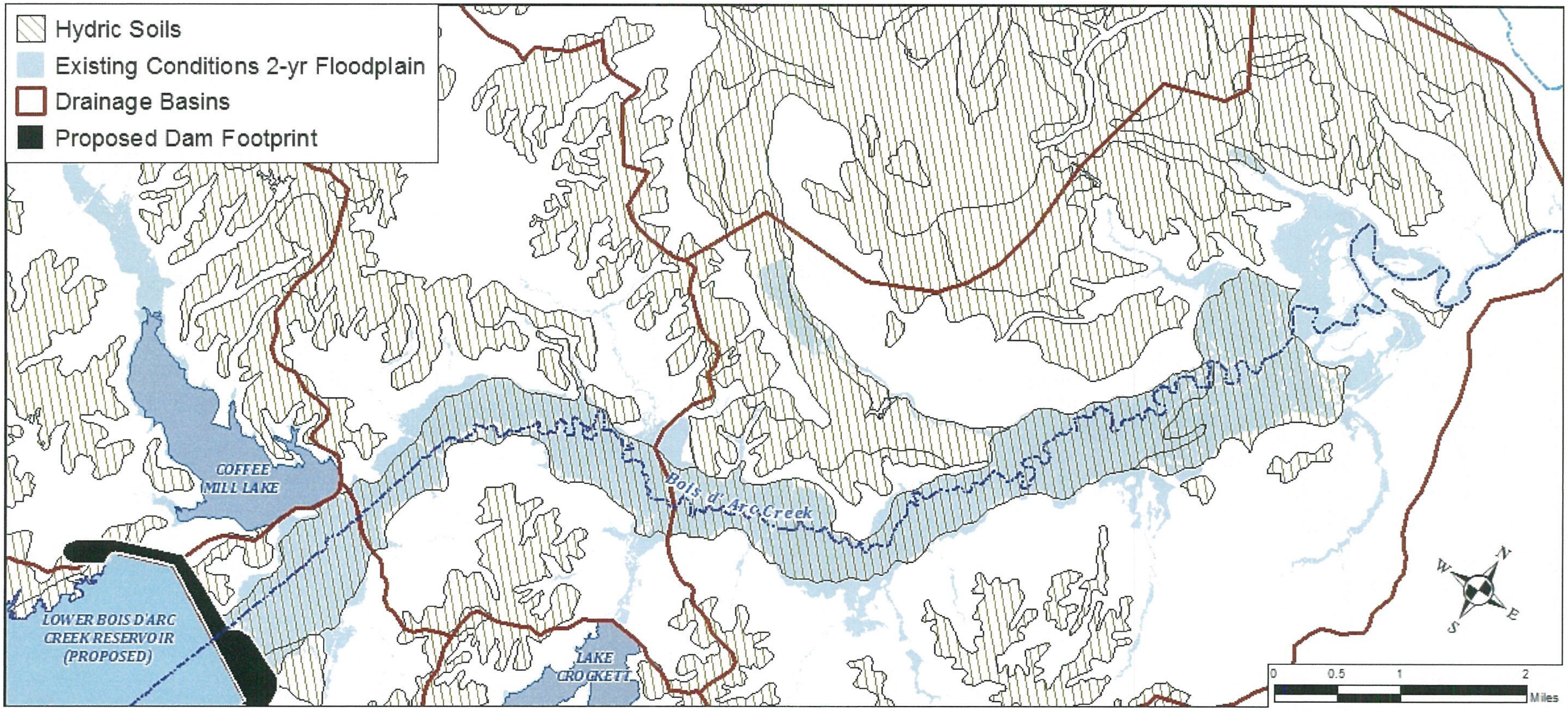


Figure 3 Hydric Soils

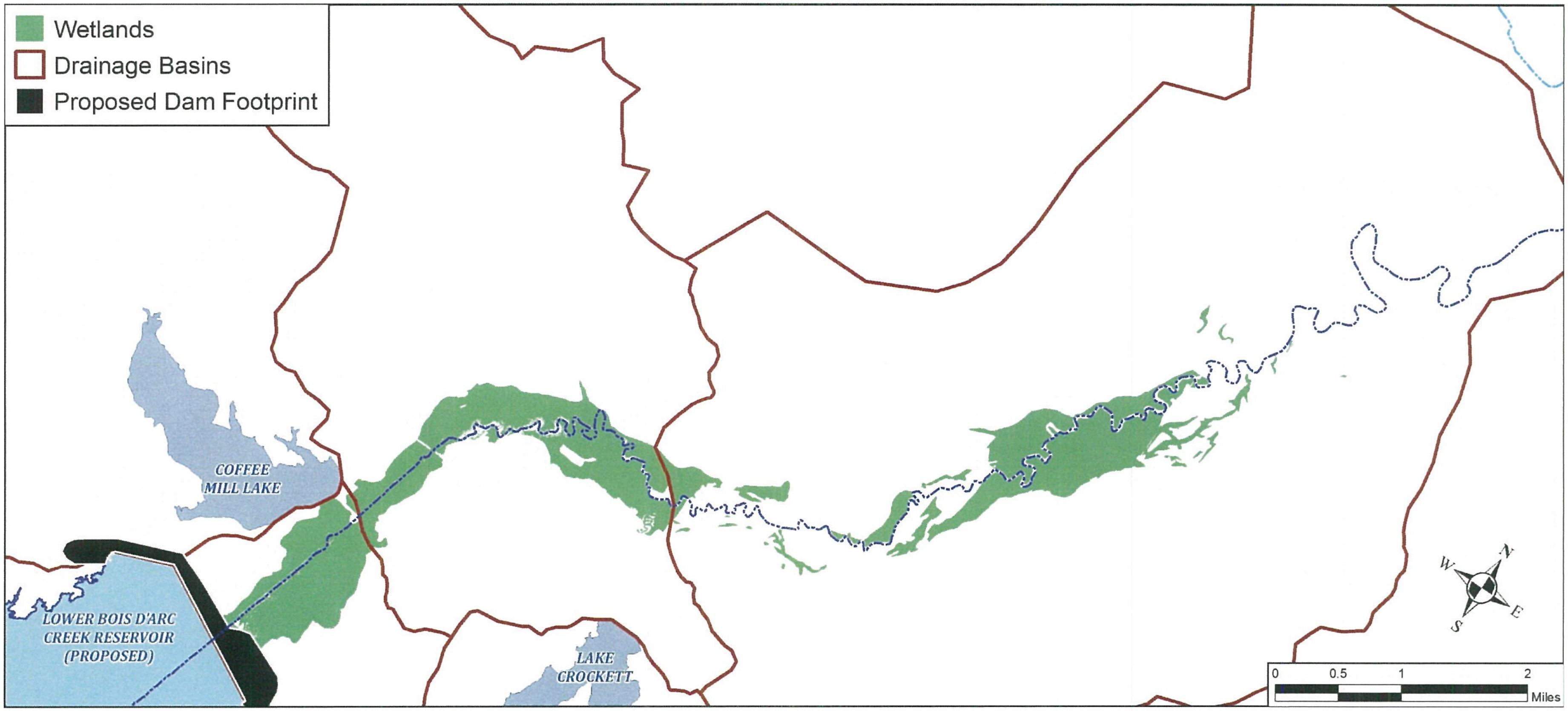


Figure 4 Estimated extent of wetlands based on desktop analysis

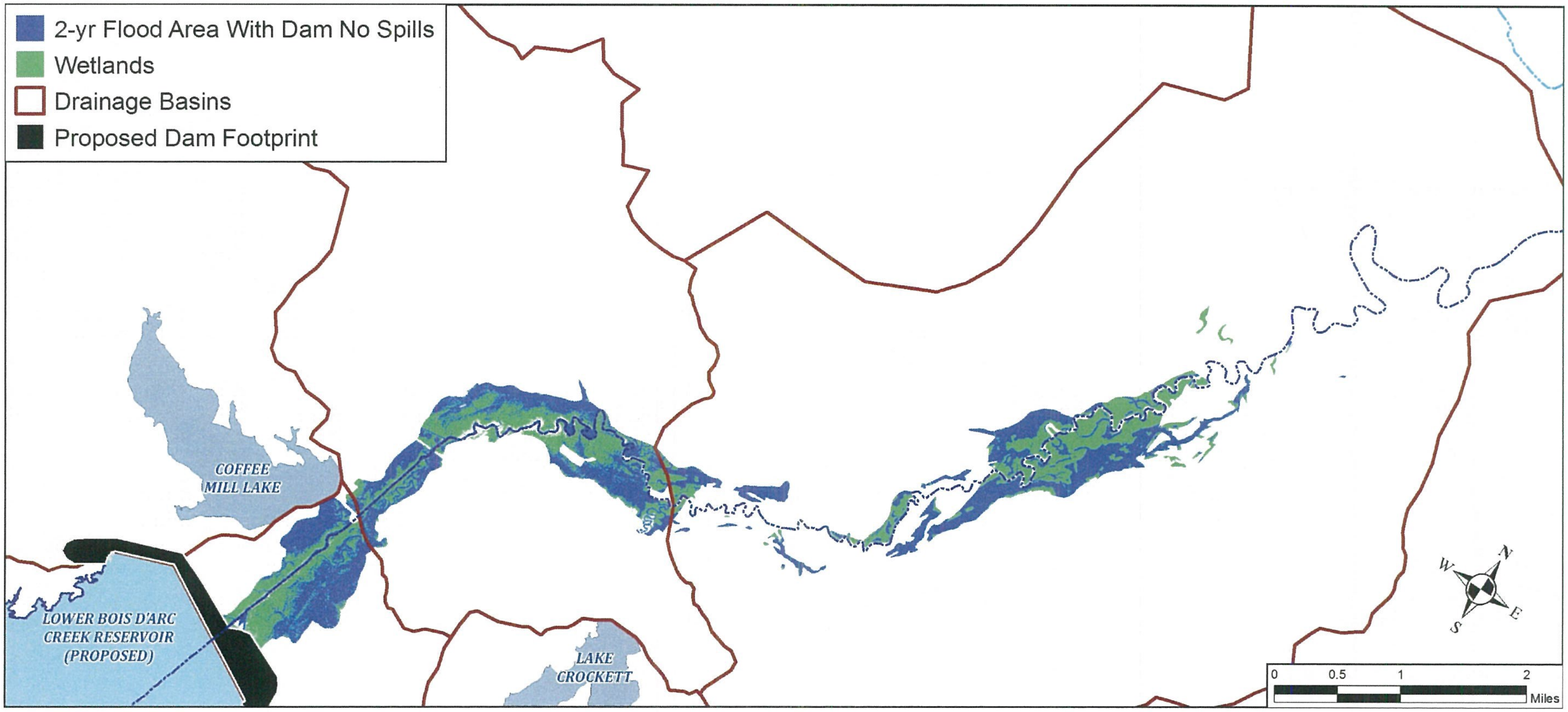


Figure 5 2-Year Flood Event – Inundation Area with LBCR Dam, No Spills from LBCR

APPENDIX F

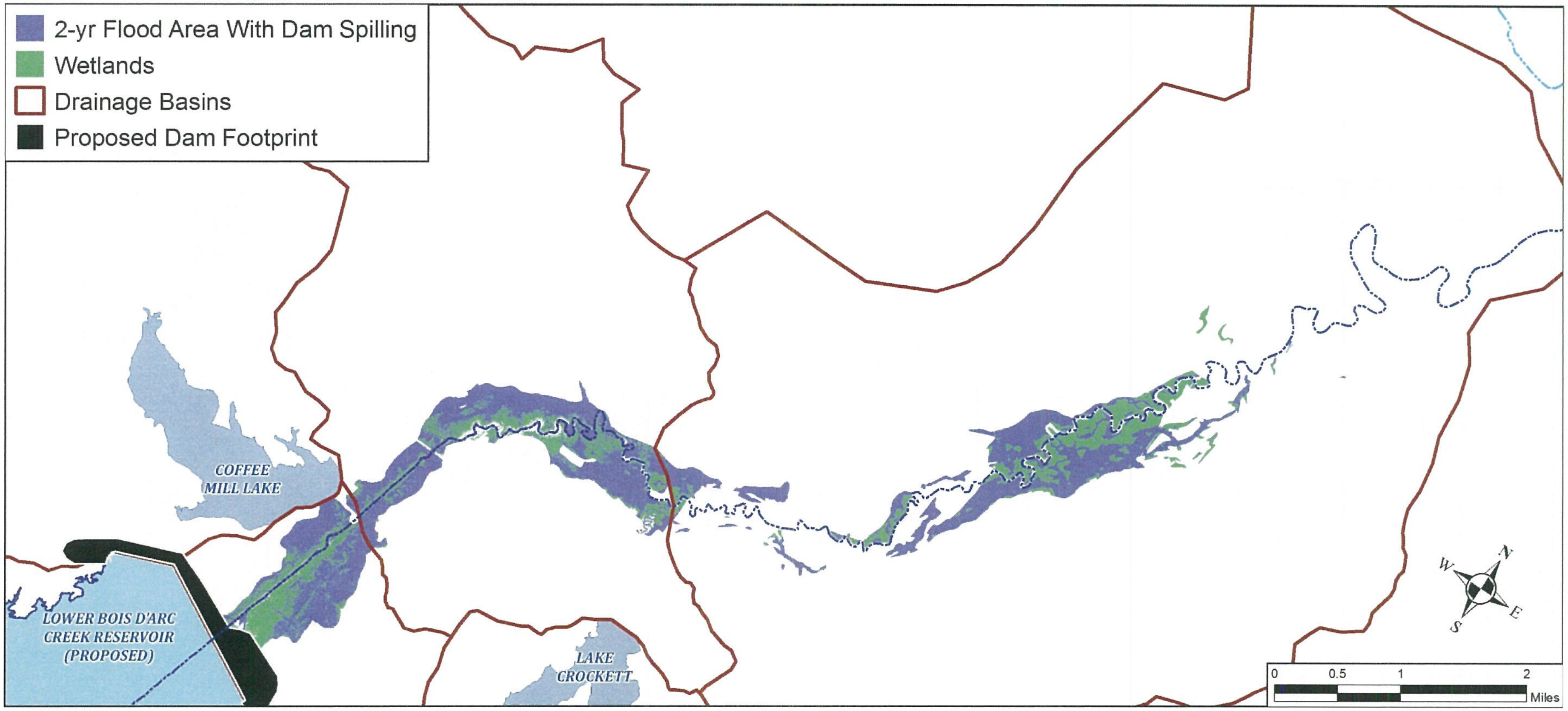


Figure 6 2-Year Flood Event – Inundation Area with LBCR Dam, Spills from LBCR

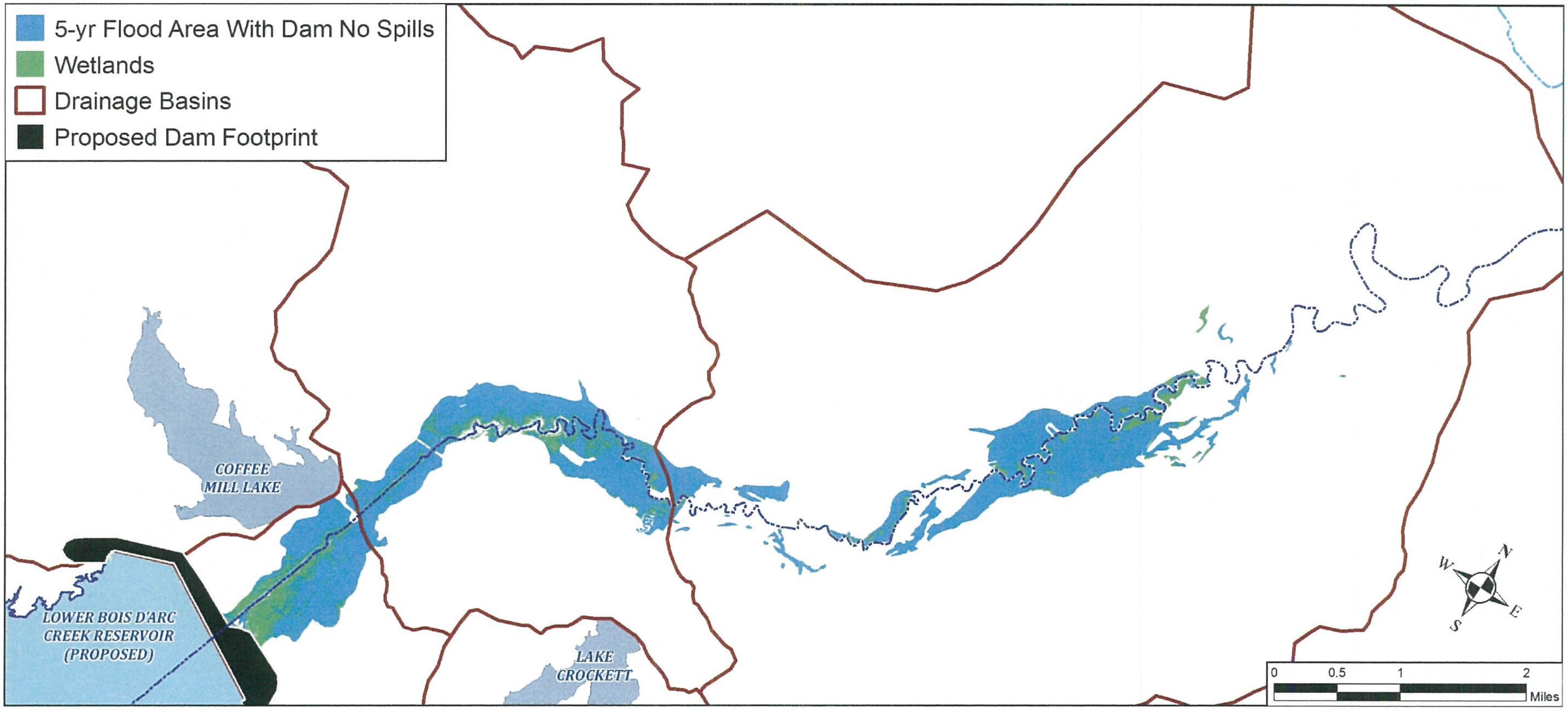


Figure 7 5-Year Flood Event – Inundation Area Wetlands with LBCR Dam, No Spills from LBCR

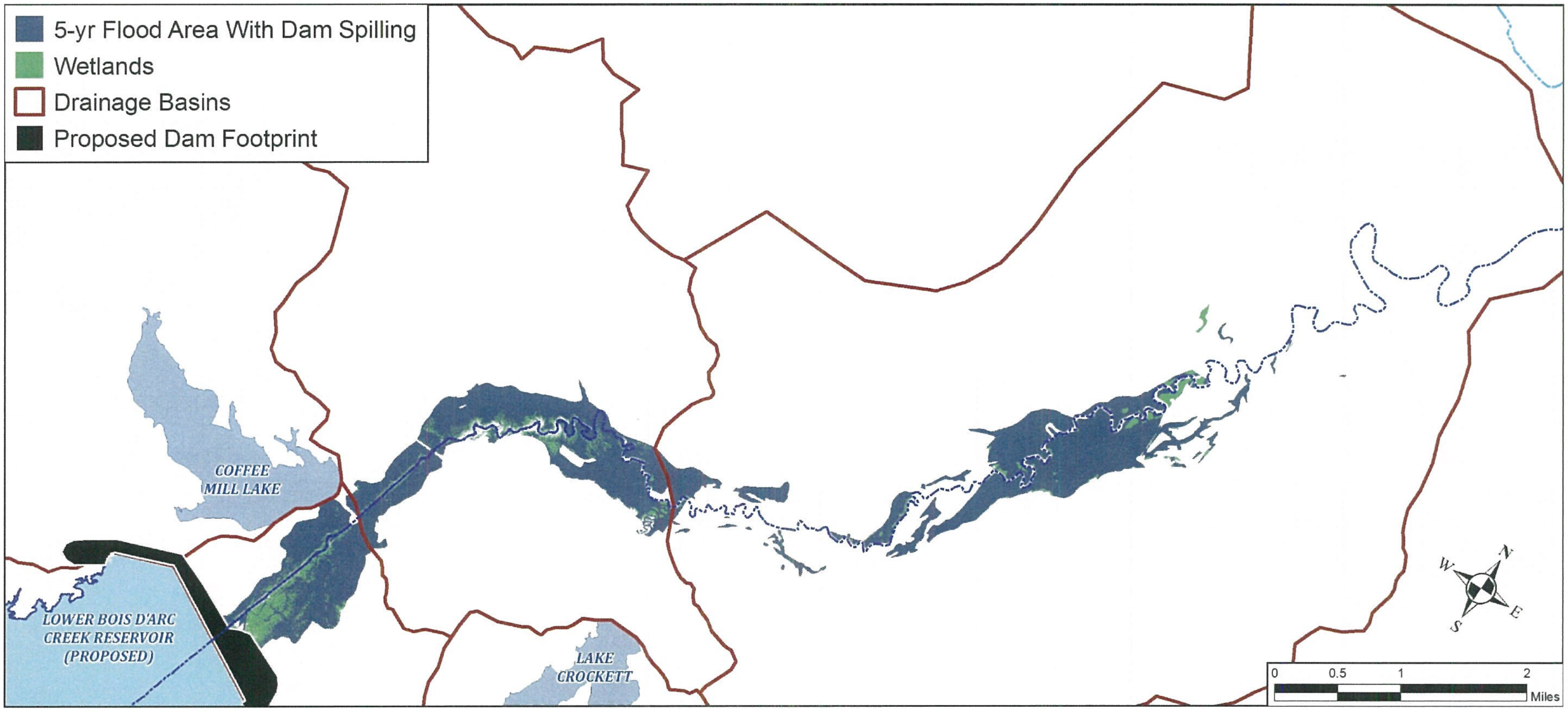


Figure 8: 5-Year Flood Event – Inundation Area with LBCR Dam, Spills from LBCR

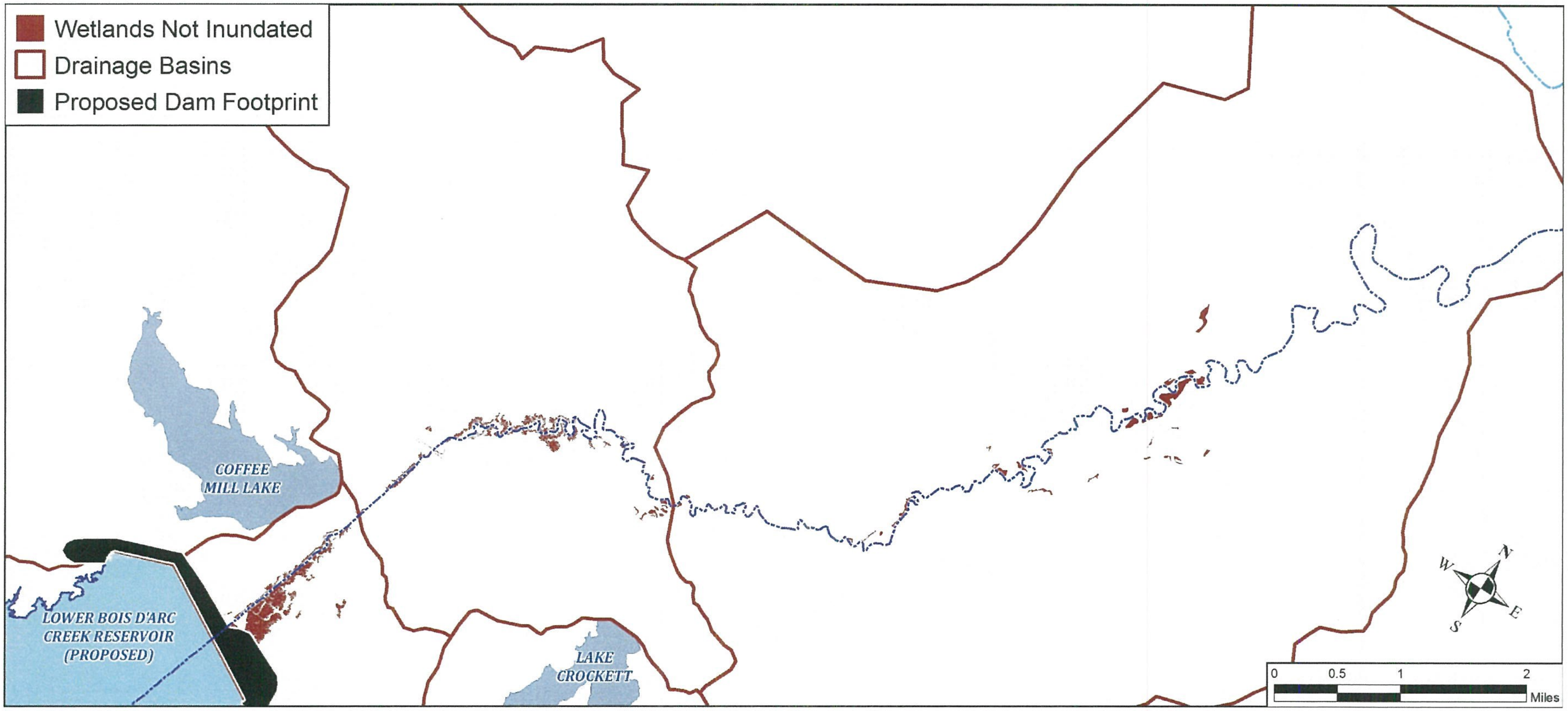


Figure 9 Areas not Inundated under the 5-Year Flood with Spills

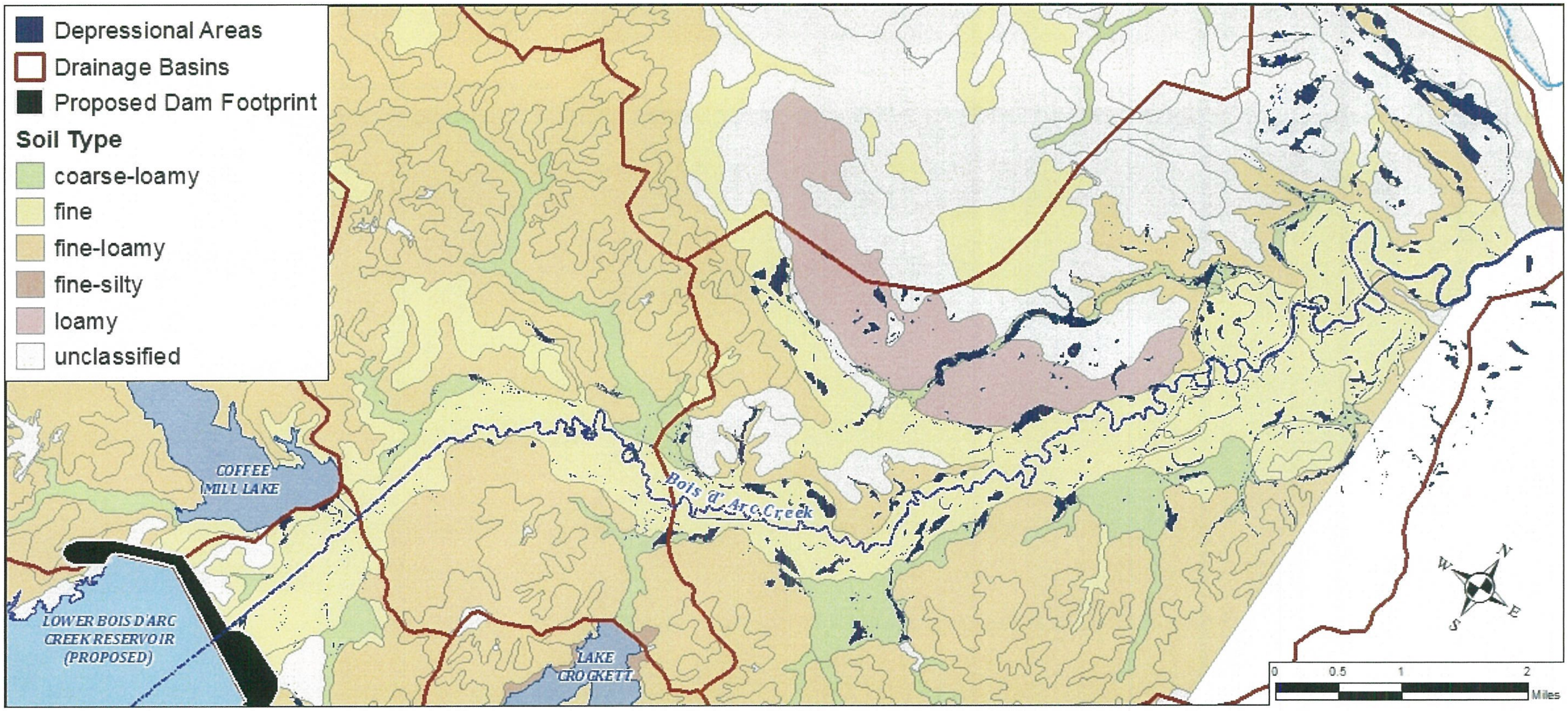


Figure 12 Ponding, Recharge and Interflow Potential

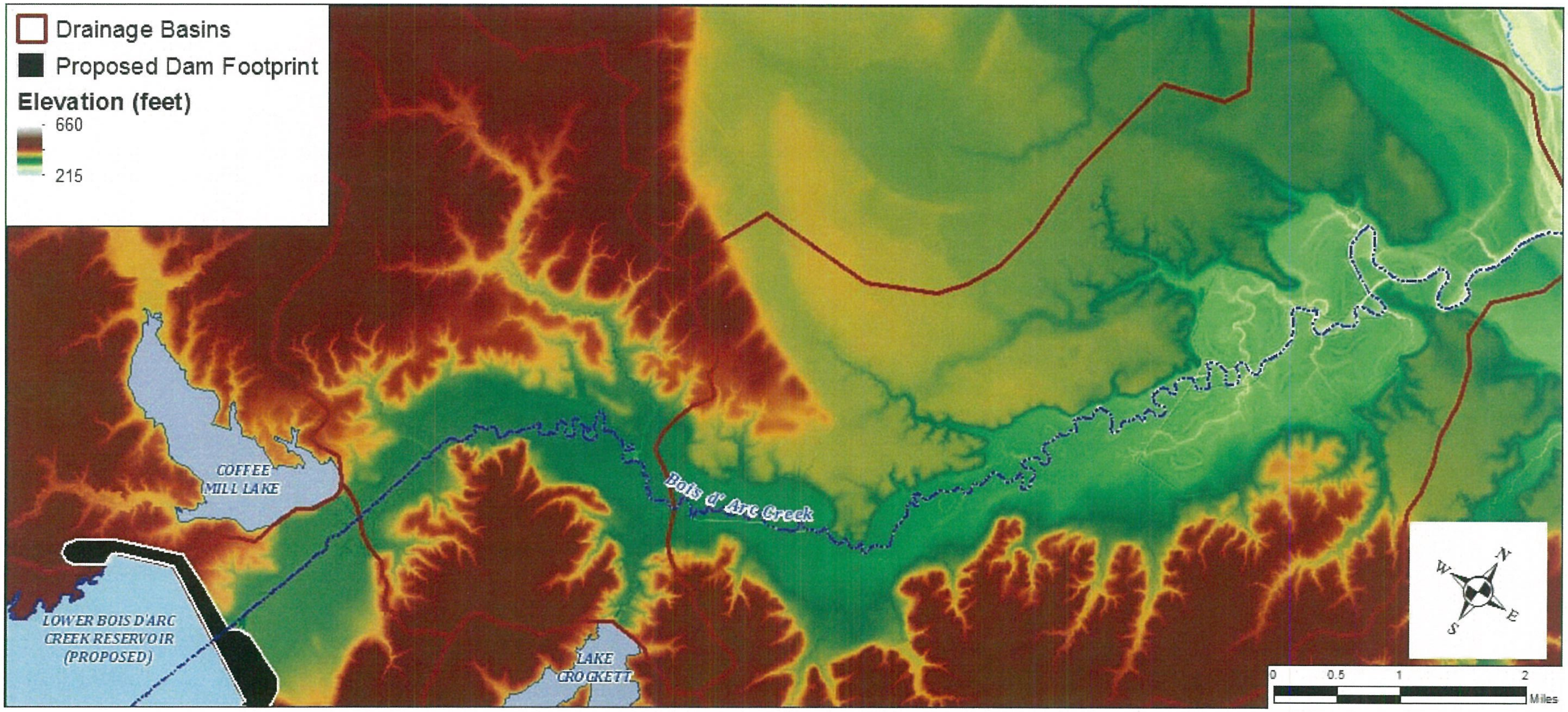


Figure 13 Topography of Bois d'Arc Creek Watershed Downstream of LBCR Dam

ATTACHMENT 1

APPENDIX C Downstream Corridor Impacts

Supplemental Instream Flow Study, September 2010

C-1 INTRODUCTION

The flow regime of Bois d'Arc Creek has evolved over time. More than 100 years ago, the channel was a meandering stream that moved flood waters slowly through the basin to the Red River. Today, the creek responds to rain events by moving flood waters quickly through the channel, which is observed in the rapid rise and fall of flood waters. This response results in continued downcutting of the channel and potential future disconnect between the channel and riparian corridor. The proposed flow regime for Bois d'Arc Creek is expected to reduce the downcutting and may contribute to aggradation of the stream, which would better serve the downstream riparian corridor. This flow regime is based on three components defined for the Texas Instream Flow Program (TIFP), and is expected to be sufficient to protect the instream flow needs of the channel and the associated riparian corridor.

Overbanking flows are the fourth category of environmental flow criteria established by the TIFP. The proposed flow regime for Bois d'Arc Creek excludes deliberate releases from the reservoir to produce overbanking flows. This recommendation was supported by the results of the hydrological, biological, and fluvial geomorphological components of the 2010 *Instream Flow Study*, as high flows were shown to be erosive and destructive to existing instream habitats. It is also consistent with the Texas Commission on Environmental Quality's (TCEQ) position to not require overbank releases in water rights permits, as indicated by agency staff during meetings for the Bois d'Arc Creek instream flow study. Deliberate overbanking or flooding flows create liability issues relating to potential property damage and/or loss of life.

A sound ecological environment, as defined for the Bois d'Arc Creek *Instream Flow Study* (FNI, 2010), requires environmental flow releases that provide sufficient stream power to move sediment in the channel to promote habitat diversity without creating excessive stream bed and bank erosion. The recommended pulse release amount to meet this criterion is 50 cfs. This flow, while sufficient to meet this goal, will not generate overbank flows by itself. The anticipated change in the number and frequency of overbank flows may result in potential impacts to the instream and floodplain environments downstream of the proposed dam. Potential impacts and established mitigation for instream impacts associated with the proposed Lower Bois d'Arc Creek Reservoir project were addressed in the 2010 *Instream Flow Study* report and supported with this Supplemental Report. The primary purpose of this Appendix is to address potential impacts to the floodplain of Bois d'Arc Creek downstream of the proposed dam, specifically those effects that pertain to expected modification of overbanking flows.

C-2 POTENTIAL IMPACTS OF LOWER BOIS D'ARC CREEK RESERVOIR ON DOWNSTREAM FLOODPLAIN

In a comprehensive report on Dams and Development (WCD, 2000), the World Commission on Dams documented potential environmental impacts of dams (Petts, 1984). These potential impacts can be considered within a hierarchical framework of interconnected effects, with differing levels of impacts.

Considerations of potential impacts to the downstream floodplain environments include abiotic variables relating to hydrology, water quality, and sediment loading. The proposed project ecosystem and reservoir purpose (i.e., whether water is extracted, diverted, or released) dictate the extent of change to downstream floodplain hydrology and sedimentation processes (WCD, 2000). Significant changes associated with the abiotic variables can result in altered floodplain morphology and riparian vegetation. These are dependent on the extent of impacts created by dam operations, local conditions, and the characteristics of the stream prior to dam (Acreman, 2000). Potential changes to the biological environment are the result of the integrated effects of these impacts. Complex interactions may take place over many years before a new "ecological equilibrium" is achieved (McCartney et al., 2000).

The proposed flow regime for Lower Bois d'Arc Creek Reservoir may result in changes to the downstream corridor. However, based on local conditions, these changes are not expected to have a negative impact, and may help contribute to maintaining a sound ecological environment in the area.

C-2.1 Potential Effects on Hydrology and Sedimentation

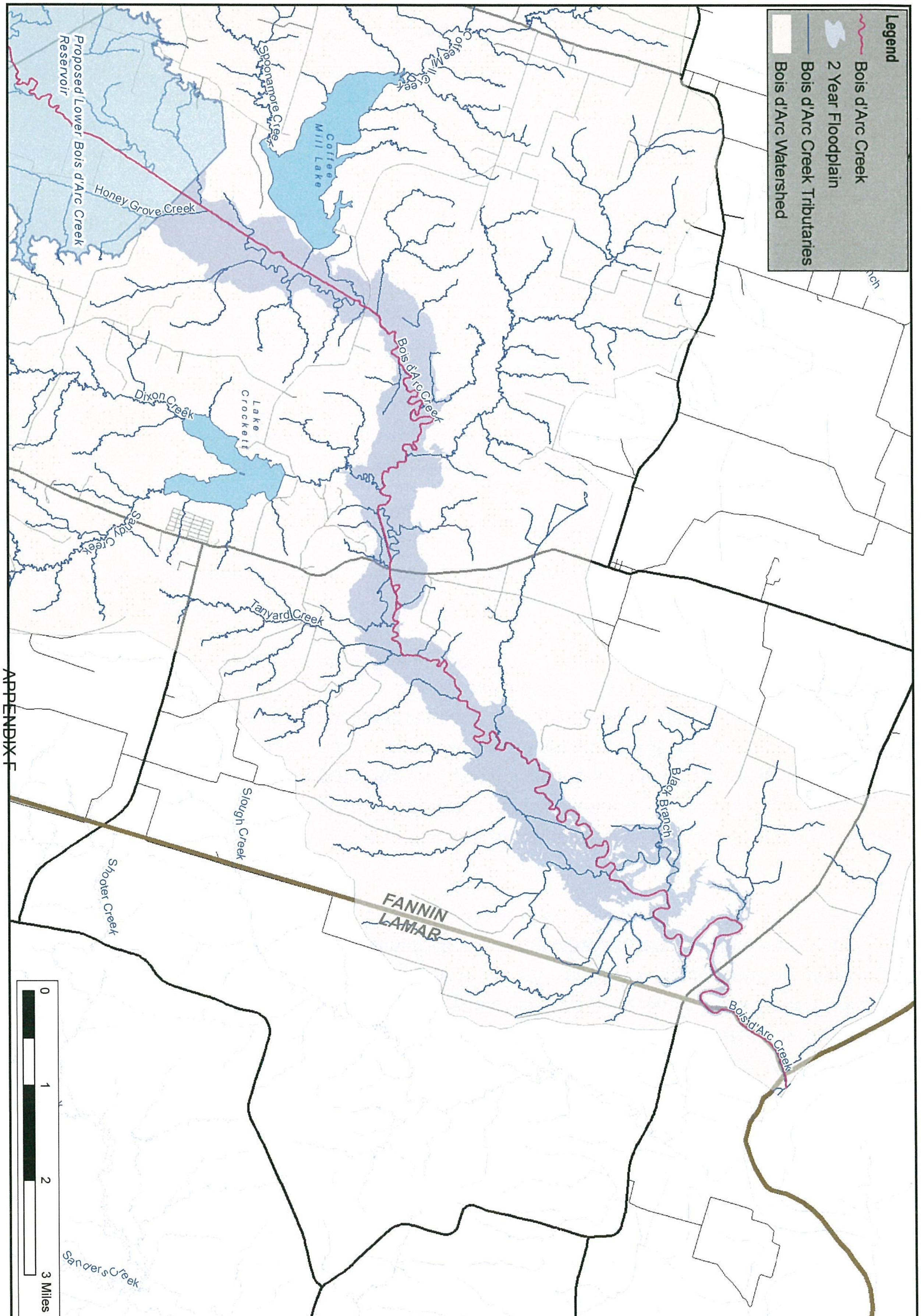
Several integrated factors determine how the modified flow regime and reduced sediment loading will impact the downstream floodplain. Overbanking flows can play a role in floodplain inundation duration and frequency, sediment deposition, and soil fertility (McCartney, 2000). Reducing overbanking flows may also influence longer-term processes of groundwater/aquifer recharge and connectivity. However, other factors such as current channel conditions, climatic conditions (e.g., precipitation), topography, soils, land cover, and dam design and operation will affect the level of impacts.

C-2.1.1 Hydrology

The current channel conditions of Bois d'Arc Creek are generally considered "poor" and in a state of disequilibrium and stream instability (FNI, 2010). Bois d'Arc Creek watershed is a highly channelized stream system (62%), with stream bank heights ranging between 20 to 30 feet. Stream channelization began in the 1920s; therefore, current stream conditions to a degree reflect over 90 years of altered stream-floodplain connectivity.

With the dam in place, hydrologic modeling results indicate that there will be fewer overbanking events along the downstream corridor of Bois d'Arc Creek; however, several other factors will continue to contribute to floodplain inundation. These include spills from the reservoir, effects

APPENDIX F



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

Contributing Downstream Tributaries

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C-2

Figure

associated with overbanking events associated with local tributaries, regional climatic conditions and existing riparian vegetation. Regionally, inundation is supplemented by high average annual rainfall and existing soils types (i.e. Tinn clay) with the slow permeability and low runoff potential (USDA, 2001). Behind the Gulf Coastal Plains and the Pacific Northwest, East Texas receives among the highest average rainfall in the conterminous U.S. (about 42-44 inches/year). Additionally, 42 percent of the downstream floodplain (modeled post-dam) is part of the Caddo National Grasslands. The relatively undisturbed vegetative state of these areas potentially promotes water retention and encourages soil infiltration (Acreman, 2000).

Hydrological effects of dams become less significant with distance downstream because the area of uncontrolled catchment of the watershed increases. The frequency of tributary confluence and their hydrological contribution play a large role in determining the length of stream affected by an impoundment (Acreman, 2000). Below the proposed Bois d'Arc Creek reservoir, there are numerous contributing tributaries (Figure C-2). These tributaries provide additional stream flow to Bois d'Arc Creek as well as the potential to provide overbanking flows to the adjacent floodplain.

Altered drainage systems, such as Bois d'Arc Creek, create reduced groundwater-surface water interaction and modify infiltration processes resulting in decreased groundwater recharge (Winter et al., 1998). The floodplain soils are documented to have a deep groundwater table (greater than six feet) (USDA, 2001). Groundwater-stream channel interaction may actually increase as a result of the proposed environmental flow regime, as it maintains steady base flows throughout the year. This can promote lateral connectivity between the active channel and the near surface groundwater table (Winter et al., 1998).

C-2.1.2 Sedimentation

The majority of impacts associated with reduced sediment loading occur within the active channel, though overbanking flows do contribute fluvial sediment deposits and associated soil nutrients to the adjacent floodplain (Ligon et al., 1995).

Over the course of the modeled historical hydrological record, overbanking events in Bois d'Arc Creek occur on average three times per year. With continued channel incision and degradation, the frequency of overbanking flows could decrease, limiting sediment and nutrient deposition as compared to pre-channelized stream conditions. The 2010 *Instream Flow Study* proposed environmental flow regime incorporates pulse flow events (50 cfs) to maintain or improve channel characteristics by minimizing erosional processes and promoting the establishment of stream bank vegetation. With the proposed flow regime, the channel is expected to aggrade over time, increasing potential connectivity with the adjacent floodplain. (See discussion on Yegua Creek in Section C-2.2.1.)

C-2.2 Potential Effects on Floodplain Morphology and Riparian Vegetation

C-2.2.1 Floodplain Morphology

Downstream of the proposed dam, the floodplain morphology of Bois d'Arc Creek has been affected by the historical upstream channelization practices. In general, the banks of Bois d'Arc Creek downstream of the proposed dam are actively eroding, resulting in channel widening (approximately 0.5 feet/year), incision, and bank steepening. Currently, all stream migration is confined within the incised channel; therefore, the proposed stable low flow reservoir releases are expected to promote floodplain retention through stream bank stabilization and channel aggradation.

Stream aggradation has been documented at other streams downstream of existing reservoir sites. In Yegua Creek, downstream of Somerville Dam, Somerville, TX, the channel capacity decreased following dam closure due to reduced flood flow frequency. Since construction of the dam, there has been an 85 percent reduction in flood peaks. Aggradation has caused the channel depth to decrease approximately 60 percent. Channel banks have remained stable as a result of increased vegetation density caused by increased low flows during the typically dry summer months. Decreased channel capacity allows for increased sediment delivery to the floodplain by flows that have been traditionally contained in a larger channel (Chin et al., 2002).

C-2.2.2 Riparian Vegetation

The inclusion of overbanking flows in the TIFP is often cited to maintain the ecological health of the downstream riparian corridor. Concerns with reduced overbanking include potentially decreased soil fertility and reduced "seedbed" area for riparian vegetation. However, impacts on riparian vegetation are site specific and depend, to a large extent, on dam operations and current site conditions (e.g., existing vegetative species, active channel width, land use, topography) (Acreman, 2000; Chang and Crowley, 1997; Williams and Wolman, 1984). In some instances, particularly in altered systems, regulated stream flows promote stream bank stabilization, vegetation growth, and species diversity.

For example, the riparian corridor below the Sam Rayburn Reservoir promotes greater species diversity than a relatively undisturbed corridor along the Neches River. For this assessment, streamflow and vegetation characteristics were compared between the study areas: 1) immediately below Sam Rayburn Dam in the Angelina River floodplain and 2) a relatively undisturbed area along the Neches River approximately 12 miles to the west. After impoundment, the monthly stream flows were higher in the summer months, duration of high flows was lower, and spring peak flows and flood conditions were reduced due to reservoir operation and management. Vegetation comparisons, including woody and herbaceous species in all strata of the forest stands at each site, indicated that the site immediately below Sam Rayburn Dam had greater species diversity, richness and evenness. The study concluded that the reduced flooding and moderation of stream flow variation created a more suitable habitat for plant growth and development. The dam created a more diverse and stable ecosystem in the downstream area (Chang and Crowley, 1997). Similar results could be expected to occur downstream of the Lower Bois d'Arc Creek Reservoir dam where the regulated flow regime would encourage channel bank stability and vegetative growth.

To assess the potential impacts from reduced overbanking events to the riparian vegetation along the downstream corridor, vegetative species were identified using the Habitat Evaluation Procedures (HEP) protocol and indicator species defined for the HEP survey of the proposed reservoir pool (FNI, 2007). A total of eight HEP points were collected in August 2009 as part of the downstream study. Both the species composition data from the 2007 HEP reservoir surveys and the downstream riparian corridor (2009) were used to establish a representative vegetative community assemblage for Bois d'Arc Creek. Each species' wetland indicator status (USDA-NRCS, Region 6) and anaerobic soil tolerance (USDA-NRCS 2010) were used as surrogates for flood tolerance. Table C-1 defines wetland indicator status with comments on occurrence, and Tables C-2 and C-3 identify HEP documented species by vegetative strata (i.e., trees, shrubs, and herbaceous) with wetland indicator status and anaerobic soil tolerance.

As described in Table C-1 wetland plant species except for obligates (OBL) can, to various degrees, grow in non-wetland conditions. Facultative species may occur equally in wetland or non-wetland conditions. The anaerobic tolerance of a species is also an indicator of a species' ability to grow in hydric soils, which can produce anaerobic (no free oxygen) conditions during periods of inundation. Non-wetland species actually have none to low tolerance of anaerobic soils conditions.

In the Bois d'Arc Creek downstream riparian corridor, the riparian woodland community is currently most similar to the forest cover type described as Sugarberry-American Elm-Green Ash (Society of Foresters; Allen et al., 2001). These woodlands are typically found at transitional elevations between poorly drained flats (e.g., overcup oak-water hickory stands) and well-drained ridges (e.g., sweetgum-willow oak stands). In total, one-third of the tree species are classified as facultative upland or upland species, suggesting a community prone to temporary rather than semi-permanent flooding. Every vegetative strata was dominated by facultative species (equally likely to occur in wetlands or uplands), and would be considered drought-tolerant.

Table C-1 Wetland Indicator Categories with Comments on Occurrence (USDA-NRCS, 2010)

Wetland Type	Indicator Code	Comment
Obligate Wetland	OBL	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
Facultative Wetland	FACW	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
Facultative	FAC	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
Facultative Upland	FACU	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).
Obligate Upland	UPL	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the project region. If a species does not occur in wetlands in any region, it is not on the National List of Plant Species that Occur in Wetlands..

Table C-2 Plant Species of the Bois d'Arc Creek Riparian Woodlands and Bottomland Hardwood Forest with Wetland Indicator Status and Anaerobic Soil Tolerance -2007 HEP Study at the Proposed Lower Bois d'Arc Creek Reservoir Site

Wetland Indicator Status	*TREES*			*SHRUBS*			*HERBACEOUS*		
	Observed Species	**Anaerobic Tolerance**	*% of Total*	**Observed Species**	**Anaerobic Tolerance**	*% of Total*	**Observed Species**	**Anaerobic Tolerance**	*% of Total*
OBL				Button Bush	High		Duckweed	High	
			0	Water Hickory	Medium	*10*	Sedge Species	Medium - High	*20*
FACW	Box-Elder	Medium		Box-Elder	Medium		Cherokee Sedge	--	
	Green Ash	Medium		Deciduous Holly	Medium		Frog Fruit	--	
	Black Willow	High		Green Ash	Medium				
				False Willow	High				
			33	Black Willow	High	*25*			*20*
FAC	Cedar Elm	None		Yaupon	None		Poison Ivy	--	
	Honey Locust	None		Cedar Elm	None		Virginia Wildrye	--	
	Sugarberry	Medium		Cottonwood	High		Virginia Creeper	Medium	
				Honey Locust	None		Ragweed	None	
				Poison Ivy	--		Inland Sea Oats	Medium	
				Ragweed	--		Trumpet Vine	None	
				Sugarberry	Medium				
			33	False Willow	--	*40*			*60*
FACU	Red Mulberry	Medium		Eastern Red Cedar	Low				
	Winged Elm	Low		Western Soapberry	None				
				Red Mulberry	Medium				
				Winged Elm	Low				
			22	Coral Berry	None	*25*			*0*
UPL	Bois d'Arc	None	*11*			*0*			*0*

Table C-3 Plant Species of the Bois d'Arc Creek Riparian Woodlands and Bottomland Hardwood Forest with Wetland Indicator Status and Anaerobic Soil Tolerance -Data Points Downstream of Proposed dam Site

Wetland Indicator Status	*TREES*		*SHRUBS*	
	Observed Species	**Anaerobic Tolerance**	**Observed Species**	**Anaerobic Tolerance**
OBL	Water Locust	Low		
FACW	Green Ash	Medium	Box-Elder	Medium
			Deciduous Holly	Medium
			Green Ash	Medium
FAC	Bur Oak	None	Cedar Elm	None
	Cedar Elm	None	Honey Locust	None
	Sugarberry	Medium	Northern Catalpa	None
			Roughleaf-Dogwood	
			Sugarberry	Medium
			Yaupon	None
FACU	Eastern Red Cedar	Low	Eastern Red Cedar	Low
			Western Soapberry	None
UPL	Bois d'Arc	None	Bois d'Arc	None

Several facultative upland species were found in adjacent upland areas (Table C-4) that were not found in the riparian woodlands and bottomland hardwood forests of Bois d'Arc Creek. Over time, if the downstream riparian corridor experiences a decline in facultative wetland species (e.g., green ash, box-elder, deciduous holly) there is potential to gain hardmast producing species (e.g., southern red oak, post oak, black cherry) from the adjacent uplands. An increase in these species will help to mediate faunal impacts and increase available habitat types.

Table C-4 Plant Species of the Lower Bois d'Arc Creek Upland Deciduous Forest with Wetland Indicator Status and Anaerobic Tolerance

Wetland Indicator Status	TREES			SHRUBS			HERBACEOUS		
	Observed Species	Anaerobic Tolerance	*% of Total*	Observed Species	Anaerobic Tolerance	*% of Total*	Observed Species	Anaerobic Tolerance	*% of Total*
OBL			*0*			*0*			*0*
FACW							Beggars Ticks	Medium	
			0	Green Ash	Medium	*6*	Cherokee Sedge	--	*10*
FAC	Cedar Elm	None		Common Persimmon	None		Alabama-Supplejack	--	
	Common Persimmon	None		Hawthorn	Medium - High		Blackberry		
	Honey Locust	None		Honey-Locust	None		Canada Wildrye	--	
	Sugarberry	Medium		Roughleaf-Dogwood	Low		Common Greenbriar	Low	
	Water Oak	Medium		Sugarberry	Medium		Dewberry	None	
							Grape Vine	--	
							Poison Ivy	--	
							Spike Uniola	--	
							Tick Seed	Medium	
							Tick Trefoil	Medium	
							Trumpet Creeper	None	
							Virginia Creeper	None	
							Virginia Wildrye	Medium	
			50			*31*		--	*65*
FACU	Black Cherry	None		American-Beautyberry	None		Carolina Snailseed	--	
	Eastern Red Cedar	Low		Black Cherry	None		Frostweed	--	
	Post Oak	Low		Coral Berry	None		Prickly Pear	--	
	Southern Red Oak	None		Eastern Red Cedar	Low		Yellow-Woodsorrel	--	
				Gum Bumelia	--				
				Post Oak	Low				
				Rusty Blackhaw	None				
				Winged Elm	Low				
			40	Yaupon Holly	None	*56*			*20*
UPL	Bois d'Arc	None	*10*	Eastern Redbud	None	*6*	Threeseed-Mercury	--	*5*

C-2.3 *Potential Effects on Downstream Fauna*

The integrated effects of impacts can lead to changes to the biological environment. These include potential impacts to species close to the top of the food chain (e.g., fish, birds, and mammals), and can be the result of direct habitat loss, reduced resource availability, or reduced habitat quality. In some cases, there have been noted increases in habitat availability and quality associated with the shift in riparian vegetation.

Wildlife species observed and habitat quality data collected during HEP surveys were used to characterize the current habitat conditions along Bois d'Arc Creek and to evaluate future conditions. In the HEP procedure, a set of evaluation species were selected by state and federal resource agency representatives and current habitat conditions were evaluated in light of the optimum habitat characteristics for these species (FNI, 2008). Habitat quality is expressed in terms of a Habitat Suitability Index (HSI), and ranges from 0.0 to 1.0 (i.e., unsuitable to suitable). This metric was used as a surrogate to estimate current habitat quality in accordance with HEP protocols.

Bois d'Arc Creek riparian woodland and bottomland hardwood evaluation species were the Barred Owl, Downy Woodpecker, Wood Duck, Fox Squirrel, and Raccoon (Table C-5). The 2007 HEP study indicated that the quality of riparian woodland and bottomland hardwood wildlife habitat was fairly poor, with HSI values ranging from 0.03 to 0.52 (Table C-6). The HEP study of the downstream sites conducted in 2009 indicated that these areas might also have poor quality habitat for all species except the downy woodpecker. The measured habitat characteristics used to assess habitat availability were compared to potential impacts associated with reduced overbanking flows. Table C-7 identifies these habitat characteristics and the associated predicted change represented as +/0/- (i.e., positive, neutral, or negative, respectively).

Based on the predicted changes to the downstream riparian corridor, habitat quality and availability are expected to increase. Improvements to wildlife habitat quality would result from the continued maturation of the forest within the current floodplain, and a potential shift in vegetative composition. Primary effects of a shift in vegetation might include: (1) increased hardmast producers, (2) decreased shrubs and herbaceous species (e.g., green ash), and (3) increased heterogeneity in canopy cover. In protected areas, such as the corridor through the Caddo National Grasslands, such a vegetative shift would expect to be minimal due to the existing closed canopy that limits seedbed areas. Areas where a vegetative shift would have the greatest potential impact are areas that could be disturbed by logging, fire, insects or disease. The combination of forest maturation and potential vegetative shift would increase resource availability, while providing habitat for nesting, foraging, and refugia. The proposed steady base flow releases will also provide permanent water for wildlife species.

Table C-5 Wildlife Species of the Bois d'Arc Creek Riparian Woodland and Bottomland Hardwood

Observed Species	Evaluation Species
Birds	
American Crow	Barred Owl
Barred Owl	Downy Woodpecker
Carolina Chickadee	Wood Duck
Carolina Wren	
Downy Woodpecker	
Hummingbird	
Indigo Bunting	
Mourning Dove	
Northern Cardinal	
Northern Parula	
Red-eyed Vireo	
Tufted Titmouse	
White-eyed Vireo	
Wood Duck	
Yellow-billed Cuckoo	
Mammals	
Beaver (chew marks)	Fox Squirrel
Hog (tracks)	Raccoon
Raccoon (tracks)	

Table C-6 Baseline habitat Suitability Index (HSI) Values of the Bois d'Arc Creek Riparian Woodland and Bottomland Hardwood

Evaluation Species	HSI Values	
	Reservoir	*Downstream*
Barred Owl	0.14	0.14
Downy Woodpecker	0.34	0.71
Fox Squirrel	0.03	0.1
Raccoon	0.52	0.26
Wood Duck	0.22	0.0

Table C-7 Predicted Changes in Quality of Habitat Variables Measured in the Downstream Portion of the Lower Bois d'Arc Creek Riparian Woodland / Bottomland Hardwood After Dam Construction

Evaluation Species	Habitat Characteristic	Potential Impact	Predicted Change
Barred Owl	Number of large trees	Growth with Age	+
	Average diameter of overstory trees	Growth with Age	+
	Canopy cover of overstory trees	Growth with Age	+
Downy Woodpecker	Basal area	Growth with Age	+
	Number of large snags	Reduced flooding	-
Fox Squirrel	Canopy closure of large trees that produce hard mast	Growth with Age	+
	Distance to available grain	Agricultural Production Not Expected	0
	Average diameter of overstory trees (inches)	Growth with Age	+
	Percent tree canopy closure	Growth with Age	+
	Percent shrub crown cover	Increased shrub/herbaceous mortality	+
Raccoon	Distance to water	Permanent base flows	+
	Water regime (Permanent, Semi-permanent, or Ephemeral)	Permanent base flows	+
	Overstory forest size class	Growth with Age	+
	Number of refuge sites	Increased Tree Mortality with Age	+
Wood Duck	Number of potentially suitable tree cavities	Increased Tree Mortality with Age	+
	Number of nest boxes (management tool)	-	+
	Percent of water surface covered by potential brood cover	Reduced inundation duration	-
	Percent of water surface covered by potential winter cover	Reduced inundation duration	-

C-3 CONCLUSIONS

Potential impacts to the downstream floodplain of Bois d'Arc Creek would likely be limited by several factors: (1) the existing community is not dependent upon overbank flow for reproduction and overall success. Many of the species along Bois d'Arc Creek riparian corridor are equally likely to occur in uplands; (2) the local site conditions (e.g., rainfall, soil type, and land cover) supplement floodplain inundation; (3) the proposed release of steady base flows should increase channel-groundwater connectivity and promote growth of streambank vegetation; (4) the reduction in highly erosive flows would allow the stream to aggrade over time increasing the potential for floodplain connectivity; and (5) contributing downstream hydrology provide instream flow and supplement floodplain connectivity. Certain aspects of the riparian corridor may even be improved as a result of the dam, including increased streambank stabilization, vegetation growth, and gain of hardmast producing woody species.

ATTACHMENT 2

Technical Memorandum on Downstream Flood Mapping of High Frequency Events

Lower Bois d'Arc Creek

Technical Memorandum on Downstream Flood Mapping of High Frequency Events Lower Bois d'Arc Creek

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TO: Project File

CC: Simone Kiel, P.E.

FROM: Patrick Miles, P.E.

SUBJECT: Lower Bois d'Arc Creek Reservoir
Downstream Flood Mapping for High Frequency Events

DATE: June 3, 2016

PROJECT: NTD06128

STATE OF TEXAS
JAMES PATRICK MILES II
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The purpose of this memorandum is to document the processes and results of recent updated hydraulic modeling downstream of the Lower Bois d'Arc Creek Reservoir (LBCR) Dam. Throughout the process of preparing permitting documents and designing the dam and appurtenant structures, Freese and Nichols has developed a suite of hydrologic and hydraulic models for Lower Bois d'Arc Creek and its overall watershed. These models represent flood events ranging from a one half-year return period up to the Probable Maximum Flood. For the purposes of the study documented by this memorandum, the modeling efforts focused on smaller, more frequent events characterized as the 2-year and 5-year events.

Precipitation Data

Precipitation depth-duration-frequency data was obtained from a combination of National Weather Service Technical Paper No. 40 (TP-40) and Technical Memorandum NWS HYDRO-35. The point rainfall data was adjusted by the areal reduction factors provided by TP-40, in order to account for the large drainage area of the total watershed. The table below presents the precipitation depths for given combinations of frequency event and duration. This data was input to the hydrologic model as a critically stacked, 24-hour rainfall distribution for each storm event.

Frequency Event	Precipitation Depth (inches)							
	5 min	15 min	60 min	2 hr	3 hr	6 hr	12 hr	24 hr
2-year	0.49	1.06	1.26	1.71	1.97	2.49	3.10	3.69
5-year	0.57	1.24	1.56	2.29	2.58	3.33	4.14	4.96

Hydrologic Model

The hydrologic model was compiled in HEC-HMS, Version 3.5, and consists of 11 drainage basins upstream of the dam site and 5 basins between the dam site and the confluence with the Red River. The model utilizes an initial and constant loss method based on soil parameters and the Snyder Unit Hydrograph method for runoff transformation. The model accounts for three existing reservoirs within the watershed: Lake Bonham, which is upstream of the dam site, and Coffee Mill Lake and Lake Crockett, which are located shortly downstream from the dam site. For the purposes of this study, the hydrologic model was not altered in any way from the existing model of previous studies.

Hydraulic Model

From previous studies, a one-dimensional hydraulic model was built in HEC-RAS, Version 4.1, representing the full length of Lower Bois d'Arc Creek from about 4 miles south of Bonham to the confluence with the Red River. For the purposes of this study, the existing one-dimensional model was utilized to route the upstream flow hydrographs to the location of the dam site. A new two-dimensional model was constructed in HEC-RAS, Version 5.0, representing the area from the dam site to the Red River confluence. The two-dimensional model is based on LiDAR topography data and able to more accurately depict the flow conditions of the downstream area and of specific interest to this study – low flows, out of banks, shallow floodplains, etc.

Boundary conditions for the two-dimensional model consist of lateral inflow hydrographs and downstream normal depth calculations. Inflow hydrographs were developed from the 5 downstream basins in the hydrologic model; however, the hydrographs were distributed by drainage area ratios along all the small tributaries to Lower Bois d'Arc Creek for a total of 22 lateral inflow locations. A separate boundary condition represents the hydrographs from upstream of the dam. For existing conditions, this simply represents the combined hydrograph for the upstream areas of the watershed. For with dam conditions, this hydrograph represents releases from the dam and/or spillway discharges. A constant base flow of 4,000 cfs was assumed on the Red River.

Model Run Scenarios

Four conceptual scenarios were developed for the model runs: *Existing Conditions*, *With Dam–No Spills*, *With Dam–Median Conditions,* and *With Dam–Spilling*. Each scenario is described in more detail in the following paragraphs:

Existing Conditions

This scenario represents the hydrology of existing conditions without any dam or impoundment in place. The upstream drainage area hydrographs are routed through Lower Bois d'Arc Creek via the existing one-dimensional model, as described previously.

With Dam–No Spills

This scenario represents the worst-case condition where the only flows out of the dam are the required environmental base flow releases, assumed to be a constant 3 cfs for the duration of the model run. Downstream runoff hydrographs from the uncontrolled drainage basins still provide flows to the downstream areas.

With Dam–Median Conditions

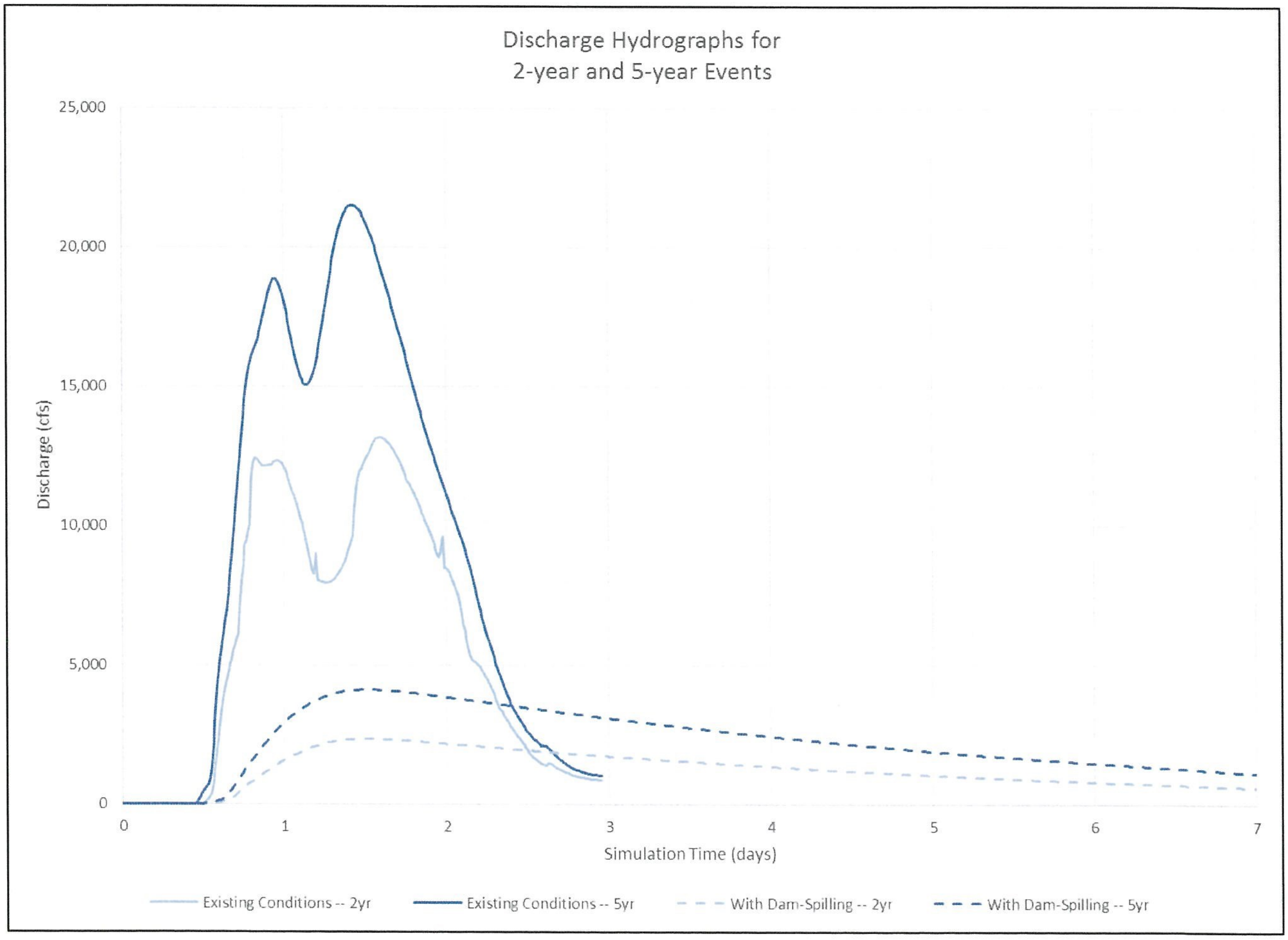
This scenario was not computed in the two-dimensional model because the reservoir would have sufficient storage capacity to contain a 5-year flood event. Based on water availability modeling, the median reservoir elevation is 529.6 feet-msl, corresponding to a storage volume of approximately 297,700 acre-feet. The spillway crest is set at a conservation pool elevation of 534.0 feet-msl, corresponding to a volume of 367,600 acre-feet. Therefore, the incremental storage volume is approximately 69,900 acre-feet. The total runoff volume produced by the 5-year flood hydrograph is approximately 53,700 acre-feet, which would not engage the spillway. By linear interpolation, any flood event that could produce spillway discharges when starting at the median pool level would have to exceed an approximately 12-year return period. The *Median Conditions* scenario produces the same inundation mapping as the *With Dam–No Spills* scenario.

With Dam–Spilling

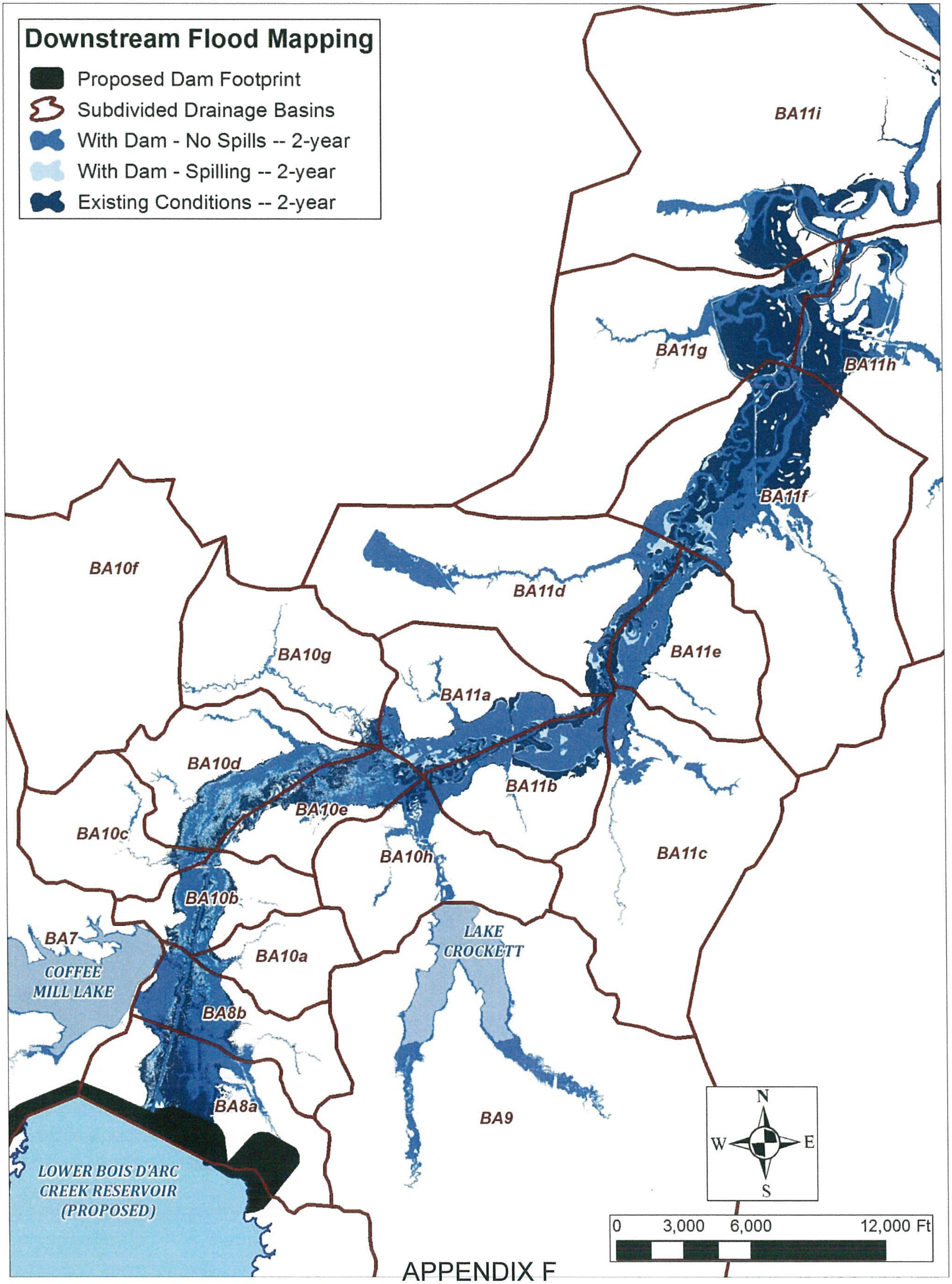
This scenario assumes the reservoir is at the conservation pool elevation of 534.0 feet-msl and any runoff event will produce discharges through the spillway. The minimum flow was also set to the same 3 cfs to represent minimum environmental base flows.

Downstream Flood Mapping Results

Each of these scenarios was computed for the 2-year and 5-year events. The flood mapping extents shown in the figures attached with this memorandum are being utilized in the assessment of impacts to downstream wetlands. For comparison purposes, discharge hydrographs calculated immediately downstream from the dam site are provided below, representing the *Existing Conditions* and *With Dam–Spilling* scenarios. Note the extended duration of flows in the *With Dam* condition, which is caused by the storage attenuation effects of the reservoir and labyrinth spillway. While the peak discharge decreases substantially, flows from the spillway remain in the system for a longer period of time.



The double peak shown in the *Existing Conditions* hydrographs simply represents timing delay as flows from the upper portions of the watershed are routed downstream. There is not a second peak in the rainfall applied to the model. The nature of the slow reservoir rise and gradual spillway discharges results in significant hydrograph dampening, such that the double peak is not apparent for the *With Dam–Spilling* scenario.


Downstream Flood Mapping
Proposed Dam Footprint
Subdivided Drainage Basins
With Dam - No Spills -- 2-year
With Dam - Spilling -- 2-year
Existing Conditions -- 2-year
BA11i
BA11g
BA11h
BA11f
BA10f
BA11d
BA11e
BA10g
BA11a
BA10d
BA11b
BA10e
BA10c
BA10h
BA11c
BA10b
BA7
LAKE CROCKETT
COFFEE MILL LAKE
BA10a
BA8b
BA8a
BA9
LOWER BOIS D'ARC CREEK RESERVOIR (PROPOSED)
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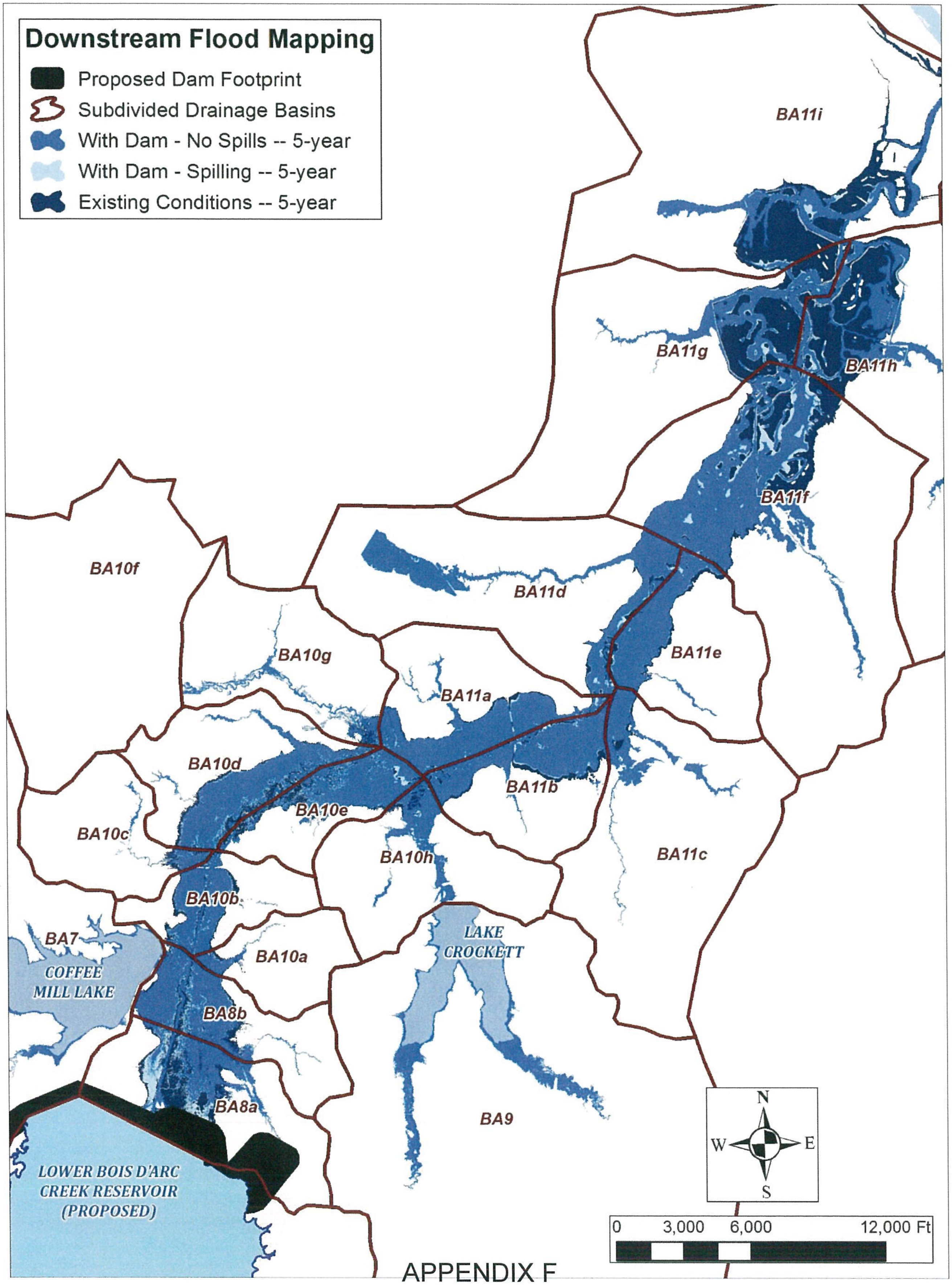
Downstream Flood Mapping
Proposed Dam Footprint
Subdivided Drainage Basins
With Dam - No Spills -- 5-year
With Dam - Spilling -- 5-year
Existing Conditions -- 5-year
BA11i
BA11g
BA11h
BA11f
BA10f
BA11d
BA11e
BA10g
BA11a
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BA10c
BA10h
BA11c
BA10b
BA7
LAKE CROCKETT
COFFEE MILL LAKE
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LOWER BOIS D'ARC CREEK RESERVOIR (PROPOSED)
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12,000 Ft

Technical Memorandum on Functional Assessment of Downstream Wetlands

MEMORANDUM

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TO: Robert McCarthy, NTMWD

CC: File, NTD06128

FROM: Stephen Novair, Simone Kiel

SUBJECT: Functional Assessment of Downstream Wetlands

DATE: October 27, 2016

PROJECT: Lower Bois d'Arc Creek Reservoir, NTD06128

Objective

The purpose of this memo is to discuss expected HGM subindex variable changes for the forested wetlands downstream of the proposed Lower Bois d'Arc Creek Reservoir (LBCR) after dam construction. This report draws on existing information to populate and implement the Hydrogeomorphic (HGM) Approach to assess potential changes in wetland functions downstream of the LBCR due solely to expected changes associated with the construction of the LBCR (FNI_1, 2016). It is assumed that changes associated with natural maturation of the wetlands would continue to occur for conditions with and without the dam in place.

Method

This study assumes that the forested wetlands downstream of the LBCR dam are analogous to the present conditions of the forested wetlands within the footprint of the reservoir because they are contiguous, part of the same drainage network, and have similar plant communities. Each subindex variable score (Table 1) used in the HGM model was estimated based on potential system changes to the assumed current conditions after 20 years that may be associated with the construction of the LBCR. Subindex variables that are not expected to be affected by the construction of the dam were not changed. These values were then used to compute the Functional Capacity Index (FCI) values (Table 2), and ultimately the potential functional impacts that may be attributed to the proposed LBCR project.

General System Changes

The change from a natural flow regime to a regulated flow regime on Bois d'Arc Creek is expected to create lower peak-flood discharges and less overbank flooding with longer flood durations. Flow regimes, including overbanking flows, along downstream tributaries will not change. With the proposed instream flow regime, the flow in Bois d'Arc Creek would also be more consistent. This means extended periods of no flow are expected to be fewer and the system will be less flashy. As discussed in the FNI downstream memorandum (FNI_2, 2016), there are multiple sources of hydrology to sustain wetland communities consisting of precipitation (which is not expected to change), overland flow (which is not expected to change), and subsurface groundwater (which may be enhanced). In general, land degradation from large flood events will become less frequent and water will be more readily available and consistent for use by the plant community. Lastly, the stream channel, which has been in a continuous state of degradation (average bank erosion rate of ~0.5 feet per year), is predicted to stop eroding and begin to aggrade. Over time this will reconnect the channel with the flood plain and raise the groundwater table. While this process will take longer than 20 years, previous studies show that this will lead to an enriched and more stable ecosystem.

Hydrologic and hydraulic modeling indicate that there will be changes in the aerial extent of the 5-year flood events. These changes are discussed in the FNI downstream memorandum (FNI_2, 2016). While it is expected that the hydrology to sustain the wetlands downstream of the dam will continue after construction, the sources of hydrology may shift for some areas. It is this shift in hydrology source and changes associated with specific subindex variables that were evaluated.

Results and Discussion

Subindex variables

Due to the different changes in hydrology across the study area after construction of the dam, the subindex variables were evaluated separately for following subareas: 1) area that will remain inundated under the 2-year flood, 2) area inundated under the 5-year flood but not under the 2-year flood, and 3) area not inundated under the 5-year flood. These subareas are based on the HEC-RAS (2-D) modeling with no spills from the reservoir. Many of the subindex variables remained the same for conditions with and without the dam. The following are brief descriptions of each subindex variables that changed and the reasoning for each chosen score.

Change in Frequency of Flooding (VFREQ) – The frequency of flooding during the growing season was evaluated by subareas. For the area that remains flooded under a 2-year flood event, it was assumed that there will be no changes in flood frequency, resulting in a subindex score of 1.0. For the subarea that is not flooded under a 2-year event, but is flooded under a 5-year event, the VFREQ has a subindex score of 0.40, which reflects a change in frequency of 3 years. For the area that is not flooded under a 5-year flood, VFREQ was assumed to be not applicable.

Change in Growing Season Flood Duration (VDUR) – This variable was also evaluated by subarea. Flood duration in the Bois d'Arc Creek watershed for a single event typically is 2 to 3 days (based on HEC-RAS modeling). This is characteristic of the flashy nature of the existing system. Therefore, while there is expected to be changes in some areas for flood frequency, the duration of a single flood event is expected to remain the same. For the area with no change in flood frequency and the incremental area flooded under the 5-year event, it was assumed that the flood duration would be the same and the VDUR would be 1.0. For the area that is not flooded under a 5-year flood, VDUR was assumed to be not applicable.

O-Horizon Organic Accumulation (VOHOR) – The current VOHOR is assumed to be 0 cm (score of 0.20). The East Texas HGM Guidebook indicates 1 cm O-horizon is generated in 20 years for typical hardwood forests. In addition to continual deadwood decomposition and less frequent erosive flood events, O-horizon soils should increase after reservoir construction. The O-horizon was assumed to be the same for wetlands within the 2-year flood. For those inundated every 5 years, it was increased to 0.5 cm, and 0.8 cm for the areas no longer inundated from overbanking flows.

Litter Cover (VLITTER) – The current VLITTER is 57% (score of 0.92). The HGM Guidebook indicates approximately 80% litter cover for typical hardwood forests. It is expected that with reduced scouring of high flow events downstream, the litter cover would increase. VLITTER was assumed to be the same for wetlands within the 2-year flood. For those inundated every 5 years, it was increased to 65% (score of 1.00), and 80% (score of 1.00) for the areas no longer inundated from overbanking flows.

Table 1. Assumed Current and Projected HGM Subindex Scores

Subindex Variables in the Modified East TX HGM Model	Assumed Current Score	20 Year Projection Score by Subarea with LBCR		
		2-yr Flood	*5-yr Flood*	*>5-yr Flood*
Change in Growing Season Flood Duration (VDUR)	1.00	1.00	1.0	NA
Change in Frequency of Flooding (VFREQ)	1.00	1.00	0.40	NA
Total Ponded Area (VPOND)	1.00	1.00	1.00	1.00
Composition of Overstory Vegetation (VTCOMP)	0.70	0.70	0.70	0.70
Number of Vegetation Strata (VSTRATA)	1.00	1.00	1.00	1.00
Snag Density (VSNAG)	1.00	1.00	1.00	1.00
Tree Basal Area (VTBA)	1.00	1.00	1.00	1.00
Log Volume (VLOG)	1.00	1.00	1.00	1.00
Forest Patch Size (VPATCH)	1.00	1.00	1.00	1.00
Ground Vegetation Cover (VGVC)	1.00	1.00	1.00	1.00
Shrub-Sapling Density (VSSD)	0.88	0.88	0.88	0.88
Tree Density (VTDEN)	0.81	0.81	0.81	0.81
O-Horizon Organic Accumulation (VOHOR)	0.20	0.20	0.52	0.71
Litter Cover (VLITTER)	0.92	0.92	1.00	1.00
Woody Debris Biomass (VWD)	1.00	1.00	1.00	1.00
Composition of Tallest Woody Stratum (VCOMP)	0.70	0.70	0.70	0.70
Soil Integrity (VSOIL)	1.00	1.00	1.00	1.00

Table 2. Expected Future Functional Capacity Indices (FCI) for Downstream Wetlands

		Expected Future FCI		
Function	**Existing FCI**	**2-Yr Flood**	**5-Yr Flood**	**>5-Yr Flood**
Area (Acres)	*1,852*	*954*	*541*	*357*
Detain Floodwater	0.92	0.92	0.37	Not Assessed
Detain Precipitation	0.78	0.78	0.88	0.93
Cycle Nutrients	0.85	0.85	0.90	0.93
Export Organic Carbon	0.87	0.87	0.37	Not Assessed
Maintain Plant Communities	0.90	0.90	0.90	0.90
Provide Habitat for Fish/Wildlife	0.86	0.86	0.87	0.94
Average	**0.86**	**0.86**	**0.715**	**0.925**
Functional Capacity Reduction (FCU)	-	**0**	**78.4**	**0**

References

Votaw, M. (2016, June 22). Functional Assessment of Forested Wetlands at the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM. *Freese and Nichols, Inc.*

Waters, S., & Kiel, S. (2016, June 3). Assessment of Potential Impacts of Wetlands Downstream of LBCR. *Freese and Nichols, Inc.*

Appendix G

May 27, 2014, Lower Bois d'Arc Creek Littoral Zone/Fringe Wetland Development Technical Memorandum

Technical Memorandum on Lower Bois d'Arc Creek Littoral Zone/Fringe Wetland Development

MEMORANDUM

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TO: Simone Kiel, P.E.

CC: Steve Watters, PWS; Randall Howard

FROM: Michael Votaw, CWB, PWS

SUBJECT: Lower Bois d'Arc Creek Littoral Zone/Fringe Wetland Development

DATE: 5/27/2014

PROJECT: NTD06128 – Lower Bois d'Arc Creek Reservoir

Introduction

On May 14-15, 2014, environmental scientists with Freese and Nichols, Inc. (FNI) conducted pedestrian surveys along the lake margins of five reservoirs located in Northeast Texas. Reservoirs surveyed were Cooper Reservoir, Pat Mayse Reservoir, Lake Bonham, Coffee Mill Lake, and Davy Crockett Reservoir (Figure 1). These reservoirs were selected based on their proximity to the proposed Lower Bois d'Arc Creek reservoir site. The purpose of the survey was to identify plant species that occur within the littoral zone/fringe wetlands along the margins of these reservoirs in order to better predict the species expected to develop within the littoral zone/fringe wetland areas of the proposed Lower Bois d'Arc Creek Reservoir. An additional purpose of this investigation was to evaluate the expected plant response during extended periods of low water elevations within the reservoir (i.e., below 530 ft. msl).

Results

All five of the reservoirs that were surveyed had developed functioning littoral zone/fringe wetlands along their shorelines that extended for some distance into the reservoir pool. These littoral zone/fringe wetlands showed high plant diversity with over 49 different species of plants being observed. Species observed at each reservoir during the survey are listed in Table 1. This list is not meant to be comprehensive and it is only representative of the species that were readily observable/identifiable at the locations that were surveyed. Photographs of the littoral zone/fringe wetlands observed at each of these reservoirs are located in Attachment 1. Species that were observed most frequently at the reservoirs that were surveyed include soft rush and other rush species, obedient plant, frog fruit, cattail, goldenrod, several species of smartweed, winter bentgrass, black willow, buttonbush, and a variety of different sedge and dock species.

Based on the results of the pedestrian survey, it is likely that a wide variety of plant species would develop within the littoral zone/fringe wetland areas of the proposed Lower Bois d'Arc Creek Reservoir. Although it is not possible to predict exactly which species will establish within the littoral zone/fringe wetland areas around the proposed Lower Bois d'Arc Creek Reservoir, many of the species identified above and within Table 1 would likely be present.

Table 1. Plant Species Identified within the Littoral Zone/Fringe Wetlands of Five Reservoirs in Northeast Texas.

Reservoir	Cooper	Pat Mayse	Bonham	Coffee Mill	Davy Crockett
Species					
Ravenfoot sedge (*Carex crus-corvi*)	●				
Sedge (*Carex* spp.)	●		●	●	
Buttonbush (*Cephalanthus occidentalis*)	●	●	●	●	●
Curly dock (*Rumex crispus*)	●	●	●		
Winter bentgrass (*Agrostis hyemalis*)	●	●	●		
Goldenrod (*Solidago* spp.)	●	●	●		●
Rush (*Juncus* spp.)	●	●	●	●	●
Blackberry (*Rubus* sp.)	●				
Smartweed (*Polygonum* spp.)	●	●	●		●
Balloonvine (*Cardiospermum halicacabum*)	●				
Loosestrife (*Lythrum* sp.)	●				
Eastern baccharis (*Baccharis halimifolia*)	●	●			
Black willow (*Salix nigra*)	●	●	●	●	●
Spiny aster (*Chloracantha spinosa*)	●				
Stickywilly (*Galium aparine*)	●				
Cattail (*Typha* sp.)		●	●		●
California Bulrush (*Schoenoplectus californicus*)			●		●
Water primrose (*Ludwigia peploides*)			●		
Frog fruit (*Phyla nodiflora*)		●	●		●
Ovate false fiddleleaf (*Hydrolea ovata*)			●		
Mock bishopweed (*Ptilimnium nuttallii*)			●		

Reservoir	Cooper	Pat Mayse	Bonham	Coffee Mill	Davy Crockett
Golden alexanders (*Zizia aurea*)			●	●	
Vine mesquite (*Panicum obtusum*)		●	●		
Obedient plant (*Physostegia virginiana*)		●	●	●	●
Beaksedge (*Rhynchospora* spp.)			●		
Texas toadflax (*Nuttallanthus texanus*)			●		
Rabbitsfoot grass (*Polypogon* sp.)			●		
Barnyardgrass (*Echinochloa crus-galli*)					●
Lotus (*Nelumbo lutea*)				●	●
Soft rush (*Juncus effuses*)	●	●		●	●
Buttercup (*Ranunculus* sp.)					●
Morning-glory (*Ipomoea* sp.)			●		●
Bald cypress (*Taxodium distichum*)					●
Spikerush (*Eleocharis* spp.)		●			●
False indigo bush (*Amorpha fruticosa*)					●
Water willow (*Justicia americana*)				●	●
Common selfheal (*Prunella vulgaris*)				●	
American pondweed (*Potamogeton nodosus*)				●	
Water hemlock (*Cicuta maculata*)				●	
Florida paspalum (*Paspalum floridanum*)				●	
Arrowhead (*Sagittaria* sp.)				●	
Green ash (*Fraxinus pennsylvanica*)		●		●	
Common duckweed (*Lemna minor*)				●	

Reservoir	Cooper	Pat Mayse	Bonham	Coffee Mill	Davy Crockett
Giant cutgrass (*Zizaniopsis miliacea*)		●			
Maidencane (*Panicum hemitomon*)		●			●
Ironweed (*Vernonia* sp.)		●	●		
Common marshmallow (*Althaea officinalis*)		●			
River birch (*Betula nigra*)		●			
Pennywort (*Hydrocotyle* sp.)		●			

Plant Response to Extended Periods of Low Water Levels

As described in the Mitigation Plan for the proposed Lower Bois d'Arc Creek Reservoir, littoral zone/fringe wetlands are expected to develop in locations three feet deep or less (between elevations 531-534 ft. msl) within the reservoir. The time it will take for these wetlands to develop is unknown, but it is estimated to take two to three years following inundation. These wetlands would most likely develop in broad, shallow areas and in coves where tributaries flow into the reservoir. It is estimated that approximately 1,402 acres of these littoral zone/fringe wetlands would develop and provide on-site mitigation.

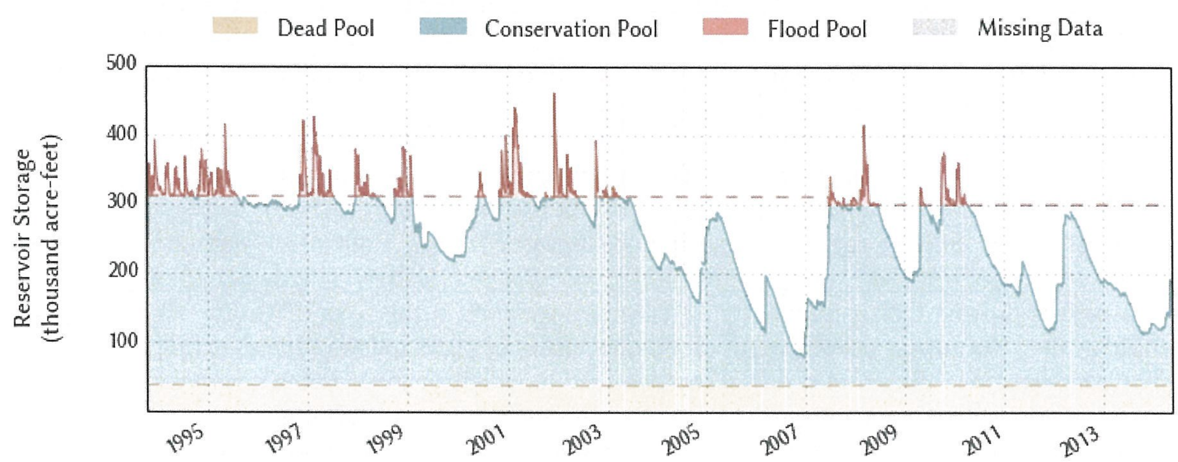
Wetlands, contrary to their name, do not always contain water. Many seasonal and temporary wetlands experience periods of drought at some point in time. Such wetlands tend to flood or recharge during winter months and will hold water into spring or early summer before drying out in the hot summer months (http://www.ducks.org/media/Conservation/GLARO/_documents/_library/_landowner/Landowner_Guide.pdf). This is a natural process that is frequently observed in wetlands in this area of Texas. These wet/dry cycles are beneficial as they discourage development of a monoculture of plant species such as cattail and bulrush. Another benefit of this wet/dry cycle is that it encourages seed production from many of the emergent wetland plant species. In fact, many wetlands that have capacity for water-level control are managed in such a way that they are drawn down during the spring, specifically to maximize seed production from native annual plants (http://www.ducks.org/conservation/habitat/conservation-private-marsh-management). This seed production not only establishes a seed bank in the wetland sediment, it also serves as a food source for many species of waterfowl and other seed-eating wildlife species.

If low water levels (i.e., below 530 ft. msl) within the proposed Lower Bois d'Arc Creek Reservoir persist for an extended period, it is likely that some of the plant species present in these wetlands might go dormant or possibly die, especially those species that are dependent on being submerged or inundated. However, other plant species that are not dependent on being submerged or inundated would likely survive and persist. This is expected as a result of Fannin County having a total annual precipitation of approximately 44 inches (http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/texas/TX147/0/Fannin.pdf), which would likely provide ample moisture for many of the plant species listed in Table 1 to survive within the littoral zone/fringe wetland areas of the reservoir once they become established.

Such persistent low water conditions were observed at both Pat Mayse Reservoir and Cooper Lake during the current field survey. Both of these reservoirs have been below their conservation pool elevations for extended periods of time as a result of the ongoing drought in this area of Texas. Within the littoral zone/fringe wetlands observed at these reservoirs, species such as cattail and smartweed were dormant or dead, while other species such as button bush, ironweed, goldenrod, as well as a variety of different species of sedges and rushes were alive. It is expected that once water levels rise in these reservoirs (i.e., return to their conservation pool elevations) and these littoral zone/fringe wetlands become inundated again, the plants in these areas that have died or gone dormant would respond by breaking dormancy, re-sprouting from root systems, or developing from the seed bank in the wetland sediment.

This expected response is reinforced by looking at reservoir storage for Cooper Lake from 1995 to present (Graphic 1) and relating that back to what was observed at the reservoir during the current field survey. According to Graphic 1, persistent low water conditions have occurred at Cooper Lake several times, including recently. However, during the current field survey, many plants were observed within the littoral zone/fringe wetlands that were living, even though they were not submerged or inundated. The same, or similar conditions, are expected to occur within the proposed Lower Bois d'Arc Creek Reservoir.

Graphic 1. Cooper Lake Reservoir Storage from Approximately 1995-Present.



http://waterdatafortexas.org/reservoirs/individual/jim-chapman

In summary, it is expected that Lower Bois d'Arc Creek Reservoir will develop the same or similar conditions within the littoral zone/fringe wetlands that were observed at the five reservoirs surveyed in this study. It is likely that a wide variety of different plant species would establish within the littoral zone/fringe wetlands that would develop around the proposed Lower Bois d'Arc Creek Reservoir. It is also likely that there will be extended periods of low water levels within Lower Bois d'Arc Creek Reservoir that will preclude constant inundation of these wetlands. However, this "drying out" is expected to increase plant diversity by discouraging development of a monoculture of plant species such as cattail and bulrush.

ATTACHMENT A

PHOTOGRAPHS

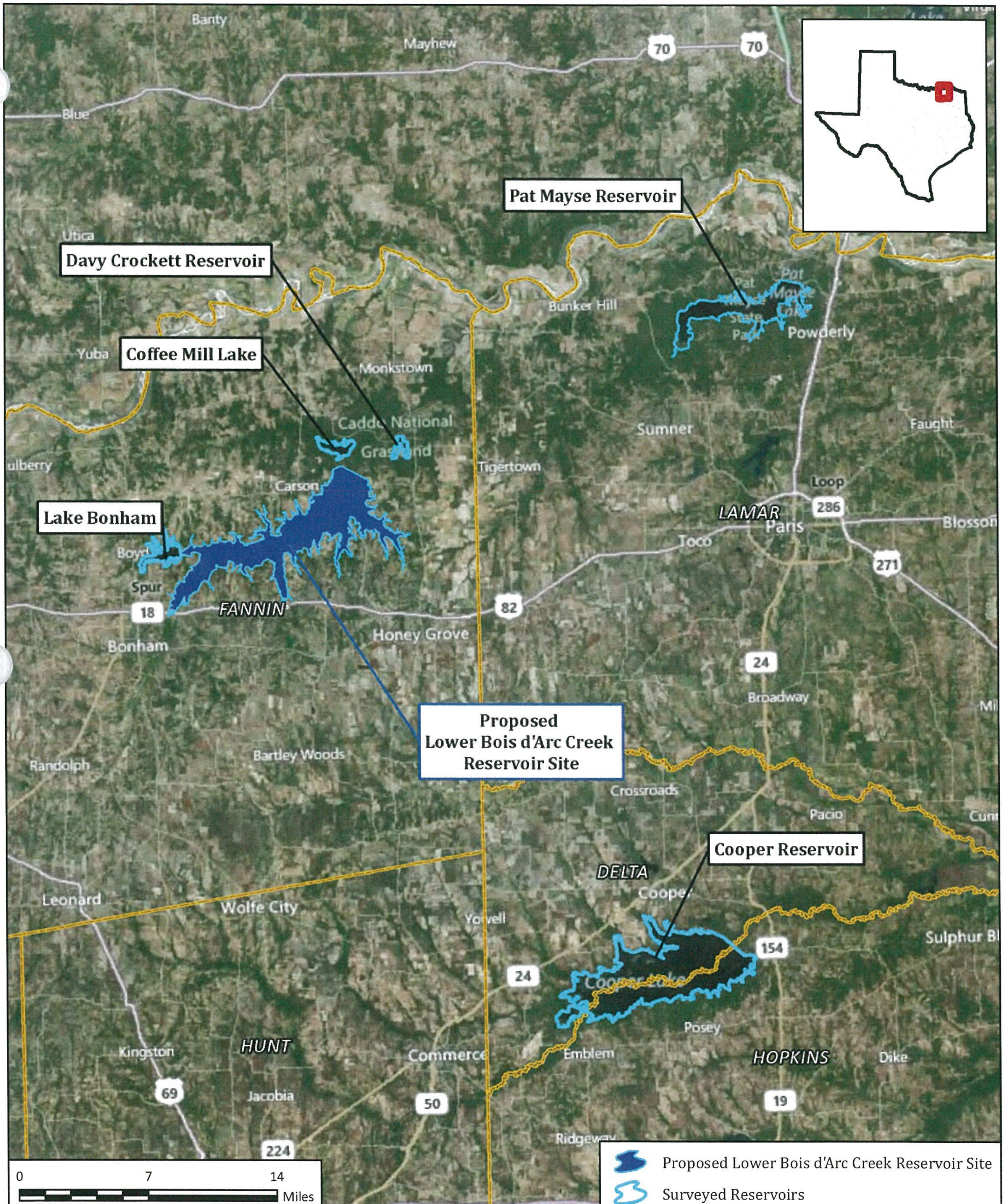
Photo 1. View of littoral zone/fringe wetland area at Pat Mayse Reservoir.

Photo 2. View of littoral zone/fringe wetland area at Lake Bonham.

Photo 3. View of littoral zone/fringe wetland area at Coffee Mill Lake.

Photo 4. View of littoral zone/fringe wetland area at Cooper Lake.

Photo 5. View of littoral zone/fringe wetland area at Davy Crockett Reservoir. Photograph shows fringe wetland regrowth after being dewatered and burned as part of the USFS's management program.



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N W E S

NTMWD

Lower Bois d'Arc Creek Reservoir

Littoral Zone/Fringe Wetland Reservoir Survey

FN JOB NO	NTD06128
FILE NAME	Regional_Reservoirs.mxd
DATE	5/27/2014
SCALE	1:450,000
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DRAFTED	ssj

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FIGURE

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APPENDIX G

Appendix H

May 13, 2011, Response to TCEQ Request for Information, Attachment F, *Impacts to Terrestrial and Riparian Habitats*

ATTACHMENT F

Impacts to Terrestrial and Riparian Habitats

The North Texas Municipal Water District has provided evaluations of the impacts of the proposed Lower Bois d'Arc Creek Reservoir to the Commission through supplemental reports to the water right application and supporting documents to the Section 404 permit application. A list of these reports and associated relevant sections is provided at the end of this attachment. The following discussions are compilations of data analyses and evaluations that have been previously reported. New and/or changed information in this attachment includes an updated list of threatened and endangered state-listed species in Fannin County and a comparative map of the 100-year floodplain with and without the proposed reservoir (Figure F-1).

DIRECT IMPACTS OF PROJECT

The proposed Lower Bois d'Arc Creek reservoir will impact approximately 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 habitat types and acreages found within the reservoir site are shown in Table F-1. The habitat suitability indices by cover type are shown in Table F-2.

Table F-1
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**

Source: Table 3-4, *Environmental Report Supporting an Application for a Section 404 Permit,* FNI, 2008.

Table F-2
Habitat Suitability Indices 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**

Source: Table 12, Appendix D, "Habitat Evaluation procedure (HEP) Report for the Lower Bois d'Arc Creek Reservoir", *Environmental Report Supporting an Application for a Section 404 Permit,* FNI, 2008

Terrestrial Impacts:

Of the total 17,068 acres impacted by the construction of the proposed lake, approximately 16,762 acres are vegetated by terrestrial vegetation. This includes existing wetlands. Based on an inter-agency Habitat Evaluation Procedure study conducted at the reservoir site, these acreages represent 7,494 habitat units. With the construction of the reservoir, these habitat units will convert to aquatic habitats with approximately 2,150 acres of emergent wetlands created along the shores of the proposed reservoir (based on a 5-foot water level fluctuation). Terrestrial wildlife within the project area will likely relocate to nearby areas and new aquatic wildlife will develop within the project area.

The U.S. Fish and Wildlife Services lists one species occurring or potentially occurring in Fannin County as either threatened or endangered: least tern (endangered). The bald eagle, which was previously federally listed as threatened, has been recently delisted as recovered and being monitored for the first five years.

The Texas Parks and Wildlife Department (TPWD) also lists eleven additional terrestrial species as endangered or threatened with statewide extinction that are considered to potentially occur in Fannin County. Protections for state-listed species are limited to direct takings such as capture, trapping or killing. Incidental takings, such as destruction of habitats, are not prohibited. A list of the state listed species is shown on Table F-3. Based on the studies conducted at the site, no threatened or endangered terrestrial species are expected to be adversely affected by the proposed project.

Table F-3

State-Listed Threatened and Endangered Terrestrial Species in Fannin County

	Species	State Status	Description of Suitable Habitat
Birds	American Peregrine Falcon *Falco peregrinus anatum*	E	Found in open country habitats, including tundra, mountainous and coastal areas, and marshes; usually near water. Also in open forested areas. Cliffs are used for nest sites.
	Peregrine Falcon *Falco peregrinus*	T	Nests in tundra regions; migrates through Texas; winter inhabitant of coastlines. Subspecies *anatum* is a resident breeder in W. Texas. Open areas, usually near water.
	Bald Eagle *Haliaeetus leucocephalus*	T	Nests and winters near rivers, lakes and along coasts; nests in tall trees or on cliffs near large bodies of water.
	Eskimo Curlew *Numenius borealis*	E	Found in tundra habitats, and in grasslands, pastures, or plowed fields; may also frequent marshes or mudflats.
	Interior Least Tern *Sterna antillarum athalassos*	E	Nests along sand and gravel bars within braided streams and rivers; also known to nest on man-made structures.
	Piping Plover *Charadrius melodus*	T	Wintering migrant along Texas Gulf coast; nests near beaches and bayside mud or salt flats.
	Whooping Crane *Grus americana*	E	Potential migrant via plains throughout most of Texas to coast; winters in coastal marches of Aransas, Rufugio and Calhoun counties
	Wood Stork *Mycteria americana*	T	Forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds; breeds in Mexico and birds move into the Gulf states in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960.
Reptiles	Texas Horned Lizard *Phrynosoma cornutum*	T	Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; sandy to rocky soil.
	Timber/Canebrake Rattlesnake *Crotalus horridus*	T	Swamps, floodplains, upland woodlands, riparian zones, abandoned farmland; prefers dense ground cover, i.e. grapevines or palmetto.
Mammals	Black Bear *Ursus americanus*	T	The Louisiana black bear is a habitat generalist and often overwinters in hollow cypress trees either in or along sloughs, lakes, or riverbanks in bottomland habitats. Constituent elements of black bear habitat include hard and soft mast, escape cover, denning sites, corridor habitats, and some freedom from disturbance by man.
	Red Wolf *Canis rufus* (extirpated)	E	Formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies. It appears that in Texas, red wolves are now extinct.

T – State-Listed Threatened E – State-Listed Endangered

Riparian Impacts

For this discussion, direct impacts to riparian habitats include impacts to streams and channels within and adjacent to the project site. Within the proposed reservoir site boundaries, all perennial and intermittent streams will be lost due to inundation of the proposed site by waters forming the Lower Bois d'Arc Creek Reservoir. It is estimated that approximately 123.3 miles of perennial and intermittent streams will be inundated. (It should be noted that a segment of Bois d;Arc Creek is listed by TCEQ as perennial, but there are anecdotal records that show there is no flow in this stream segment for extended periods of time.) 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 backwater of the lake. Tributary streams will become more stable as bank cutting and instability is reduced due to lower head differentials with impounded water in the lake.

The change from lotic (river) to lentic (lake) habitat will shift the present species composition toward more pool-associated species. Based on the fish assemblages found during the instream flow study, Lower Bois d'Arc Creek Reservoir would probably be characterized by combinations of red shiner, longear sunfish, bullhead minnow, logperch, and orange spotted sunfish as the dominant species. Other common fish expected in the proposed Lower Bois d'Arc Creek Reservoir would include gizzard shad, threadfish shad, bluegill, and redear sunfish. The few fluvial species identified during the instream flow study would likely relocate to the downstream corridor and be supported by instream flow releases.

The dominant 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 proposed 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. Over time new species, such as flathead catfish, blue catfish, striped bass, white bass, 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.

No detrimental impacts to mussel species resulting from the construction of the proposed Lower Bois d'Arc Creek Reservoir project are expected to occur. According to available literature, it appears that all species identified during site visits can and do adapt to life in a lake environment. (Howells et al, 1996 and Roe, 2002)

There are no federally listed threatened or endangered aquatic species within the Bois d'Arc Creek watershed. The state has listed five fish species and one aquatic reptile as threatened which are shown on Table F-4. No mollusks known to occur or potentially occur in Fannin County have been listed as threatened or endangered.

INDIRECT IMPACTS OF PROJECT

Indirect impacts include direct or associated actions of the project that potentially impact habitat upstream, adjoining, and downstream of the project site.

Terrestrial and Riparian Habitats

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 would likely result in additional habitat loss to adjacent upland habitats. These developments would likely have occurred without the project, but may occur sooner with the reservoir in place. It is proposed that the development around the lake will be controlled and monitored by a county agency. The NTMWD is purchasing property to the spillway elevation of 541 ft msl and purchasing a flowage easement to elevation 545 ft. Restrictions on development in these zones will provide added protections to the terrestrial habitats around the lake.

Table F-4

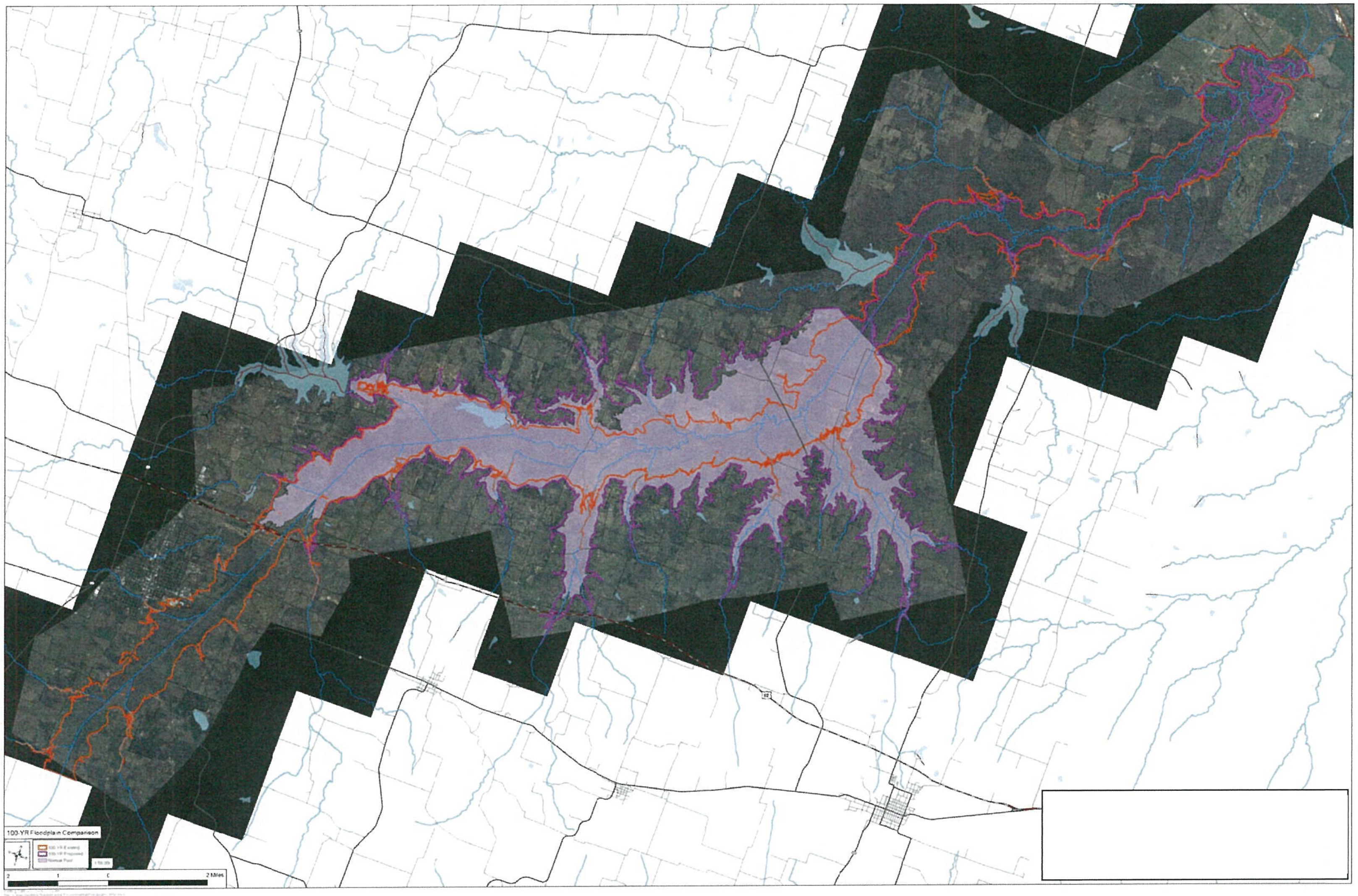
State-Listed Threatened and Endangered Aquatic Species in Fannin County

	Species	State Status	Description of Suitable Habitat
Reptiles	Alligator Snapping Turtle *Macrochelys temminckii*	T	Deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October.
Fishes	Blackside Darter *Percina maculata*	T	Clear, gravelly streams; prefers pools with some current, or even quiet pools, to swift riffles.
	Blue Sucker *Cycleptus elongatus*	T	Usually inhabits channels and flowing pools with a moderate current; bottom type usually consists of exposed bedrock, perhaps in combination with hard clay, sand, and gravel; adults winter in deep pools and move upstream in spring to spawn on riffles.
	Creek Chubsucker *Erimyzon oblongus*	T	Small rivers and creeks of various types; seldom in impoundments; prefers headwaters, but seldom occurs in springs; young typically in headwater rivulets or marshes; spawns in river mouths or pools, riffles, lake outlets, upstream creeks.
	Paddlefish *Polyodon spathula*	T	Prefers large, free-flowing rivers, but will frequent impoundments with access to spawning sites; spawns in fast, shallow water over gravel bars; larvae may drift from reservoir to reservoir.
	Shovelnose Sturgeon *Scaphirhynchus platorynchus*	T	Open, flowing channels with bottoms of sand or gravel; spawns over gravel or rocks in an area with a fast current; never more than a rare occurrence in Rio Grande.

T – State-Listed Threatened

As part of the instream flow study, habitat evaluations of the downstream corridor were conducted. The discussion of these results and findings is included in Appendix C of the *Instream Flow Study Supplemental Data* (FNI, 2010). This study evaluated stream hydrology with the proposed instream flow regime, geomorphic processes, and fauna in the downstream riparian corridor and adjacent terrestrial habitats. Impacts to the habitats downstream of the reservoir are expected to be minimal due to several factors: (1) the existing community is not dependent upon overbank flow for reproduction and overall success. Many of the species along Bois d'Arc Creek riparian corridor are equally likely to occur in uplands; (2) the local site conditions (e.g., rainfall, soil type, and land cover) contribute to floodplain inundation; (3) the proposed release of continuous base flows should increase channel-groundwater connectivity and promote growth of streambank vegetation; (4) the reduction in highly erosive flows would allow the stream to aggrade over time increasing the potential for floodplain connectivity; and (5) downstream hydrology will continue to contribute to instream flow and supplement floodplain connectivity. Certain aspects of the riparian corridor may even be improved as a result of the dam, including increased streambank stabilization, vegetation growth, and gain of hardmast producing woody trees.

Flood studies conducted in support of this project found that 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. The study results found that the reservoir did not increase water levels upstream of the Highway 82 bridge for the simulated 10-, 50-, 100- or 500-year flood events. The hydrologic modeling shows that flood levels decrease immediately downstream of the dam, and then return to existing levels without the project within about one mile downstream of the dam. Figure F-1 shows the comparison of the 100-year floodplain with and without the proposed reservoir.


100-YR Floodplain Comparison
100-YR Existing
100-YR Proposed
Normal Pool
2 1 0 2 Miles

APPENDIX H

PREVIOUS STUDIES SUBMITTED TO TCEQ

The direct and indirect impacts associated with the inundation of the proposed reservoir are discussed in more detail in the following reports:

Wtr Rt Report	*Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir*, 2 volumes, submitted to TCEQ on December 29, 2006
404 Report	*Environmental Report, Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir*, submitted to TCEQ water rights permitting section on October 8, 2008
JD Report	*Section 404 Permit Application and Jurisdictional Determination Report*, submitted to TCEQ water rights permitting section on October 8, 2008
IFS	*Instream Flow Study Report for the Proposed Lower Bois d'Arc Creek Reservoir, May 2010.* Submitted to USACE and Cooperating agencies on May 27, 2010. Submitted to TCEQ on June 1, 2010.
Supplemental IFS	*Instream Flow Study Supplemental Data, September 2010,* Submitted to USACE and cooperating agencies on September 17, 2010. Submitted to TCEQ on September 23, 2010.

Topic of Interest Regarding Impacts to Terrestrial and Riparian Habitats:

Water Quality Study	Chapter 4.4 and Appendix H *Wtr Rt Report* *IFS*, Main Report and Appendix E
Wetlands Delineation	*JD Report, JD Pipeline Realignment, JD WTP*
(discussions)	Chapters 3.3.2, 5.3.2, *404 Report*
Baseline Habitat Evaluation	Chapter 3.4 and Appendix D, *404 Report,* *IFS, Supplemental IFS*
Geomorphic Assessment of Bois d'Arc Creek	*RGA*, Chapter 3.3.2, *404 Report;* *IFS, Supplemental IFS*
Flooding Studies	Chapters 3.3.1, 4.3.1 and 5.3.1 and Appendix A, *404 Report*
Instream Flow Assessment	*IFS, Supplemental IFS.*
Downstream Impacts	*Supplemental IFS*, Appendix C

References:

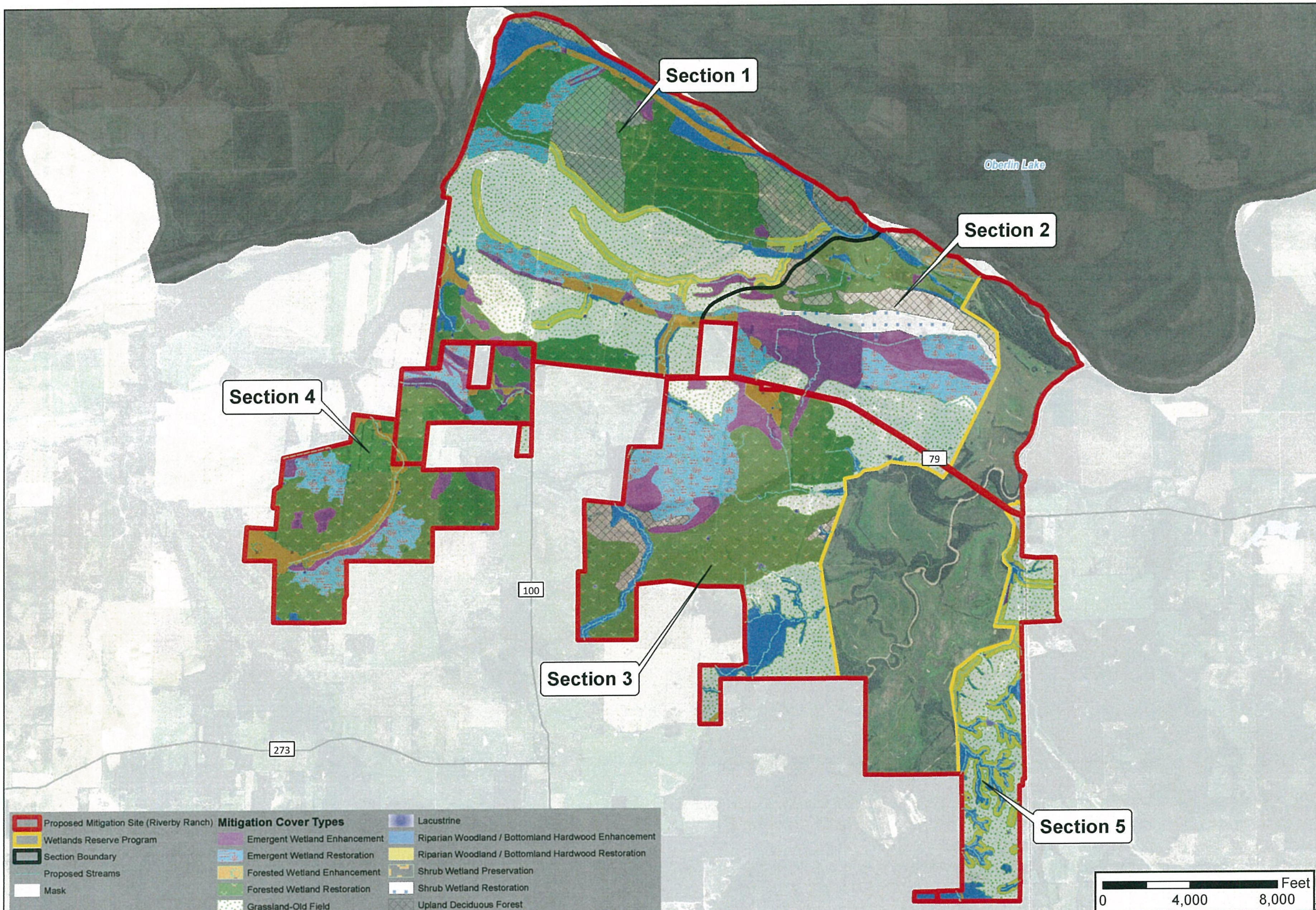
Howells, R.G., et al. 1996. Freshwater Mussels of Texas. Texas Parks and Wildlife Press. Austin, Texas.

Roe, Kevin J. 2002. Conservation Assessment for the Yellow Sandshell (*Lampsilis teres*). USDA Forest Service, Region 9. Saint Louis, MO.

Texas Parks and Wildlife Department, Annotated County Lists of Rare Species, downloaded from http://www.tpwd.state.tx.us/landwater/land/maps/gis/ris/endangered_species, May 2011.

Appendix I

Typical Plans and Details for Aquatic Mitigation



North Texas Municipal Water District

Riverby Ranch Mitigation Site
Cover Type Map

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

FIGURE
I.1

F&N JOB NO	NTD06128
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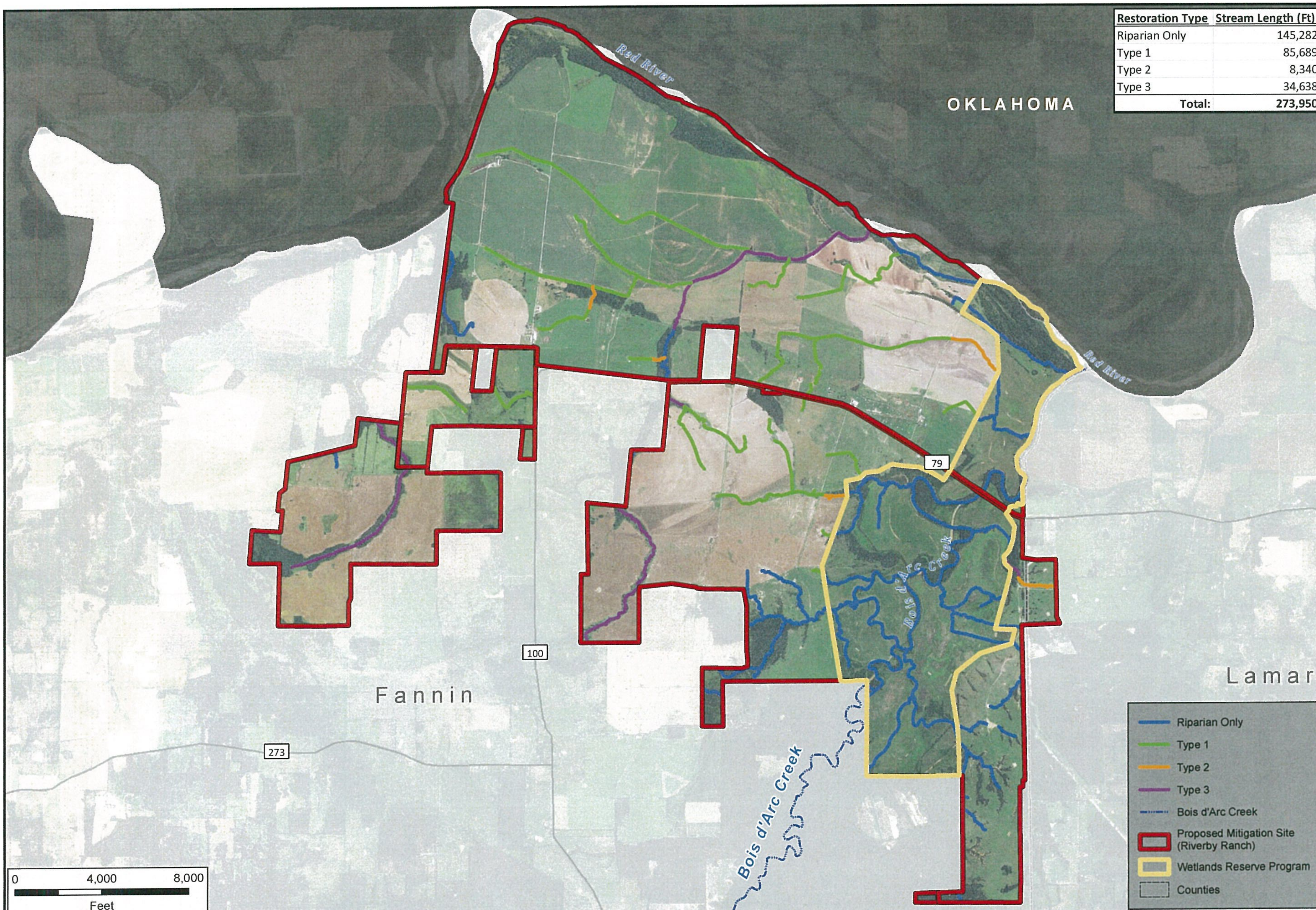

Restoration Type	Stream Length (Ft)
Riparian Only	145,282
Type 1	85,689
Type 2	8,340
Type 3	34,638
Total:	273,950

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North Texas Municipal Water District

Riverby Ranch Stream Restoration Type

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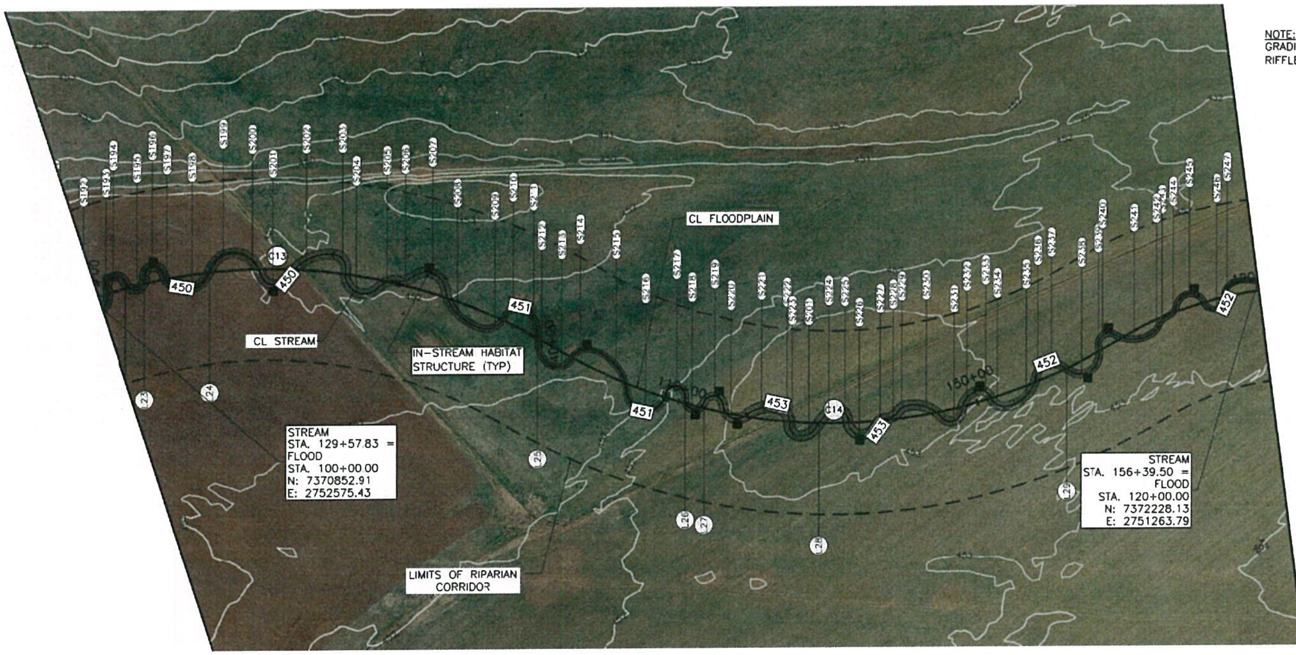
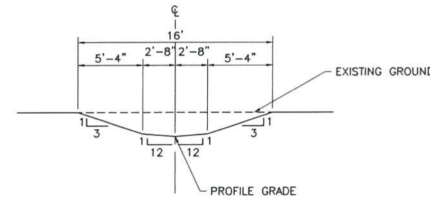
Fort Worth, Texas 76109-4895
817-735-7300

FIGURE I.2

NOTE:
GRADING PLAN DOE NOT SHOW RIFFLE/POOL GEOMETRY.





STREAM TYPICAL SECTION
STA 129+57.83 TO STA 143+00

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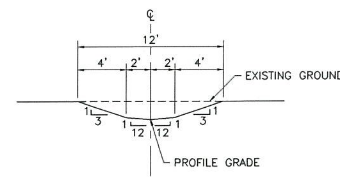


STREAM TYPICAL SECTION
STA 143+00 TO STA 156+39.50

0 5' 10'
SCALE IN FEET

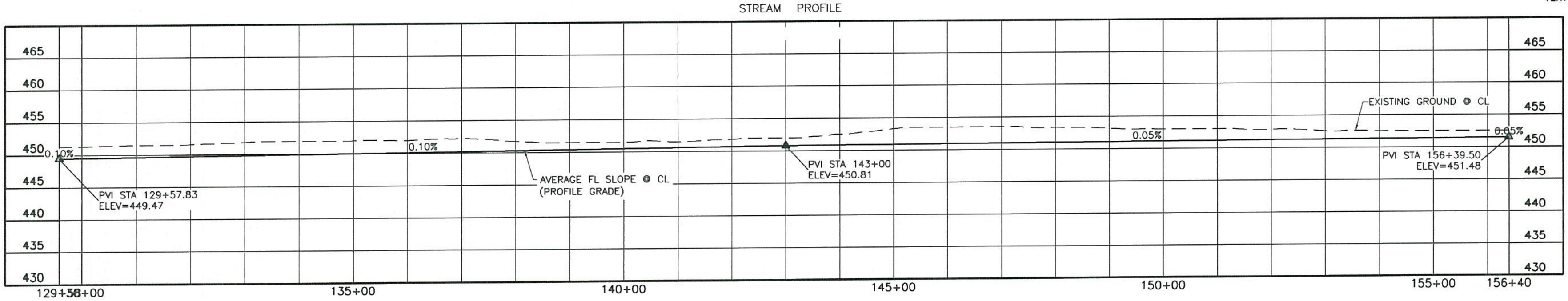
NORTH

NOTE:
BANKFULL STREAM CHANNEL PROFILE DOES NOT SHOW RIFFLE/POOL GEOMETRY.

0 100' 200'
SCALE IN FEET
HORIZONTAL

0 5' 10'
SCALE IN FEET
VERTICAL

STREAM PROFILE



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Alan Plummer Associates, Inc.
Texas Registered Engineering Firm F-13

NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
STREAMS
TYPICAL PLAN AND PROFILE
TYPE 1 STREAM

NO.	ISSUE	BY	DATE		
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				DATE	JUNE 2016
				DESIGNED	BEK
				DRAWN	NBB
				REVISED	
				CHECKED	
				FILE NAME	CV-PP-SC1-STR02.dwg

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FIGURE
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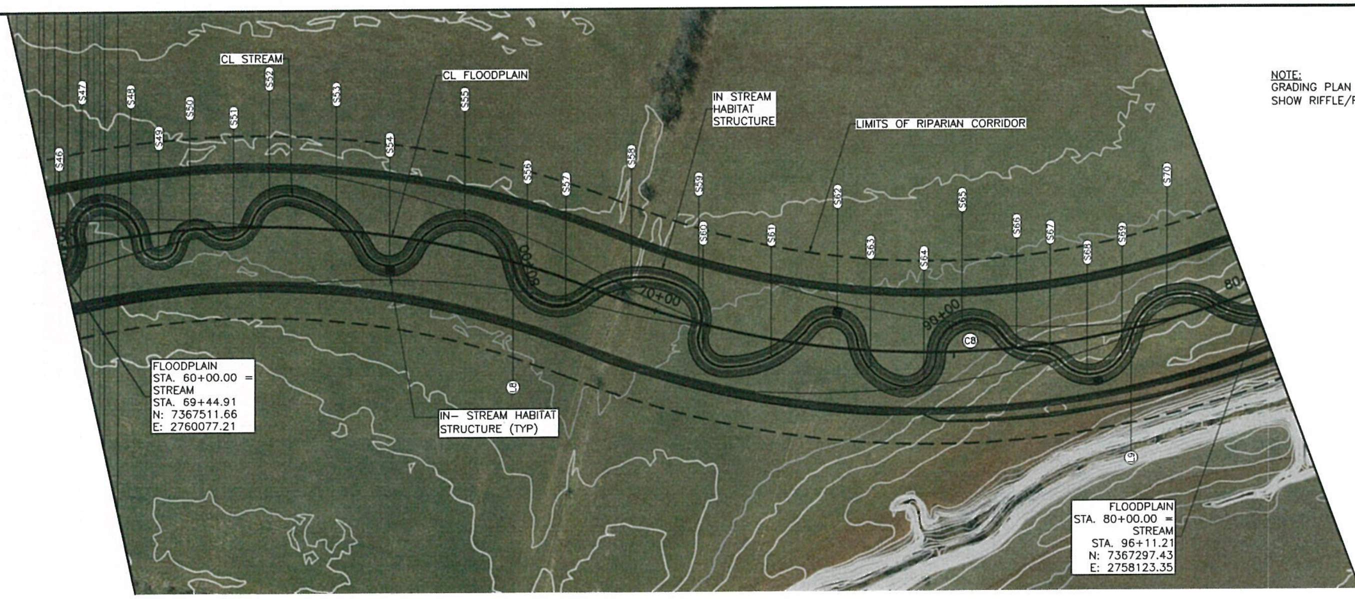
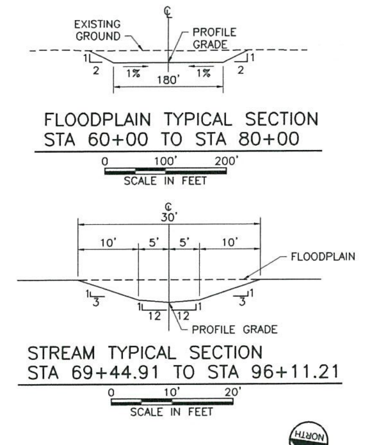
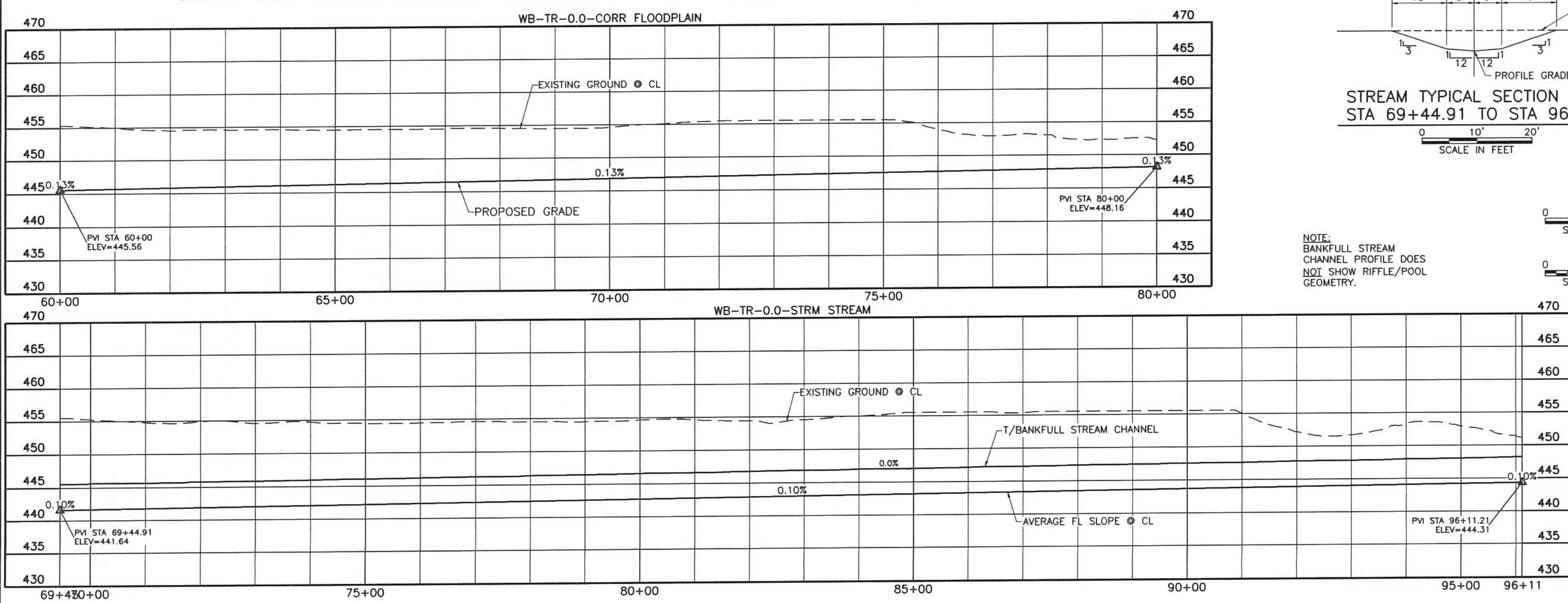


NOTE:
GRADING PLAN DOES NOT SHOW RIFFLE/POOL GEOMETRY.





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SCALE IN FEET VERTICAL

NOTE:
BANKFULL STREAM CHANNEL PROFILE DOES NOT SHOW RIFFLE/POOL GEOMETRY.

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NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
STREAMS

TYPICAL PLAN AND PROFILE TYPE 2 STREAM

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DATE	JUNE 2016
DESIGNED	BEK
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NO.	ISSUE	BY	DATE

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FIGURE
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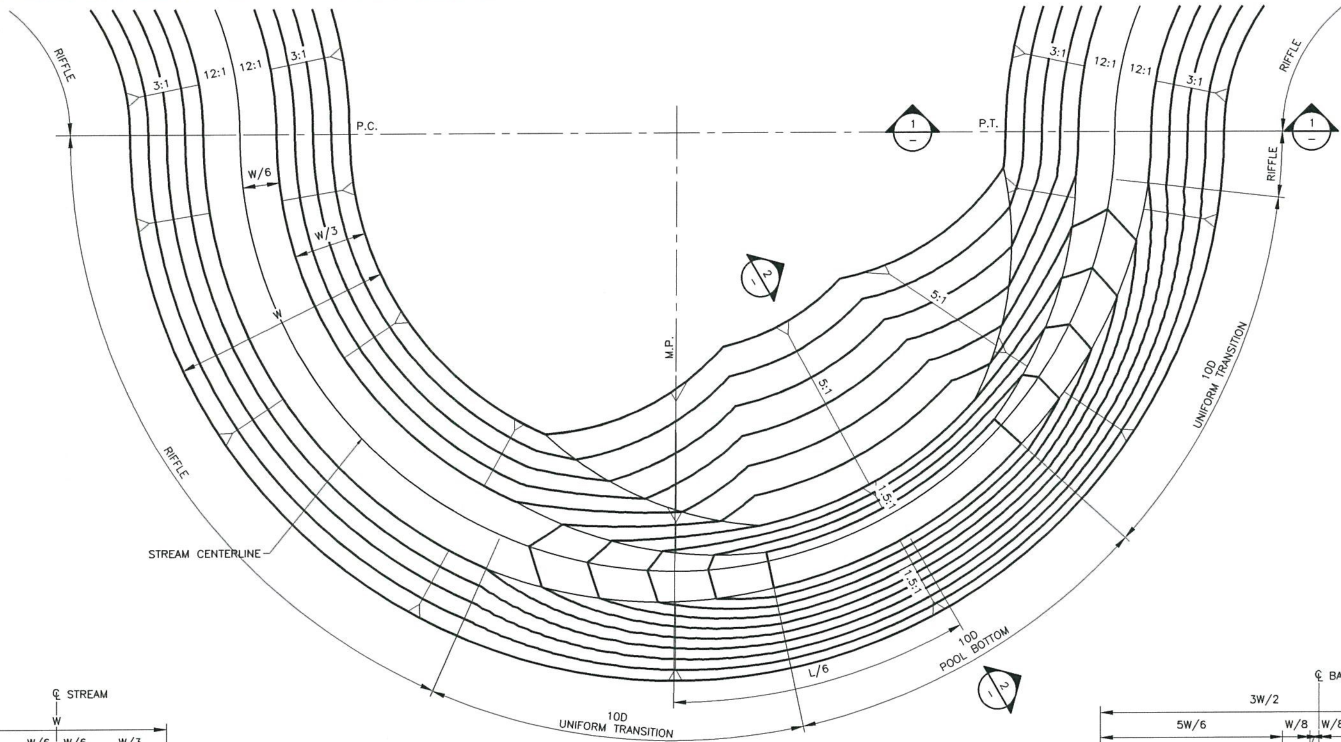
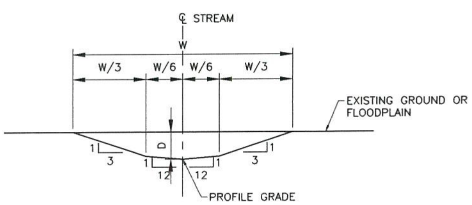


PLAN VIEW – POOL @ CURVATURE



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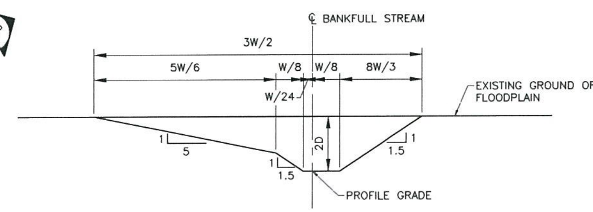

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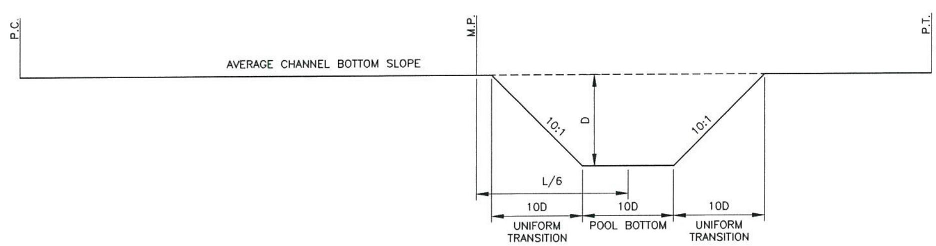

3 PROFILE VIEW – POOL

NOT TO SCALE

NORTH TEXAS MUNICIPAL WATER DISTRICT

LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM

MITIGATION PROJECT

STREAMS

POOL DETAILS

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FIGURE 1.5

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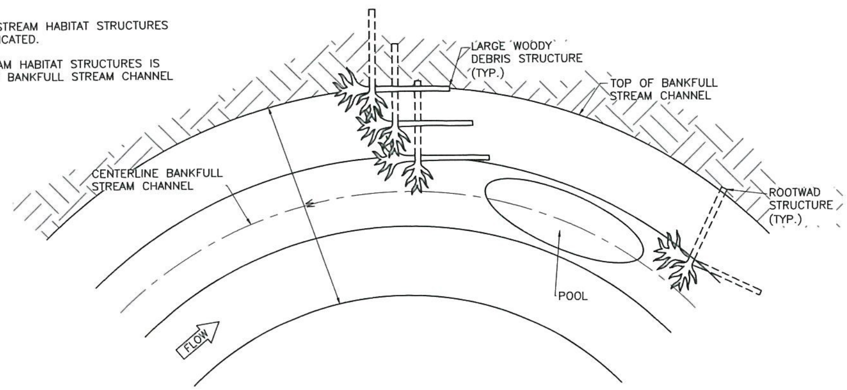
NOTES:

1. LOCATION OF IN STREAM HABITAT STRUCTURES SHALL BE AS INDICATED.
2. SIZE OF IN-STREAM HABITAT STRUCTURES IS PROPORTIONAL TO BANKFULL STREAM CHANNEL TOP WIDTH (W).



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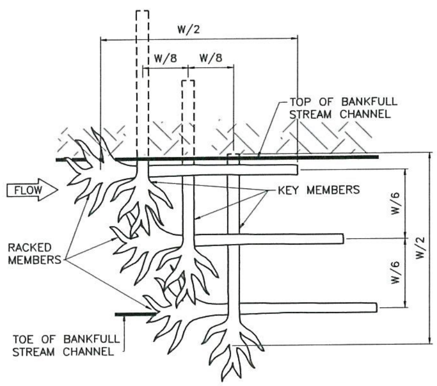

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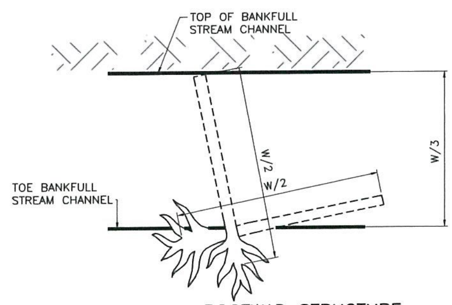

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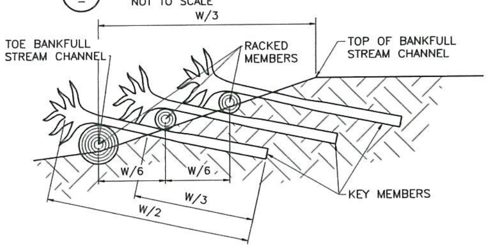

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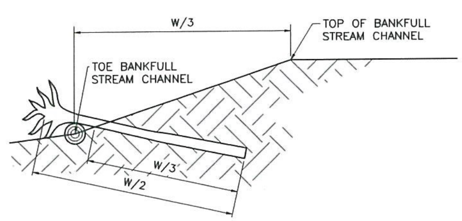

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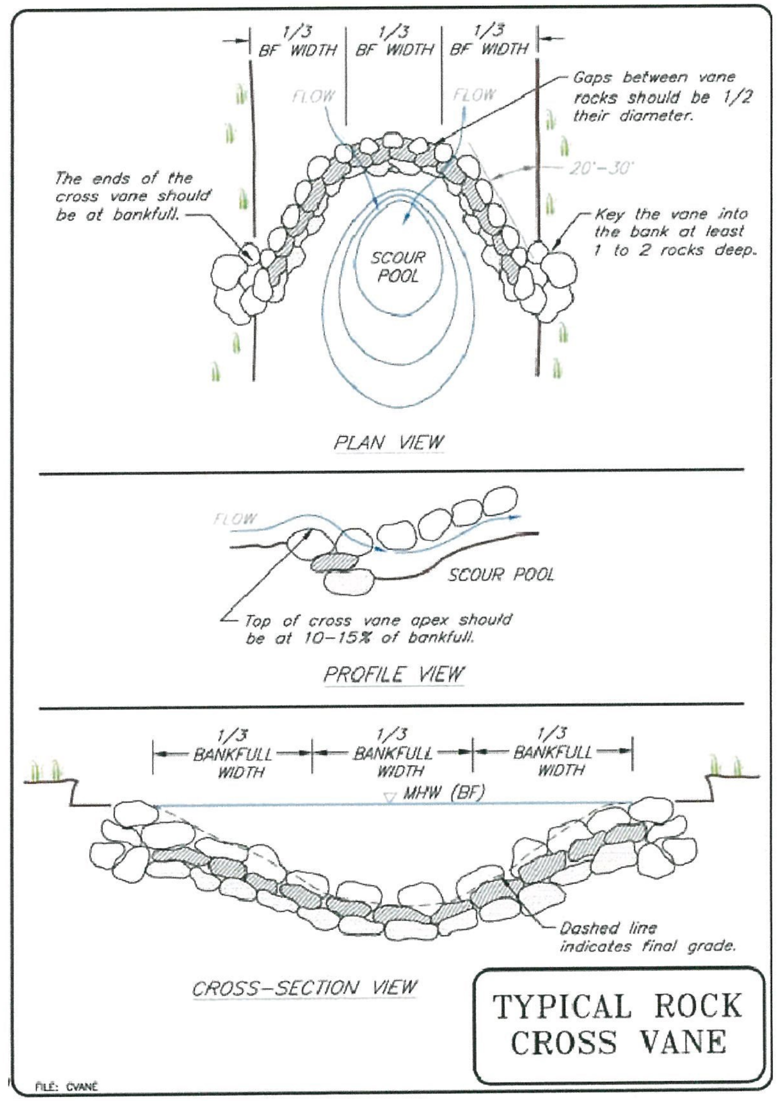

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NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
STREAMS
STREAM DETAILS

NO	ISSUE	BY	DATE

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DRAWN NBB
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FIGURE I.6

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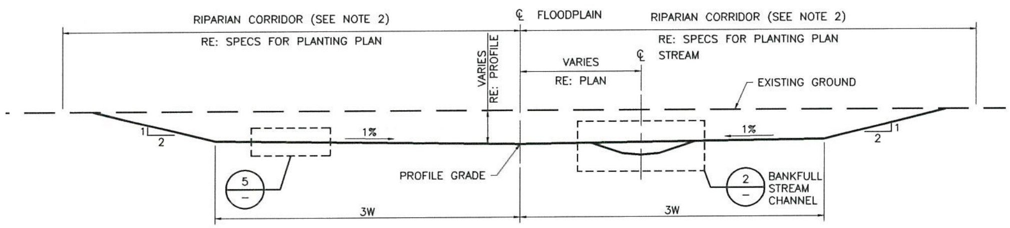
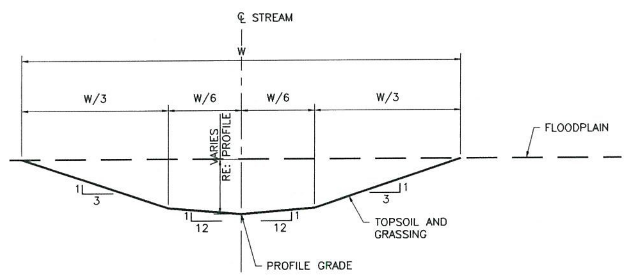


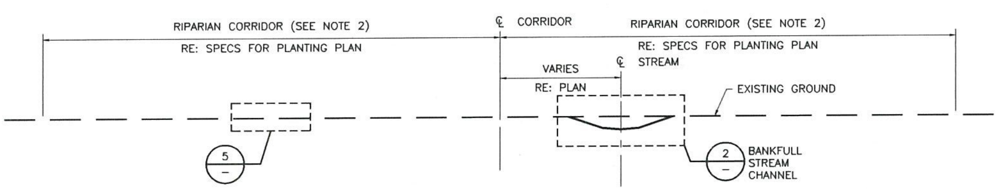
1 – TYPICAL SECTION – TYPE 2 FLOODPLAIN

NOMENCLATURE:

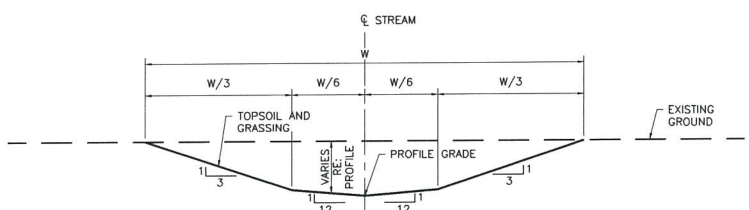
1. THE ALIGNMENTS AND PROFILES WHICH ARE USED TO ESTABLISH THE HORIZONTAL AND VERTICAL GEOMETRY OF THE STREAMS USE THE FOLLOWING NOMENCLATURE:
   a. "WB-TR-X.X" REFERS TO THE PARTICULAR STREAM NAME. (I.E. 0.0. REFERS TO THE MAIN STEM OF WILLOW BRANCH, 1.0 REFERS TO TRIBUTARY 1, ETC.)
   b. "_CORR" REFERS TO THE CORRIDOR OR FLOODPLAIN OF THE PARTICULAR STREAM, WHICH REPRESENTS THE GENERAL ORIENTATION OF THE STREAM.
   c. "_STRM" REFERS TO THE BANKFULL STREAM CHANNEL.
   d. EXAMPLE, AN OBJECT LABELED "WB-TR-2.1-STRM" WOULD PROVIDE GEOMETRY DATA FOR THE BANKFULL STREAM CHANNEL OF WILLOW BRANCH TRIBUTARY 2.1.



2 – TYPICAL SECTION – TYPE 2 BANKFULL STREAM CHANNEL



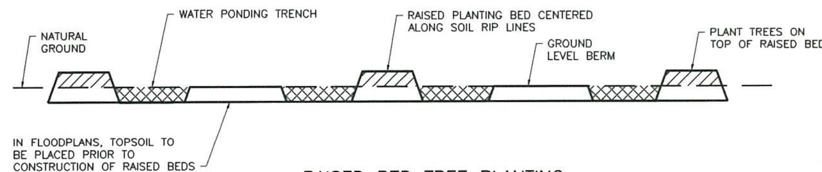
3 – TYPICAL SECTION – TYPE 1 CORRIDOR



4 – TYPICAL SECTION – TYPE 1 BANKFULL STREAM CHANNEL

NOTES:

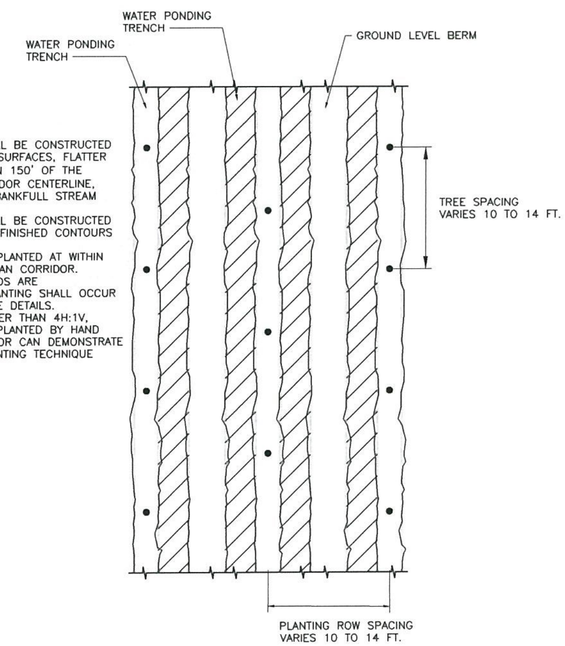
1. ALL STREAM DIMENSIONS ARE PROPORTIONAL TO THE BANKFULL STREAM CHANNEL TOPWIDTH (W), TYPICAL SECTIONS INCLUDED IN THIS SHEET ARE INTENDED TO ILLUSTRATE THIS PROPORTIONAL GEOMETRY. ACTUAL DIMENSIONS FOR EACH STREAM SEGMENT ARE INCLUDED IN THE PLAN AND PROFILE SHEETS.
2. RIPARIAN CORRIDOR WIDTH VARIES EITHER SIDE OF BANKFULL STREAM CHANNEL WITHIN FLOODPLAIN, BUT OVERALL RIPARIAN CORRIDOR WIDTH REMAIN CONSTANT 300 FEET.



5 – RAISED BED TREE PLANTING ROW DETAIL CROSS SECTION

NOTES:

1. RAISED BEDS SHALL BE CONSTRUCTED ON ALL FINISHED SURFACES, FLATTER THAN 4H:1V WITHIN 150' OF THE FLOODPLAIN/CORRIDOR CENTERLINE, OUTSIDE OF THE BANKFULL STREAM CHANNEL.
2. RAISED BEDS SHALL BE CONSTRUCTED PARALLEL TO THE FINISHED CONTOURS OF THE SURFACE.
3. TREES SHALL BE PLANTED AT WITHIN THE ENTIRE RIPARIAN CORRIDOR.
4. WHERE RAISED BEDS ARE CONSTRUCTED, PLANTING SHALL OCCUR ACCORDING TO THE DETAILS.
5. ON SLOPES STEEPER THAN 4H:1V, TREES SHALL BE PLANTED BY HAND UNLESS CONTRACTOR CAN DEMONSTRATE SATISFACTORY PLANTING TECHNIQUE OTHERWISE.



6 – RAISED BED TREE PLANTING DETAIL FOR RIPARIAN CORRIDOR

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NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
STREAMS
TYPICAL SECTIONS

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I.7
FIGURE

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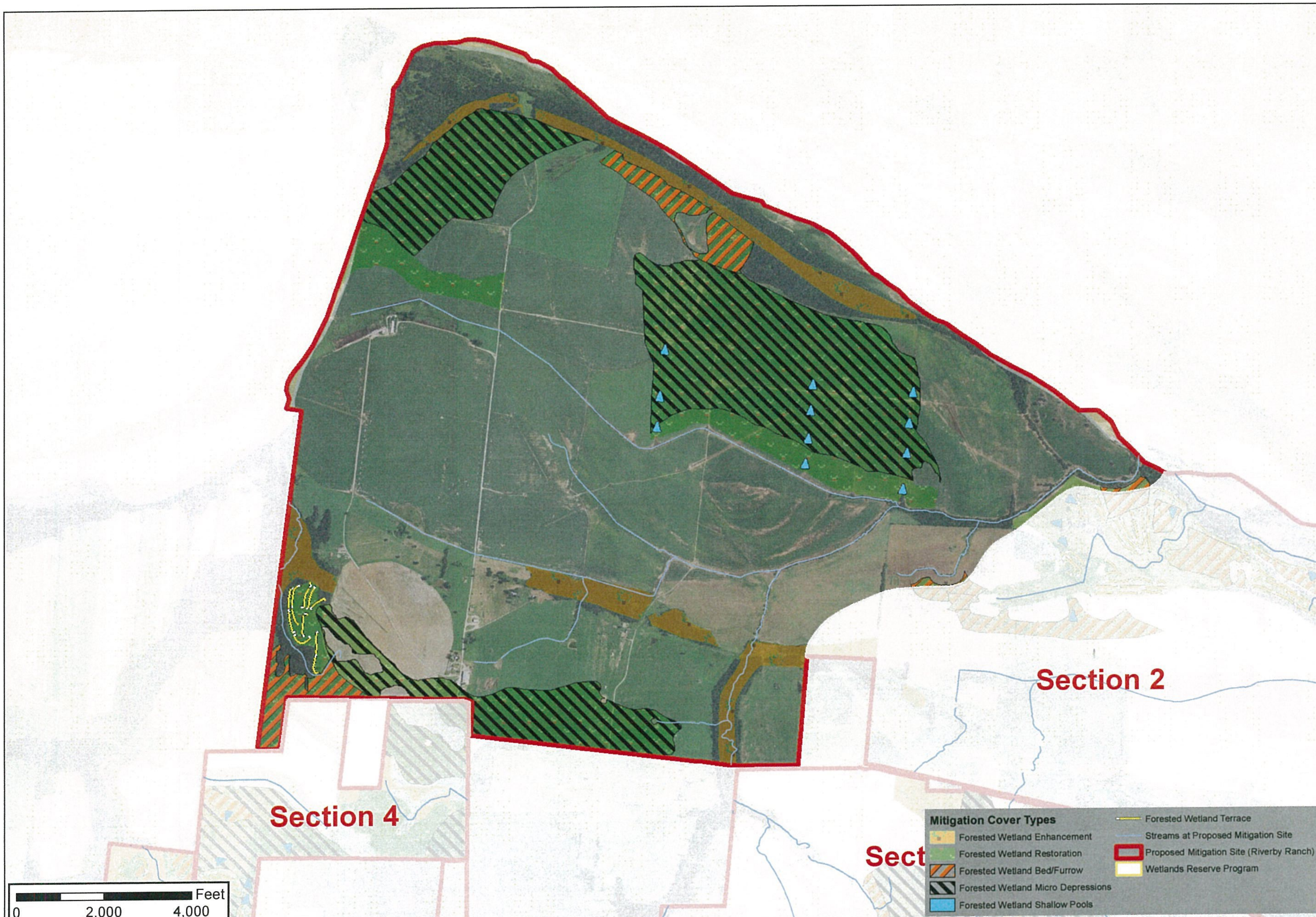

North Texas Municipal Water District

Proposed Mitigation - Forested Wetland Restoration Cover Types - Section 1

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FIGURE
I.8

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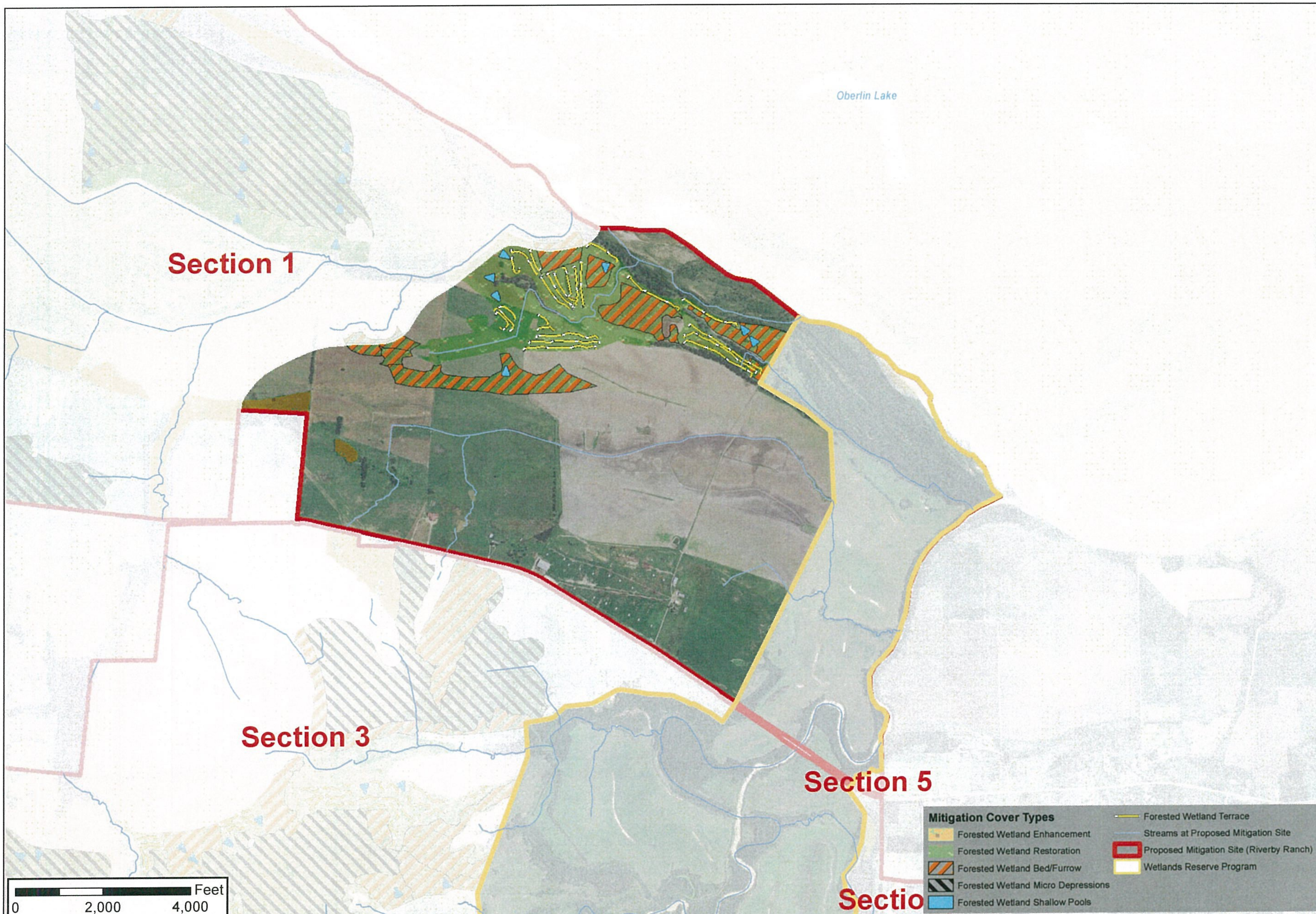

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North Texas Municipal Water District

Proposed Mitigation -
Forested Wetland Restoration Cover Types - Section 2

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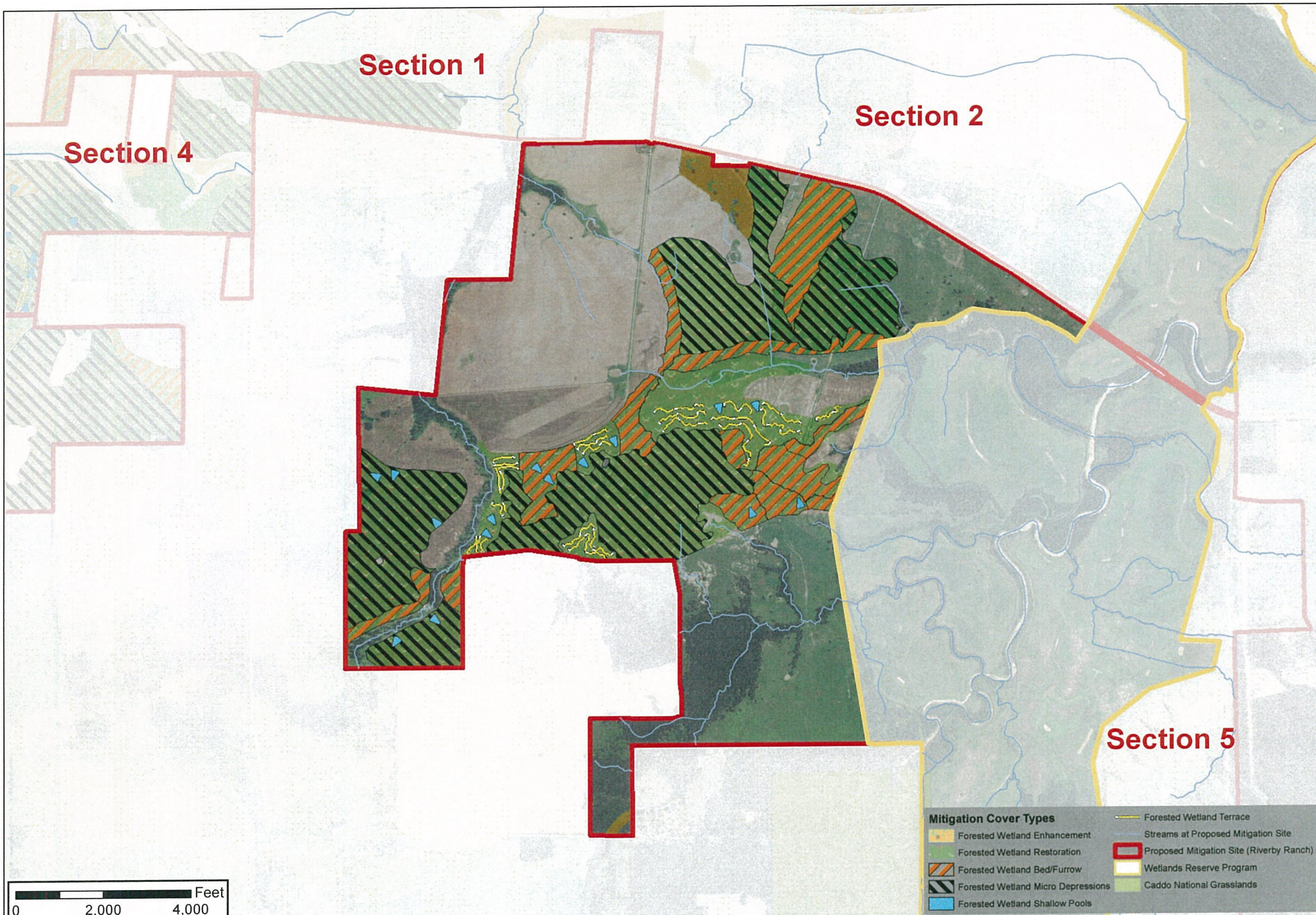
I.9

FIGURE



North Texas Municipal Water District

Proposed Mitigation - Forested Wetland Restoration Cover Types - Section 3

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FIGURE
I.10

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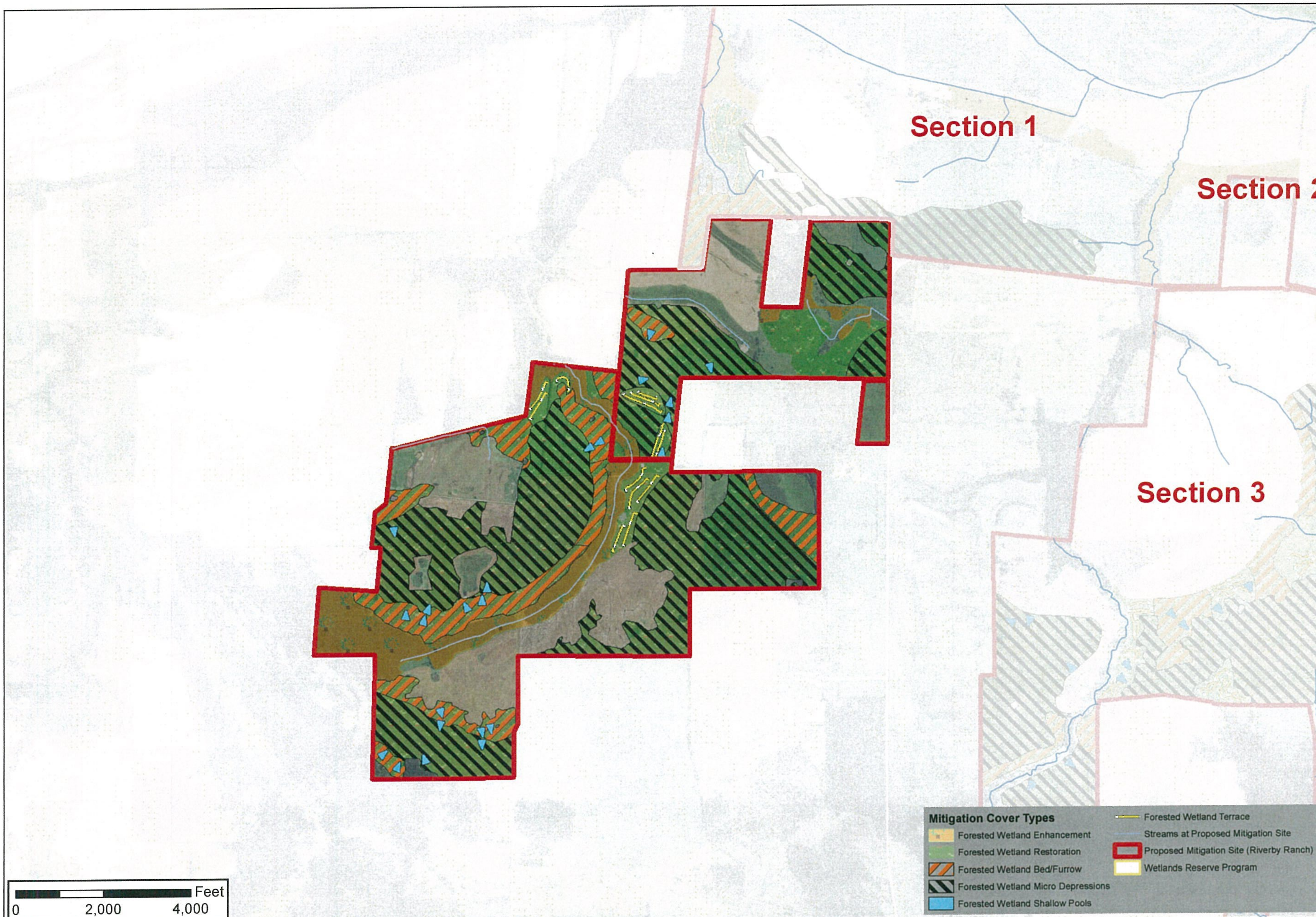

North Texas Municipal Water District

Proposed Mitigation -
Forested Wetland Restoration Cover Types - Section 4

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FIGURE
I.11

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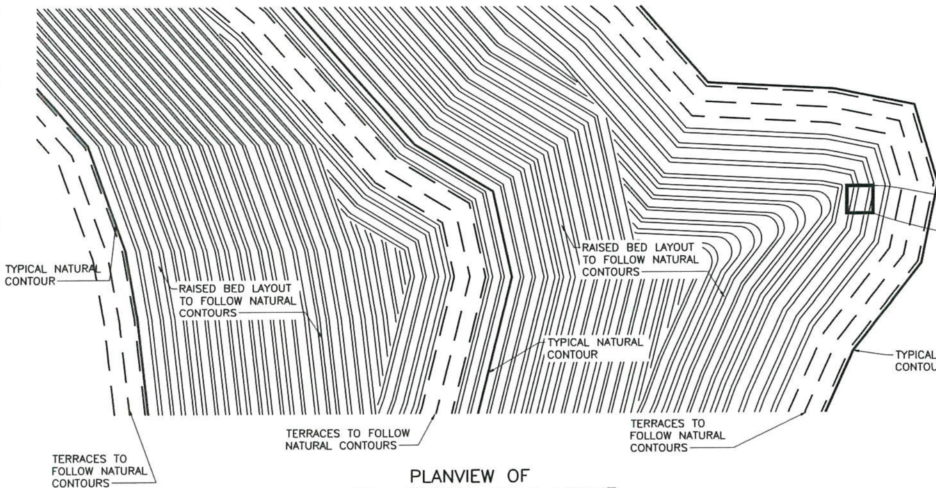
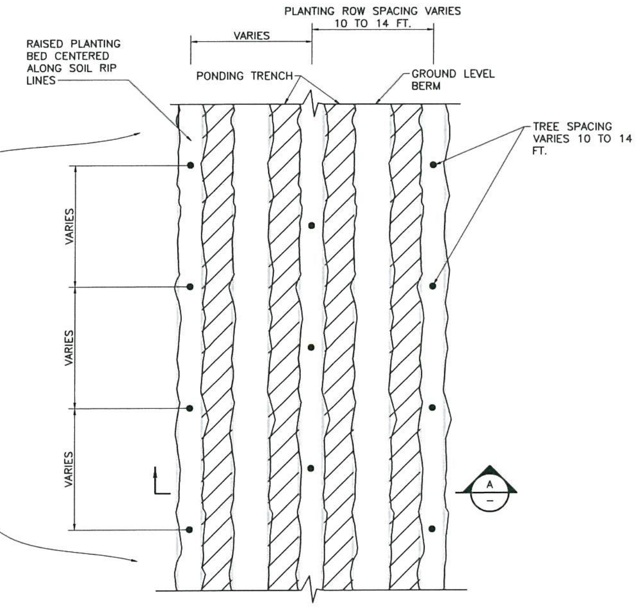
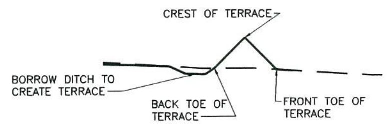


1 PLANVIEW OF TYPICAL FIELD LAYOUT
N.T.S.

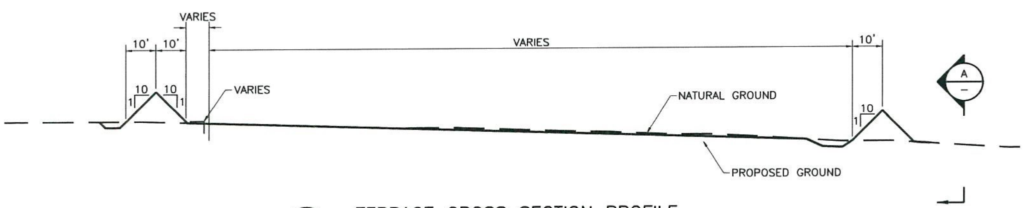
NOTE: EARTHWORK ACTIVITIES– RIPPING, DISKING, RAISED BED FORMING, TERRACE FORMING, ARE INTENDED TO USE THE LAND'S NATURAL CONTOURS UNLESS SPECIFICIED ON PLAN SHEETS.



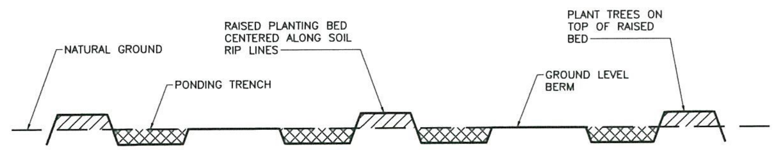
4 RAISED BED ROW STYLE 1 – PLAN VIEW



2 TERRACE DESCRIPTION
N.T.S.



3 TERRACE CROSS SECTION PROFILE
N.T.S.



A RAISED BED ROW DETAIL STYLE 1 CROSS SECTION
N.T.S.

NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
FORESTED WETLANDS

TERRACE & RAISED BED ROW DETAILS

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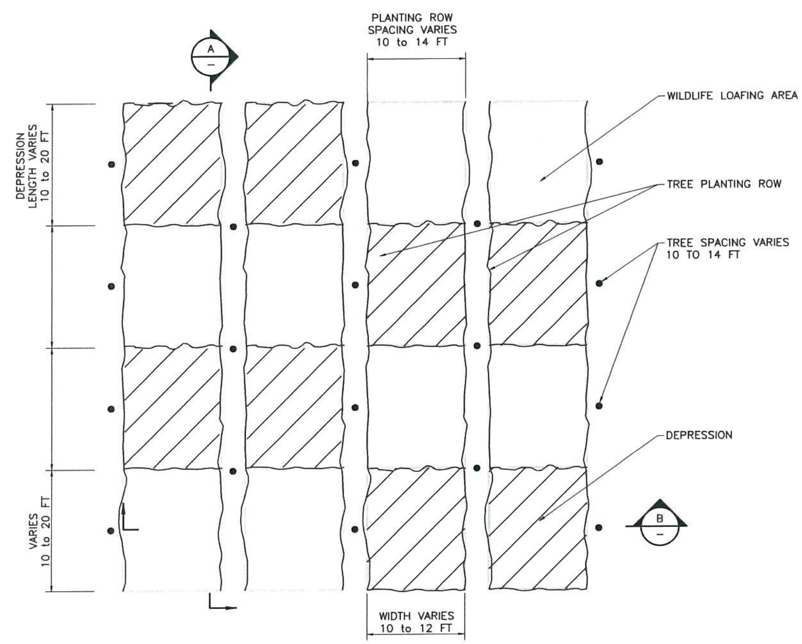
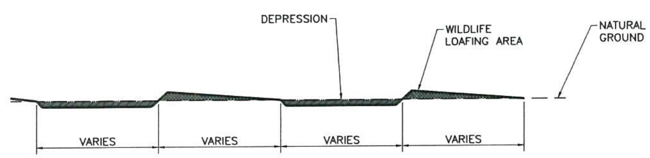
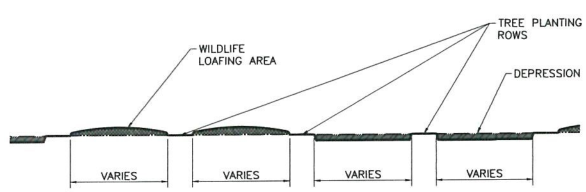


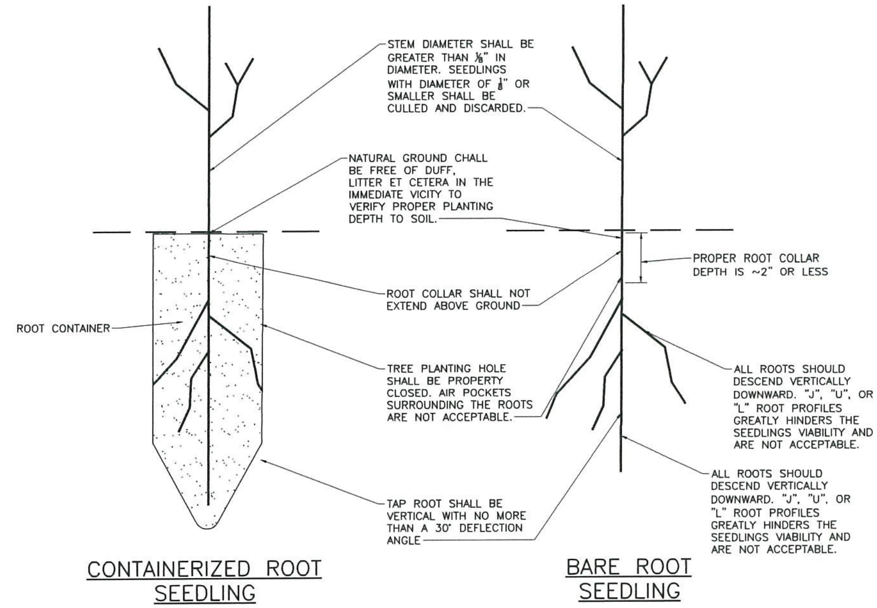
DEPRESSIONAL WETLAND PLAN VIEW



(A) DEPRESSIONAL WETLAND PROFILE VIEW



(B) DEPRESSIONAL WETLAND CROSS SECTION PROFILE



CONTAINERIZED ROOT SEEDLING

BARE ROOT SEEDLING

(2) TREE PLANTING DETAIL
N.T.S.

0 5' 10'
SCALE IN FEET
HORIZONTAL

NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC CREEK RESERVOIR PROGRAM
MITIGATION PROJECT
FORESTED WETLANDS

FORESTED WETLAND DETAILS

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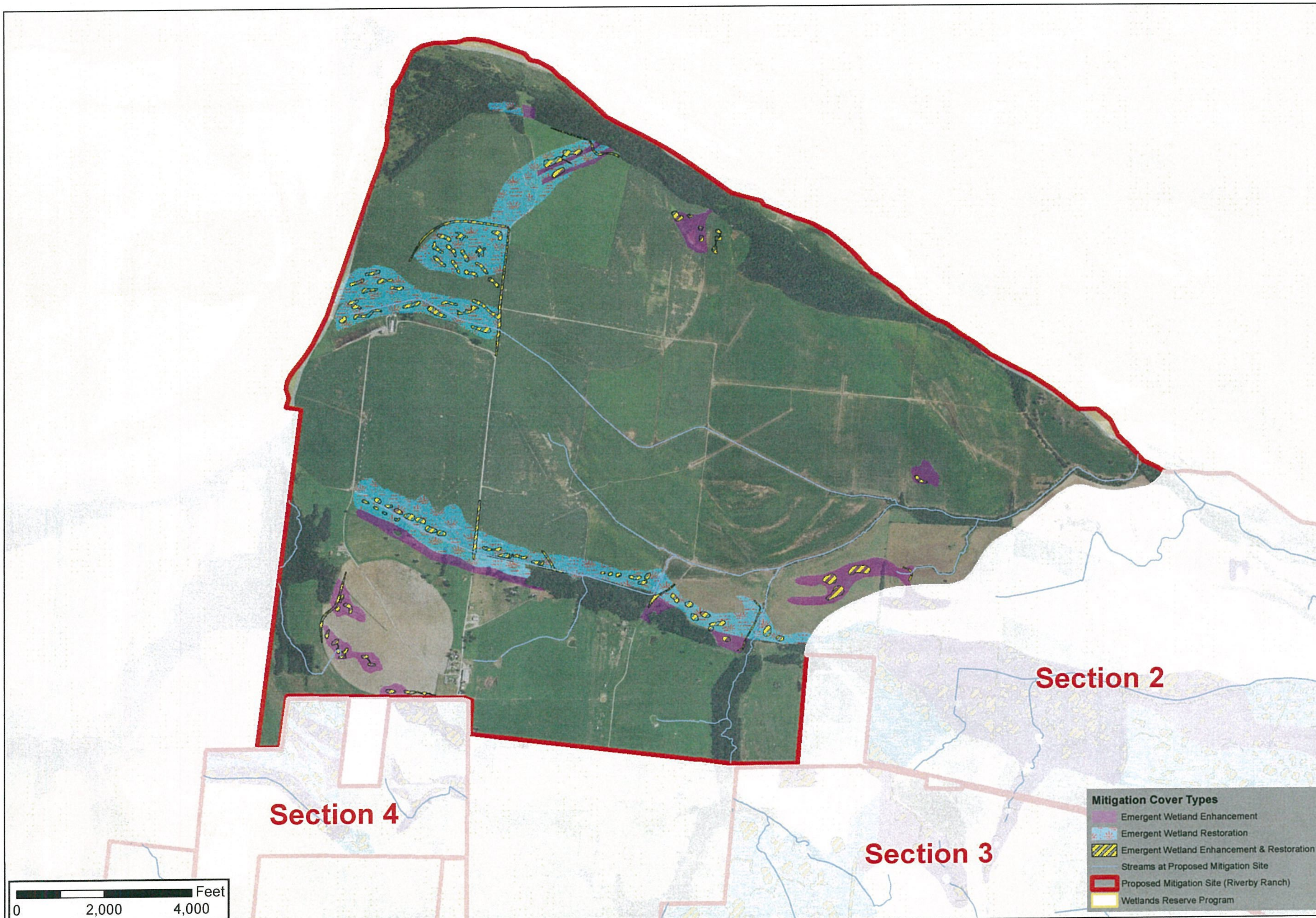

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North Texas Municipal Water District

Proposed Mitigation - Emergent Wetland Cover Types - Section 1

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FIGURE I.14

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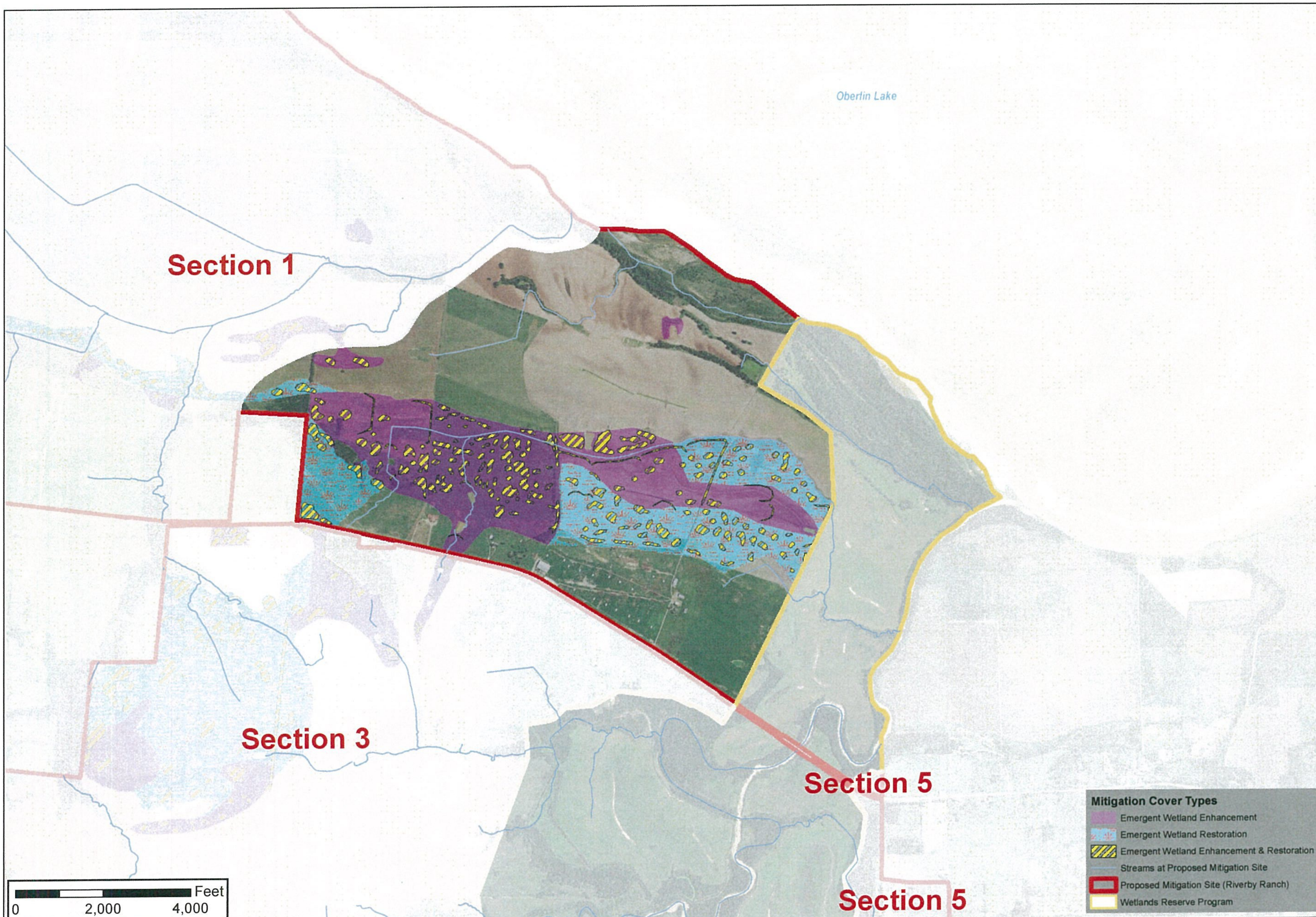

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North Texas Municipal Water District

Proposed Mitigation -
Emergent Wetland Cover Types - Section 2

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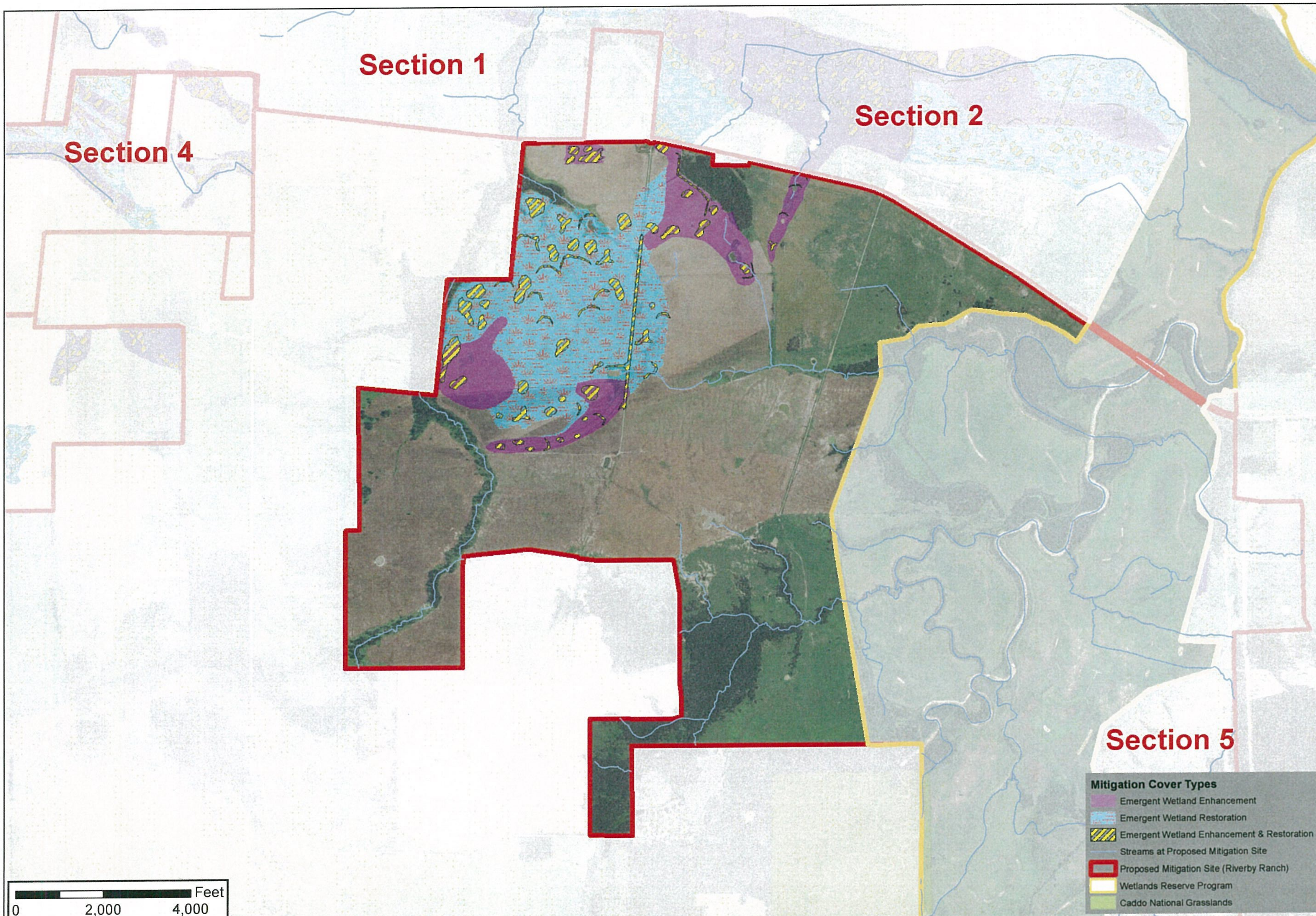
I.15

FIGURE



North Texas Municipal Water District

Proposed Mitigation -
Emergent Wetland Cover Types - Section 3

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FIGURE
I.16

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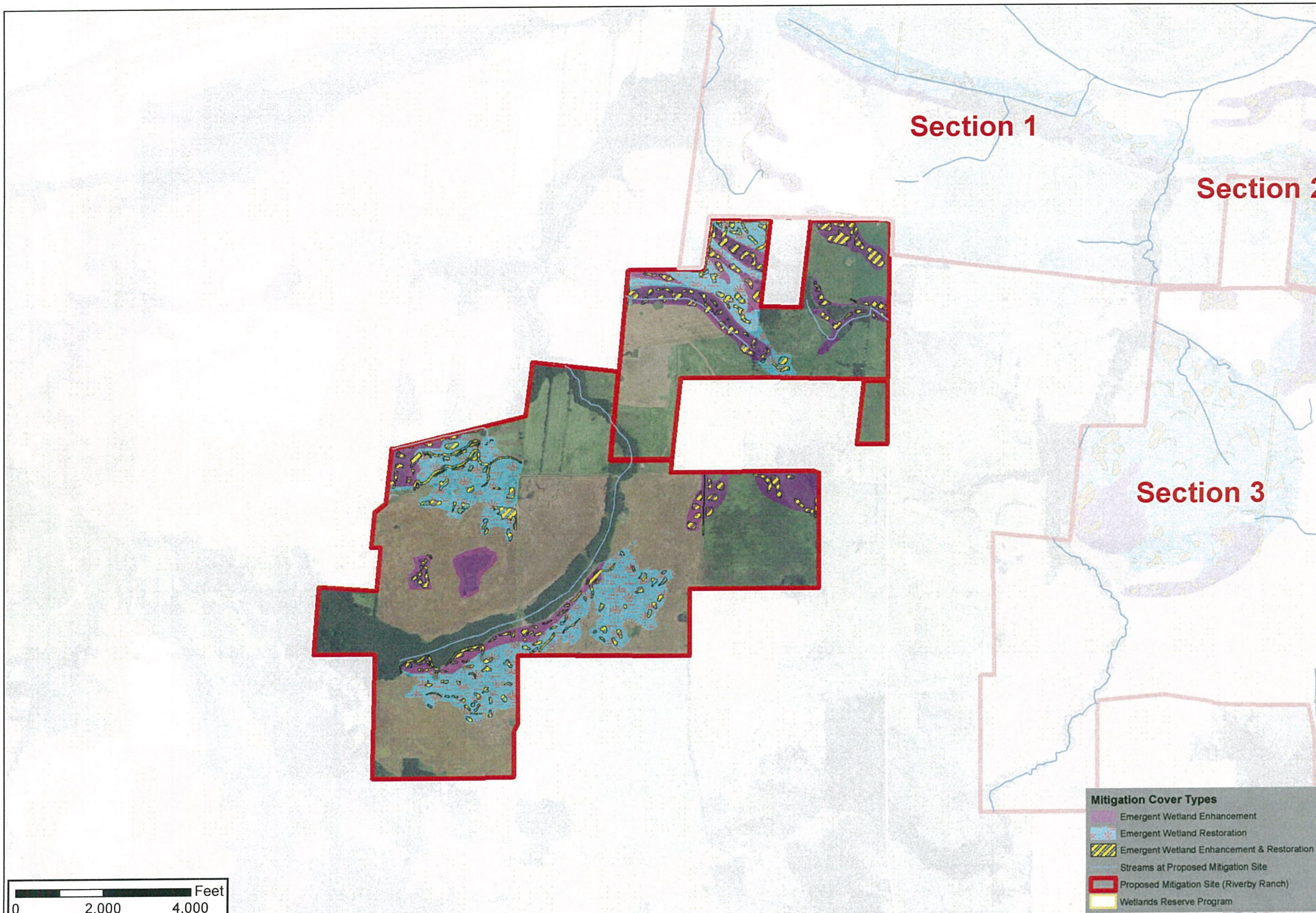

North Texas Municipal Water District

Proposed Mitigation -
Emergent Wetland Cover Types - Section 4

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FIGURE
I.17

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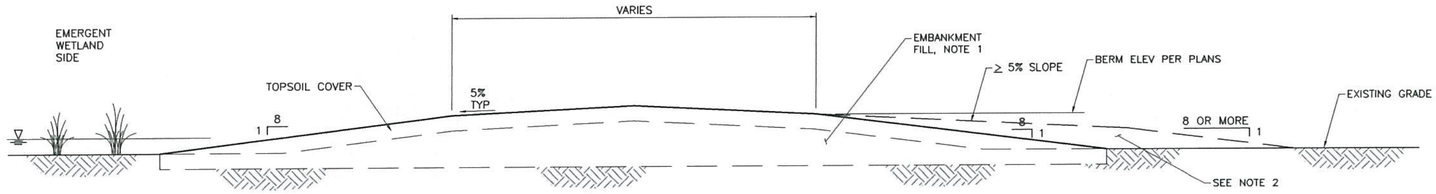
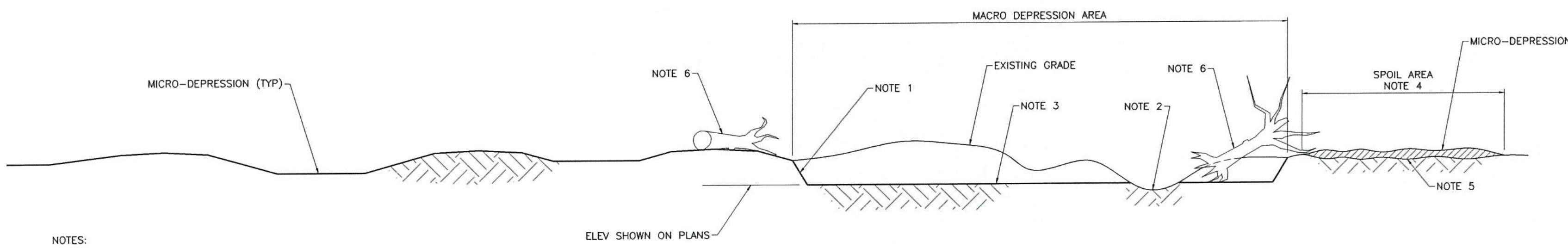


NOTES:

1. REFER TO PLANS FOR PLACEMENT OF EMBANKMENT FILL.
2. EXCESS SOIL MAY BE WASTED BY WIDENING THE BERM ON THE OPPOSITE SIDE OF THE EMERGENT WETLAND. WIDENED SECTIONS SHALL BE PARALLEL TO CENTERLINE OF BERM AND FINISHED BERM SHALL BE COVERED WITH TOPSOIL AND BE SLOPED AS SHOWN.
3. ESTABLISH VEGETATIVE COVER PER SPECIFICATIONS.

DETAIL 1 – BERM SECTION WITH TOPSOIL DRIVE SURFACE

NTS



NOTES:

1. NO SLOPE REQUIREMENT FOR EDGE OF EXCAVATED AREAS.
2. EXISTING GRADES LOWER THAN THE DESIGN BOTTOM ELEVATION SHOULD NOT BE FILLED.
3. TOPSOIL REPLACEMENT NOT REQUIRED IN EXCAVATED MACRO DEPRESSIONS EXCEPT IN THOSE NOTED ON THE CIVIL PLANS WHERE SEED BANK SOIL WILL BE PLACED.
4. REFER TO APPROVED SPOIL AREAS SHOWN ON CIVIL PLAN SHEETS.
5. TOPSOIL STRIPPING IS NOT REQUIRED IN SPOIL AREAS.
6. INSTALL WOODY DEBRIS PER SPECIFICATIONS.

DETAIL 2 – TYPICAL SECTION
EXCAVATED MACRO/MICRO DEPRESSION COMPLEX

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NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC RESERVOIR PROGRAM
MITIGATION PROJECT
EMERGENT WETLANDS

STANDARD DETAILS I

NO	ISSUE	BY	DATE

FNI JOB NO.	NTD15291
DATE	APR 2016
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CHECKED	TJN
FILE NAME	GN-DT-PL-01.dwg

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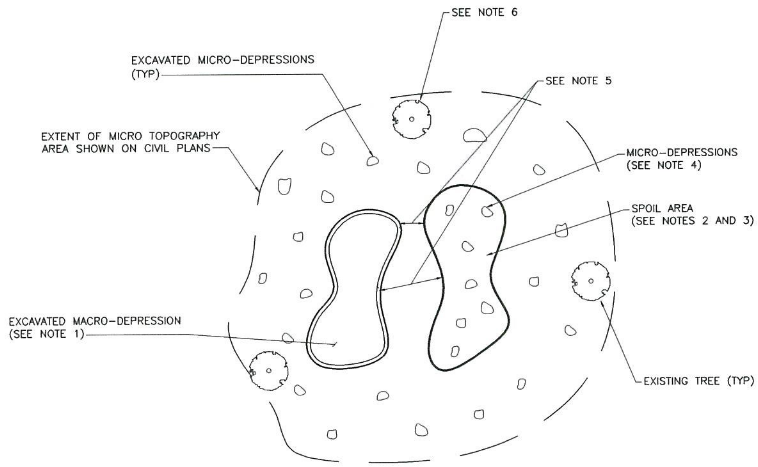
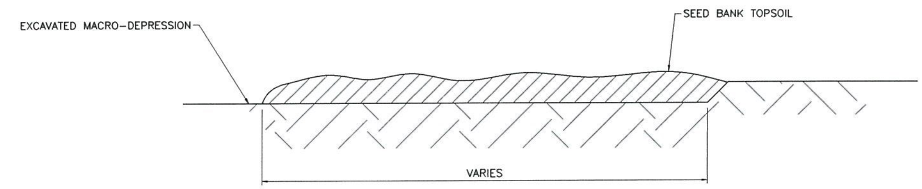
SEQ.



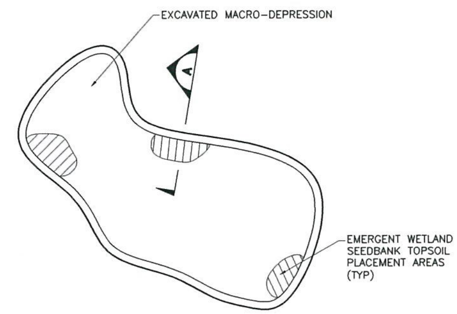
NOTES:

1. EXCAVATED MACRO DEPRESSIONS SHALL BE CONSTRUCTED PER CIVIL PLAN SHEETS.
2. SPOIL AREAS ARE TO BE LOCATED IMMEDIATELY ADJACENT TO EXCAVATED MACRO-DEPRESSIONS. REFER TO CIVIL PLAN SHEETS FOR APPROXIMATE LOCATIONS AND SHAPES.
3. FOOTPRINT OF SPOIL AREA SHALL BE APPROXIMATE SHAPES SHOWN IN CIVIL PLANS. HOWEVER EXTENT OF FOOTPRINT MAY BE FIELD ADJUSTED TO ACCOMMODATE ACTUAL VOLUME OF SPOIL WHILE MAINTAINING TOTAL SPREAD THICKNESS OF 0.5' TO 1.5', UNLESS A MINIMUM ELEV IS SHOWN ON THE CIVIL PLANS. SPOIL AREAS DO NOT NEED TO COMPLETELY DRAIN WATER AS SHALLOW PONDING IS ACCEPTABLE.
4. MICRO-DEPRESSIONS SHALL BE SHALLOW EXCAVATED DEPRESSIONS MEASURING APPROX 1 TO 2 EQUIPMENT WIDTHS BY 5' TO 20' LONG. SPOIL FROM MICRO DEPRESSIONS MAY BE DEPOSITED ADJACENT TO THE MICRO-DEPRESSION, SPREAD SPOIL TO NO MORE THAN 1' HIGH. MICRO-DEPRESSIONS SHALL BE PLACED IN RANDOM PATTERNS IN THE SPOIL AREA AND AROUND THE MACRO-DEPRESSION TO THE EXTENT LINE SHOWN ON THE PLANS. DO NOT PLACE MICRO-DEPRESSIONS WITHIN THE EXCAVATED MACRO-DEPRESSIONS.
5. DISTANCE BETWEEN SPOIL AREA AND EXCAVATION SHALL VARY.
6. AVOID PLACING MICRO-DEPRESSIONS WITHIN 10 FEET OF THE DRIP LINE OF EXISTING TREES GREATER THAN 6" DBH.

DETAIL 3
TYPICAL PLAN VIEW EXCAVATED MACRO/MICRO DEPRESSION COMPLEX
NTS



SECTION A
NTS



PLAN

NOTES:

1. FOR EXCAVATED MACRO DEPRESSIONS IDENTIFIED TO RECEIVE SEEDBANK TOPSOIL, PLACEMENT SHALL BE AS SHOWN. EACH AREA REPRESENTS ONE TRUCK LOAD. DUMP LOAD NEAR EDGE, THEN SPREAD OUT INTO DEPRESSION AWAY FROM THE EDGE. TRUCK LOADS SHOULD BE PLACED AT THE EXTREMITIES OF THE DEPRESSION AND ALSO NEAR THE CENTER. MACRO DEPRESSIONS IDENTIFIED FOR SEED BANK TOPSOIL ARE SHOWN IN SECTION 35 25 13.03.

DETAIL 4
SEED BANK TOPSOIL PLACEMENT
NTS

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FREESE AND NICHOLS
4055 International Plaza
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Phone - (817) 735-7300
fax - (817) 735-7491
Web - www.freese.com
Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

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Texas Registered Engineering Firm F-13

NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC RESERVOIR PROGRAM
MITIGATION PROJECT
EMERGENT WETLANDS

STANDARD DETAILS II

FNI JOB NO.	NTD15291
DATE	APR 2016
DESIGNED	RMP
DRAWN	FJC
REVISED	APAI
CHECKED	TJN
FILE NAME	GN-DT-PL-02.dwg

NO.	ISSUE	BY	DATE

VERIFY SCALE: Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.

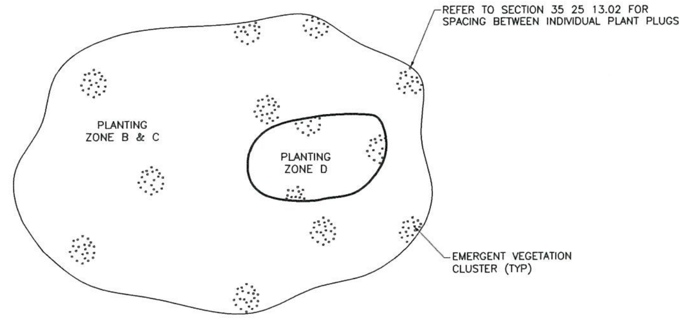
GRID
WORK/PACK.
SEQ.

ACAD Rel: 20.1s (LMS Tech)
Filename: L:\Projects\0312\048-02\2-0 Wrk Prod\2-1 ACAD\SHEETFILES\GENERIC DETAILS\GN-DT-PL-02.dwg
Last Saved: 10/31/2016 1:13 PM Saved By: rellis

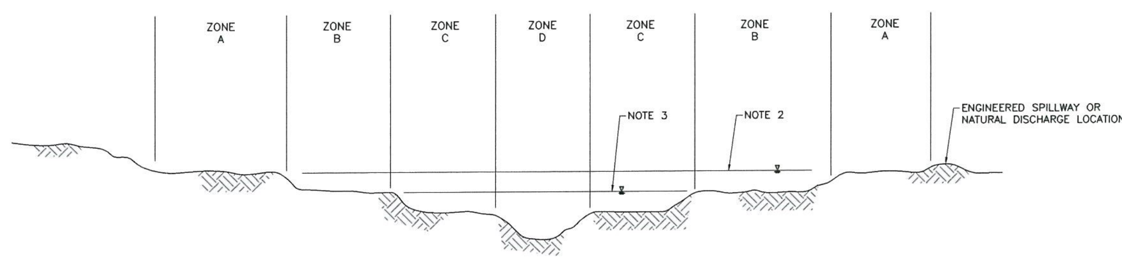
Plot Date: 10/31/2016 2:43 PM Plot By: rellis Filename: L:\Projects\0312\048-02\2-0 Wrk Prod\2-1 ACAD\SHEETFILES\GENERIC DETAILS\GN-DT-PL-02.dwg

NOTES:

1. EACH CLUSTER TO CONTAIN ONE PLANT SPECIES WITH 8–20 PLANT PLUGS PER CLUSTER FOR PLANTING ZONES B AND C, AND 8–12 PLANT PLUGS FOR ZONE D.
2. RANDOMLY PLACE EACH CLUSTER WITHIN THE SPECIFIED PLANTING ZONE



EXAMPLE PLACEMENT OF EMERGENT WETLAND PLANT CLUSTERS
NTS



NOTES:

1. ZONE A = TEMPORARY FLOODED
   ZONE B = SEASONALLY FLOODED
   ZONE C = SEMI–PERMANENTLY FLOODED
   ZONE D = PERMANENTLY FLOODED
   SEE ALSO SECTION 31 25 13.02 FOR ADDITIONAL DETAILS.
2. COOL SEASON NORMAL WATER LEVEL.
3. WARM SEASON NORMAL WATER LEVEL.

AQUATIC VEGETATION PLANTING ZONES
NTS

NORTH TEXAS MUNICIPAL WATER DISTRICT
LOWER BOIS D'ARC RESERVOIR PROGRAM
MITIGATION PROJECT
EMERGENT WETLANDS

STANDARD DETAILS IV

NO	ISSUE	BY	DATE	FAN JOB NO NTD15291
				DATE APR 2016
				DESIGNED RMP
				DRAWN FJC
				REVISED APAI
				CHECKED TJN

VERIFY SCALE Bar is one inch on original drawing. If not one inch on this sheet, adjust scale. 0 1

FILE NAME GN–DT–PL–04.dwg

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WORK/PACK.
SEQ.

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Appendix J

Site Protection and Financial Assurance

DEED RESTRICTION

North Texas Municipal Water District ("NTMWD"), a conservation and reclamation district created under Article 16, Section 59, of the Texas Constitution, is the owner of the real property more particularly described and shown in Exhibit "A" (hereinafter the "Property") attached hereto and made a part hereof. The Property is approximately _____ acres and is also referenced in the "[Proposed] Lower Bois d'Arc Creek Reservoir Mitigation Plan." The Property is subject to the conditions of Department of the Army Section 404/Section 10 Permit Number _____, dated _____. One of the conditions of the referenced permit requires restrictions be placed on the deed for the Property for the purpose of providing appropriate compensatory mitigation for authorized adverse impacts to waters of the United States. The intent of this document is to assure that the Property will be retained, maintained, and protected in accordance with the "[Proposed] Lower Bois d'Arc Creek Reservoir Mitigation Plan. Activities, which may, in the future, be conducted within the Property that will affect the intended extent, condition and function of property for mitigation as provided in the "[Proposed] Lower Bois d'Arc Creek Reservoir Mitigation Plan.," must be coordinated with and approved by the United States Army Corps of Engineers ("USACE"), Tulsa District, Regulatory Branch, prior to initiation.

The parties to this agreement include the Property owner(s) who by their signature accept the third-party rights of enforcement herein and agree that the deed restrictions will be subject to the following conditions:

1) Use of Property

The Property, as more particularly described in "Exhibit A," is hereby dedicated for the purpose of compensatory mitigation for authorized adverse impacts to waters of the United States associated with the Lower Bois d'Arc Creek Reservoir project as authorized by Department of the Army Section 404/Section 10 Permit Number _____, dated _____. The Property shall not be disturbed except by those USACE-approved activities that would not adversely affect the intended extent, condition, and function of the mitigation area as provided in the "Proposed Lower Bois d'Arc Creek Reservoir Mitigation Plan." Any change, modification or disturbance of the dedicated Property not addressed in the "[Proposed] Lower Bois d'Arc Creek Reservoir Mitigation Plan," or a revision thereof, shall require prior written approval of the District Engineer, USACE, Tulsa District, or his/her duly authorized representative.

2) Term

These restrictions shall run with the land in perpetuity and be binding on all future owners, heirs, successors, administrators, assigns, lessees, or other occupiers and users. The owner must file this Deed Restriction of record with the County Clerks of Fannin County, Texas and Lamar County, Texas within 10 days of the date this document is signed and provide a copy of the recorded Deed Restriction to the USACE, Tulsa District within 30 days of filing.

3) Rights of Access and Entry

The USACE shall have the right to enter and go upon the Property for purposes of inspection, and to take actions including but not limited to scientific or educational observations and studies, and collection of samples.

4) Enforcement

In the event of a breach of the restrictions by the owner, or a third party working with the permission of or under the direction of the owner, the USACE must be notified immediately. If the USACE becomes aware of a breach of this Agreement, the USACE will notify the owner of the breach. The owner shall have thirty (30) days after receipt of such notice to undertake actions that are reasonably calculated to swiftly correct the conditions constituting the breach. If the owner corrects the conditions constituting the breach in a timely and reasonable manner, no further action is warranted or authorized. If the owner fails to initiate such corrective action within thirty (30) days or fails to complete the necessary corrective action, the USACE may undertake such actions, including legal proceedings, as are necessary to effect such corrective action. Any forbearance on the part of the USACE to exercise its rights in the event of a breach of the restrictions shall not be deemed or construed to be a waiver of their rights hereunder in the event of any subsequent failure of the Property owner to comply.

This notice of restriction does not grant any property rights or exclusive privileges.

EXECUTED this ________ day of ________, 20__.

NORTH TEXAS MUNICIPAL WATER DISTRICT

By: ___________________________________
__________, President

ATTEST:

____
__________, Secretary

STATE OF TEXAS §
§
COUNTY OF COLLIN §

This instrument was acknowledged before me on this ______ day of ____________, 201__, by __________, President of North Texas Municipal Water District, a conservation and reclamation district and political subdivision of the State of Texas, on behalf of said conservation and reclamation district.

____
Notary Public, State of Texas
Printed Name of Notary:

____
My Commission Expires: ____________________

NORTH TEXAS MUNICIPAL WATER DISTRICT

Resolution No. ___-___

A RESOLUTION FOR SITE PROTECTION OF THE MITIGATION SITES ASSOCIATED WITH THE NORTH TEXAS MUNICIPAL WATER DISTRICT LOWER BOIS D'ARC CREEK RESERVOIR PROJECT

WHEREAS, NTMWD has proposed the Lower Bois D'Arc Creek Reservoir ("LBCR") Project, SWT Permit No. 14659, to the U.S. Army Corps of Engineers Tulsa District ("USACE") for a Clean Water Act Section 404 Permit ("404 Permit");

WHEREAS, pursuant to applicable regulatory guidance, USACE requires NTMWD to submit for approval a mitigation plan for the 404 Permit to compensate for authorized impacts to certain aquatic resources associated with the proposed LBCR Project;

WHEREAS, NTMWD submitted a mitigation plan to USACE for the LBCR Project ("Mitigation Plan") in November of 2016;

WHEREAS, NTMWD's proposed Mitigation Plan includes compensatory mitigation through a holistic, watershed and ecosystem approach to mitigation;

WHEREAS, to accomplish the mitigation approach, NTMWD has purchased property in Fannin and Lamar Counties to serve as the sites at which mitigation efforts will be concentrated to fulfill USACE-imposed mitigation requirements ("Mitigation Sites");

WHEREAS, following issuance of a 404 Permit for the LBCR that contains terms and conditions acceptable to NTMWD, and pursuant to the Mitigation Plan as finalized and approved by USACE ("Final Mitigation Plan"), NTMWD will own each Mitigation Site until the respective property has satisfied the performance standard requirements set forth in that Final Mitigation Plan;

WHEREAS, in accordance with the conditions of the issued 404 Permit, during NTMWD's ownership of the Mitigation Sites, USACE-approved deed restrictions will be imposed and enforced to allow for the implementation of the Final Mitigation Plan;

WHEREAS, in accordance with the conditions of the issued 404 Permit, NTMWD shall notify the USACE Tulsa District Engineer of any action affecting the Mitigation Sites, including a modification of the instrument, management plan, or long-term protection mechanism;

WHEREAS, once each Mitigation Site has satisfied the performance standard requirements set forth in that Final Mitigation Plan and in accordance with the issued 404 Permit for the LBCR, for long-term management of each Mitigation Site NTMWD will either: (1) enter into a conservation easement, or some other similar agreement approved by USACE, for the Mitigation Site with an USACE-approved third party easement holder/property manager; or (2) transfer title to that Mitigation Site to a federal or state management agency.

NOW, THEREFORE, THE BOARD OF DIRECTORS IN A REGULAR MEETING RESOLVES THAT:

1. Following issuance of a final 404 Permit for the LBCR that contains terms and conditions acceptable to NTMWD, NTMWD shall impose and enforce USACE-approved deed restrictions on the Mitigation Sites and any other land acquired by NTMWD to satisfy the compensatory mitigation requirements imposed for the LBCR Project.

2. The deed restrictions shall allow for the implementation of the compensatory mitigation proposed in the Final Mitigation Plan.

3. The deed restrictions shall contain a provision requiring 60-day advance notification to the USACE Tulsa District Engineer before any action is taken by NTMWD to void or modify Mitigation Site's instrument, management plan, or long-term protection mechanism, including transfer of title to, or establishment of any other legal claims over, the Mitigation Sites.

4. NTMWD shall record the USACE-approved deed restrictions with each of the Fannin and Lamar County clerks, as applicable, and provide a copy of the recorded deed restrictions to the USACE Tulsa District.

5. Once each Mitigation Site has satisfied the performance standard requirements set forth in that Final Mitigation Plan and in accordance with the final 404 Permit and Final Mitigation Plan, for long-term management of each Mitigation Site NTMWD will either: (1) enter into a conservation easement, or some other similar agreement approved by USACE, for the Mitigation Site with an USACE-approved third party easement holder/property manager; or (2) transfer title to that Mitigation Site to a federal or state management agency.

6. This Resolution shall take effect and be in full force and effect from and after the date of its adoption; provided, however, this Resolution shall terminate automatically and be of no further force or effect in the event a final 404 Permit for the LBCR that contains terms and conditions acceptable to NTMWD is not issued or, after issuance, in the event the final 404 Permit is modified or rescinded.

THIS RESOLUTION ADOPTED BY THE NTMWD BOARD OF DIRECTORS IN A REGULAR MEETING ON [MONTH AND DATE], 2017, IN THE ADMINISTRATIVE OFFICES OF THE NTMWD, WYLIE, TEXAS.

JOHN SWEEDEN, Secretary	TERRY SAM ANDERSON, President

(Seal)

NORTH TEXAS MUNICIPAL WATER DISTRICT

Resolution No. ___-___

A RESOLUTION FOR FINANCIAL ASSURANCES FOR COMPENSATORY MITIGATION ASSOCIATED WITH THE NORTH TEXAS MUNICIPAL WATER DISTRICT LOWER BOIS D'ARC CREEK RESERVOIR PROJECT

WHEREAS, NTMWD has proposed the Lower Bois D'Arc Creek Reservoir ("LBCR") Project, SWT Permit No. 14659, to the U.S. Army Corps of Engineers Tulsa District ("USACE") for a Clean Water Act Section 404 Permit ("404 Permit");

WHEREAS, applicable USACE regulatory guidance requires NTMWD to perform appropriate and practicable mitigation to compensate for authorized impacts to certain aquatic resources associated with the proposed LBCR Project;

WHEREAS, applicable USACE regulatory guidance allows USACE to require appropriate financial assurances to provide funding necessary to satisfy compensatory mitigation requirements and ensure mitigation success;

WHEREAS, USACE requires NTMWD to provide financial assurances for the mitigation proposed in the NTMWD mitigation plan for the LBCR Project ("Mitigation Plan");

WHEREAS, NTMWD has purchased property to serve as the site for mitigation activities as a financial assurance to USACE ("Mitigation Sites");

WHEREAS, USACE requires additional financial assurances to ensure the continuous protection of mitigation efforts on the Mitigation Sites for so long as such sites require funding; and

WHEREAS, NTMWD agrees to provide appropriate long-term financial assurances that NTMWD will fund the Mitigation Sites and mitigation activities performed thereon as long as a final 404 Permit is issued and effective for the LBCR Project as proposed or modified by NTMWD, including funding for any period after which NTMWD either: (1) enters into a conservation easement, or some other similar agreement approved by USACE, for each Mitigation Site with an USACE-approved third party easement holder/property manager; or (2) transfers title to each of the Mitigation Sites to a federal or state management agency.

NOW, THEREFORE, THE BOARD OF DIRECTORS IN A REGULAR MEETING RESOLVES THAT:

1. NTMWD shall provide funding in the amount necessary to satisfy compensatory mitigation requirements associated with the LBCR Project as outlined in the Mitigation Plan, as such plan is finalized and approved by the USACE ("Final Mitigation Plan"), and as required by the final issued 404 Permit.

2. NTMWD shall ensure compensatory mitigation funding for the LBCR Project is not withdrawn, reduced, delayed, or otherwise impaired or modified as a result of the transfer of title of the Mitigation Sites to a federal or state management agency or to a third party managing the Mitigation Sites under a conservation easement, or some other similar agreement approved by USACE.

3. This Resolution shall take effect and be in full force and effect from and after the date of its adoption; provided, however, this Resolution shall terminate automatically and be of no further force or effect in the event a final 404 Permit for the LBCR that contains terms and conditions acceptable to NTMWD is not issued or, after issuance, in the event the final 404 Permit is modified or rescinded.

THIS RESOLUTION ADOPTED BY THE NTMWD BOARD OF DIRECTORS IN A REGULAR MEETING ON [MONTH AND DATE], 2017, IN THE ADMINISTRATIVE OFFICES OF THE NTMWD, WYLIE, TEXAS.

______________________________	______________________________
JOHN SWEEDEN, Secretary	TERRY SAM ANDERSON, President

(Seal)

APPENDIX D: RESERVOIR OPERATION PLAN

Draft Operation Plan
Proposed Lower Bois d'Arc Creek Reservoir

1.0 Introduction

North Texas Municipal Water District (NTMWD) supplies treated water to customers in suburban communities north and east of Dallas. Figure 1 is a diagram of the NTMWD raw water supply system (System). Currently NTMWD obtains raw water from six reservoirs[1] and from reuse. The primary reservoirs include Lakes Lavon, Chapman, Texoma and Tawakoni as shown on Figure 1. The operation of the System is governed by numerous water rights, regulatory requirements, contracts, and operating agreements. In operating the System, NTMWD considers the availability and reliability of the sources of supply, water quality, pumping costs, and other factors. NTMWD also operates several raw water pipelines, three water treatment plants (WTPs), a manmade wetland, sixteen wastewater treatment plants (WWTPs), and a large treated water transmission network

Because NTMWD's service area is growing rapidly, new infrastructure and water sources are planned to be added in the future. Lower Bois d'Arc Creek Reservoir (LBCR) is one of several new sources. Since there will be many changes to the System, the operation of the System will change over time as required to meet future needs. This draft operation plan describes how the LBCR will fit into the System, operational requirements associated with the Texas Commission on Environmental Quality's (TCEQ) water right permit (Water Permit), anticipated monthly water use patterns and some of the operational factors that will govern the System and the operation of the reservoir itself when the LBCR is added to the System.

[1] The six reservoirs include Lakes Lavon, Texoma, Chapman, Tawakoni, Bonham and Fork.

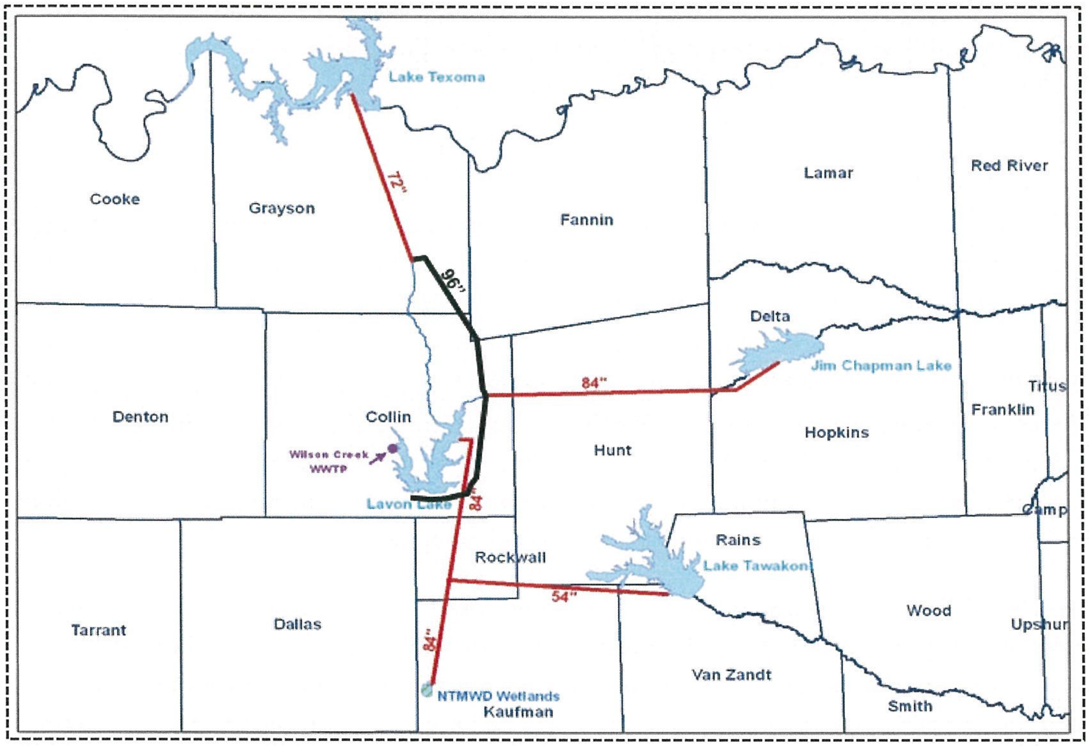

Figure 1 – NTMWD Existing Raw Water Transmission System

2.0 Future Supplies – Lower Bois d'Arc Creek Reservoir

The LBCR will be located on Bois d'Arc Creek in the Red River Basin. Supplies from the LBCR will be pumped by pipeline to a planned fourth NTMWD WTP near the City of Leonard in Fannin County (Leonard WTP). From there treated water will enter into the NTMWD treated water distribution system. It is anticipated that much of this supply will be used for the growing north and northeast part of the NTMWD service area (Figure 2), but it could also be used in other parts of the treated water distribution system. The Leonard WTP eventually may also treat supplies from other sources.

The LBCR will be a significant and much needed source of reliable high-quality water for NTMWD. It will replace temporary sources of water such as those from the Upper Sabine Basin, and will provide supplies to meet growth in the NTMWD service area. NTMWD expects to fully utilize the LBCR water supplies within the next 15 to 20 years.

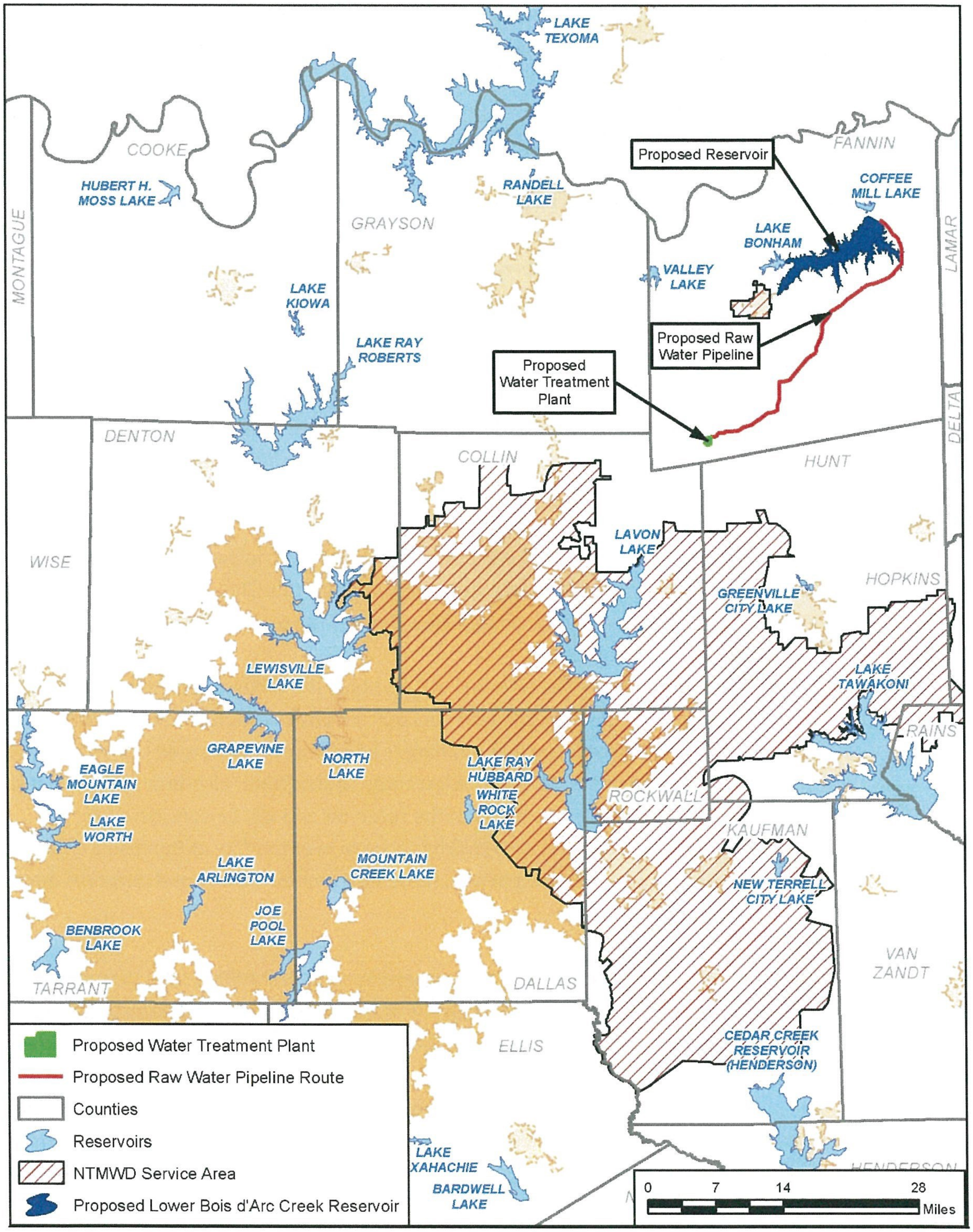

Figure 2 - NTMWD Service Area

Operation of the LBCR will be conducted in compliance with Texas water law and the Water Permit. Some of the specific operational considerations NTMWD will implement, including requirements of the Water Permit, are listed below:

- Storage – LBCR is authorized to impound 367,609 acre-feet of State water for municipal, industrial, agricultural and recreational use.
- Diversions – NTMWD is authorized to divert 175,000 acre-feet per year at a maximum diversion rate of 365.15 cfs from any point on the perimeter of the reservoir.
- Pass-Throughs (Pass-Throughs are inflows that are released (or "passed through") through the LBCR Dam to Bois d'Arc Creek. Pass-Throughs do not include releases of stored water. For purposes of this operation plan, the terms "pass-through" and "release" are used interchangeably.)
    - Downstream senior water rights - In compliance with State water law, NTMWD will pass inflows through the dam for existing water right holders. There are two existing water rights on Bois d'Arc Creek between the LBCR and the confluence with the Red River and thirteen Texas water rights on the Red River downstream of the confluence with Bois d'Arc Creek.
    - Environmental flows – NTMWD will pass inflows through the dam in compliance with the environmental flow requirements in the Water Permit. The environmental flow regime is based on the Texas Instream Flow Program and requires Seasonal base flow and pulse flow releases.
    - Wastewater discharges – The NTMWD will also pass the effluent return flow of the City of Bonham that is discharged upstream of LBCR for environmental flow purposes downstream of the dam. The City's discharges have historically ranged from <1 cfs to 3.5 cfs, with an average of 1.8 cfs over the last three years. (Note: all effluent return flows to the LBCR are considered as inflow to the reservoir and will be considered for environmental flow purposes. NTMWD has control over the City of Bonham's effluent return flows and has committed to pass these flows for environmental purposes during subsistence conditions.)
- Monitoring and Compliance
    - Monitoring Plan – A Monitoring Plan was developed by NTMWD for the Water Permit. This plan was reviewed and accepted by the TCEQ for monitoring the hydrology, water quality and biology for compliance with the Water Permit. A copy of this plan is included in Attachment 1.
    - Accounting Plan – An accounting plan is required by Texas to document compliance with the Water Permit. This plan documents inflows, pass-throughs and compliance with the environmental flow requirements. A copy of the narrative for the Accounting Plan for LBCR is included in Attachment 2.

Reservoir Inflows / Impoundment

Inflows will be stored in the LBCR in compliance with the Water Permit. The normal conservation pool elevation is 534 ft msl. Water that enters the reservoir above the normal pool level will be discharged downstream over the uncontrolled service spillway. The service spillway is a 60' wide labyrinth weir structure. Water that flows over the service spillway is discharged to Bois d'Arc Creek via a concrete spillway channel. The emergency spillway elevation is 541 ft msl. If water levels in the lake exceed 541 ft msl, the flood water will be released downstream over the uncontrolled emergency spillway.

Daily inflows to the reservoir will be determined in the accounting plan by two methods: a mass balance calculation and a partial gage/drainage area ratio calculation. The mass balance calculation is used to determine compliance with impoundment and diversions requirements for the Water Permit. The USGS gage/drainage area ratio calculation is used to determine compliance with environmental flows.

Mass-Balance Method. The mass balance calculation will use daily records of reservoir storage, diversions, spills, downstream releases, rainfall and evaporation to calculate the inflow to the reservoir. This calculation will be used to determine compliance with the impoundment and diversion requirements in the Water Permit.

Gage/Drainage Area Ratio Method. A stream gage will be installed upstream from the reservoir at Texas Hwy 56. This gage will capture approximately 144 square miles of drainage area, which is 44% of the drainage area for the lake. To estimate the total inflow to the lake, the drainage area ratio method will be applied to the remaining 56% of the contributing drainage area. Wastewater discharges from the City of Bonham and City of Honey Grove will be recorded and included in the inflow calculations. The daily inflow to the reservoir by the partial gage/drainage area ratio calculation will be estimated as follows:

> Estimated inflow to reservoir = Measured Flow Upstream x (327 square miles at dam) / (144 square miles at measurement point) + Wastewater Discharge from Bonham + Wastewater Discharge from Honey Grove

Diversions

Water will be diverted by NTMWD through a multi-level intake tower located near the dam that transports the water to a pump station located immediately downstream of the dam. The intake structure will be a rectangular tower with two cells, each of which will have the capacity to withdraw water for the needed water supply demands as well as the releases of inflow required for base and subsistence flows. Under normal operating conditions, both cells will be used concurrently and will feed a pair of 78" pipes that will be concrete encased through the dam embankment to the pump station located shortly downstream. Diversions could occur through a single cell when the other is closed for maintenance, but this operation is not planned to occur during times of high demand. In the pump station, the two 78" pipes will feed a 90" suction header line that will distribute the flow to the pumps being utilized. An approximately 27" pipeline (referred to as the low level outlet works) will extend from this suction header line to the spillway channel and will be used to deliver releases of inflow required for base and subsistence flows (including the subsistence period freshet as required by the water period) to the downstream channel via the spillway chute. Releases for downstream water right holders can be made from this 27" pipe or through the service spillway outlet works. Both diversions and downstream flow releases can be made at the same time.

Flows into the intake structure to be pumped or released as base or subsistence bypass flows will be screened in order to minimize the potential for impingement and/or entrainment. In accordance with the Water Permit the velocity of the water into the intake structure shall be no more than 1 foot per second.

Pass-Throughs for Environmental Flows

Environmental flows will be passed through the dam in compliance with the special conditions in the Water Permit. These conditions were developed from site-specific instream flow studies of Bois d'Arc Creek (FNI, May 2010 and FNI, September 2010) and were found by the TCEQ to provide a sound ecological environment in Bois d'Arc Creek downstream of the dam.

Environmental flows are defined for normal and subsistence hydrologic conditions in the watershed. Subsistence conditions are defined as when the reservoir is below 40% capacity. This corresponds to approximately 9% of the historical hydrologic record. Normal conditions are all other times.

In compliance with the Texas Instream Flow program, the environmental flow regime includes base flows and pulse flows during normal hydrologic conditions. During subsistence conditions, only base flows and a subsistence period freshet are applicable during operations. Base flows are daily operational flows and are limited to inflows to the reservoir. Pulse flows are typically associated with a rain event. The characteristics of a pulse flow include a peak, volume and duration. Pulse events are not released during subsistence conditions. A subsistence period freshet is a small pulse that is released only during subsistence conditions. The conditions and frequency of the subsistence period freshet differ from the pulse events. The decisions and triggers to pass inflows through the reservoir for environmental flow purposes are outlined in detail in the Accounting Plan (Attachment 2).

If there are inflows to the reservoir, environmental flows will be passed through the dam, by season, in accordance with the criteria in Table 1. In accordance with the Water Permit, passage of environmental flows are limited to the inflow into the reservoir. If inflows into the reservoir are less than the environmental flow requirements, NTMWD is only obligated to pass the amount of inflow into the reservoir. The base flow values for summer and fall-winter in Table 1 were selected to provide connectivity of flow in Bois d'Arc Creek at FM 409. The base flow amounts in the spring were selected to provide flows adequate for spawning.

Pulse flows provide for channel maintenance and water quality functions. A qualifying pulse event is one in which the peak flow criterion is met and either the volume or duration criteria is met (see Table 1). A qualifying pulse event that enters the reservoir is passed through the reservoir if a comparable pulse event does not occur naturally at the FM 409 stream gage. If the number of events for a season are met, then no additional pulse flows are passed through the dam for that season. If a qualifying pulse event does not occur during a season, then no pulse flows are passed. Each season is independent of each other for purposes of meeting the environmental flow criteria.

A subsistence period freshet provides a creek bed wetting flow during periods of drought. Similar to a pulse event, the subsistence period freshet consists of a peak, volume and duration. A qualifying subsistence period freshet that enters the reservoir is passed-through the dam if a qualifying event does not occur naturally at FM 409 within the previous 60 days. Once a qualifying event is recorded at the FM 409 gage or passed through the reservoir, the 60-day time period begins again until the reservoir is no longer in subsistence conditions.

In addition to the environmental flow pass-throughs outlined in the Water Permit, NTMWD will pass the effluent return flows of the City of Bonham through the LBCR to Bois d'Arc Creek downstream of the dam, even under subsistence flow conditions. NTMWD has under contract only the right to that portion of Bonham's wastewater that is discharged to a State watercourse, and intends to continue to release these flows for environmental purposes. Bonham could develop a direct reuse project in the future, which could reduce the effluent return flows. However, it is anticipated that with the projected growth of Bonham, the wastewater effluent would increase and a future direct reuse project would not significantly impact current effluent return flow amounts. The effluent return flows of the City of Honey Grove to Honey Grove Creek would also be considered as inflow for the purposes of determining environmental flow pass-throughs. Honey Grove controls its effluent discharges and these discharges could be reduced if the City implemented a reuse project. The NTMWD would still be required to pass inflows in accordance with the seasonal environmental criteria and enhancement of Bois d'Arc Creek does not rely on these effluent return flows. It is anticipated that the passage of effluent return flows will result in a minimum daily pass-through of 1 cfs, but likely would be higher since current wastewater discharges average 1.8 cfs for the City of Bonham and 0.5 cfs for the City of Honey Grove.

Table 1 - Environmental Flow Criteria for Bypassing Inflows through the Reservoir

Season	Months	Subsistence	Base	Pulse
Fall-Winter	November - February	1 cfs*	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 ac-ft Duration: 7 days
Spring	March - June	1 cfs*	10 cfs	2 per season Trigger: 500 cfs Volume: 3,540 ac-ft Duration: 10 days
Summer	July - October	1 cfs*	3 cfs	1 per season Trigger: 100 cfs Volume: 500 ac-ft Duration: 5 days

cfs = cubic feet per second ac-ft = acre-feet

*A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 af, and a duration of 3 days, to occur no more than every 60 days, also applies.

As discussed under **Diversions**, base and subsistence flows will be released from the reservoir through the multi-level intake tower and low level outlet works to be discharged to the service spillway chute. Pulse flows will be released from the reservoir through multiple levels of sluice gates located in the service spillway (referred to as the service spillway outlet works). The service spillway outlet works consist of two 5'x5' gates and two 6'x5' sluice gates located at three different elevations. Typical pulse flow patterns for each season are included in the Accounting Plan and shown in Attachment 2. If needed, the lower level pulse flows can be released from the reservoir through the low level outlet works or released through the service spillway outlet works. A gage will be included as part of the low level outlet work for measuring flow rates. Flows released through the service spillway outlet works will be measured using a stage-discharge curve. The stage-discharge curve will be calibrated based on measured flows.

To assist with the reservoir operations for environmental flow pass-throughs, dissolved oxygen and temperature profiling of the lake water column will be conducted in the main body of the lake near the reservoir intake tower on a weekly basis beginning the first week of each May. Weekly monitoring will continue until a temperature and dissolved oxygen gradient is observed indicating that stratification has become established. After determining that stratification is present, monitoring frequency will be decreased to monthly until stratified conditions no longer exist. The profile data collected will be used to determine which gates on the intake tower should be operated to deliver oxygenated water for pass-throughs. Verification that surface water quality standards for dissolved oxygen and temperature for Bois d'Arc Creek are met will be provided by the water quality measurements at the stream gage at FM 409 downstream of the dam.

Monitoring and Compliance

NTMWD will use data collected from three stream gages to assist with operations and compliance determination with the water permit:

- A new stream gage located at Texas Hwy 56 will be used to calculate inflows to the reservoir for operations of environmental flow pass-throughs.
- The existing stream gage at FM 409 will be used to monitor flow and water quality (temperature and dissolved oxygen) of Bois d'Arc Creek downstream of the dam for compliance with environmental flows.
- A new stage discharge gage will be installed near FM 100 to measure larger flow events (> 500 cfs) that are expected to occur naturally in the lower part of the basin.

It is anticipated that a rainfall gage and evaporation pan will be installed at the dam to collect data for calculating inflows by mass-balance. Alternatively, existing nearby gages may be used. There are several active nearby rain gages, including one at Bonham (410923) and Honey Grove (414257). The most likely nearby evaporation gage is located at Lake Jim Chapman. However, the NTMWD may choose to use other gages if needed.

Biological monitoring of Bois d'Arc Creek will be conducted in accordance with the special conditions in the Water Permit and as outlined in the Mitigation Plan. Documentation of environmental flow releases will be provided to the USACE in accordance with the reporting requirements in Section 10 of the Mitigation Plan.

Daily operation data will be recorded in the LBCR Accounting Plan (Attachment 2). The TCEQ will verify compliance with the Water Permit through inspection of the Accounting Plan and the required annual reporting.

If the monitoring indicates that the operations are not meeting water quality standards or biological indices, NTMWD will immediately begin an adaptive management initiative. This initiative will assess the root cause of the non-compliance, identify remedial actions and implement those actions. Each adaptive management initiative will be unique to the non-compliance.

3.0 Normal Operations

LBCR will be operated as part of the NTMWD water system. Figure 3 shows the projected annual supplies from NTMWD's current sources and potential future sources as of July 2015.

Under normal operations, it is expected that the full yield of the reservoir will be 67% utilized within ten years of operation (2032). Figure 4 shows the projected annual diversions from LBCR based on current normal year projected demands.

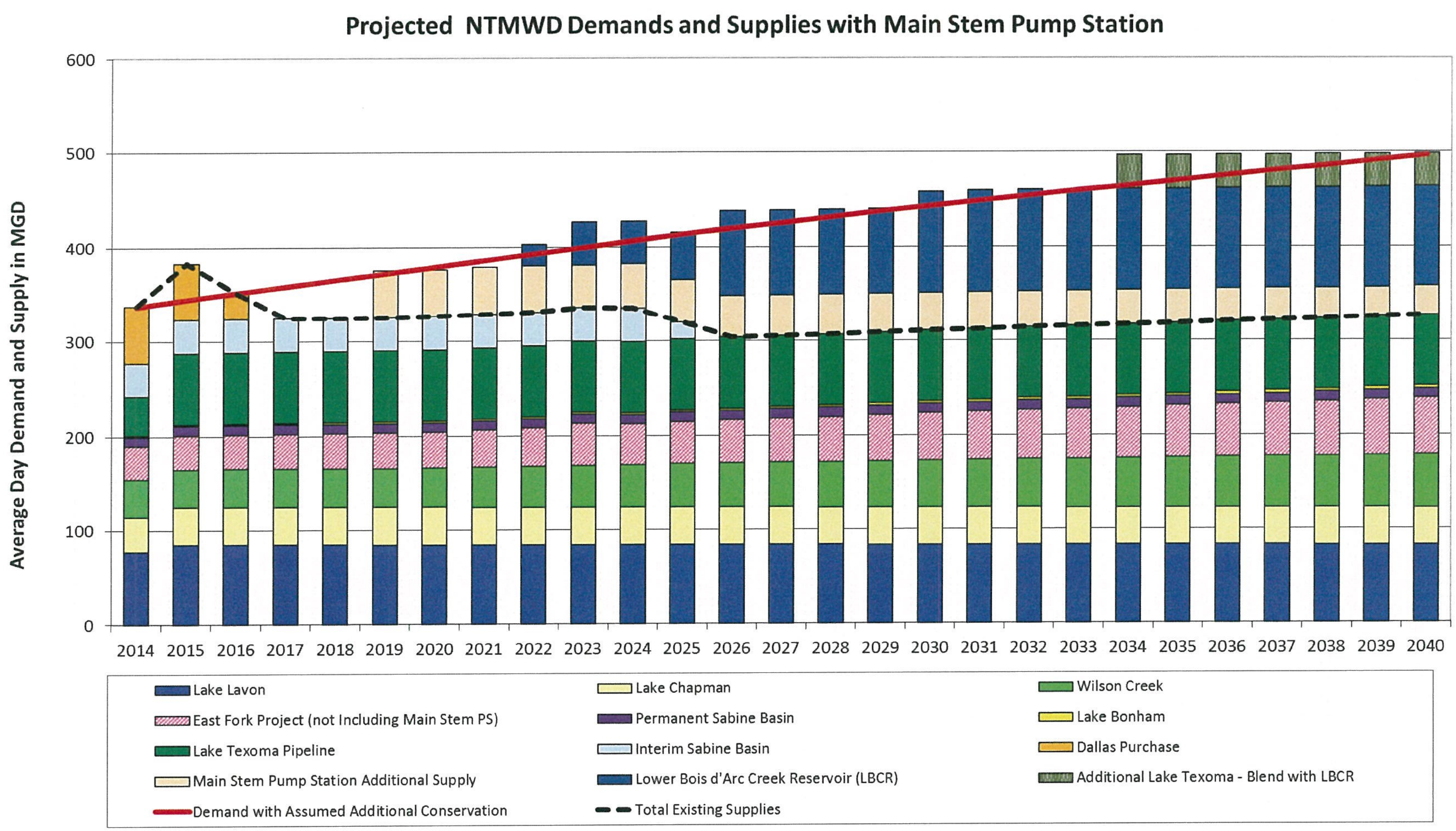

Figure 3 - NTMWD System Demands

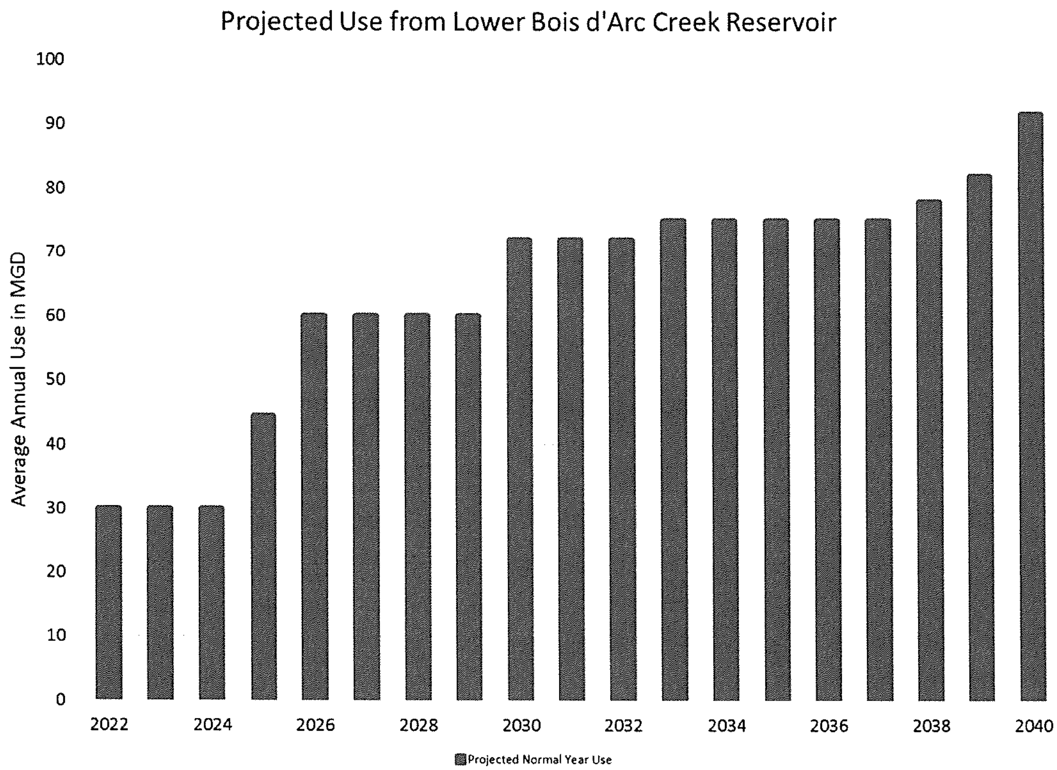

Figure 4 - Projected Normal Year Demands on LBCR

It is expected that the reservoir will be operated on a firm yield basis (diversions totaling approximately 120,000 acre-feet per year) or less during normal year demand and climatic conditions. During wet periods, the reservoir may be operated at its maximum diversion rate of 236 MGD. A potential operations scenario provided in Attachment 3 assumes that overdraft operations could occur as long as the LBCR is less than 2 feet below the top of conservation storage and the maximum diversion amount of 175,000 acre-feet per year has not been reached. When the LBCR drops more than 2 feet below the top of conservation storage, the diversions would be reduced to less than the LBCR firm yield. Modeling studies of the overdraft operation found little differences in the downstream flows at FM 409 and little difference in the water levels in the lake between the potential overdraft operation and normal operations.

Some of the factors that can affect the operation of the LBCR as part of the System include:

- *Climatic conditions.* For example, during relatively wet times NTMWD may elect to use less imported water if Lake Lavon is full, reducing power consumption.

- *Available infrastructure.* Initially the full use of the LBCR may be limited by treatment and distribution capacity. At times, use of the LBCR may increase if another reservoir or other water transfer facilities are out of service which would limit the use from other supply sources.

- *Other future water sources.* As NTMWD adds more sources of supply to the System the operation of the Reservoir may change to accommodate the use of those supplies, particularly if those sources are treated at the Leonard WTP.

Figure 5 shows the flow frequency at FM 409 under firm yield operations. These flows are from modeling runs using the daily RiverWare model that was developed to examine environmental flows for the project. The final environmental flows are included in the modeling. Flows are displayed on both a normal and a log scale. The log scale graph is provided to facilitate examination of the low flow periods. As shown on these graphs, there is expected to be a minimum of about 2 cfs flow in Bois d'Arc Creek at all times due to passing the wastewater discharges from Bonham. This will provide water to the downstream ecological system during conditions when the Bois d'Arc Creek would otherwise be dry. Note that in Figure 5 flows are at 2 cfs approximately 20 percent of the time. This does not imply that the reservoir will be in subsistence condition 20 percent of the time. According to the model, subsistence conditions occur about 9 percent of the time. The model limits releases from the LBCR to inflows to the reservoir, so inflows are about 2 cfs approximately 20 percent of the time. The remaining 11 percent of the time that flows are at 2 cfs are periods when there is little or no inflow into the LBCR other than wastewater discharges, but reservoir storage is above the subsistence trigger level.

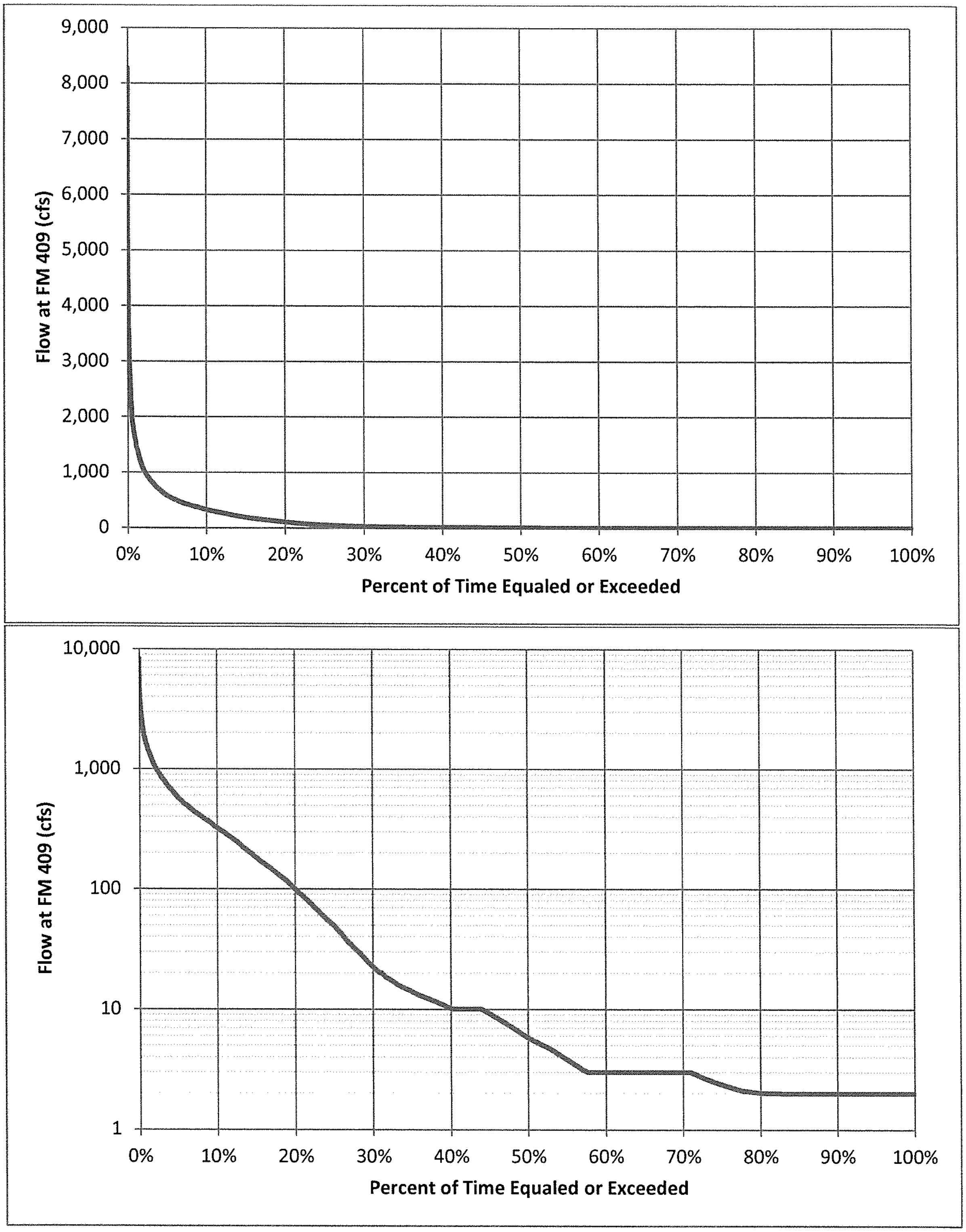

Figure 5: Modeled Flow Frequency at FM 409

4.0 Drought Operations

During drought there are two considerations: increased demands and potentially reduced storage in NTMWD water sources. Based on projected dry year demands, the expected demand on LBCR is shown in Figure 6.

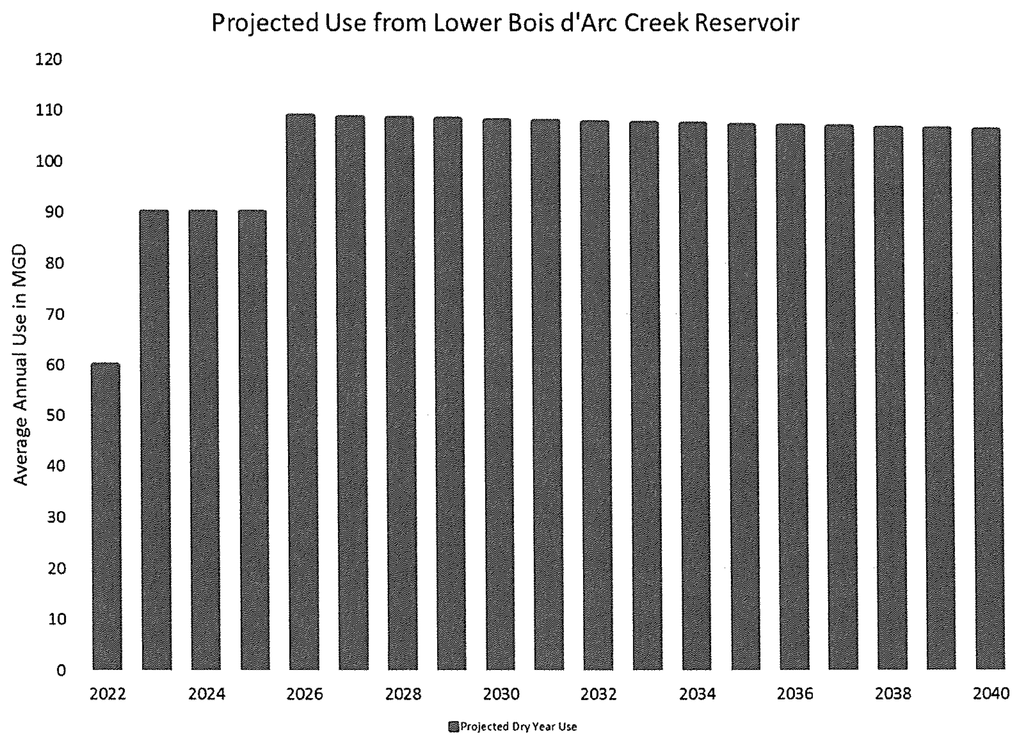

Figure 6 – Projected Dry Year Demands on LBCR

Under drought conditions, it is expected that full utilization of the reservoir would occur sooner (within five years) than under normal operations. As with normal operations, NTMWD intends to manage the reservoir in concert with its other water sources.

Upon completion of the reservoir, NTMWD will update its drought contingency plan to include the LBCR. The drought contingency plan will identify specific triggers and actions in response to drought conditions. One of the goals of the drought plan is to reduce system demands so that NTMWD can better manage its water supplies during dry periods.

Under the Water Permit, the reservoir is considered in subsistence conditions when the lake storage reaches 40% capacity. During this period, wastewater inflows will be passed through the dam to Bois d'Arc Creek. If a rain event occurs such that LBCR receives inflows of at least 20 cfs peak flow and 69 acre-feet pulse volume, and a corresponding event does not occur at the FM 409 gage, NTMWD will release a subsistence period freshet during a 60-day period. This will provide the downstream Bois d'Arc Creek with a small pulse event for maintaining downstream habitats even under subsistence conditions.

Attachment 1

Monitoring Plan

NORTH TEXAS MUNICIPAL WATER DISTRICT
MONITORING PLAN
For Proposed Lower Bois d'Arc Creek Reservoir

BACKGROUND:
The North Texas Municipal Water District (NTMWD) has applied for a water right (Application No. 12151) to store, divert and use water from the proposed Lower Bois d'Arc Creek Reservoir. During processing of the water right Application No. 12151, Commission staff determined that the environmental flow regime outlined in the draft permit maintains a sound ecological environment downstream of the dam. To document the downstream flow regime in Bois d'Arc Creek after the dam is completed and closed, Commission staff has recommended that a monitoring program be implemented.

The NTMWD has also applied for a USACE Section 404 Permit to construct the proposed reservoir. As part of the water right application and the USACE Section 404 application, the NTMWD has prepared a mitigation plan. This mitigation plan will be approved by the federal and state agencies and made part of the Section 404 Permit. The Mitigation Plan outlines the actions necessary to compensate for project impacts, details the monitoring of these mitigating actions, and specifies when the mitigation actions have met compliance with the mitigation goals.

BOIS D'ARC CREEK MONITORING PROGRAM
The Monitoring Program for Bois d'Arc Creek will consist of three primary components:

1. Hydrologic Monitoring
2. Biological Monitoring
3. Water Quality Monitoring

<u>Hydrologic Monitoring</u>
Hydrologic Monitoring of Bois d'Arc Creek downstream of the dam will consist of daily measurements at the existing USGS gage at FM 409 and a new partial record stage recording gage near FM 100. Hydrologic parameters monitored by the NTMWD at the FM 409 gage will include flow readings on 15-minute intervals and calculated average daily flows. Parameters monitored by the NTMWD at the new FM 100 gage will include stage data to calculate larger flows (flows greater than 500 cfs).

Hydrologic monitoring will begin after closure of the dam and data will be summarized on an annual basis and submitted to the Commission. After five and ten years of data collection, the NTMWD will prepare a summary report describing the results of its hydrologic monitoring. Hydrologic monitoring at FM 100 will cease after ten years or when the biological monitoring component ceases, whichever is later.

<u>Biological Monitoring</u>
Biological Monitoring will be conducted in accordance with the approved Mitigation Plan. Biological monitoring will be performed in years 1, 3, 5 and 10 following closure of the dam. A biological monitoring report will be submitted to the Executive Director of the TCEQ within six (6) months of the completion of the field activities. A summary report comparing the biological monitoring data to baseline conditions also will be prepared in years 5 and 10. If the metrics show no trends indicating

degradation of the aquatic community and the annual diversions from the reservoir have exceeded 100,000 acre-feet during at least one year of operation prior to the year 5 monitoring, then monitoring will end after 10 years. If these conditions are not met, biological monitoring will continue to be performed each subsequent 5 years until such conditions are met and a minimum of two yearly sampling events have been conducted following the diversion of 100,000 acre-feet in a given year.

Water Quality Monitoring

Water quality will be monitored downstream of the reservoir after closure of the dam to verify compliance with the stream standards for dissolved oxygen and temperature. Water quality parameters will be continuously recorded at the USGS gage at FM 409, and include at a minimum water temperature, pH, dissolved oxygen and specific conductivity.

To assist with the reservoir operations for environmental flow pass throughs, dissolved oxygen and temperature profiling of the lake water column will be conducted in the main body of the lake near the reservoir intake tower on a weekly basis beginning the first week of each May. Weekly monitoring will continue until a temperature and dissolved oxygen gradient is observed indicating that stratification has become established. After determining that stratification is present, monitoring frequency will be decreased to monthly until stratified conditions no longer exist. The profile data collected will be used to determine which gates on the intake tower should be operated to deliver oxygenated water for pass throughs. Verification that instream water quality criteria for dissolved oxygen and temperature are met will be provided by the measurements at the USGS gage at FM 409 downstream of the dam.

Water quality monitoring data will be summarized on an annual basis and submitted to the Commission. After five and ten years of data collection, the NTMWD will prepare a summary report describing the results of its water quality monitoring. The summary reports will be prepared as part of the hydrologic monitoring report. Water quality monitoring of dissolved oxygen and temperature at FM 409 and within the main body of the lake will continue through the life of the project. All formal water quality reporting to the Commission will cease after 10 years or when the biological monitoring ceases, whichever is later.

Attachment 2

Accounting Plan Narrative

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TEXAS REGISTERED
ENGINEERING FIRM
F-2144

NORTH TEXAS MUNICIPAL WATER DISTRICT
RESERVOIR ACCOUNTING PLAN
For the Lower Bois d'Arc Creek Reservoir

Simone Kiel, P.E. and Jon S. Albright, Freese and Nichols, September 5, 2014

INTRODUCTION

The North Texas Municipal Water District (the "District") is seeking a water use permit to store, divert and use surface water from the proposed Lower Bois d'Arc Creek Reservoir (the "Reservoir") in Fannin County. This water would be used within the District's service area.

The District has a pending application (Application No. 12151) that requests, among other things, the following rights:

- The impoundment of up to 367,609 acre-feet.
- The use of the impounded water for recreation purposes.
- The diversion and use of up to 175,000 acre-feet per year for municipal, industrial and agricultural purposes.
- The diversion from any point on the perimeter of the Reservoir at a maximum diversion rate of 365.15 cfs (163,889 gpm, 236 mgd).

This accounting plan provides the framework to document compliance with the environmental flow regime that has been developed by the Texas Commission on Environmental Quality, which is shown in the table below (Table 1). A qualifying pulse occurs when the peak and either the volume or duration criterion have been met. If the District intentionally releases water downstream to generate a qualifying pulse at the USGS gage 07332622, Bois d'Arc Creek at FM 409, then the qualifying pulse at FM 409 must meet the peak and both the volume and duration criteria.

Table 1
Environmental Flow Regime for the Reservoir

Season	Months	Subsistence Flow (cfs)[1]	Base Flow (cfs)	Pulse Volume (ac-ft)	Pulse Duration (days)	Pulse Peak Flow (cfs)
Spring	March-June	1	10	3,540	10	500
Summer	July-October	1	3	500	5	100
Fall/Winter	Nov-Feb	1	3	1,000	7	150

1. A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 ac-ft, and a duration of 3 days, as further defined below, also applies.

During subsistence conditions, a subsistence flow freshet requirement will be in effect. Similar to the pulse flow requirements, a qualifying freshet occurs when the peak and either the volume or duration criterion have been met. The freshet requirement occurs only during subsidence periods and there is a consideration of a 60-day period between qualified freshets. Once the Reservoir is no longer in subsistence conditions, the pulse flow requirements outlined in Table 1 return in effect.

ELEMENTS OF THE ACCOUNTING PLAN

The accounting plan includes the following tables:

Table 1: Basic Input Data – includes basic data for the Reservoir on a daily basis, including elevation, releases, diversions from the lake, etc.

Table 2: Calculation of Reservoir Inflows – calculates daily inflow to the Reservoir using a basic mass-balance calculation.

Table 3: Calculation of Environmental Flows – calculates the environmental flow conditions for compliance with the agreed on environmental flow regime for the Reservoir, with the exception of the subsistence freshet.

Table 4: Calculation of Subsistence Freshet - calculates the environmental flow conditions for compliance with the subsistence freshet for the Reservoir

Table 5 - Net Reservoir Evaporation – computes the net Reservoir evaporation rate from the Reservoir. This information is used for the calculation of inflows in Table 2.

Table 6: Summary Reporting Data for Water Right – provides a monthly summary of data necessary for the annual water right report.

Table 7: Summary of Environmental Flows for Current Year – summarizes the environmental flows for the calendar year.

These tables are discussed individually in the following sections of the plan. There are also three tables that provide reference data. These include: a) Area-Capacity-Elevation table (ACE); b) Factors, which provides unit conversion factors and pan evaporation factors; and c) Release Patterns, which presents qualifying release patterns for pulse events by season and the subsistence freshet. In addition to these tables there are two charts that track daily inflows to the Reservoir and flows at FM 409. These charts are tools for the District to use to identify and confirm qualifying pulse events for compliance with environmental flow requirements.

The Accounting Plan Excel workbook is currently developed for one 365-day year. Each year a new workbook template will be used. A leap year template will be used for leap years.

TABLE 1 – BASIC INPUT DATA

This table gives the basic input data for the Reservoir on a daily basis. Data on this worksheet are hand entered and will be either measured by the District or obtained from outside sources (such as USGS). The columns in the table are developed as follows:

(1.1) Date. This is the date to which the data apply.
(1.2) Daily Elevation. This is Reservoir surface water elevation, which will be recorded by District staff each day. It will be recorded in feet mean sea level.
(1.3) Pumped Amount. This is the volume of water pumped from the Reservoir each day. This is measured in Million Gallons (MG).
(1.4) Releases. This is the daily average amount of water released from the Reservoir for environmental flows and/or for senior water rights. This is measured at the dam in cubic feet per second (cfs).
(1.5) Type of release. This denotes whether the release is a base flow release (1), a pulse release (2), a subsistence freshet release (3), or a supplemental release (4) used to create a pulse at FM 409. Subsistence flows (other than the freshet release) and supplemental releases are classified as base flows for this column. Base and subsistence flow releases are determined using Table 3 – Calculations of Environmental Flows, Columns 3.6 through 3.8. Pulse flow releases from the Reservoir are determined using Table 3 Columns 3.10 through 3.30. Freshet releases are determined using Table 4 – Calculations of Subsistence Freshet. Tables 3 and 4 are discussed in more detail later in this Accounting Plan narrative. This column is formatted with a drop down menu such that only numbers 1 – 4 can be entered.
(1.6) Spills. This is the daily volume of water spilled from the Reservoir. It is measured in day second feet (dsf). (A dsf is one cfs of discharge for one day.)

(1.7) Flow at FM 409. This is the average daily flow recorded by the USGS at the FM 409 gage. This is measured in cfs.

(1.8) Rainfall. This is measured rainfall data at the dam for the Reservoir. (It is assumed that a rainfall gage will be installed at the dam.) This is measured in inches of rainfall.

(1.9) Pan Evaporation. This is the amount of evaporation at the dam for the Reservoir. (It is assumed that an evaporation pan will be installed at the dam. Alternatively, daily evaporation data may be obtained from an existing nearby lake.) This is measured in inches of evaporation.

(1.10) Flow at FM 100. This is the daily average flow for a future partial flow gage on Bois d'Arc Creek located near FM 100. It is anticipated that the flow gage will measure flows at and above 500 cfs. Flows less than 500 cfs will be denoted either as a dash or "<500".

(1.11) Flow at TX 56. This is the daily average flow for a future USGS flow gage on Bois d'Arc Creek located near Texas Highway 56. This is measured in cfs. Data from this flow gage will be used to provide estimates of inflows to the Reservoir under low flow conditions for purposes of environmental flow compliance.

(1.12) Bonham Wastewater Discharge. This is the amount of wastewater discharged to the Bois d'Arc Creek watershed from the City of Bonham's wastewater treatment plant. It is measured in cfs.

(1.13) Honey Grove Wastewater Discharge. This is the amount of wastewater discharged to the Bois d'Arc Creek watershed from the City of Honey Grove's wastewater treatment plant. It is measured in cfs.

Data from the previous year's accounting plan for December 31 will be entered on row 12, and include End-of-Day Elevation (1.2), Pumped Amount (1.3), Releases (1.4) and Spills (1.6). The number of pulses credited during November and December of the previous year will be entered in cell K2. This value is taken from Table 3, cell AG4 of the previous year's accounting plan.

TABLE 2 – CALCULATION OF RESERVOIR INFLOWS

This table calculates the inflow to the Reservoir using two methodologies: 1) a basic mass-balance computation and 2) a measured gage flow with drainage area ratio computation. The gage flow/drainage area method also considers wastewater discharges from the Bonham and Honey Grove wastewater treatment plants. The gage flow/drainage area method will only be used for environmental flow calculations and compliance for days on which the flows that are calculated by the mass-balance method are 150 cfs and less. On days that flows exceed 150 cfs by the mass-balance method, the mass-balance method would be used for environmental flow calculations and compliance.

The columns in the table are developed as follows:

Columns (2.1) through (2.11) describe the Reservoir inflows using mass-balance method:

(2.1) Date. This is the date to which the data apply. It is referenced from Table 1 (1.1).

(2.2) Month. This is the month to which the data apply.

(2.3) Storage. This is the calculated Reservoir storage in acre-feet based on the previous day's measured surface water elevation (Table 1 (1.2)) and the Area-Capacity-Elevation Table.

(2.4) Area. This is the calculated Reservoir area in acres (ac) based on the previous day's measured surface water elevation (Table 1 (1.2)) and the Area-Capacity-Elevation Table.

(2.5) Net Evaporation. This is the net evaporation rate in feet for the Reservoir. This rate is calculated in Table 4.

(2.6) Net Reservoir Evaporative Loss. This is the calculated daily evaporative loss based on the surface area of the Reservoir (Columns (2.4) x (2.5)). It is reported in acre-feet of loss.

(2.7) Diversion. This is the actual diversion from the lake in acre-feet. The information is taken from Table 1 (1.3) and converted from million gallons to acre-feet.

(2.8) Releases. This is the actual releases from the lake in acre-feet. The information is taken from Table 1 (1.4) and converted from cubic feet per second (cfs) to acre-feet.

(2.9) Spills. This is the actual spills from the lake in acre-feet. The information is taken from Table 1 (1.6) and converted from day second feet (dsf) to acre-feet.

(2.10) Inflow (ac-ft). This is the mass-balance calculated inflow to the lake in acre-feet. It is determined by the change in storage from the previous day (2.3 for the current day minus 2.3 for the previous day) plus the net evaporative loss (2.6), diversions (2.7), releases (2.8), and spills (2.9).

(2.11) Inflow (cfs). This is the mass-balance calculated inflow to the lake (2.10) converted to cfs.

Column (2.12) calculates the Reservoir inflows using gage/drainage area method:

(2.12) Inflow (cfs). This is the calculated inflow to the lake using the gage/drainage area method by multiplying the gage flow at TX 56 (1.11) times the drainage area ratio [Factor (C21)] plus the Bonham wastewater discharges (1.12) and the Honey Grove wastewater discharges (1.13).

Columns (2.13) and (2.14) describes the Reservoir inflows that are used for environmental flow purposes:

(2.13) Inflow (cfs). This column selects the appropriate inflow value for environmental flow calculations and compliance. If the inflow using the mass-balance method (2.11) is greater than 150 cfs, then the mass-balance method inflow (2.11) is recorded in this column. If the mass-balance method (2.11) is less than or equal to 150 cfs, then the gage/drainage area inflow (2.12) is recorded.

(2.14) Inflow (ac-ft). This is the calculated inflow to the lake (2.13) converted to ac-ft that is used for environmental flow calculations and compliance.

TABLE 3 – CALCULATION OF ENVIRONMENTAL FLOWS

This table calculates the environmental flow conditions for compliance with the environmental flow regime for the Reservoir, with the exception of the Subsistence Freshet, which is calculated in Table 4. This environmental flow regime is shown on Table 1 and provided for reference in the spreadsheet in the array located in cells F2:L4. The columns in this table are developed as follows:

Columns (3.1) through (3.5) describe the Reservoir inflow and identify the season:

(3.1) Date. This is the date to which the data apply. It is referenced from Table 1 (1.1).

(3.2) Month. This is the month to which the data apply.

(3.3) Season. This is the corresponding season as defined for environmental flows. It is based on the month (3.2) and the environmental flow regime shown on Table 1.

(3.4) Reservoir Inflow. This is the Reservoir inflow expressed in cfs. It is taken from Table 2 (2.13).

(3.5) Reservoir Day Type. This is the classification of day type for purposes of environmental flows. A day would be classified as "subsistence" if the Reservoir is below elevation 516.4 ft msl. A day would be classified as "pulse" if the previous day is a base flow day and inflows are greater than 25 cfs. The 25 cfs level provides a distinction between varying base flow levels and pulse flows for purposes of initiating a pulse event. The 25 cfs value, based on inspection of historical data for Bois d'Arc Creek, is a good indicator of when a pulse is about to occur. The "pulse" day classification remains in effect until the flows return to the season's base flow criteria. All other days are classified as "base" flow days.

Columns (3.6) through (3.9) describe the base flow calculations:

(3.6) Seasonal Base Flow. This is the seasonal base flow criterion. This is referenced from the environmental flow regime and season (3.3). It is measured in cfs.

(3.7) Base Flow Calculation. This is the required base flow release. It is calculated as the smaller amount of the inflow (3.4) or seasonal base flow (3.6). It is calculated for both "base" flow and "pulse" flow days (3.5). While temporarily impounding pulse flows, base flow releases will continue to be made. If the temporarily impounded pulse flow is subsequently released from the Reservoir, the base flow releases made during temporary impoundment are considered for compliance of the volume requirements for pulse flow release in Column (3.42) and (3.43). It is measured in cfs.

(3.8) Subsistence Flow Calculation. This is the required subsistence flow release (not including the subsistence freshet). It is calculated as the smaller amount of the inflow (3.4) or subsistence flow criterion (1 cfs). It only applies to "subsistence" days (3.5). It is measured in cfs. Days not designated as "subsistence" are shown as "NA" for "Not Applicable".

(3.9) Actual Base/Subsistence Flow Releases. This is the amount of flow that is actually released to satisfy the base flow and subsistence flow (excluding the subsistence freshet) requirements of the environmental flow regime. It is taken from Table 1 (1.4) for releases noted as base flow (Table 1 (1.5) = 1) and flows designated as supplemental releases (Table 1 (1.5) = 4). For pulse flow releases (Table 1 (1.5) = 2), the season's base flow requirement (3.6) is recorded in this column. Subsistence freshet flows (Table 1 (1.5) = 3) are shown as "NA" for not applicable.

Columns (3.10) through (3.12) describe the pulse flow seasonal qualifiers:

(3.10) Qualifying Duration. This is the seasonal pulse flow duration criterion. This is referenced from the environmental flow regime and season (3.3). This is measured in days.

(3.11) Qualifying Volume. This is the seasonal pulse flow volume criterion measured in acre-feet. This is referenced from the environmental flow regime and season (3.3).

(3.12) Qualifying Pulse Peak. This is the seasonal pulse flow peak criterion measured in cfs. This is referenced from the environmental flow regime and season (3.3).

Columns (3.13) through (3.18) describe the pulse flow calculations for the Reservoir:

(3.13) Reservoir Pulse Volume. This is the daily volume of inflow to the Reservoir for days that are designated as a "pulse" day. The volume is in acre-feet and is referenced from Table 2 (2.14).

(3.14) Reservoir Pulse Duration. This calculates the number of days in a continuous pulse with the maximum number of days equal to the qualifying duration for the season (3.10).

(3.15) Reservoir Cumulative Pulse Volume. This is the cumulative volume of the pulse entering the Reservoir, calculated for the previous (n) days of the pulse, where the maximum (n) is the qualifying duration for the season. This is calculated in acre-feet.

(3.16) Reservoir Qualifying Pulse Volume. This column compares the Reservoir cumulative pulse volume (3.15) to the qualifying volume (3.11). If the cumulative volume of the pulse equals or exceeds the qualifying volume, then a "Y" is recorded for "Yes". If the cumulative volume is less than the qualifying volume, then an "N" is recorded for "No".

(3.17) Reservoir Qualifying Pulse Duration. This column compares the duration of the Reservoir pulse (3.14) to the qualifying pulse duration (3.10). If the duration of the pulse equals the qualifying duration, then a "Y" is recorded for "Yes". If the duration is less than the qualifying duration, then an "N" is recorded for "No".

(3.18) Reservoir Qualifying Pulse Peak. This column compares the Reservoir pulse flow (3.4) to the qualifying pulse peak (3.12). If the daily pulse flow (cfs) equals or exceeds the qualifying peak flow, then a "Y" is recorded for "Yes". If the flow is less than the qualifying peak flow, then an "N" is recorded for "No". Since this analysis is not applicable to subsistence conditions, an "N" is recorded for "No" if the Reservoir is in subsistence conditions.

Columns (3.19) through (3.26) describe the pulse flow calculations at FM 409:

(3.19) Flows at FM 409. This is the average daily flow at the USGS gage at FM 409 in cfs. It is obtained from Table 1 (1.7).

(3.20) FM 409 Pulse Day. This is the determination of whether the flows at FM 409 constitute a pulse flow. A pulse day would be recorded as "Y" (for yes) if flows at FM 409 are greater than 25 cfs or the previous day was classified as a pulse and the flows have not returned to seasonal base flow level. The 25 cfs level provides a distinction between varying base flow levels and pulse flows for purposes of initiating a pulse event. The 25 cfs value, based on inspection of historical data for Bois d'Arc Creek, is a good indicator of when a pulse is about to occur. All other days are classified as a non-pulse flow day and recorded with an "N" for "No". Since this analysis is not applicable to subsistence conditions, an "N" is recorded for "No" if the Reservoir is in subsistence conditions.

(3.21) FM 409 Pulse Volume. This is the daily volume of flow at FM 409 for days that are designated as a pulse day. The volume is in acre-feet.

(3.22) FM 409 Pulse Duration. This calculates the number of days in a continuous pulse at FM 409 with the maximum number of days equal to the qualifying duration for the season (3.10).

(3.23) FM 409 Cumulative Pulse Volume. This is the cumulative volume of the pulse at FM 409, calculated for the previous (n) days of the pulse, where the maximum (n) is the qualifying duration for the season. This is reported in acre-feet.

(3.24) FM 409 Qualifying Pulse Volume. This column compares the FM 409 cumulative pulse volume (3.23) to the qualifying volume (3.11). If the cumulative volume of the pulse equals or exceeds the qualifying volume, then a "Y" is recorded for "Yes". If the cumulative volume is less than the qualifying volume, then an "N" is recorded for "No".

(3.25) FM 409 Qualifying Pulse Duration. This column compares the duration of the FM 409 pulse (3.22) to the qualifying pulse duration (3.10). If the duration of the pulse equals the qualifying duration, then a "Y" is recorded for "Yes". If the duration is less than the qualifying duration, then an "N" is recorded for "No".

(3.26) FM 409 Qualifying Pulse Peak. This column compares the flows at FM 409 (3.19) to the qualifying pulse peak (3.12). If the daily pulse flow (cfs) equals or exceeds the qualifying peak flow, then a "Y" is recorded for "Yes". If the flow is less than the qualifying peak flow, then an "N" is recorded for "No". Since this analysis is not applicable to subsistence conditions, an "N" is recorded for "No" if the Reservoir is in subsistence conditions.

(3.27) Deliberate Release to Create a Pulse. This column records whether a release (not a qualified pulse release) was made from the Reservoir to create a pulse at FM 409. If such a release is made, a qualifying pulse at FM 409 must meet both the volume and duration criteria. This is determined from Table 1 (1.5). If the type of release recorded on Table (1.5) = 4, then a "Y" is recorded for "Yes". For all other types of releases, an "N" is recorded for "No".

Columns (3.28) through (3.30) describe the pulse flow credit determination:

(3.28) Pulse Credit at FM 409. This column records whether a qualifying pulse occurred at FM 409. This is hand entered based on whether there was a qualifying peak flow at FM 409 [(3.26) ="Y"] and the pulse had a qualifying duration [(3.25) = "Y"] or volume [(3.24) = "Y"]. A value of "1" is recorded in this column during the time of the qualifying pulse or immediately following qualification. If flow is released from the Reservoir to create a qualifying pulse at FM 409 (Column (3.27) shows a "Y" during or immediately preceding the pulse event), the pulse must meet both the volume and duration criteria (i.e., both Columns 3.24 and 3.25 must show a "Y" during the pulse event). The pulse can be counted as qualifying pulse at FM 409 (3.28), but it cannot also be counted as qualifying pulse release from the Reservoir (3.29). If the pulse flow requirements have been met for the season (see Table Z1:AC4), then no additional recordings are needed for the season. Pulses recorded during November and December of the current year fall/winter season (AG4) will be counted in the following calendar year accounting plan for compliance purposes. Pulses recorded in November and December of the previous year (AF4) are credited against the fall/winter season pulse criteria for the current year. The value in cell AF4 is referenced from T1-Input, cell K2.

(3.29) Pulse Release from Reservoir. This column records whether a qualifying pulse was released from the Reservoir. This is hand entered based on whether there was no qualifying pulse at FM 409 (i.e., review of Columns 3.24 through 3.26 shows that the flows at FM 409 did not exceed the peak flow criteria or if the peak flow criteria was met but neither the volume or duration was met), yet there was a qualifying peak flow into the Reservoir (3.18) and the Reservoir pulse had a qualifying duration (3.17) or volume (3.16) during the same time period, and a qualifying pulse is subsequently released from the Reservoir. A value of "1" is recorded in this column during the time of the release of the qualifying pulse. Pulse flow releases will meet the minimum qualifying peak flow and the qualifying volume or duration for the specific season. Qualifying pulse flow will be released as close as practicable to the release patterns by season that are included in the worksheet called *Release Patterns*. The flow from a qualifying pulse released from the Reservoir **that is counted as a qualifying pulse** cannot also be counted as a qualifying pulse at FM 409. If the pulse flow requirements have been met for the season (see Table Z1:AC4), then no additional recordings are needed for the season. Pulses recorded during the months of November and December in the current year winter season (AG4) will be counted in the following calendar year accounting plan for compliance purposes.

(3.30) Released Pulse Amount. This is the amount of flow released from the Reservoir specifically to meet the pulse flow requirements of the environmental instream flow regime. It is taken from Table 1 (1.4) for releases noted as pulse flow (Table 1 (1.5) = 2) less the amount released for base flow (3.9).

Table Z1:AC4: This table shows the required number of pulses per season and the number of credited pulses by season. The number of credited pulses is the sum of the recorded pulses in Columns (3.28) and (3.29) for each respective season. The credits for the fall/winter season include the recorded pulses in January and February of the current year plus the number of pulses recorded in November and December from the previous year. As discussed above, qualifying pulses that occur during the winter portion of the Fall/Winter season (November and December) from the previous year are shown in cell AF4. Qualifying pulses that occur during the winter portion of the Fall/Winter season (November and December) in the current year are recorded in cell AG4. Once the number of credited pulses equals the number of required pulses for a season, no additional recordings of pulses is required for the respective season.

Columns (3.31) through (3.38) provide checks for base/subsistence flow compliance and Columns (3.39) through (3.45) provide a check on compliance for pulse flows that are released directly from the Reservoir. These checks are included to allow the District to make adjustments if needed during the appropriate season.

Since base/subsistence flow calculations are made at the end of the day and the base/subsistence flow for the day would have already been released, the Accounting Plan provides a 14-day window for verification that the cumulative base/subsistence flow released (recorded in day-second-feet (dsf)) equals or exceeds the cumulative base/subsistence flow calculated to be released (dsf). If the calculations show that the actual base/subsistence flow released is less than the amount calculated, the District can adjust the base/subsistence releases over the subsequent 14 days.

Columns (3.31) through (3.34) describe the compliance check for base flows:

(3.31) Counter (Days). This column counts the number of days up to a maximum of 14 days that base flows are passed from the Reservoir. It includes all days except the days the Reservoir is in subsistence conditions. This column is used to calculate the cumulative base flows released and the cumulative base flows that were calculated for release over a period up to 14 days.

(3.32) Cumulative Calculated Base Flow Releases (dsf). This calculates the cumulative calculated base flow (3.7) over the previous number of days (3.31). This is calculated in day-second-feet (dsf). The annual total is shown in the last row (below data entries for December 31 of the current year).

(3.33) Cumulative Actual Base Flow Releases (dsf). This calculates the cumulative base flow that was released from the Reservoir (3.9) over the previous number of days

(3.31). This is calculated in day-second-feet (dsf). Flow that is released for purposes of creating a pulse at FM 409 is included in the cumulative base flow release amounts, however, the flow above base flow requirements cannot be counted above the current daily base flow amount unless it is used to correct a deficit from the previous 14 days. The annual total is shown in the last row (below data entries for December 31 of the current year).

(3.34) Comparison of Actual Release to Calculated Release (dsf). This column subtracts the calculated cumulative base flow release amount (3.32) from the actual cumulative base flow release (3.33). If the difference is less than "0", then the cell turns red. Negative flow amounts can be made up during the subsequent 14-day period. The annual total is shown in the last row (below data entries for December 31 of the current year). This value will help the user determine if any additional base flow releases are needed for compliance with the calculated base flow releases.

Columns (3.35) through (3.38) describe the compliance check for subsistence flows (excluding freshets):

(3.35) Counter (Days). This column counts the number of days up to a maximum of 14 days that subsistence flows are passed from the Reservoir. It includes only days the Reservoir is in "subsistence" conditions. Days that the Reservoir is in "freshet" conditions are shown as "0".

(3.36) Cumulative Calculated Subsistence Flow Releases (dsf). This calculates the cumulative calculated subsistence flow (3.8) over the previous number of days (3.35). This is calculated in day-second-feet (dsf). The annual total is shown in the last row (below data entries for December 31 of the current year).

(3.37) Cumulative Actual Subsistence Flow Releases (dsf). This calculates the cumulative subsistence flow that was released from the Reservoir (3.9) over the previous number of days (3.35). This is calculated in day-second-feet (dsf). Freshet releases are not included in this calculation. The annual total is shown in the last row (below data entries for December 31 of the current year).

(3.38) Comparison of Actual Release to Calculated Release (dsf). This column subtracts the calculated cumulative subsistence flow release amount (3.36) from the actual cumulative base flow release (3.37). If the difference is less than "0", then the cell turns red. Negative flow amounts can be made up during the subsequent 14-day period. The annual total is shown in the last row (below data entries for December 31 of the current year). This value will help the user determine if any additional subsistence flow releases are needed for compliance with the total calculated subsistence flow release.

Columns (3.39) through (3.45) describe the compliance check for pulse flows (excluding freshets) that are released from the Reservoir:

(3.39) Released Pulse Volume (ac-ft). This is the daily volume of water released from the Reservoir for a pulse flow in acre-feet. It is calculated from Column (3.30) times Factor C7.

(3.40) Released Pulse Duration (days). This calculates the number of days in a continuous pulse from Column (3.30).

(3.41) Cumulative Released Pulse Volume (ac-ft). This is the cumulative volume of water released as part of a continuous pulse. It is calculated from Columns (3.39) and (3.40) and recorded in acre-feet.

(3.42) Reservoir Cumulative Pulse Volume Released during Temporary Impoundment (ac-ft). This is the cumulative volume of a pulse inflow that was released as base flow during the period when the pulse was being temporarily impounded. It is calculated as the base flow requirement for the season (3.6) times the number of days in the pulse (3.40) and converted to acre-feet (Factor C7). It is assumed that during temporary impoundment, the inflow to the Reservoir would exceed the base flow requirements and the amounts released for base flow compliance would be the base flow requirement for the season.

(3.43) Reservoir Qualifying Pulse Volume (Y/N). This column compares the cumulative pulse volume released from the Reservoir (3.41) to the qualifying volume (3.11). If the cumulative volume of the pulse equals or exceeds the qualifying volume, then a "Y" is recorded for "Yes". If the cumulative volume is less than the qualifying volume, then an "N" is recorded for "No".

(3.44) Reservoir Qualifying Duration (Y/N). This column compares the duration of the released pulse (3.40) to the qualifying pulse duration (3.10). If the duration of the released pulse equals the qualifying duration, then a "Y" is recorded for "Yes". If the duration is less than the qualifying duration, then an "N" is recorded for "No".

(3.45) Reservoir Qualifying Peak Flow (Y/N). This column compares the flows of the released pulse (3.30) plus the flows released for base flow compliance (3.9) to the qualifying pulse peak (3.12). The total flow released on a daily basis is the basis for compliance with peak flow requirements. If the daily total released flow (cfs) equals or exceeds the qualifying peak flow, then a "Y" is recorded for "Yes". If the flow is less than the qualifying peak flow, then an "N" is recorded for "No".

TABLE 4 – CALCULATION OF SUBSISTENCE FRESHET

This table calculates the environmental flow conditions for compliance with the agreed on Subsistence Freshet for the Reservoir. A subsistence period freshet requirement is in place during the subsistence period without seasonal differences. The subsistence freshet has a trigger level of 20 cfs, a volume of 69 acre-feet, and a duration of 3 days. A qualifying freshet occurs when the peak and either the volume or duration criterion have been met. Qualified freshets that enter the Reservoir will only need to be passed if a qualified freshet does not occur at FM 409 within the previous 60-day period. At a maximum, only 1 qualified freshet would be passed within a 60-day period if a qualified freshet was recorded in the Reservoir but no qualified freshet was recorded at FM 409 over the same time period. Data from the last day of the previous year is entered on Row 12. This data is needed if the subsistence period extends across calendar years. The columns in this table are developed as follows:

Columns (4.1) through (4.4) describe the Reservoir inflow and Reservoir day type:

(4.1) Date. This is the date to which the data apply. It is referenced from Table 1 (1.1).

(4.2) Reservoir Inflow. This is the Reservoir inflow expressed in cfs. It is taken from Table 2 (2.13).

(4.3) Subsistence Day. This identifies whether the Reservoir is in subsistence conditions. A subsistence day would be classified as "Y" for "Yes" if the Reservoir is below elevation 516.4 ft msl. All other days are classified as "N" for "No".

(4.4) Reservoir Day Type. This classifies the day as either "subsidence" or "freshet" when the Reservoir is in subsistence conditions. If inflows to the Reservoir, less the wastewater discharges from Bonham [T1-Input (1.12)] and Honey Grove [T1-Input (1.13)], are less than or equal to 1 cfs, it is a subsistence day. If inflows, less wastewater discharges, are greater than 1 cfs it is a freshet day. This calculation characterizes the intent of the freshet as a natural inflow event. If the Reservoir is not in subsistence conditions, a "NA" is recorded for "Not Applicable".

Columns (4.5) through (4.10) describe the freshet flow calculations for the Reservoir:

(4.5) Reservoir Freshet Volume. This is the daily volume of inflow to the Reservoir for days that are designated as a "freshet" day (4.4). The volume is in acre-feet and is referenced from Table 2 (2.14).

(4.6) Reservoir Freshet Duration. This calculates the number of days in a continuous freshet with the maximum number of days equal to three (3).

(4.7) Reservoir Cumulative Freshet Volume. This is the cumulative volume of the freshet entering the Reservoir, calculated for the previous (n) days of the freshet, where the maximum (n) is three (3). This is calculated in acre-feet.

(4.8) Reservoir Qualifying Freshet Volume. This column compares the Reservoir cumulative freshet volume (4.7) to the qualifying volume of 69 acre-feet (G2). If the cumulative volume of the freshet equals or exceeds the qualifying volume, then a "Y" is recorded for "Yes". If the cumulative volume is less than the qualifying volume, then an "N" is recorded for "No".

(4.9) Reservoir Qualifying Freshet Duration. This column compares the duration of the Reservoir freshet (4.6) to the qualifying freshet duration of 3 days (H2). If the duration of the freshet equals the qualifying duration, then a "Y" is recorded for "Yes". If the duration is less than the qualifying duration, then an "N" is recorded for "No".

(4.10) Reservoir Qualifying Freshet Peak. This column compares the Reservoir freshet flow (4.2) to the qualifying freshet peak of 20 cfs (I2). If the daily freshet flow (cfs) equals or exceeds the qualifying peak flow, then a "Y" is recorded for "Yes". If the flow is less than the qualifying peak flow, then an "N" is recorded for "No".

Columns (4.11) through (4.18) describe the freshet flow calculations at FM 409:

(4.11) Flows at FM 409. This is the average daily flow at the USGS gage at FM 409 in cfs. It is obtained from Table 1 (1.7).

(4.12) FM 409 Freshet Day. This is the determination of whether the flows at FM 409 constitute a freshet flow during subsistence conditions. If the Reservoir is not in subsistence conditions, the day is recorded with an "NA" for "Not Applicable". During subsistence conditions, a freshet day would be recorded as "Y" if flows at FM 409 are greater than 20 cfs or the previous day was classified as a freshet and the flows have not returned to a subsistence flow level (less than 2 cfs). All other subsistence days are classified as "N" for non-freshet day.

(4.13) FM 409 Freshet Volume. This is the daily volume of flow at FM 409 for days that are designated as a freshet day. The volume is in acre-feet.

(4.14) FM 409 Freshet Duration. This calculates the number of days in a continuous freshet at FM 409 with the maximum number of days equal to the qualifying duration for the freshet (3 days).

(4.15) FM 409 Cumulative Freshet Volume. This is the cumulative volume of the freshet at FM 409, calculated for the previous three (3) days of the freshet. This is reported in acre-feet.

(4.16) FM 409 Qualifying Freshet Volume. This column compares the FM 409 cumulative freshet volume (4.15) to the qualifying volume (G2). If the cumulative volume of the freshet equals or exceeds the qualifying volume, then a "Y" is recorded for "Yes". If the cumulative volume is less than the qualifying volume, then an "N" is recorded for "No".

(4.17) FM 409 Qualifying Freshet Duration. This column compares the duration of the FM 409 freshet (4.14) to the qualifying freshet duration (H2). If the duration of the freshet equals the qualifying duration, then a "Y" is recorded for "Yes". If the duration is less than the qualifying duration, then an "N" is recorded for "No".

(4.18) FM 409 Qualifying Freshet Peak. This column compares the flows at FM 409 (3.19) to the qualifying freshet peak (I2). If the daily freshet flow (cfs) equals or exceeds the qualifying peak flow (20 cfs), then a "Y" is recorded for "Yes". If the flow is less than the qualifying peak flow, then an "N" is recorded for "No".

Column (4.19) provides the 60-day counter for the freshet flow requirement:

(4.19) Counter (Days). This column records the number of days since a qualified freshet occurred at FM 409 or was released from the Reservoir. If the Reservoir is not in subsistence conditions, a "NA" is recorded for "Not Applicable". At the start of subsistence conditions, the counter is set at 1. Once a qualified freshet is recorded at FM 409 (4.20) or released from the Reservoir (4.21), the counter is reset at 1.

Columns (4.20) through (4.22) describe the freshet flow credit determination:

(4.20) Freshet Credit at FM 409. This column records whether a qualifying freshet occurred at FM 409. This is hand entered based on whether there was a qualifying peak flow at FM 409 [(4.18) = Y] and the freshet had a qualifying duration [(4.17) = Y] or volume [(4.16) = Y] over the duration of the freshet. A value of "1" is recorded at the end of the qualifying freshet.

(4.21) Freshet Release from Reservoir. This column records whether a qualifying freshet was released from the Reservoir. This is hand entered based on whether there was no qualifying freshet at FM 409 during the previous 60-day period in subsistence conditions [i.e., review of columns 4.16 through 4.18 shows that the flows at FM 409 did not exceed the peak flow criteria (4.18) or if the peak flow criteria was met but neither the volume (4.16) or duration (4.17) was met] and a qualifying freshet was recorded into the Reservoir [i.e., review of columns 4.8 through 4.10 shows that the inflows to the Reservoir exceeded the peak flow criteria (4.10) and either the volume (4.18) or duration (4.9) was met] and a qualifying freshet is released from the Reservoir. A value of "1" is recorded during the time of the release of the qualifying freshet. Freshet flow releases will meet the minimum qualifying peak flow and the qualifying volume or duration specified for the freshet in a manner as close as practicable to the release pattern included in worksheet *Release Patterns*. The flow from a qualifying freshet released from the Reservoir **that is counted as a qualifying freshet** cannot also be counted as a qualifying freshet at FM 409.

(4.22) Released Freshet Amount. This is the amount of flow released from the Reservoir specifically to meet the freshet flow requirements of the environmental instream flow regime. It is taken from Table 1 (1.4) for releases noted as freshet flow (Table 1 (1.5) = 3).

TABLE 5 – NET RESERVOIR EVAPORATION RATE

(5.1) Date. This is the date to which the data apply. It is referenced from Table 1 (1.1).

(5.2) Month. This is the month to which the data apply.

(5.3) Pan Evaporation. This is measured pan evaporation data in inches for the Reservoir.

(5.4) Pan Factor. This is an empirical factor to estimate evaporation from a Reservoir surface based on evaporation from a pan. The coefficients for each month are based on weighted averages of pan factors developed by the Texas Water Development Board for quadrangles 411 and 412. The empirical factors are entered on the Factors worksheet.

(5.5) Gross Reservoir Evaporation. This is the estimated gross evaporation from the Reservoir surface in inches. It is equal to Column (5.3) times Column (5.4).

(5.6) Rainfall. This is measured rainfall data in inches for the Reservoir.

(5.7) Net Reservoir Evaporation. This is the estimated net Reservoir evaporation in inches from the surface of the Reservoir. It is equal to Column (5.5) minus Column (4.6).

(5.8) Net Reservoir Evaporation. This is the estimated net Reservoir evaporation from the surface of the Reservoir expressed in feet. It is equal to Column (5.7) divided by 12.

TABLE 6 – SUMMARY REPORTING DATA FOR WATER RIGHT

This table is provided to assist the District with the reporting requirements to the TCEQ on diversions associated with its anticipated water right permit for the Reservoir.

(6.1) Month Number. This is the number of the month to which the data apply.

(6.2) Month Name. This is the month to which the data apply.

(6.3) Maximum Diversion Rate. This is the maximum diversion rate in cfs for pumped amounts for the corresponding month. It is taken from Table 1 (1.3) and converted from MG to cfs. If the maximum diversion rate exceeds the permitted amount of 365.15 cfs, the cell will be highlighted in red.

(6.4) Monthly Diversions. This is the sum of diversions by month in acre-feet. It is taken from Table 2 (2.7). If the monthly or annual diversions exceed the permitted diversion amount of 175,000 acre-feet, the cell will be highlighted red.

TABLE 7 – SUMMARY OF ENVIRONMENTAL FLOWS

This table summarizes the environmental flow releases and credits taken at FM 409 in compliance with the environmental flow regime for the Reservoir. The columns in the table are developed as follows:

(7.1) Season. This is the environmental flow season to which the data apply.

(7.2) Maximum Base Flow. This is maximum base flow value (in cfs) released from the Reservoir during the corresponding season. It is taken from Table 3 (AV4:AX4). Subsistence base flows are taken from Table 3 (AY4).

(7.3) Minimum Base Flow. This is minimum base flow value (in cfs) released from the Reservoir during the corresponding season. It is taken from Table 3 (AV3:AX3). Subsistence base flows are taken from Table 3 (AY3).

(7.4) Average Base Flow. This is average base flow value (in cfs) released from the Reservoir during the corresponding season. It is taken from Table 3 (AV5:AX5). Subsistence base flows are taken from Table 3 (AY5).

(7.5) Pulse Flow – FM 409 Credit. This is the number of pulse credits taken at FM 409 by calendar season. It is taken from Column (3.27) of Table 3.

(7.6) Pulse Flows – Reservoir Release Credit. This is the number of pulses released from the Reservoir by calendar season. It is taken from Column (3.28) of Table 3.

(7.7) Pulse Flows – Total Credit. This is the total number of pulse credits for the calendar year by season. It is the sum of Columns (7.5) and (7.6).

(7.8) Freshet Flow – FM 409 Credit. This is the number of freshet credits taken at FM 409 by calendar year. It is taken from Column (4.20) of Table 4. This statistic is given only as a total for the calendar year.

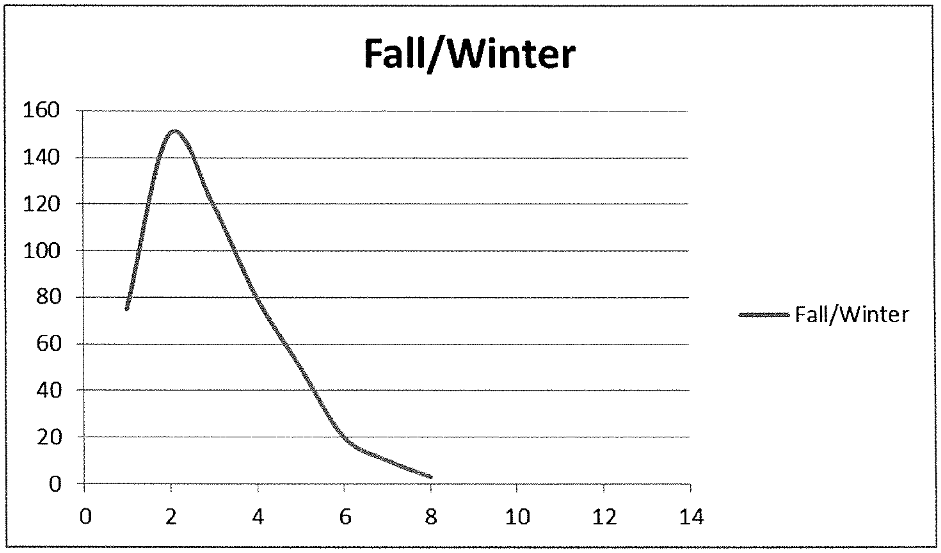
(7.9) Freshet Flows – Reservoir Release Credit. This is the number of freshets released from the Reservoir during a calendar year. It is taken from Column (4.21) of Table 4. This statistic is given only as a total for the calendar year.

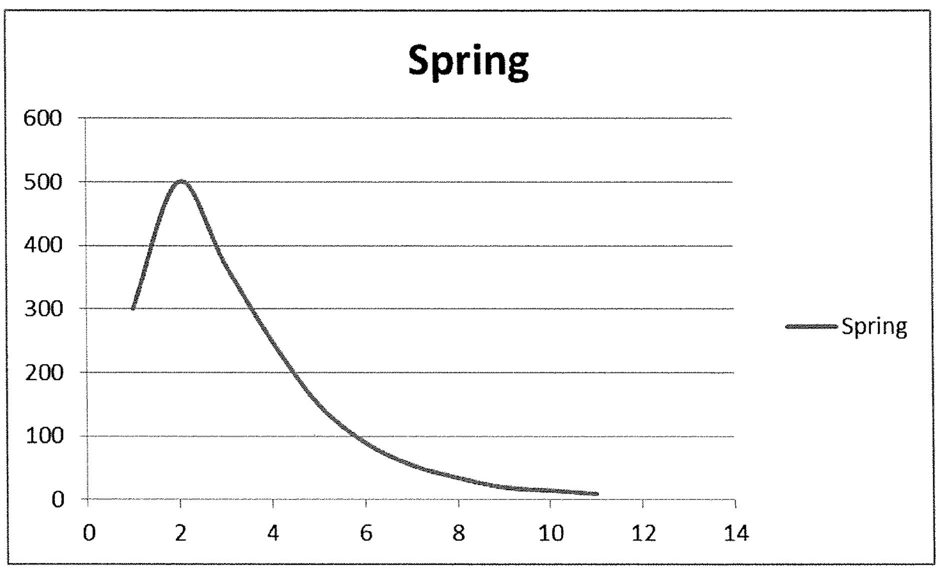
(7.10) Freshet Flows – Total Credit. This is the total number of freshets that occurred naturally at FM 409 or released from the Reservoir during subsistence conditions for the calendar year. It is the sum of Columns (7.8) and (7.9). This statistic is given only as a total for the calendar year.

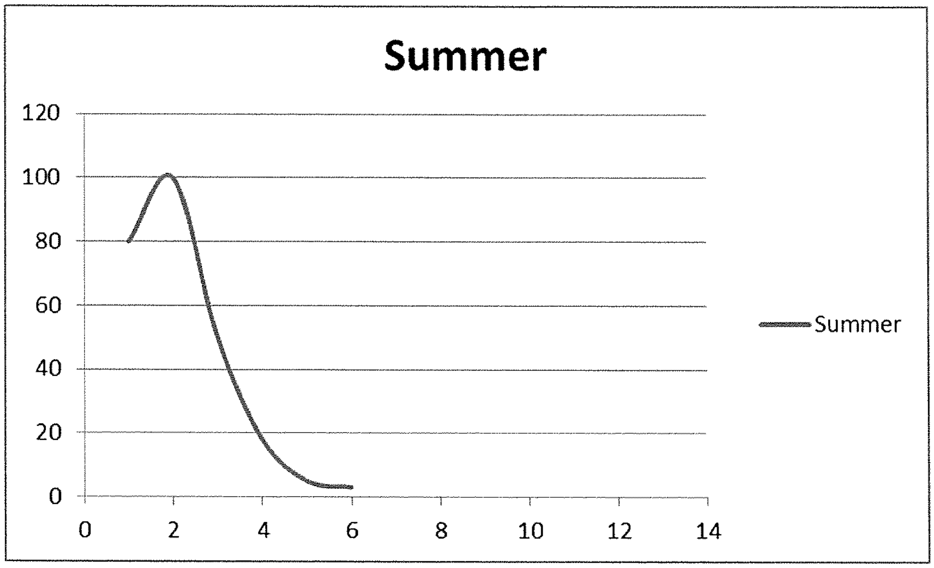
(7.11) Number of Days with Flows Greater than 500 cfs at FM 100. This is calculated from Column (1.10) of Table 1. This statistic is given only as a total for the calendar year.

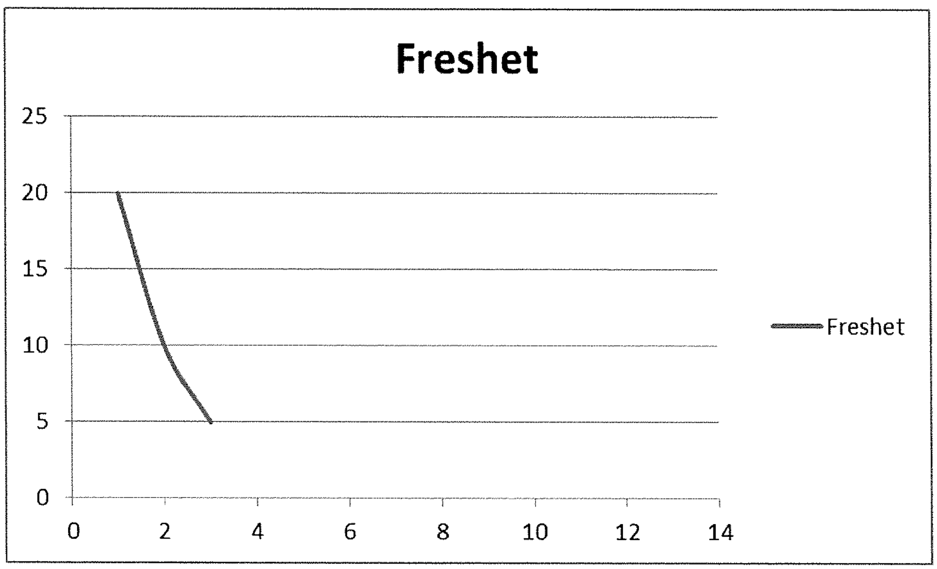
Typical Pulse Flow Release Patterns

Lower Bois d'Arc Creek Reservoir






Summer
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
Summer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Attachment 3

Potential Overdraft Operations Memorandum

(2008 Memorandum to the Texas Commission on Environmental Quality)

Freese and Nichols

MEMORANDUM

TO: File

FROM: Jon S. Albright and Tom Gooch

SUBJECT: Request to Divert 175,000 Acre-feet per Year from the Lower Bois d'Arc Creek Reservoir

DATE: December 31, 2008

STATE OF TEXAS
THOMAS C. GOOCH
50668
LICENSED
PROFESSIONAL ENGINEER

1. The application for Lower Bois d'Arc Creek Reservoir requests the ability to divert 175,000 acre-feet per year from the reservoir, which is greater than the estimated firm yield of 126,200 acre-feet per year. Lower Bois d'Arc Creek Reservoir will be one of several sources of water available to the North Texas Municipal Water District (NTMWD). The ability to maximize the supply from the reservoir is a key element in the operation of NTMWD's multiple sources as a system. As part of a system, the operation of Lower Bois d'Arc Creek Reservoir will depend on the development of the NMTWD other sources, demands from the system, and local demands in Fannin County. This memorandum examines one potential operation scenario considering the desire to maximize supply while balancing long-term needs.

2. For this potential operation scenario, NTMWD will divert up to 175,000 acre-feet per year from the reservoir in some years. During times when the Lower Bois d'Arc Creek Reservoir is less than full, the diversions from the reservoir will be reduced. The reduced level of diversion will be sufficient to provide reliable supplies for both NTMWD and local demand in Fannin County through a repeat of the drought of record.

3. The simulations in this memorandum used both the Texas Commission on Environmental Quality Red River Water Availability Model (TCEQ WAM), modified to include the proposed Lower Bois d'Arc Creek Reservoir, and an alternative version of the Red River WAM using hydrology developed by Freese and Nichols, Inc. (FNI WAM). The FNI hydrology is described in the December 2007 Draft Memorandum *Comparison of 2007 TCEQ WAM Hydrology to FNI WAM Hydrology*.

Freese and Nichols, Inc. • Engineers • Environmental Scientists • Architects
4055 International Plaza • Suite 200 • Fort Worth, Texas 76109-4895
(817) 735-7300 • Metro (817) 429-1900 • Fax (817) 735-7491

4. The potential operational policy in this memorandum uses a constant 236 MGD diversion (equivalent of 264,489 acre-feet per year) when the reservoir level is between 532 feet msl and the conservation elevation of 534 feet msl. Annual diversions are limited to a maximum of 175,000 acre-feet per year. When the reservoir elevation is more than two feet below conservation, demand is reduced to 114,930 acre-feet per year in the TCEQ WAM and 124,800 acre-feet per year in the FNI WAM. The reduced demand is about five percent less than the firm yield in the TCEQ WAM and about one percent less than the firm yield of the FNI WAM.

5. Figure 1a compares the simulated storage traces for the reservoir using a firm yield operation and the potential operation using the TCEQ WAM. Figure 1b compares the elevation trace for the same two scenarios. Figure 1c shows the total diversion from the reservoir in each year of the simulation, again using the TCEQ WAM. Figures 2a through 2c show the same data using the FNI WAM. Table 1 compares the frequencies that the reservoir is spilling, the reservoir is less than two feet below conservation, and the number of years overdraft supply is available.

Table 1
Comparison of WAM Runs

Statistic	TCEQ WAM		FNI WAM	
	Firm Yield	175,000 AF/Yr Operation	Firm Yield	175,000 AF/Yr Operation
Percent of Months Full	8.4%	4.5%	12.7%	6.9%
Percent of Months < 2 feet Down	22.4%	17.5%	27.3%	20.1%
Percent of Years with Overdraft Supply	-	43%	-	49%

6. Looking at the figures and Table 1 leads to the following observations:

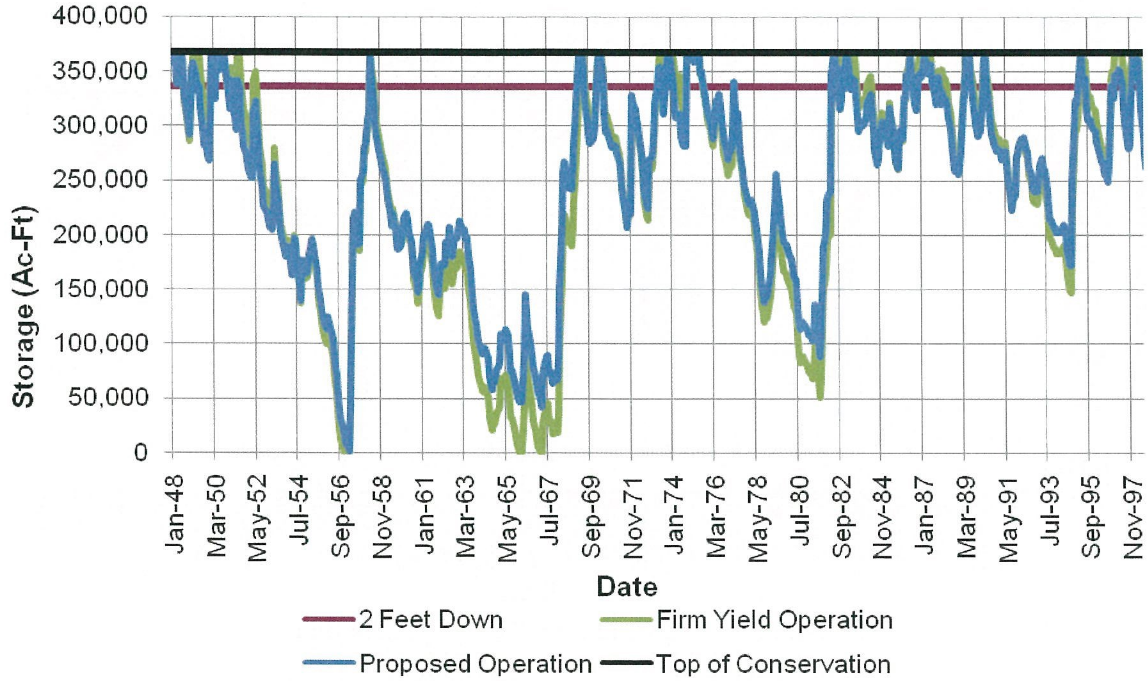
   a. The potential operation policy to use 175,000 acre-feet per year results in a slightly lower frequency of time that the reservoir is relatively full (between elevations 534 ft and 532 ft msl). However, during drought conditions when the reservoir is low there is very little change. In fact, the TCEQ WAM shows that the reservoir will have more water in storage during extremely dry periods due to the lowered demand.

   b. Some supply above the firm yield is available more than 40 percent of the time. During other times, the supply from the reservoir will be slightly less than firm yield operation.

7. **System Operation.** The operation policy in this memorandum is only one of many different potential operational policies for Lower Bois d'Arc Creek Reservoir. As previously noted, actual operation of the reservoir will depend on the level of development of the NMTWD system, demands from the system, and local demands in Fannin County. As an example of other policies that might be used, the full permitted diversion from Lower Bois d'Arc Creek Reservoir might be used even when the reservoir is drawn down below two feet if NTMWD system demands are near available supplies and if new sources are being developed that will allow reduced diversions from Lower Bois d'Arc Creek Reservoir in later years. NTMWD currently has five major sources of water (Lakes Lavon, Texoma, Chapman and Tawakoni and reuse), and will add several more over the next few decades. Some of these sources are fairly far away from the NTMWD service area and require considerable expense to pump the water to users. Water from Lake Texoma has a relatively high salt content and requires blending with other sources. Lower Bois d'Arc Creek Reservoir will be relatively close to the NTMWD service area and the water is expected to be of good quality. The ability to divert 175,000 acre-feet per year from the Lower Bois d'Arc Creek Reservoir will allow NTMWD to make efficient use of this reservoir during relatively wet times. During drier times, other sources of water will be employed to a greater extent. In all cases, NTMWD will balance the needs for reliable water supply, costs, water quality, water rights and agreements when operating its system.

8. The operation of Lower Bois d'Arc Creek Reservoir will be affected by the instream flow releases required from the reservoir. The potential for system operation will be reevaluated if instream flow releases are changed after the completion of on-going instream flow studies.

Figure 1a
Comparison of Storage Traces for Firm Yield Operation and Potential Operation using the TCEQ WAM



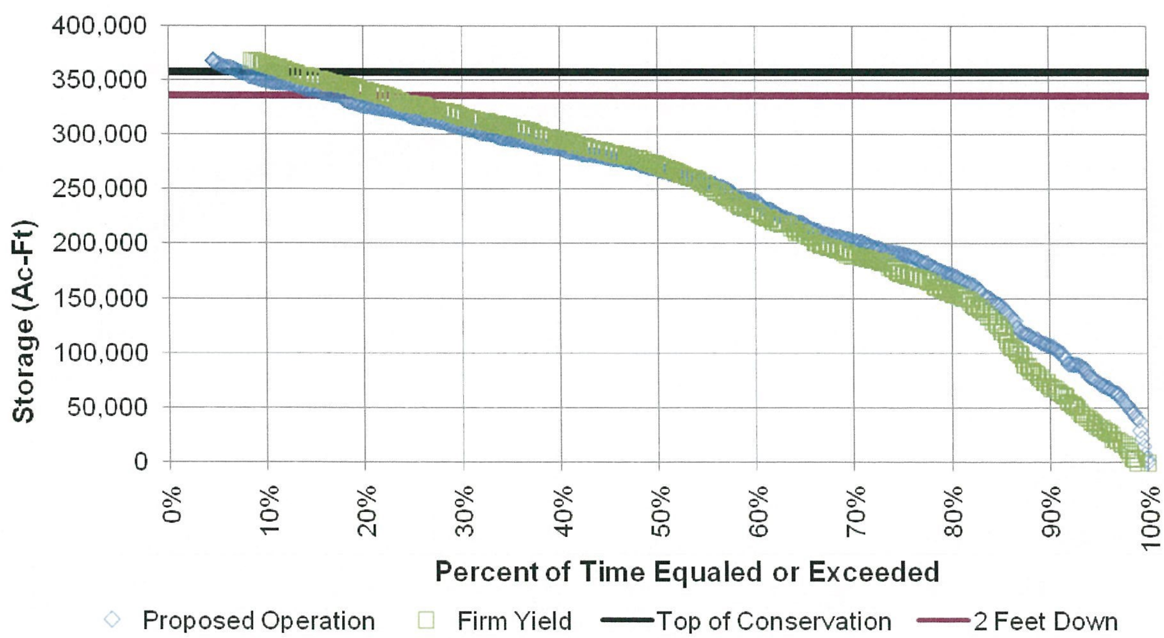
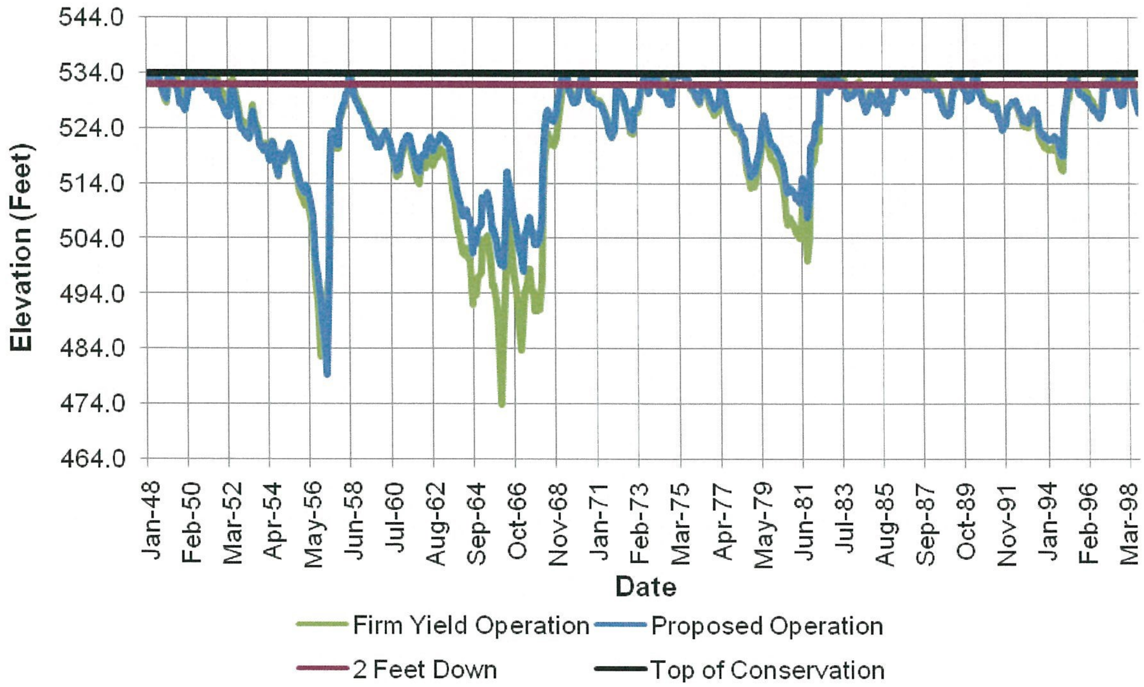


Figure 1b
Comparison of Elevation Traces for Firm Yield Operation and Potential Operation using the TCEQ WAM



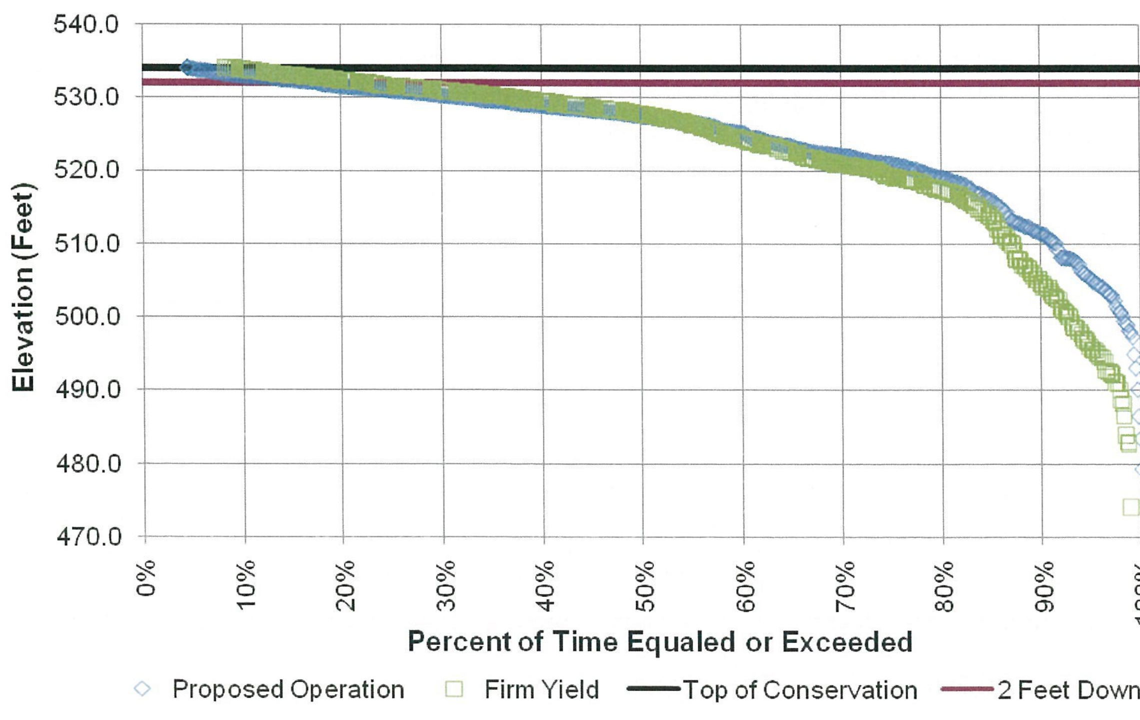


Figure 1c
Annual Diversions using Potential Operation using the TCEQ WAM

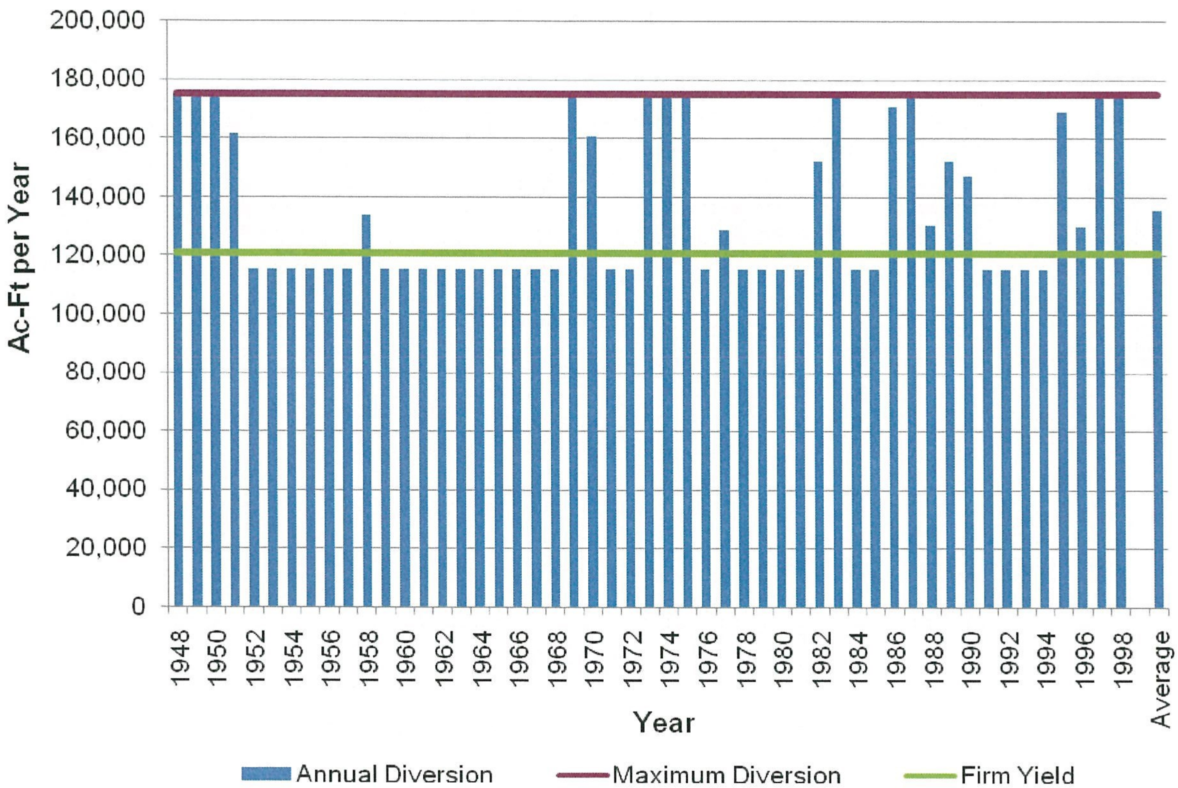
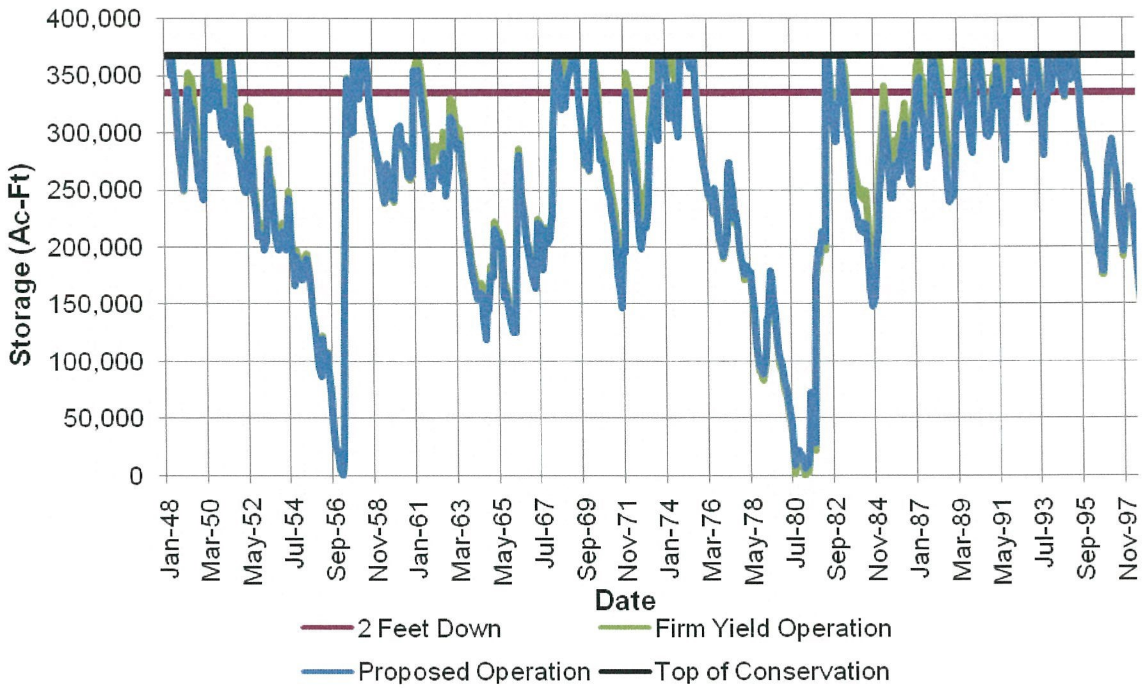


Figure 2a
Comparison of Storage Traces for Firm Yield Operation and Potential Operation using the FNI WAM



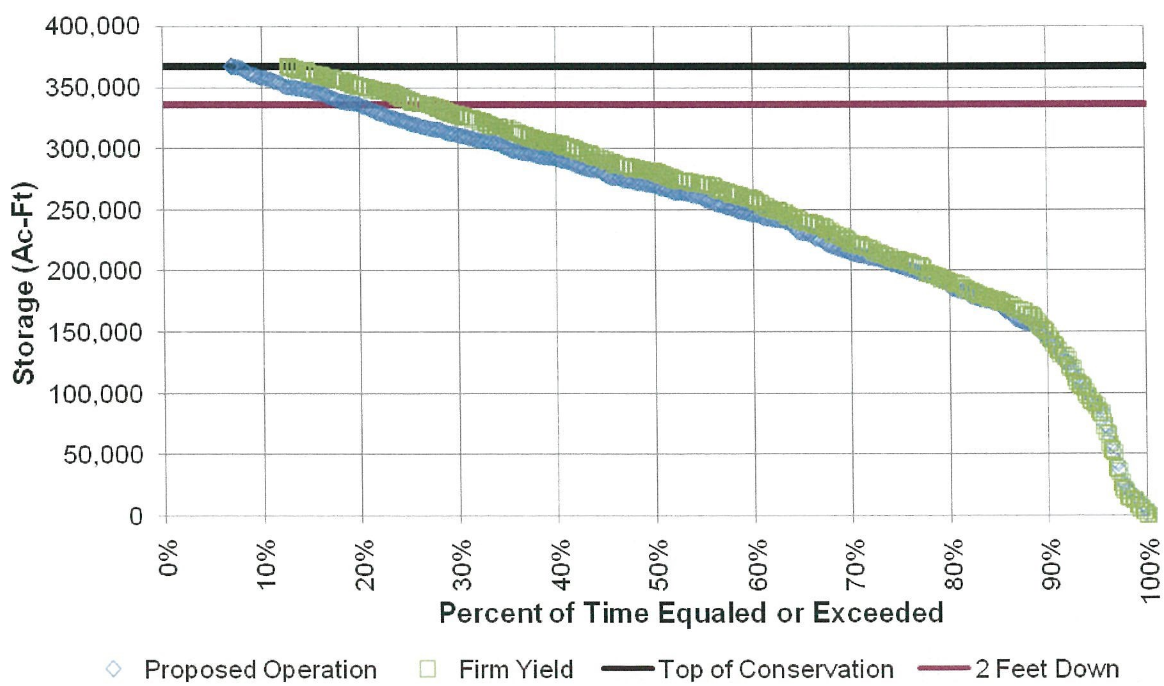
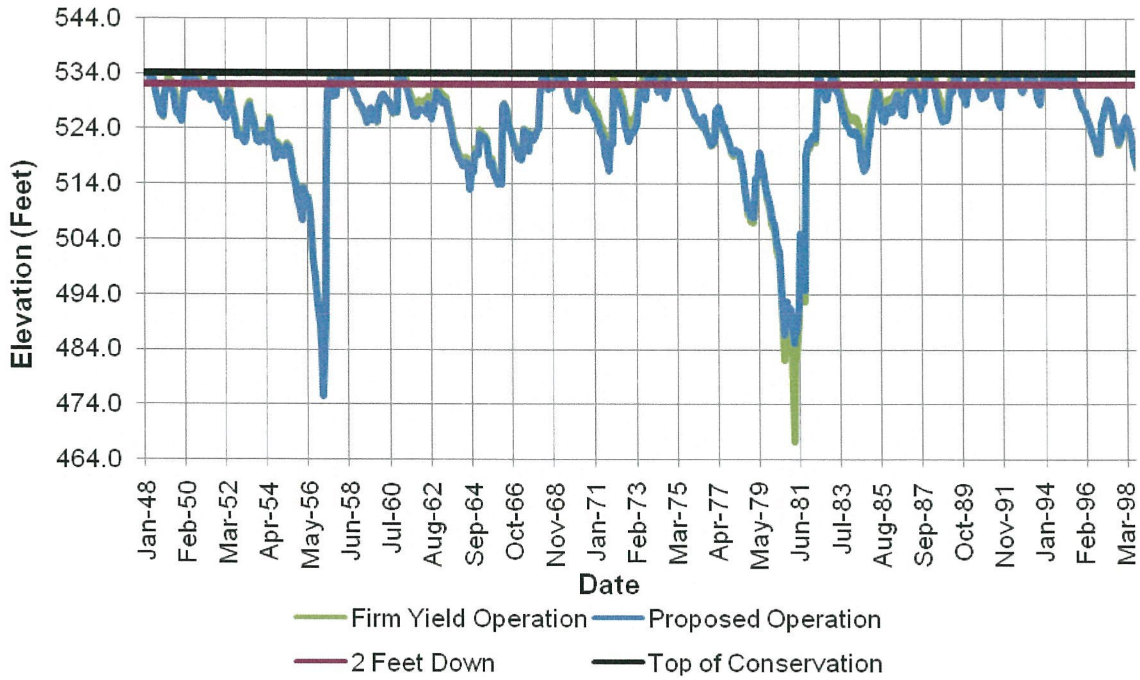


Figure 2b
Comparison of Elevation Traces for Firm Yield Operation and Potential Operation using the FNI WAM



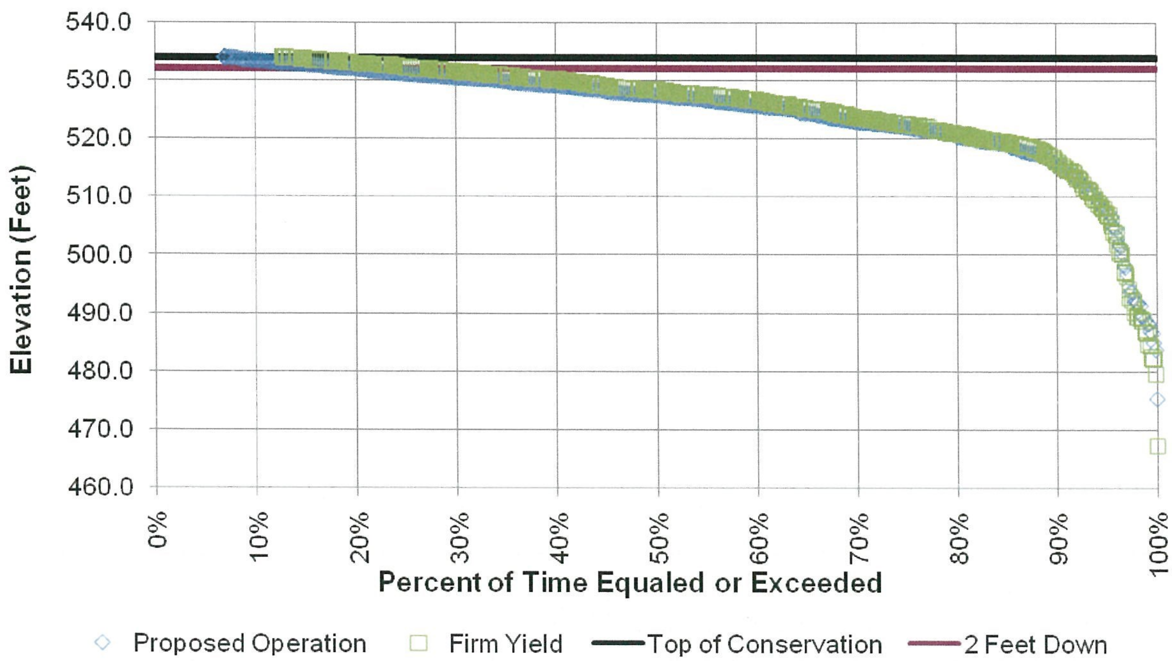
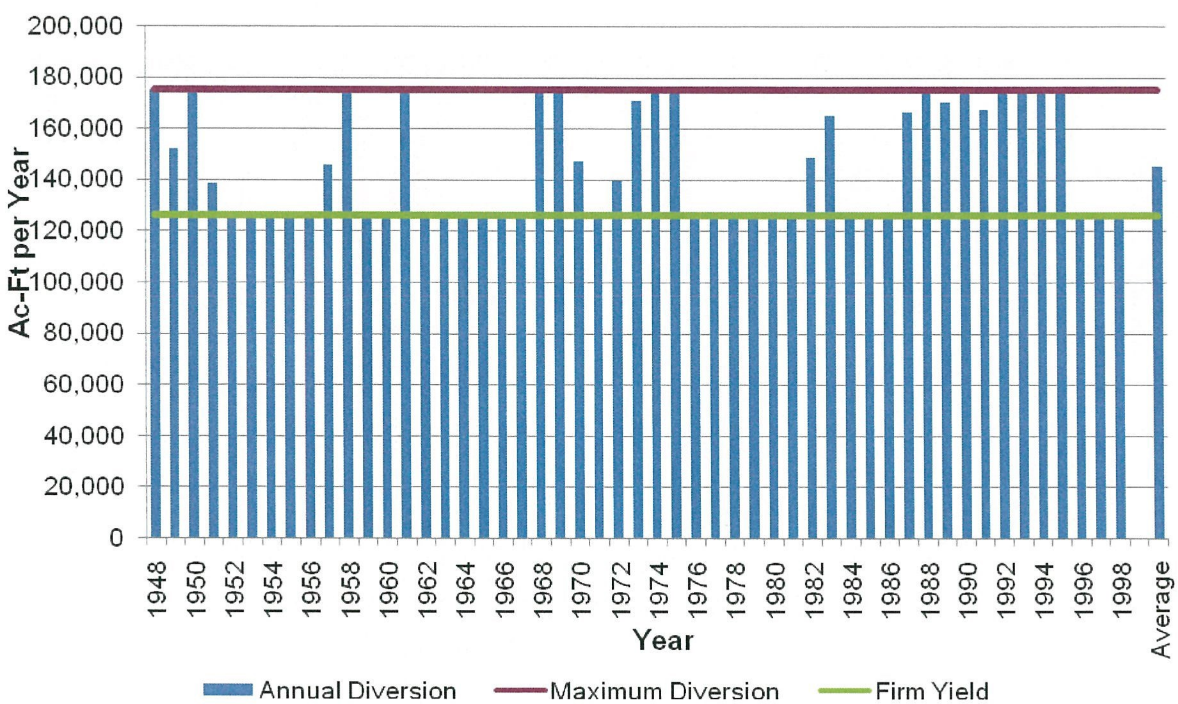


Figure 2c
Annual Diversions using Potential Operation using the FNI WAM



APPENDIX E: ECONOMIC STUDIES AND UPDATES BY DR. TERRY CLOWER*

2012, 2007, AND 2004

* At the time these studies were initially conducted, Dr. Terry Clower was Director of the Center for Economic Development and Research at the University of North Texas. He is currently Norther Virginia Chair and Professor of Public Policy at the School of Policy, Government and International Affairs at George Mason University. He is also Deputy Director for GMU's Center for Regional Analysis.

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Update of the Economic, Fiscal, and Developmental Impacts of the Proposed Lower Bois d'Arc Reservoir Project

Prepared for:

North Texas Municipal Water District

By:

Terry L. Clower, Ph.D.

March 2012
(Revised January 2015)

Executive Summary

This report provides an update of the 2007 and 2004 previous assessments of the economic, developmental, and fiscal impacts of the Lower Bois d'Arc Creek Reservoir that will be developed by the North Texas Municipal Water District (NTMWD). Construction and related spending estimates are based on projections updated in 2011 and include updated planning for ancillary infrastructure development.

- Construction of the dam to impound the proposed Lower Bois d'Arc Reservoir, intake pump station, water treatment plant, terminal storage reservoirs, and associated pipeline infrastructure will cost in the range of $385.4 million and $ 426.0 million, including planned future water treatment plant expansions. Depending on exact expenditures, local economic activity in Fannin County will increase between $509 million and $563 million during the construction phase of the reservoir development and subsequent expansion of the water treatment plant. This activity will contribute between $211 million and $234 million in gross county product and support between 4,999 and 5,525 person-years of employment with associated labor income of between $165 million and $183 million.
- It is anticipated that land acquisition for the reservoir and related mitigation areas will cost about $75 million, representing a boost to landowner household income. Assuming that local property owners take about 20 percent of this value as household income, with the remainder being used for personal and business investments, a portion of land acquisition costs will support new spending in the Fannin County area. This additional spending will create about $11 million in new economic activity in the county and support over $3.4 million in local labor income.
- Combined with the impacts of household spending supported by anticipated land acquisition payments, the total economic impacts related to the construction of the dam, pump stations, water treatment plant, and related infrastructure will boost economic activity in Fannin County by between $521 million and $574 million, support from 5,105 to 5,631 person years of employment, and pay $169 million to $186 million in labor income.[1]
- The economic activity associated with creating the Lower Bois d'Arc Creek will likely spill over to neighboring counties. Estimates of total economic activity associated with dam and other infrastructure development in the region including Fannin, Collin, Delta, Lamar, and Hunt counties will be between $682 million and $833 million.
- After construction of the dam and pipeline is completed, ongoing impacts from the operation and maintenance of these infrastructures will support about 24 Fannin County jobs and spur about $2 million in new economic activity per year.
- Once the lake is impounded, new recreational spending will likely arrive in Fannin County as visitors come to fish, boat, and participate in other water-recreation activities.

[1] Some estimates do not precisely sum due to the rounding of figures in the text.

These visitors will bring $17 million to $22 million in new annual spending to the local economy.

- The lake will also likely attract many new residents to Fannin County. It is estimated that over a 30-year period at least 1,100 new full-time resident households will be established around the lake. An additional 2,100 residences will likely be built as vacation/weekend/second homes. These new households will be in addition to any other growth projected for Fannin County. The construction of these homes will bring an average of about 133 jobs per year to the local economy over the development period.
- The reservoir will also support new industrial and commercial activities beyond those described for the hospitality industry. Using Texas Water Development Board usage estimates, it is projected that $145 million in new economic activity in Fannin County (supporting over 1,600 jobs) could be made possible by the availability of a new reliable water resource.
- The pace and quality of development will depend on many market-related factors. One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand. Examples of infrastructures will include electric services, roads, water services, and public safety and other municipal services.
- Spending by new residents in the local economy will increase economic activity in Fannin County by $81 million to $89 million each year. This analysis also suggests that economic activity in the larger region, including Fannin, Hunt, Delta, Grayson, and Lamar counties, will rise by as much as $116 million per year in response to having these new residents living near the proposed reservoir. This activity will support 857 to 947 jobs paying $21.9 million to 24.3 million in annual labor income in the five county region.
- Once developed, the proposed reservoir will enhance the region's attractiveness as a business location. As a recreational amenity, the lake will enhance the quality of life features of the region, which are an increasingly important factor in business site location decisions.
- 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 net of any losses due to the impoundment of the reservoir and related environmental mitigation. Similarly, net gains in area school district revenues will be $3.9 million per year at full development. Local taxes on retail sales will generate at least $303,000 per year with an additional $183,000 per year provided by hotel occupancy taxes.

This report includes one attachment. Attachment A is an economic and fiscal impacts analysis of operations at the Riverby Ranch in Fannin County, Texas, which has been purchased by the NTMWD to mitigate environmental impacts related to the development of the Lower Bois d'Arc Creek Reservoir.

Table ES1
Temporary Local Economic Impacts of Construction of the Lower Bois d'Arc Creek Reservoir Dam Fannin County

Description	Impact	
Dam Construction, Pipeline Construction, Water Treatment Plant, Pump Station and other infrastructure		
Description	Range of Impacts	
Economic Activity	$509,330,002	$562,943,686
Gross County Product	$211,355,290	$233,603,216
Labor Income	$165,237,561	$182,630,989
Person-Years of Employment	4,999	5,525
Property Income	$36,367,192	$40,195,318
Indirect Business Taxes	$9,750,537	$10,776,909

Sources: North Texas Municipal Water District, Author's estimates.

Table ES2
Economic and Fiscal Impacts of Household Spending Derived from Land Sales

Description	Impact
Land Acquisition Costs	$75,230,000
Economic Activity	$11,346,692
Gross County Product	$7,158,139
Labor Income	$3,411,702
Person-Years of Employment	106
Property Income	$2,817,739
Indirect Business Taxes	$928,698

Sources: North Texas Municipal Water District, Authors' estimates.

Table ES3
Total Local Economic Impacts of Development of the Lower Bois d'Arc Creek Reservoir Dam on Fannin County

Description	Impact	
Includes Dam, Pipeline, Water Treatment Plant, Pump Station and Land Acquisition Costs		
Description	Range of Impacts	
Economic Activity	$520,676,694	$574,290,378
Gross County Product	$218,513,429	$240,761,355
Labor Income	$168,649,265	$186,042,691
Person-Years of Employment	5,105	5,631
Property Income	$39,184,931	$43,013,057
Indirect Business Taxes	$10,750,537	$11,705,607

Sources: North Texas Municipal Water District, Author's estimates.

Table ES4
Recurring Annual Local Economic Impacts
(2011 dollars)

Description	Impact
Dam, Pump Station, Pipeline, and Water Treatment Plant Operations Impacted counties: Fannin	
Economic Activity	$2,137,000
Labor Income	$769,000
Jobs	24
Recreational Visitor Spending	
Annual Spending	$16,748,000 to $21,982,000
Economic Activity	$21,176000 to $28,233,000
Labor Income	$6,235000 to $8,344,000
Jobs	295 to 393
Resident Spending Permanent and Weekend/Vacation Residents: Fannin, Lamar, Grayson, Hunt, Delta	
Economic Activity	$105,294,000 to $ 116,378,000
Labor Income	$21,940,000 to $24,250,000
Jobs	857 to 947
New Industrial and Commercial Activities Based on Projected Water Usage	
Economic Activity	$145,197,000
Labor Income	$48,111,000
Jobs	1,607

Source: Author's estimates.

Table ES5
Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending*

Description	Impact
Total Taxable Value of Housing (permanent & weekend residents)	$326,200,000
Reduction in Property Value due to Inundation and Mitigation**	($10,484,000)
Net gain in Taxable Property Values	$315,716,000
Estimated New County Property Tax Revenues	$1,920,000
Estimated New School District Property Tax Revenues	$3,910,000
Total Potential*** Municipal Sales Taxes (0.01 rate)	$303,000
Hotel Occupancy Tax Revenues*	$183,000

* At build out.
** Assumes operating impact on Legacy Ridge County Club.
*** Value will be impacted by land annexation and business location decisions.
Source: Author's estimates.

Section 1: Introduction

Addressing future water needs for the North Texas Municipal Water District's service area has led to the consideration of developing several new water supplies. One proposal is for a reservoir to be located along the Lower Bois d'Arc Creek just northeast of the City of Bonham in Fannin County. The following report updates the findings of the 2007 and 2004 analyses of the economic, fiscal, and developmental impacts of this proposed reservoir.

Our estimates of the economic impacts of the reservoir and related economic activity are based on the IMPLAN input-output economic modeling system developed by the Minnesota IMPLAN Group. The modeled impacts include the direct effects of spending for construction activities and consumption spending, the indirect effects of local vendors providing goods and services to the primary firms, and the induced impacts of employees of these firms spending a portion of their earnings in the local economy. The impacts estimated in this analysis include:

- Economic Activity: The total value of transaction from direct, indirect, and induced effects.
- Contributions to Gross County/Area Product: A value-added measure equivalent to national Gross Domestic Product.
- Labor Income: Includes salaries, wages, proprietor's income, and certain benefits.
- Employment/Jobs: Employment estimates are expressed differently if the supporting spending is temporary or recurring. The construction/development phases of building the dam, related infrastructure, and new housing are temporary – once construction is completed, the impacts cease. The model employed in this analysis provides an estimate of the number of jobs associated with a given level of spending, but since that spending will occur over several years, the jobs impacts occur over several years. For example, if the construction of a new building takes three years to complete and will support 300 jobs, the estimate is not saying there will be 300 jobs each lasting for three years. Rather the estimate is saying there will be 300 person-years of employment supported. On average, the impact of the building construction would be 100 jobs per year; however, construction employment is highly variable based on the phase of the construction program, so the actual job impacts at any given time could vary dramatically. Therefore, jobs related to temporary expenditures are expressed as person-years of employment. For recurring spending such as pump station operations, tourist spending, and household spending, the impact estimates are considered recurring and the job estimates are for "permanent" jobs each year.
- Property Income: This category of impacts includes rents, royalties, dividends, and corporate profits supported by the new economic activity. For example, a worker at a new lake front hotel rents a house in Fannin County. The rent received by that worker's landlord is a property income.
- Indirect Business Taxes: This source of state and local government revenue includes sales and use taxes, property taxes, fees for permits and licenses, and other sources of revenue associated with indirect business transactions and induced household spending related to the spending categories included in this analysis.

This report begins with an economic overview of Fannin County and then proceeds to measure the new employment, income, spending, and tax revenues that will attend the construction and operations of the dam and related transportation, storage, and treatment facilities. Then the "ancillary" development likely to occur in conjunction with the dam is explored, in particular the construction of new homes and recreationally based businesses. New and recurring income, employment, and economic activity associated with this ancillary development are estimated. Finally, the impact of the proposed project on revenues to local taxing jurisdictions is examined.

Section 2: Economic Overview of Fannin County

Like many rural counties in Texas, Fannin County saw its historical peak of population and economic activity around the turn of the 20th century. The 1900 census showed a population of 51,793. Cotton and corn production were the chief crops in an economy dominated by agricultural production. Later in the 20th century, dairy operations rose in prominence, but the county suffered tremendous economic losses during the depression years and after World War II. Children of farmers sought their fortunes elsewhere. By 1970, the population had dropped to 22,705. However, after 1970 the population stabilized and began to slowly increase. In 2010 Fannin County's population had risen back to 33,915, though the growth rate in the past ten years has slowed substantially compared to the 1990s at 8.6 percent versus 22.8 percent, respectively.

As can be seen in Figure 1, year-over-year employment change in Fannin County has typically trailed the state as a whole – sometimes dramatically. These data suggest that one critical economic development strategy for Fannin County should be to diversify their economic base, particularly toward industries with greater stability over time.

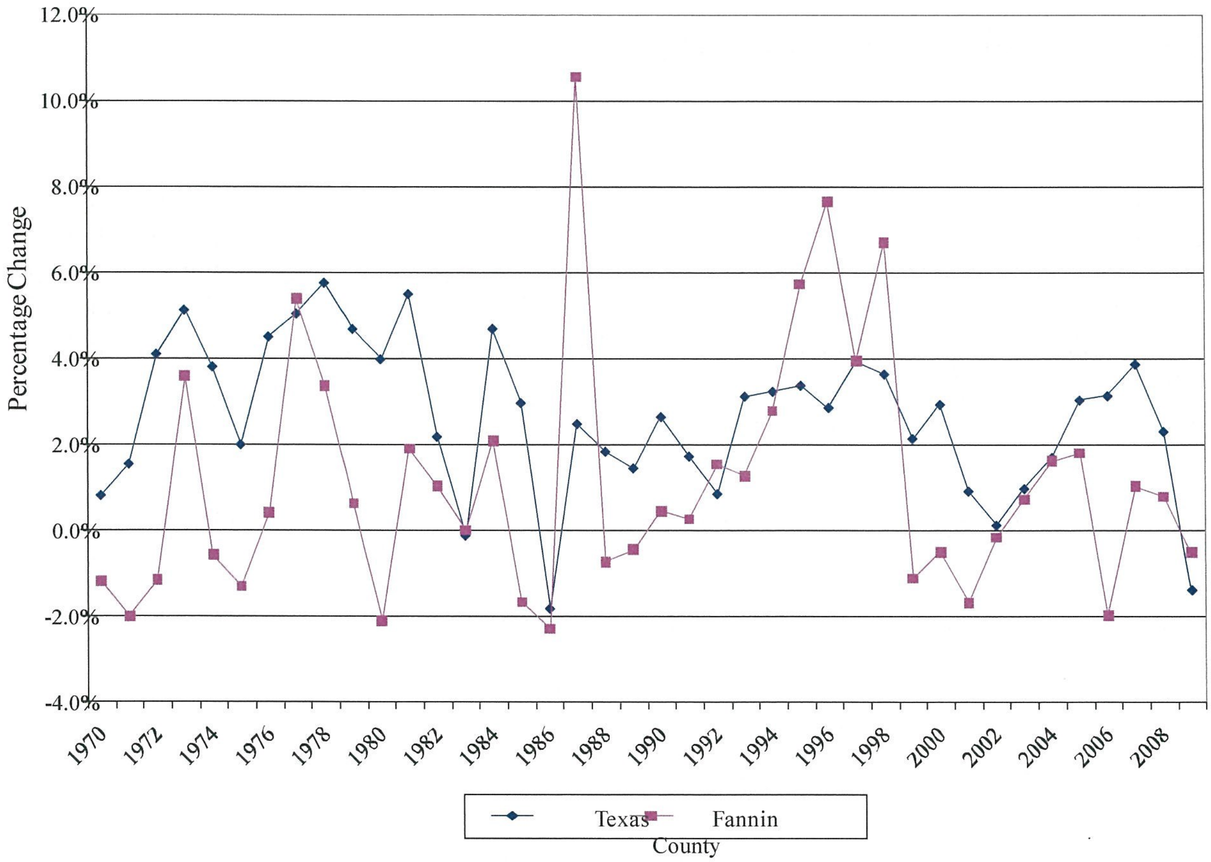
The proposed reservoir offers several economic development opportunities for Fannin County. In addition to the substantial economic activity that would be generated by construction projects related to the reservoir over a multi-year period, the new lake would attract recreational users whose spending, in turn, would spur investment in new hospitality venues. By supporting new residents and hosting new recreation-based industries, the proposed reservoir offers an excellent diversification opportunity for Fannin County.

Section 3: Economic Impacts of Dam and Related Infrastructure Construction

In this section we examine the economic impacts of the construction of the proposed Lower Bois d'Arc Reservoir dam and related infrastructure. These estimates are based on the latest cost projections for the facilities expressed in current year (2011) dollars.

Economic impact assessments for the dam and related infrastructure construction projects are examined in two models. The first looks at the impacts that will likely remain in Fannin County. However, based on the size of the development projects, businesses and residents of nearby counties will also benefit from the economic activity associated with the construction of the dam. For purposes of this analysis, we have included an estimate of the total impacts that will likely occur in a wider economic area defined by Fannin, Delta, Lamar, Grayson and Hunt counties.

Figure 1
Year-to-Year Percentage Change
Total Employment State of Texas and Fannin County
1970-2009



Source: U.S. Department of Commerce

The most recent estimates call for expenditures on dam construction to be about $112 million, including design, engineering, and related costs. In addition, related infrastructure including a water treatment plant, storage reservoirs, transport pipeline, water intake pump station, and related facilities add about $293 million to construction expenditures. This includes future planned expansions of the water treatment plant. To allow for changes in materials and other costs, we generally express cost estimates and the resulting economic impacts as a range of possible values.[2] Total expenditures for the Lower Bois d'Arc Creek reservoir and related infrastructure will be between $385 million and $426 million over several years. Based on the relative presence, or absence, of industries providing materials and supporting services to dam construction projects, some of the economic activity will "leak" out of the local area. Even so,

[2] Some spending categories, such as lake area housing construction and the impacts of new industrial activity, remain single point estimates.

these expenditures will increase total economic activity in Fannin County by $509 million to $563 million and boost gross county product (value added) by $211 million to $234 million (see Table 1). This new activity will create over 5,000 person years of employment and increase local labor income by somewhere between $165 million and $183 million. In addition, property incomes will increase by $36 million to $40 million. Indirect business taxes will boost state and local tax revenues by $9.8 million to $10.8 million.

Table 1
Temporary Local Economic Impacts of Construction of the Lower Bois d'Arc Creek Reservoir Dam
Fannin County

Description	Impact	
Dam Construction, Pipeline Construction, Water Treatment Plant, Pump Station and other infrastructure		
Description	Range of Impacts	
Economic Activity	$509,330,002	$562,943,686
Gross County Product	$211,355,290	$233,603,216
Labor Income	$165,237,561	$182,630,989
Person-Years of Employment	4,999	5,525
Property Income*	$36,367,192	$40,195,318
Indirect Business Taxes**	$9,750,537	$10,776,909

* Includes rents, royalties, dividends, and corporate profits.
** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.
Sources: North Texas Municipal Water District, Author's estimates.

Property owners for the land that will be consumed by the lake and the additional acreage that may be set aside for flood easements and environmental mitigation purposes will be compensated. These payments to land owners represent a transfer of income to the local economy supporting new spending in the region. Acquiring the land for the reservoir and related mitigation lands will be expected to cost about $75 million. Most of the affected landowners will be area residents. Assuming that about 20 percent of the land purchase price is taken as household income, as opposed to reinvesting the proceeds into other assets, we estimate that proceeds of land sales will boost local economic activity by about $11 million, supporting about $3.4 million in labor income for Fannin County workers (see Table 2).

When added to the impacts of construction activities, the non-recurring impacts of development the Lower Bois d'Arc Creek Reservoir will boost economic activity in Fannin County by somewhere between $521 and $574 million, increase county gross product $219 to $241 million, and support 5,105 to 5,631 person-years of employment. Labor income associated with these jobs will be between $169 million and $186 million; and property income will rise by $39 million to $43 million. Indirect business taxes will rise by $10.8 to $11.7 million (see Table 3).

Table 2
Economic and Fiscal Impacts of Household Spending Derived from Land Sales

Description	Impact
Land Acquisition Costs	$75,230,000
Economic Activity	$11,346,692
Gross County Product	$7,158,139
Labor Income	$3,411,702
Person-Years of Employment	106
Property Income*	$2,817,739
Indirect Business Taxes**	$928,698

* Includes rents, royalties, dividends, and corporate profits.
** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.
Sources: North Texas Municipal Water District, Authors' estimates.

Table 3
Temporary Local Economic Impacts of Development of the Lower Bois d'Arc Creek Reservoir Dam on Fannin County

Description	Impact	
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Indirect Business Taxes**	$10,750,537	$11,705,607

* Includes rents, royalties, dividends, and corporate profits.
** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.
Sources: North Texas Municipal Water District, Author's estimates.

Looking at the expanded economic region defined by Fannin, Collin, Lamar, Delta, Grayson and Hunt counties, the impacts are larger reflecting these additional counties' abilities to attract a portion of the jobs and business activity related to the development of the reservoir. Including the spillover to these adjacent counties, total economic activity associated with property acquisition and the construction of the Lower Bois d'Arc Creek reservoir dam and other infrastructure rises to between $682 million and $833 million during the reservoir development phase. The increase in gross area product will be $347 million to $425 million. Total labor income paid in the six-county region will increase between $256 to $313 million through the creation of between 5,430 and 6,636 person-years of employment. Property income will also rise to between $73 million and $89 million, while state and local governments will see between $18.7 million and $22.8 million in revenue from indirect business taxes (see Table 4).

Table 4
Temporary Local Economic Impacts of Development of the Lower Bois d'Arc Creek Reservoir Dam
Fannin, Collin, Delta, Lamar, Grayson, and Hunt Counties

Description	Impact	
Includes Dam, Pipeline, Water Treatment Plant, Pump Station and Land Acquisition Costs		
Description	Range of Impacts	
Economic Activity	$681,688,798	$833,175,198
Gross Regional Product	$347,401,467	$424,601,793
Labor Income	$255,942,225	$312,818,275
Person-Years of Employment	5,430	6,636
Property Income*	$72,807,443	$88,986,875
Indirect Business Taxes**	$18,651,798	$22,796,642

* Includes rents, royalties, dividends, and corporate profits.
** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.
Sources: North Texas Municipal Water District, Author's estimates.

Section 4: Ongoing Economic Impacts of Dam and Pipeline Operations

Once the dam and pipeline are built, ongoing operations and maintenance of these infrastructures will continue to provide a modest number of jobs and a minor boost to local economic activity. Recurring maintenance and operating expenditures for the dam and related infrastructures will increase local economic activity by about $2.1 million each year in Fannin County. This activity will support 24 direct and indirect jobs paying about $769,000 in labor income (see Table 5).

Table 5
Recurring Annual Local Economic Impacts of Dam, Pipeline and Related Infrastructure Operations in Fannin County

Description	Impact
Economic Activity	$2,137,000
Gross County Product	$1,346,000
Labor Income	$769,000
Employment	24
Property Income*	$486,000
Indirect Business Taxes**	$91,000

* Includes rents, royalties, dividends, and corporate profits.
** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.
Sources: North Texas Municipal Water District, Author's estimates.

Section 5: Developmental Impacts of the Proposed Reservoir

In addition to the one-time and recurring impacts described above, the impoundment of a 16,641-acre reservoir in Fannin County would have substantial spillover benefits on the local economy. This section considers the impacts associated with recreational spending based at the reservoir and the economic and fiscal consequences for the region from attracting new permanent and weekend residents.

5.1 Impacts of recreational users

The "field of dreams" scenario often works for lakes. If you build a publicly accessible water recreation resource, visitors will use it. The North Texas region currently has many excellent reservoirs supporting water-based recreational activities. However, some of these reservoirs are so overcrowded that water accidents occur with increasing frequency. As the Dallas-Fort Worth (DFW) population continues to grow over the next 30 years, demand for water recreation sites will increase, and Fannin County is ideally situated to capture more than a fair share of this recreational activity.

Unfortunately, few studies offer specific guidance on estimating the magnitude of the economic impacts that will attend increased recreational visitors to Fannin County when the proposed reservoir is fully developed. However, in the mid-1990s, Texas A&M, working for the Texas Parks and Wildlife Department and the Sabine River Authority, surveyed anglers at Lake Fork to assess their levels of local spending. Over two-thirds of the survey respondents were non-local residents, with about one-third hailing from outside of Texas. Non-local angler-visitors to Lake Fork spent an estimated $14.5 million in Wood, Rains, and Hopkins counties during their fishing trips for food, lodging, and supplies. This level of spending encourages business development and supports jobs. While some of this employment will be seasonal, North Texas weather patterns permit water-based recreation on a year-round basis.

Other lake-based recreation activities will draw additional out-of-area visitors to the region. While we do not suggest that the new reservoir will soon enjoy Lake Fork's national reputation as a fishing lake, when combined with non-angler spending it is estimated that non-local recreation visitors will add $16.7 million to $22 million in new spending for dining, food, retail goods, and lodging to the Fannin County economy. This spending will generate between $21.2 million and $28.2 million in economic activity, support 295 to 393 new jobs, and increase local labor income by $6.2 million to $8.3 million (see Table 6). Undoubtedly, bringing new recreational visitors to the area will present opportunities for businesses located in adjacent counties, especially Lamar County. However, given existing amenities and attractions in the City of Bonham, most of the recreational spending is expected to stay in Fannin County.

In addition to recreational spending by visitors to the reservoir, the designated mitigation area in the northern part of Fannin County will potentially be used for some type of recreational activities that would draw additional visitor spending to the area. However, the specific uses of the mitigation land have not been determined at the time of this analysis and therefore those potential impacts are not included here.

Table 6
Recurring Annual Local Economic Impacts of Recreational Out-of-Area Visitor Spending

Description	Impact
Annual Spending: Recreational Visitors	$16,748,000 to $21,982,000
Economic Activity	$21,176,000 to $28,233,000
Labor Income	$6,235,000 to $8,344,000
Employment	295 to 393

Source: Author's estimates.

5.2 Impacts of new permanent and weekend residents

One trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have enjoyed greater population growth than counties without these important amenities. Many recreational lake visitors eventually decide to move close to their favorite reservoirs. Carefully managed residential development can prove to be a tremendous economic boon for lake county economies.

Fannin County is well-positioned to take full advantage of opportunities to attract new permanent and weekend residents to the reservoir. The proposed dam, which will be on the north side of the reservoir, will be only 50 miles from McKinney and 80 miles from downtown Dallas. Already, spillover growth from the DFW Metroplex is reaching the Bonham area. Within reasonable travel time to big-city amenities, yet removed from most urban disamenities, we expect the proposed reservoir to attract at least 1,100 full- time resident households over and above anticipated growth for the area over the next 30 years. Recognizing the impacts of the Great Recession and sub-prime lending crisis has had on regional and national housing markets, the original assessment of potential growth will still hold true, since the reservoir will not be impounded until well after local housing markets have recovered. Therefore, new households will be expected to bring almost $60 million in new income to the area. In addition, at least 2,100 new dwellings will be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. The estimate of these weekender residences is likely understated. However, while relative proximity to the Metroplex will encourage permanent residents that same proximity will lower demand for weekend/vacation housing. Nonetheless, it is estimated that weekend and vacation resident will bring an equivalent of $10 million in household income that will in turn be used for local purchases. In sum, and in keeping with our aforementioned approach of expressing spending estimates as a range of possibilities, we estimate new household spending from vacation and permanent lake-area residents will total about $71 million to $78 million per year.

Modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, the Fannin County economy will realize a net increase in economic activity of between $80.7 million and $89.2 million each year once full development is reached. This activity will support 517 to 572 permanent employment (jobs) paying $13.3 million to $14.7 million in labor income (see Table 7).

Table 7
Recurring Annual Local Economic Impacts of New Resident Spending

Description	Impact
Fannin County	
Annual Spending	$70,891,000 to $77,764,000
Economic Activity	$80,726,000 to $89,223,000
Labor Income	$13,332,000 to $14,735,000
Employment	517 to 572
Fannin, Hunt, Delta, Grayson, and Lamar counties	
Economic Activity	$105,294,000 to $116,378,000
Labor Income	$21,940,000 to $24,250,000
Employment	857 to 947

Source: Author's estimates.

It is likely that businesses located in Hunt, Lamar, Grayson, and Delta counties, as well as Fannin County, will offer goods and services to the new permanent and weekend residents. Including the economic activity that is likely to go to these other counties, spending by households drawn to the new reservoir will increase economic output in the broader region by $105 million to $116 million, boost local labor income by $22 million to $24 million, and support between 857 to 947 permanent jobs.

It should be strongly emphasized that the pace and quality of development will depend on many market-related factors. **One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand.** Examples of infrastructure would include such things as electric services, roads, water services, and public safety and other municipal services.

5.3 Impacts of new housing construction

These projections assume that the new permanent and weekend resident households will be single-family units. This is consistent with most of the development trends experienced in other lake counties. Even if residential real estate demand shifts to the inclusion of multi-family properties, the costs of development, and hence the economic and fiscal impacts, will be within the range of possibilities projected below.

Because of recent housing market volatility, the estimates of housing prices have been retained from the 2007 study. Undoubtedly, this approach results in a more conservative estimate of the likely impacts of housing development near the new reservoir. The estimated average cost of land and improvements for permanent-resident dwellings will be about $127,000. Based on the findings of nationwide housing studies, vacation and weekend homes will likely be valued somewhat less than those of permanent residents. An average market value of $115,000 per weekend dwelling is assumed. About 25 percent of the housing values will represent land. Therefore, based on earlier estimates of the number of households that will eventually occupy the areas around the proposed reservoir, almost $288 million in new residential construction activity will be expected to occur primarily in Fannin County over a 30- year period. These construction activities will boost the local economy by about $432.5 million supporting almost 4,000 person-years of employment that will pay over $102 million in labor income (see Table 8).

Table 8
Local Economic Impacts of Housing Construction
(30-year development)

Description	Impact Total	Average Annual[3]
Construction Spending	$287,805,000	$9,594,000
Economic Activity	$432,538,000	$14,418,000
Labor Income	$102,123,000	$3,404,000
Person-Years of Employment	3,997	133

Source: Author's estimates.

5.4 *Business development and recruitment*

One of the key attractions for new residents, including business people making location choices for plant sites, distribution centers, and other industrial land uses, is the presence of recreational amenities and quality-of-life features. These characteristics have become critical in the site selection process. Given Fannin County's existing locational advantages, the presence of a new reservoir providing a reliable source of water for industrial uses will enhance the county's ability to attract and retain businesses. To estimate the magnitude of the economic activity that could be gained through expanded business activities, projected water demand estimates from the Texas Water Development Board (TWDB)[4] and the previously described IMPLAN model are utilized.

Based on its latest published estimates, the TWDB expects manufacturing industry water use to rise in Fannin County by eight acre-feet per year between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 acre-feet per year. Livestock and irrigation uses are not expected to increase over this period, which is reasonable given the impact of the lake's impoundment on these land uses. Mining industry activities are also not expected to increase.[5] Municipal uses are expected to rise by 1,326 acre feet per year. While much of this

[3] Housing construction will not be evenly distributed across the period of development
[4] Though the TWBD estimates do not specifically include the proposed reservoir, they provide a reasonable basis for conservatively estimating future economic activity.
[5] Projected water usage for livestock and irrigation purposes are substantially lower than current usage estimates.

increase in municipal usage will be accounted for by the increase in households described earlier, some of the increase will be due to increased commercial and other non-manufacturing business activities not previously described in this analysis.

Based on year 2000 data for Fannin County and production input data from the IMPLAN model, we estimate the current economic value of goods production per acre-foot of water used for several product categories. Multiplying these values by the projected increase in water usage suggests that manufacturing, commercial,[6] and electricity generating activities will increase by $117.9 million annually in Fannin County. While there are many factors that drive economic development, without the water resources made available by the proposed reservoir, it is unlikely that Fannin County will see this increase in economic activity.

Increasing Fannin County's direct economic activity would also create spin-off indirect and induced economic impacts as described earlier in this report. However, two adjustments are required to improve the accuracy of estimating these indirect and induced impacts. Firstly, induced (household spending) impacts are not included in order to avoid double counting the impacts of permanent resident spending described above that would be employed by companies creating this new business activity. Secondly, current economic models of Fannin County do not adequately represent how the economy will operate 25 years from now. Therefore Rockwall County impact multipliers are used, which currently has a population about equal to TWBD's projected population for Fannin County in 2020.[7] Increasing Fannin County's industrial and commercial output by $117.9 million will result in $145 million in economic activity, boost area labor income by $48 million, and support over 1,600 jobs (see Table 9).

Table 9
Economic Impacts of New Industrial and Commercial Activities
(10-year increase after reservoir development)

Description	Annual Impact
New Direct Activity	$117,866,000
Economic Activity	$145,197,000
Labor Income	$48,111,000
Employment	1,607

Source: Authors' estimates.

Section 6: Local Fiscal Impacts

This section estimates some of the new tax revenues that will be enjoyed by counties and school districts adjusted for the loss of taxable land in the impoundment and mitigation areas. The analysis of foregone tax revenues from property inundation, environmental mitigation area, and

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[6] No more than 20 percent of municipal water usage is assumed for commercial business activities.
[7] Local officials in Fannin County suggest that the TWBD population projections are substantially underestimated. While concurring with these officials, the TWBD data enhance the conservative nature of these estimates.

the redrawing of flood plain maps are based on the 2007 analysis with property valuations increased to reflect estimated average growth of valuations in Fannin County through 2011.

The Lower Bois d'Arc Creek Reservoir will be expected to cover more than 16,000 acres. (This does not include the proposed environmental mitigation area at Riverby Ranch.) As noted above, the reservoir will attract residential, commercial, and industrial property development, substantially boosting property tax revenues for local taxing jurisdictions. However, as NTMWD acquires property for the reservoir, local tax rolls will be reduced somewhat before much of the anticipated new development occurs. This analysis estimates potential tax losses for the county, the City of Bonham, and affected school districts in the near-term.

The area of land the NTMWD will acquire can generally be described as southwest of the proposed dam, at or below 545 feet above mean sea level. The affected land parcels are identified using Geographic Information System (GIS) data and software that was provided by the consulting engineers on the Lower Bois d'Arc Creek Reservoir project. Data are obtained from the Fannin County Appraisal District showing the size and taxable value in 2007 for each parcel that will lose land to the reservoir. This includes those parcels that will lose only a portion of their land to the lake and/or flood plain area.

In all, there are about 556 unique parcels at or below the 545-foot elevation level. Of these, we found taxable values for 502 parcels, leaving 54 without data. For those parcels not wholly within the land purchase area, aerial photography and tax records were used to assess the potential loss of taxable improvements on each parcel in the reservoir and flood plain area. For purposes of this analysis, no allowances were made for moving structures. If a structure is located within the 545 elevation line, it is considered lost for taxation purposes.

It is important to clarify that the estimates presented here represent taxable values and not market values. What's more, the assessed values are net of agricultural and homestead exemptions. It is assumed that any exemptions will continue after the reservoir land purchase.

For those parcels without valuation data from the Fannin County Appraisal District online database, aerial photography and GIS software were used to identify taxable improvements and land that NTMWD will purchase from each parcel. Land valuations for these parcels are based on the average taxable value of land for all other parcels, about $305 per acre including exemptions in 2007. Since 2007, taxable property values in Fannin County, like most areas, have been affected by the downturn in the real estate market. It is estimated that real property valuations net of new development have increased 0.67% per year since 2007 for an average taxable value of about $313 per acre. We assigned this estimated valuation to each school district based on their relative portion of land in the reservoir area.

There are two parcels without data that are treated differently. These two parcels include portions of the Legacy Ridge Country Club, comprising about 47 acres. Fiscal impact estimates for Fannin County, the City of Bonham, and the Bonham Independent School District (ISD) that include an estimated taxable value of the country club are presented below. However, it is possible that the country club will still be operationally viable once the flood plain lines are redrawn. Therefore, the actual impact on tax revenues may be substantially less than shown when the full value of the country club is removed from the tax rolls.

The findings presented below are estimates. There has been no independent verification of the accuracy of the Fannin County Appraisal District online database, nor has there been direct engagement in specific surveys to gauge the accuracy of the map images provided by the project engineers. These estimates should be used for planning purposes only. As property values will begin to rise based on new development near the new reservoir, the annual tax losses will diminish and turn to net new revenues for local taxing jurisdictions. Estimates of temporary tax losses are shown in Table 10. In addition to the inundation area, the Riverby Ranch has been acquired by NTMWD to serve as proposed environmental mitigation for the reservoir. See Attachment A for the 2012 Economic Impacts of the Riverby Ranching Operations. Prior to acquisition, this property had an appraised value of slightly more than $4 million, including improvements, and generated just under $78,000 per year in total property taxes, about $52,000 of which went to the Sam Rayburn ISD.

Table 10
Temporary Annual Tax Revenue Impacts of Land Acquisition for the Lower Bois d'Arc Creek Reservoir
(2011 valuation estimates, including mitigation area)

Entity	Value Before	Value After	Difference	Tax Rate	Temporary Tax Loss
Bonham ISD	$1,545,679	$1,206,037	$339,643	0.011505	$3,908
Including golf course	$2,593,067	$1,206,037	$1,387,030	0.011505	$15,958
Dodd City ISD	$3,429,167	$2,318,673	$1,110,493	0.01115	$12,382
Honey Grove ISD	$3,965,947	$2,114,933	$1,851,014	0.0135912	$25,158
Sam Rayburn ISD	$7,696,517	$1,550,066	$6,146,451	0.012039	$73,997
Fannin County	$16,641,590	$7,194,981	$9,446,608	0.006081	$57,445
Including golf course	$17,678,708	$7,194,981	$10,483,726	0.006081	$63,752
City of Bonham	$36,909	$29,571	$7,338	0.0067	$49
Including golf course	$1,074,027	$29,571	$1,044,456	0.0067	$6,998
Total Loss not/including golf course					**$172,938**
Total Loss including golf course					**$198,244**

Sources: Fannin County Appraisal District, North Texas Municipal Water District, Freese & Nichols, Author's estimates.

The taxable value of permanent and weekend resident housing at full development is estimated at $326.2 million[8], which would generate an estimated $5.9 million in county and school district revenues. Therefore, the net increase in tax revenues will be about $5.7 million at full development, of which $3.9 million will be enjoyed by school districts in Fannin County. Importantly, much of this gain in school district revenues will not be accompanied by a proportionate increase in students since a large percentage of the estimated valuations are for weekend or vacation residences. Area municipalities and townships could also benefit from

[8] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

increased property tax revenues depending on the degree to which their taxing jurisdictions are expanded to include land adjacent to the proposed reservoir (see Table 11).

Taxable retail sales in Fannin County will increase as new residents and visitors come to the area. Taking a very conservative approach, it is estimated that local sales tax revenues could increase by $303,000 or more per year. Hotel revenues for room rentals are expected to be at least $3.7 million per annum. Based on a local bed-tax rate of five percent, these expenditures will boost local tax receipts by an additional $183,000 annually. These estimates do not consider the additional taxable property value that will be created as stores, bait shops, hotels/resorts, restaurants, and other businesses locate around the lake.

Table 11
Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending

Description	Impact
Total Taxable Value of Housing (permanent & weekend residents)	$326,200,000
Reduction in Property Value due to Inundation and Mitigation**	($10,484,000)
Net gain in Taxable Property Values	$315,716,000
Estimated New County Property Tax Revenues	$1,920,000
Estimated New School District Property Tax Revenues	$3,910,000
Total Potential Municipal Sales Taxes (0.01 rate)*	$303,000
Hotel Occupancy Tax Revenues*	$183,000

* Value will be impacted by land annexation and business location decisions.
** Includes golf course.
Source: Author's estimates.

Section 7: Conclusions

The proposed Lower Bois d'Arc Reservoir will provide tremendous short-term economic gains to Fannin County that will certainly spill over to residents and businesses in surrounding counties as the dam and related infrastructures are constructed over a multi-year period. Construction spending for the dam and water transport infrastructure will add as much as $563 million to local economic activity and provide more than 5,500 person-years of employment.

Recurring operations supporting the dam and related infrastructure will create new opportunities for local businesses by adding $2.1 million in annual local economic activity and supporting about 24 jobs. Once impounded, the lake will attract substantial new private investment by hospitality firms anxious to provide services, meals, and specialty retail goods to the lake's recreational users. Out-of-area recreational users are projected to spend upwards of $22 million per year in the local economy. In addition, as seen with other Texas lakes, residents will be attracted to the region to take advantage of the new recreational amenities, bringing substantial new local spending to the area at full development. These new personal outlays will increase local economic activity by up to $89 million per year and up to about 570 jobs. The reservoir will provide water resources that will in turn support additional business development in Fannin County. Using conservative TWBD usage estimates, new industries attracted by the enhanced water resource will add $145 million in new economic activity in the county supporting 1,600 jobs. Any comparable industrial investment offering this magnitude of economic benefit would probably require exceptional incentive packages from state, county, and municipal governments. Construction of housing units for permanent and weekend residents will likely be spread over a 30-year period, providing long-term employment and business opportunities in the construction trades.

An expanded tax base will be another payoff from the ancillary development that will attend construction of the reservoir, allowing local governments to provide a broader range of public services while maintaining competitive tax rates. In sum, the economic opportunities supported by the proposed reservoir will promote sustainable development while diversifying the local job base.

ATTACHMENT A

Briefing Paper
The Economic Impacts of Riverby Ranch Operations
Prepared by Terry L. Clower
April 25, 2012

Briefing Paper

The Economic Impacts of Riverby Ranch Operations

Prepared by Terry L. Clower

April 25, 2012

The following reports the findings of the economic and fiscal impacts analysis of operations at the Riverby Ranch in Fannin County, Texas. The ranch has been purchased by the North Texas Municipal Water District as a designated environmental mitigation area to meeting statutory requirements related to the development of the Lower Bois d'Arc Creek Reservoir. Though the ranch has been purchased, it is currently being leased by previous owners and is still in operation. Operations at the ranch will likely continue unless the proposed reservoir is impounded. The loss of operations at Riverby Ranch, which largely consist of raising cattle, would somewhat offset the economic activity that would occur in the area during and after reservoir development. All figures are reported in 2011 dollars.

The following estimates focus on the economic impacts in Fannin County. Based on information provided by the previous owner/current executive of Riverby Ranch, many of the cattle trading activities currently based at Riverby would not cease, but would likely be transferred out of Fannin County once the mitigation plan is implemented. In addition, the fiscal impacts reported here are based on indirect spending activities and do not include the loss of taxable property value when the North Texas Municipal Water District purchased the ranch, which is addressed by payments in lieu of taxes by the Water District.

Our estimates of the economic and fiscal impacts of closing operations at Riverby Ranch are based on data provided by Riverby executives and analyzed using the IMPLAN economic input-output model developed by the Minnesota Implan Group (MIG, Inc.). This model is widely used in academic and professional research. Direct ranch spending data are not reported to protect data confidentiality.

Based on current operations, Riverby Ranch creates $13.5 million in economic activity in Fannin County.

This economic activity supports 264 jobs paying about $962,000 in salaries, wages, and benefits. However, most of these jobs are part-time positions employed during key ranching operations. It is likely that some of these jobs are itinerant in nature.

Gross county product is boosted by less than $3 million suggesting the total impacts of Riverby Ranch operations have a modest impact on the local economy.

Property income associated with the ranch operating would decrease by $1.6 million, once ranch operations cease.

State tax revenues would decline by about $244,000 per year and local tax jurisdictions would fall about $100,000,

The Economic and Fiscal Losses from Ceasing Operations at Riverby Ranch
Fannin County Impacts
2011 dollars

Description	Impact
Economic Impact	$13,524,000
Gross County Product (value added)	$2,935,000
Employment (full- and part- time)	264
Labor Income (salaries, wages, benefits)	$962,000
Property Income (rents, royalties, dividends, corporate profits)	$1,596,000
State taxes (sales taxes, fees, other business taxes)	$244,000
Local Taxes (property taxes, sales and use taxes, fees)*	$98,000

* Does not include direct property taxes paid by the ranch prior to being acquired by the North Texas Municipal Water District.

Sources: Riverby Ranch, IMPLAN, Author's estimates.

ATTACHMENT B

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

Prepared by Terry L. Clower, Ph.D.
Bernard L. Weinstein
September 2007

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

Prepared for:

The North Texas Municipal Water District

By:

Terry L. Clower, Ph.D.*
Bernard L. Weinstein

September 2007

Executive Summary

This report updates the findings of our 2004 analysis of the economic, developmental, and fiscal impacts of the Lower Bois d'Arc Creek reservoir that will be developed by the North Texas Municipal Water District.

- Construction of the dam to impound the proposed Lower Bois d'Arc Creek Reservoir, the intake pump station, and other related expenditures will cost about $100 million. In addition, construction spending for other related infrastructure in Fannin County, including a water intake pump station, transport pipeline and related facilities will add another $181 million to local spending for the reservoir. In total, current estimates call for infrastructure spending in Fannin County to be between $267 million and $295 million over a four to five year period. Depending on exact expenditures, local economic activity will increase between $303 million and $335 million during the construction phase of the reservoir development. This activity will support in the range of 1,600 to over 1,760 person-years of employment with associated salaries and wages of between $53.6 million and $59.2 million.

- Including infrastructure development that will occur in Collin County, total water transmission and treatment facilities associated with the Lower Bois d'Arc Creek Reservoir will cost in the range of $365 million to $403 million boosting economic activity in Fannin and Collin counties by a combined $536 million to $593 million, supporting over 4,000 person-years of employment and paying upwards of $200 million in salaries and wages.

- After construction of the dam and pipeline is completed, on-going impacts from the operation and maintenance of these infrastructures will support about 20 full-time-equivalent direct and indirect jobs and spur about $4 million in new economic activity per year.

- Once the lake is impounded, new recreational spending will arrive in Fannin County as visitors come to fish, boat, and participate in other water-recreation activities. These visitors will bring $16 million to $21 million in new annual spending to the local economy.

- The lake will also attract many new residents to Fannin County. We estimate that over a 30-year period at least 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. These new households will be in addition to any other growth projected for Fannin County. The construction of these homes will bring an average of over 133 jobs per year to the local economy over the development period.

- The reservoir will also support new industrial and commercial activities beyond those described in the hospitality industry. Using Texas Water Development Board usage estimates, we project that $139 million in new economic activity in Fannin County supporting over 1,600 permanent jobs could be made possible by the availability of a new reliable water resource.

- The pace and quality of development will depend on many market-related factors. One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand. Examples of infrastructures would include such things as electric services, roads, water services, and public safety and other municipal services.

- Spending by new residents in the local economy will increase economic activity in Fannin County by $67 million to $74 million each year. Our analysis also suggests that economic activity in the larger region including Fannin, Hunt, Delta, and Lamar counties will rise by as much as $91 million per year in response to having these new residents living near the proposed reservoir. This activity will support well over 700 permanent jobs paying about $17 million in annual salaries and wages.

- Once developed, the proposed reservoir will enhance the region's attractiveness as a business location. As a recreational amenity, the lake will enhance the quality of life features of the region, which are an increasingly important factor in business site location decisions.

- 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 net of any losses due to the lake impoundment and related environmental mitigation. Similarly, net gains in area school district revenues will exceed $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.

Table ES1

Temporary Local Economic Impacts of Construction Of the Lower Bois d'Arc Creek Reservoir Dam

Description	Impact
Dam Construction, Pipeline Construction, Pump Station and other infrastructure Impacted counties: Fannin. Construction period: 4-5 years.	
Construction costs	$ 267,279,000 to $ 295,414,000
Total economic activity	$ 302,931,000 to $ 334,819,000
Total salaries and wages	$ 53,579,000 to $ 59,219,000
Total person-years of employment	1,596 to 1,764
Property Income*	$ 14,773,000 to $ 16,328,000
Indirect Business Taxes**	$ 2,663,000 to $ 2,944,000

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending. Sources: North Texas Municipal Water District, authors' estimates.

Table ES1 -- continued

Temporary Local Economic of Pipeline, Treatment Plant, and Related Infrastructure Construction

Description	Impact
Pipeline, Storage, and Treatment Facilities Construction Impacted counties: Fannin, Collin. Construction period: 3-4 years.	
Construction costs	$ 365,001,000 to $ 403,422,000
Total economic activity	$ 536,540,000 to $ 593,018,000
Total salaries and wages	$ 180,658,000 to $ 199,674,000
Total person-years of employment	4,122 to 4,556
Other property income*	$ 53,308,000 to $ 58,919,000
Indirect business taxes**	$ 12,147,000 to $ 13,426,000

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending. Sources: North Texas Municipal Water District, authors' estimates.

Table ES2

Recurring Annual Local Economic Impacts
(2007 dollars)

Description	Impact
Dam, Pump Station, Pipeline, and Treatment Plant Operations Impacted counties: Fannin, Collin	
Total economic activity	$ 3,966,000
Total salaries and wages	$ 825,000
Total full-time-equivalent employment	20
Recreational Visitor Spending	
Total annual spending	$ 16,000,000 to $ 21,000,000
Total economic activity	$ 20,230,000 to $ 26,972,000
Total salaries and wages	$ 5,957,000 to $ 7,972,000
Total full-time-equivalent employment	295 to 393
Resident Spending Permanent and Weekend/Vacation Residents: Fannin, Lamar, Hunt, Delta	
Total economic activity	$ 82,303,000 to $ 90,967,000
Total salaries and wages	$ 17,150,000 to $ 18,955,000
Total full-time-equivalent employment	701 to 775
New Industrial and Commercial Activities Based on Projected Water Usage	
Total economic activity	$ 138,710,000
Total salaries and wages	$ 45,961,000
Total full-time-equivalent employment	1,607

Source: Authors' estimates

ES3

Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending+

Description	Impact
Total taxable value of housing (permanent and weekend residents)	$ 326,200,000
Reduction in property value due to inundation and mitigation	($ 10,524,000)
Net gain in taxable property values	$ 315,676,000
Estimated new county property tax revenues	$ 1,894,000
Estimated new school district property tax revenues	$ 5,118,000
Total potential* municipal sales taxes (0.01 rate)	$ 290,000
Hotel occupancy tax revenues*	$ 175,000

+ at buildout * Value will be impacted by land annexation and business location decisions.
Source: Authors' estimates

Section 1: Introduction

Addressing future water needs for the North Texas Municipal Water District's service area has led to the consideration of developing several new water supplies. One proposal is for a reservoir to be located along the Lower Bois d'Arc Creek northeast of the City of Bonham in Fannin County. The following report updates the findings of our 2004 analysis of the economic, fiscal, and developmental impacts of this proposed reservoir.

Our estimates of the economic impacts of the reservoir and related economic activity are based on the IMPLAN input-output economic modeling system developed by the Minnesota IMPLAN Group. The modeled impacts include the direct effects of spending for construction activities and consumption spending, the indirect effects of local vendors providing goods and services to the primary firms, and the induced impacts of employees of these firms spending a portion of their earnings in the local economy.

We begin with an economic overview of Fannin County and then proceed to measure the new employment, income, spending, and tax revenues that will attend the construction and operations of the dam and related transportation, storage, and treatment facilities. We then explore the "ancillary" development likely to occur in conjunction with the dam, in particular the construction of new homes and recreationally based businesses. New and recurring income, employment, and economic activity associated with this ancillary development are estimated. Finally, we examine the impact of the proposed project on revenues to local taxing jurisdictions.

Section 2: Economic overview of Fannin County.

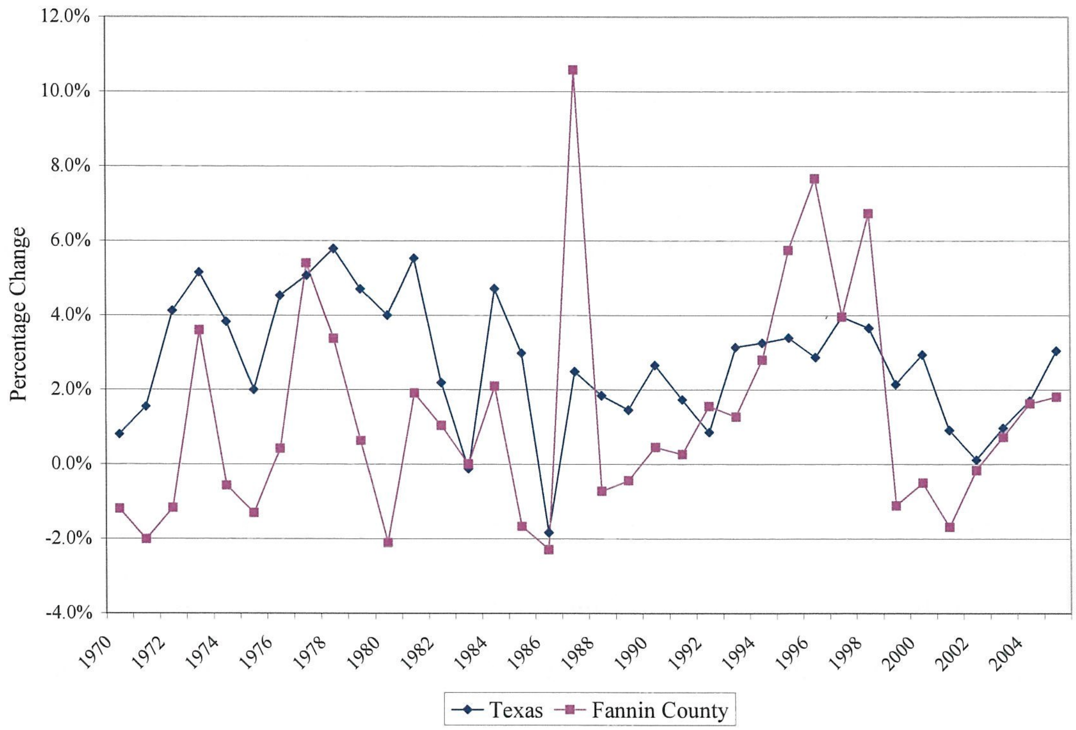
Like many rural counties in Texas, Fannin County saw its historical peak of population and economic activity around the turn of the 20th century. The 1900 census showed a population of 51,793. Cotton and corn production were the chief crops in an economy dominated by agricultural production. Later in the 20th century, dairy operations rose in prominence, but the county suffered tremendous economic losses during the depression years and after World War II. Children of farmers sought their fortunes elsewhere. By 1970, the population had dropped to 22,705. However, after 1970 the population stabilized and began to slowly increase. Today Fannin County is home to over 33,000 residents and during the decade of the 1990s actually grew faster than the state as a whole (26 percent increase versus 22.8 percent increase) as spillover growth from Dallas' northern suburbs reached the county.

As can be seen in Figure 1, year-over-year employment change in Fannin County has not seen consistent growth as shown for the state. With the exception of 1986 and 1994-1997, the county has lagged state economic performance, sometimes dramatically. These data suggest that one critical economic development strategy for Fannin County should be to diversify the economic base, particularly toward industries with greater stability over time.

The proposed reservoir offers several economic development opportunities for Fannin County. In addition to the substantial economic activity that would be generated by construction projects related to the reservoir over a multi-year period, the new lake would attract recreational users whose spending, in turn, would spur investment in new hospitality venues. By supporting new residents and hosting new recreation-based industries, the proposed reservoir offers an excellent diversification opportunity for Fannin County.

Figure 1

Year-to-Year Percentage Change
Total Employment State of Texas and Fannin County
1970-2005



Source: US Department of Commerce.

Section 3: Economic impacts of dam and related infrastructure construction.

In this section we examine the economic impacts of the construction of the proposed Lower Bois d'Arc Creek Reservoir dam and related infrastructure. These estimates are based on the latest cost projections for the facilities expressed in current year (2007) dollars.

Economic impact assessments for the dam and related infrastructure construction projects are examined in two models. The first looks at the impacts that will likely remain in Fannin County. However, based on the size of the development projects, businesses and residents of nearby counties will also benefit from the economic activity associated with the construction of the dam. For purposes of this analysis, we have included an estimate of the total impacts that will likely occur in a wider economic area defined by Fannin, Delta, Lamar, and Hunt counties.

The most recent estimates call for expenditures on dam construction to be about $100 million. In addition, related infrastructure including transport pipeline, a water intake pump station, and related facilities add about $181 million to construction expenditures. Total expenditures for the Lower Bois d'Arc Creek reservoir and related infrastructure in Fannin County will be between $267 million and $295 million over a four to five year period. Based on the relative presence, or absence, of industries providing materials and supporting services to dam construction projects, some of the economic activity will "leak" out of the local area. Even so, these expenditures will increase total economic activity in Fannin County by $303 million to $335 million (see Table 1). This new activity will create over 1,500 person years of employment that will increase local labor income (salaries, wages, and benefits) by somewhere between $53.5 million and $59 million. In addition, property incomes in the form of rent, royalties, corporate profits, and dividends will increase by $14 million to $16 million. Business taxes from indirect transactions will boost state and local tax revenues by $2.7 million to $2.9 million.

Looking at the expanded economic region defined by Fannin, Lamar, Delta, and Hunt counties, the impacts are slightly larger reflecting these additional counties' abilities to attract a portion of the jobs and business activity related to the development of the reservoir. Including the spillover to these adjacent counties, total economic activity associated with the construction of the Lower Bois d'Arc Creek reservoir dam and other infrastructure rises to between $330 million to over $364 million during the four to five year period. Total labor income paid in the four-county region will increase to $76 to $84 million through the creation of between 2,200 and 2,400 total temporary jobs. Property income will also rise to between $21.7 million and $24 million, while state and local government will see between $4 million and $4.5 million in revenue from indirect business taxes including sales taxes, property taxes, and fees for permits and licenses.

Table 1

Temporary Local Economic Impacts of Construction
Of the Lower Bois d'Arc Creek Reservoir Dam

Description	Impact
Dam Construction, Pipeline Construction, Pump Station and other infrastructure Impacted counties: Fannin. Construction period: 4-5 years.	
Construction costs	$ 267,279,000 to $ 295,414,000
Total economic activity	$ 302,931,000 to $ 334,819,000
Total salaries and wages	$ 53,579,000 to $ 59,219,000
Total person-years of employment	1,596 to 1,764
Property Income*	$ 14,773,000 to $ 16,328,000
Indirect Business Taxes**	$ 2,663,000 to $ 2,944,000
Dam Construction, Pipeline Construction, Pump Station and other infrastructure Impacted counties: Fannin, Hunt, Lamar, Delta. **Construction period: 4-5 years.**	
Total economic activity	$ 329,871,000 to $ 364,595,000
Total salaries and wages	$ 76,275,000 to $ 84,304,000
Total person-years of employment	2,240 to 2,476
Property Income*	$ 21,745,000 to $ 24,033,000
Indirect Business Taxes**	$ 4,093,000 to $ 4,524,000

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending. Sources: North Texas Municipal Water District, authors' estimates.

Property owners for the land that will be consumed by the lake and the additional acreage that may be set aside for flood easements and environmental mitigation purposes will be compensated. These payments to land owners represent a transfer of income to the local economy supporting new spending in the region.

In addition to construction activities in Fannin County, Collin County will see a share of the economic benefits of the reservoir development including pipeline, terminal storage facilities and a water treatment plant. These infrastructure components will be located in either Fannin County or Collin County. These facilities will cost between $365 million and $403 million to build. This spending, which includes the Fannin County spending described above, will generate between $536 million and $593 million in economic activity in the Fannin/Collin Counties region during the development phase. Between 4,122 and 4,556 person-years of employment will be supported and labor income will rise by $180 million to $200 million (see Table 2). Property income will rise between $53 million and $59 million. Finally, state and local governments will gain an estimated $12 million to $13.4 million in taxes and fees.

Table 2

Temporary Impacts of Transmission and Treatment Infrastructure Construction

Description	Impact
Pipeline, Storage, and Treatment Facilities Construction Impacted counties: Fannin, Collin. Construction period: 3-4 years.	
Construction costs	$ 365,001,000 to $ 403,422,000
Total economic activity	$ 536,540,000 to $ 593,018,000
Total salaries and wages	$ 180,658,000 to $ 199,674,000
Total person-years of employment	4,122 to 4,556
Other property income*	$ 53,308,000 to $ 58,919,000
Indirect business taxes**	$ 12,147,000 to $ 13,426,000

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending. Sources: North Texas Municipal Water District, authors' estimates.

Section 4: On-going economic impacts of dam and pipeline operations

Once the dam and pipeline are built, on-going operations and maintenance of these infrastructures will continue to provide a modest number of jobs and a minor boost to local economic activity. Recurring maintenance and operating expenditures for the dam and related infrastructures are expected to increase local economic activity by about $4 million each year in Fannin and Collin counties combined. This activity will support 20 full-time-equivalent (FTE) direct and indirect jobs paying about $825,000 in annual wages and salaries (see Table 2).

Table 2

Recurring Annual Local Economic Impacts of Dam, Pipeline and Related Infrastructure Operations (Fannin and Collin Counties)

Description	Impact
Total economic activity	$ 3,966,000
Total salaries and wages	$ 825,000
Total full-time-equivalent employment	20
Indirect state and local business taxes	$ 151,000

Source: Authors' estimates

Section 5: Developmental impacts of the proposed reservoir

In addition to the one-time and recurring impacts described above, the impoundment of a 16,526 acre reservoir in Fannin County would have substantial spillover benefits on the local economy. In this section we consider the impacts that will follow new recreational spending based at the reservoir and the economic and fiscal consequences for the region from attracting new permanent and weekend residents.

5.1 Impacts of recreational users

The "field of dreams" scenario often works for lakes. If you build a publicly accessible water recreation resource, visitors use it. The north Texas region currently has many excellent reservoirs supporting water-based recreational activities. However, some of these reservoirs are so overcrowded that water accidents occur with increasing frequency. As the DFW population continues to grow over the next 30 years, demand for water recreation sites will increase, and Fannin county is ideally situated to capture more than a fair share of this recreational activity.

Unfortunately, few studies offer specific guidance on estimating the magnitude of the economic impacts that will attend increased recreational visitors to Fannin County when the proposed reservoir is fully developed. However, in the mid-1990s, Texas A&M, working for the Texas Parks and Wildlife Department and the Sabine River Authority, surveyed anglers at Lake Fork to assess their levels of local spending. Over two-thirds of the survey respondents were non-local residents, with about one-third hailing from outside of Texas. Non-local angler-visitors to Lake Fork spent an estimated $14.5 million in Wood, Rains, and Hopkins counties during their fishing trips for food, lodging, and supplies. This level of spending encourages business development and supports jobs. While some of this employment will be seasonal, north Texas weather patterns permit water-based recreation on a year-round basis.

Other lake-based recreation activities will draw additional out-of-area visitors to the region. We are not suggesting that the proposed reservoir will rise to Lake Fork's national reputation as a fishing lake, but when combined with non-angler spending, we estimate that non-local recreation visitors will add $16 million to $21 million in new spending for dining, food, retail goods, and lodging to the Fannin County economy. This spending will generate between $20.2 million and $26.9 million in economic activity, support 300 to 400 new jobs, and increase local earnings by $6 million to $7.9 million (see Table 3). Undoubtedly, bringing new recreational visitors to the area will present opportunities for businesses located in adjacent counties, especially Lamar County. However, given existing amenities and attractions in the City of Bonham, we expect that most of the recreational spending will stay in Fannin County.

Table 3

Recurring Annual Local Economic Impacts of Recreational Out-of-Area Visitor Spending

Description	Impact
Total annual spending: recreational visitors	$ 16,000,000 to $ 21,000,000
Total economic activity	$ 20,230,000 to $ 26,972,000
Total salaries and wages	$ 5,957,000 to $ 7,972,000
Total full-time-equivalent employment	295 to 393

Source: Authors' estimates

5.2 Impacts of new permanent and weekend residents

One trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have enjoyed greater population growth than counties without these important amenities. Many recreational lake visitors eventually decide to move close to their favorite reservoirs. Carefully managed residential development can prove to be a tremendous economic boon for lake county economies.

Fannin County is well-positioned to take full advantage of opportunities to attract new permanent and weekend residents to the reservoir. The proposed dam, which will be on the north end of the reservoir, will be only 50 miles from McKinney and 80 miles from downtown Dallas. Already, as indicated earlier, spillover growth from the Dallas-

Fort Worth Metroplex is reaching the Bonham area. Within reasonable reach of big-city amenities, yet removed from most urban disamenities, we expect the proposed reservoir to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Though this may not seem like a huge number of new households, at least by urban development standards, these new households will bring $57 million in new income to the area.

In addition, at least 2,100 new dwellings will be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. Our estimate of these weekender residences is likely understated. However, we caution that while relative proximity to the Metroplex will encourage permanent residents, it will lower demand for weekend/vacation housing. Nonetheless, we estimate that weekend and vacation resident will bring an equivalent of $9.6 million in household income that will be used for local purchases.

Modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, we find the Fannin County economy will realize a net increase of between $77 million and $85 million each year once full development is reached. This activity will support 517 to 572 permanent jobs paying $12.8 million to $14 million in salaries and wages (see Table 4).

It is likely that businesses located in Hunt, Lamar, and Delta counties, as well as Fannin County, will offer goods and services to the new permanent and weekend residents. Including the economic activity that is likely to go to these other counties, spending by households drawn to the new reservoir will increase economic output in the broader region by $82.3 million to $91 million, boost local income by $17 million to $19 million, and support between 701 to 775 permanent jobs.

We strongly emphasize that the pace and quality of development will depend on many market-related factors. **One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand.** Examples of infrastructures would include such things as electric services, roads, water services, and public safety and other municipal services.

Table 4

Recurring Annual Local Economic Impacts of New Resident Spending

Description	Impact
Fannin County Impacts	
Total annual spending	$ 67,724,000 to $ 74,290,000
Total economic activity	$ 77,119,000 to $ 85,237,000
Total salaries and wages	$ 12,736,000 to $ 14,077,000
Total full-time-equivalent employment	517 to 572
Fannin, Hunt, Delta, and Lamar County Impacts	
Total economic activity	$ 82,303,000 to $ 90,967,000
Total salaries and wages	$ 17,150,000 to $ 18,955,000
Total full-time-equivalent employment	701 to 775

Source: Authors' estimates

5.3 Impacts of new housing construction

In our projections we have assumed that the new permanent and weekend resident households will be single-family units. This is consistent with most of the development trends experienced in other lake counties. Even if residential real estate demand shifts to the inclusion of multi-family properties, the costs of development, and hence the economic and fiscal impacts, will be within the range of possibilities projected below.

Because of recent housing market volatility, we have retained the estimates of housing prices from our earlier study. Undoubtedly, this approach results in a more conservative estimate of the likely impacts of housing development near the new reservoir.

We estimate the average cost of land and improvements for permanent-resident dwellings will be about $127,000. Based on the findings of nationwide housing studies, vacation and weekend homes will likely be valued somewhat less than those of permanent residents. We assume an average market value of $115,000 per weekend dwelling. About 25 percent of the housing values will represent land; therefore, based on our earlier estimates of the number of households that will eventually occupy the areas around the proposed reservoir, we expect almost $288 million in new residential construction activity to occur primarily in Fannin county over a 30 year period. These construction activities will boost the local economy by about $14.5 million per year, on average,[1] support an average of 133 long-term FTE jobs, and boost local income by $3.4 million (see Table 5).

Table 5

Local Economic Impacts of Housing Construction
(30-year development)

Description	Impact Total	Impact Average Annual
Construction spending	$ 287,805,000	$ 9,594,000
Total economic activity	$ 432,538,000	$ 14,418,000
Total salaries and wages	$ 102,123,000	$ 3,404,000
Total full-time-equivalent employment	3,997	133

Source: Authors' estimates

[1] Housing construction will not be evenly distributed across the period of development.

5.4 Business development and recruitment

One of the key attractions for new residents, including business people making location choices for plant sites, distribution centers, and other industrial land uses, is the presence of recreational amenities and quality-of-life features. These characteristics have become critical in the site selection process. Given Fannin County's existing locational advantages, the presence of the new reservoir providing a reliable source of water for industrial uses will enhance the county's ability to attract and retain businesses. To estimate the magnitude of the economic activity that could be gained through expanded business activities, we utilized projected water demand estimates from the Texas Water Development Board (TWDB)[2] and the previously described IMPLAN model.

Based on its latest published estimates, the TWDB expects manufacturing industry water use to rise in Fannin County by 8 acre feet per year between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 acre feet per year. Livestock and irrigation uses are not expected to increase over this period, which is reasonable given the impact of the lake's impoundment on these land uses. Mining industry activities are also not expected to increase.[3] Municipal uses are expected to rise by 1,326 acre feet per year. While much of this increase in municipal usage will be accounted for by the increase in households described earlier, some of the increase will be due to increased commercial and other non-manufacturing business activities not previously described in this analysis.

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[2] Though the TWBD estimates do not specifically include the proposed reservoir, they provide a reasonable basis for conservatively estimating future economic activity.

[3] Projected water usage for livestock and irrigation purposes are substantially lower than current usage estimates.

Using 2000 usage data for Fannin County and adjusted commodity production estimates from IMPLAN,[4] we estimated the current economic value of production per acre foot of water used by use-category. Multiplying these values by projected increase in water usage suggests that manufacturing, commercial,[5] and electricity generating activities will increase by $112.6 million annually in Fannin County. While there are many factors that drive economic development, without the water resources made available by the proposed reservoir, it is unlikely that Fannin County will see this increase in economic activity.

Increasing Fannin County's direct economic activity would also create spin-off indirect and induced economic impacts as described earlier in this report. However, two adjustments are required to improve the accuracy of estimating these indirect and induced impacts. First, we will not include the induced (household spending) impacts to avoid double counting the impacts of permanent resident spending described above that would be employed through this new business activity. Secondly, current economic models of Fannin County do not adequately represent how the economy will operate 25 years from now. We therefore used impact multipliers for Rockwall County, which currently has a population about equal to TWBD's projected population for Fannin County in 2020. [Local officials in Fannin County suggest that the TWBD population projections are substantially underestimated. We concur with these officials; however, using the TWBD data enhances the conservative nature of our estimates.] Increasing Fannin County's industrial and commercial output by $112.6 million will result in $138.7 million in

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[4] Adjusted for the loss of the local meat packing operation.

[5] We assumed that no more than 20 percent of municipal water usage is for commercial business activities.

economic activity, boost area labor income by $46 million, and support over 1,600 jobs (see Table 6).

Table 6

Economic Impacts of New Industrial and Commercial Activities
(10-year increase after reservoir development)

Description	Annual Impact
New Direct Activity	$ 112,610,000
Total economic activity	$ 138,710,000
Total salaries and wages	$ 45,961,000
Total full-time-equivalent employment	1,607

Source: Authors' estimates

Section 6: Local fiscal impacts

In this section, we estimate some of the new tax revenues that will be enjoyed by counties and school districts. We will also consider the impacts on local property taxes from the loss of taxable land in the lake impoundment and mitigation areas.

Taxable value of permanent and weekend resident housing at full development is estimated at $326.2 million[6]. Of course, some diminution of taxable values will occur as a result of land inundation and environmental mitigation. Most of the land to be inundated is agricultural. Fannin County assess taxable values for agricultural land according to the nature of the land, the use of the land, and irrigation status. These valuations range from $65 per acre for native grasslands that are not irrigated to $323 per acre for irrigated land or land in horticultural uses. We have assumed that of the 16,526 acres that will be inundated and the estimated 30,000 acres that may be required for environmental mitigation, 50 percent is irrigated crop land valued at $323 per acre for tax

[6] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

purposes, 30 percent is valued at $157 per acre, and that 20 percent is improved land at $88 per acre. (Typically irrigated land is not used for environmental irrigation; therefore, our approach will tend to overstate potential tax losses.) Therefore, the inundation of land and mitigation areas for the reservoir will remove $10.5 million in taxable value from the local tax rolls. Therefore, the net increase in taxable value will be $315.7 million, an increase of 22 percent over Fannin County 2003 total taxable property values. This increase in valuation will generate about $1.9 million per year to the county and over $5 million per year to area school districts under current law. Importantly, much of this gain in school district revenues will not be accompanied by a proportionate increase in students since a large percentage of the estimated valuations are for weekend or vacation residences. Area municipalities and townships could also benefit from increased property tax revenues depending on the degree to which their taxing jurisdictions are expanded to include land adjacent to the proposed reservoir (see Table 7).

Taxable retail sales in Fannin County will increase as new residents and visitors come to the area. Taking a very conservative approach, we estimate that local sales tax revenues could increase by $290,000 or more per year. Hotel revenues for room rentals are expected to be at least $3.5 million per annum. Based on a local bed-tax rate of 5 percent, these expenditures will boost local tax receipts by an additional $175,000 annually. Our estimates do not consider the additional taxable property value that will be created as stores, bait shops, hotels/resorts, restaurants, and other businesses locate around the lake.

Table 7

Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending

Description	Impact
Total taxable value of housing (permanent and weekend residents)	$ 326,200,000
Reduction in property value due to inundation and mitigation	($ 10,524,000)
Net gain in taxable property values	$ 315,676,000
Estimated new county property tax revenues	$ 1,894,000
Estimated new school district property tax revenues	$ 5,118,000
Total potential* municipal sales taxes (0.01 rate)	$ 290,000
Hotel occupancy tax revenues*	$ 175,000

* Value will be impacted by land annexation and business location decisions. Source: Authors' estimates

Section 7: Conclusions

The proposed Lower Bois d'Arc Creek Reservoir will provide tremendous short-term economic gains to Fannin County that will certainly spill over to residents and businesses in surrounding counties as the dam and related infrastructures are constructed over a multi-year period. Construction spending for the dam and transport infrastructure will add over $267 million to local economic activity and provide more than 1,600 person-years of employment. The dam will also create new opportunities for local businesses by adding $4 million in annual local economic activity and supporting about 20 permanent jobs.

Once impounded, the lake will attract substantial new private investment by hospitality firms anxious to provide services, meals, and specialty retail goods to the lake's recreational users. Out-of-area recreational users are projected to spend $16 million to $21 million per year in the local economy. In addition, as seen with other Texas lakes, residents will be attracted to the region to take advantage of the new recreational amenities, bringing substantial new local spending to the area at full development. These new personal outlays will increase local economic activity by over $80 million per year and support more than 700 permanent jobs. The reservoir will provide water resources that will support additional business development in Fannin County. Using conservative TWBD usage estimates, $138.7 million in new economic activity would be supported in the county adding an additional 1,600 jobs to area payrolls. Any comparable industrial investment offering this magnitude of economic benefit would probably require exceptional incentive packages from state, county, and municipal governments. Construction of housing units for permanent and weekend residents will likely be spread over a 30-year period providing long-term job and business opportunities in the construction trades.

An expanded tax base will be another payoff from the ancillary development that will attend construction of the reservoir, allowing local governments to provide a broader range of public services while maintaining competitive tax rates. In summary, the economic opportunities supported by the proposed reservoir will promote sustainable development while diversifying the local job base.

ATTACHMENT C

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

Prepared by Terry L. Clower, Ph.D.
Bernard L. Weinstein
September 2004

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

Prepared for:

The North Texas Municipal Water District

By:

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Bernard L. Weinstein

September 2004

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Executive Summary

- Construction of the dam to impound the proposed Lower Bois d'Arc Reservoir and intake pump station will cost between $181 million and $200 million. Depending on exact expenditures, local economic activity will increase between $231 million and $256 million during the four to five year project. This activity will support in the range of 2,000 to almost 2,300 person-years of employment with associated salaries and wages of between $60.3 million and $66.7 million.

- The proposed pipeline, storage, and facilities to treat water from the Lower Bois d'Arc Reservoir will cost in the range of $233 million to $257 million boosting economic activity in Fannin and Collin counties by a combined $320 million to $354 million, supporting over 2,000 person-years of employment and paying upwards of $104 million in salaries and wages.

- After construction of the dam and pipeline is completed, on-going impacts from the operation and maintenance of these infrastructures will support about 20 full-time-equivalent direct and indirect jobs and spur about $3.7 million in new economic activity per year.

- Once the lake is impounded, new recreational spending will arrive in Fannin County as visitors come to fish, boat, and participate in other water-recreation activities. These visitors will bring $15 million to $20 million in new annual spending to the local economy.

- The lake will also attract many new residents to Fannin County. We estimate that over a 30-year period at least 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. These new households will be in addition to any other growth projected for Fannin County. The construction of these homes will bring an average of over 133 jobs per year to the local economy over the development period.

- The reservoir will also support new industrial and commercial activities beyond those described in the hospitality industry. Using Texas Water Development Board usage estimates, we project that $139 million in new economic activity in Fannin County supporting over 1,600 permanent jobs could be made possible by the availability of a new reliable water resource.

- The pace and quality of development will depend on many market-related factors. One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand. Examples of infrastructures would include such things as electric services, roads, water services, and public safety and other municipal services.

- Spending by new residents in the local economy will increase economic activity in Fannin County by $63 million to $69 million each year. Our analysis also suggests that economic activity in the larger region including Fannin, Hunt, Delta, and Lamar counties will rise by as much as $85 million per year in response to having these new residents living near the proposed reservoir. This activity will support well over 700 permanent jobs paying about $16 million in annual salaries and wages.

- Once developed, the proposed reservoir will enhance the region's attractiveness as a business location. As a recreational amenity, the lake will enhance the quality of life features of the region, which are an increasingly important factor in business site location decisions.

- 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 net of 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.

Table ES1

Temporary Local Economic Impacts of Dam, Pipeline, and Related Infrastructure Construction

Description	Impact
Dam Construction Impacted counties: Fannin. Construction period: 4-5 years.	
Construction costs	$ 181,070,000 to $ 200,130,000
Total economic activity	$ 225,859,000 to $ 249,634,000
Total salaries and wages	$ 56,286,000 to $ 62,211,000
Total person-years of employment	1,937 to 2,141
Dam Construction Impacted counties: Fannin, Hunt, Lamar, Delta. **Construction period: 4-5 years.**	
Total economic activity	$ 231,393,000 to $ 255,750,000
Total salaries and wages	$ 60,339,000 to $ 66,690,000
Total person-years of employment	2,069 to 2,287

Sources: North Texas Municipal Water District, authors' estimates.

Table ES1 -- continued

Temporary Local Economic Impacts of Dam, Pipeline, and Related Infrastructure Construction

Description	Impact
Pipeline, Storage, and Treatment Facilities Construction Impacted counties: Fannin, Collin. Construction period: 3-4 years.	
Construction costs	$ 233,035,000 to $ 257,670,000
Total economic activity	$ 319,982,000 to $ 353,664,000
Total salaries and wages	$ 94,334,000 to $ 104,264,000
Total person-years of employment	2,009 to 2,220

Sources: North Texas Municipal Water District, authors' estimates.

Table ES2

Recurring Annual Local Economic Impacts
(2004 dollars)

Description	Impact
Dam, Pump Station, Pipeline, and Treatment Plant Operations Impacted counties: Fannin, Collin	
Total economic activity	$ 3,726,000
Total salaries and wages	$ 773,000
Total full-time-equivalent employment	20
Recreational Visitor Spending	
Total annual spending	$ 15,000,000 to $ 20,000,000
Total economic activity	$ 18,871,000 to $ 25,160,000
Total salaries and wages	$ 5,577,000 to $ 7,437,000
Total full-time-equivalent employment	295 to 393
Resident Spending Permanent and Weekend/Vacation Residents: Fannin, Lamar, Hunt, Delta	
Total economic activity	$ 76,775,000 to $ 84,857,000
Total salaries and wages	$ 15,998,000 to $ 17,682,000
Total full-time-equivalent employment	701 to 775
New Industrial and Commercial Activities Based on Projected Water Usage	
Total economic activity	$ 138,710,000
Total salaries and wages	$ 45,961,000
Total full-time-equivalent employment	1,607

Source: Authors' estimates

ES3

Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending[+]

Description	Impact
Total taxable value of housing (permanent and weekend residents)	$ 326,200,000
Reduction in property value due to inundation and mitigation	($ 11,921,000)
Net gain in taxable property values	$ 314,279,000
Estimated new county property tax revenues	$ 1,886,000
Estimated new school district property tax revenues	$ 4,902,000
Total potential* municipal sales taxes (0.01 rate)	$ 290,000
Hotel occupancy tax revenues*	$ 175,000

+ at buildout * Value will be impacted by land annexation and business location decisions.
Source: Authors' estimates

Section 1: Introduction

Addressing future water needs for the North Texas Municipal Water District's service area has led to the consideration of developing several new water supplies. One proposal is for a reservoir to be located along the Lower Bois d'Arc Creek just northeast of the City of Bonham in Fannin County. The following reports our findings of an analysis of the economic, fiscal, and development impacts of this proposed reservoir.

Our estimates of the economic impacts of the reservoir and related economic activity are based on the IMPLAN input-output economic modeling system developed by the Minnesota IMPLAN Group. The modeled impacts include the direct effects of spending for construction activities and consumption spending, the indirect effects of local vendors providing goods and services to the primary firms, and the induced impacts of employees of these firms spending a portion of their earnings in the local economy. All costs and impacts are expressed in constant 2004 dollars.

We begin with an economic overview of Fannin County and then proceed to measure the new employment, income, spending, and tax revenues that will attend the construction and operations of the dam and related transportation, storage, and treatment facilities. We then explore the "ancillary" development likely to occur in conjunction with the dam, in particular the construction of new homes and recreationally based businesses. New and recurring income, employment, and economic activity associated with this ancillary development are estimated. Finally, we examine the impact of the proposed project on revenues to local taxing jurisdictions.

Section 2: Economic overview of Fannin County.

Like many rural counties in Texas, Fannin County saw its historical peak of population and economic activity around the turn of the 20th century. The 1900 census showed a population of 51,793. Cotton and corn production were the chief crops in an economy dominated by agricultural production. Later in the 20th century, dairy operations rose in prominence, but the county suffered tremendous economic losses during the depression years and after World War II. Children of farmers sought their fortunes elsewhere. By 1970, the population had dropped to 22,705. However, after 1970 the population stabilized and began to slowly increase. Today Fannin County is home to about 32,000 residents and during the decade of the 1990s actually grew faster than the state as a whole (26 percent increase versus 22.8 percent increase) as spillover growth from Dallas' northern suburbs reached the county. Total goods and services produced in the county currently exceed $1.1 billion each year. The three largest non-government industries, by value of output, include plastics products manufacturing, production of non-ferrous wire, and automobile dealerships.[1]

As can be seen in Figure 1, year-over-year employment change in Fannin County has not seen consistent growth as shown for the state. With the exception of 1986 and 1994-1997, the county has lagged state economic performance, sometimes dramatically. These data suggest that one critical economic development strategy for Fannin County should be to diversify their economic base, particularly toward industries with greater stability over time.

The proposed reservoir offers several economic development opportunities for Fannin County. In addition to the substantial economic activity that would be generated

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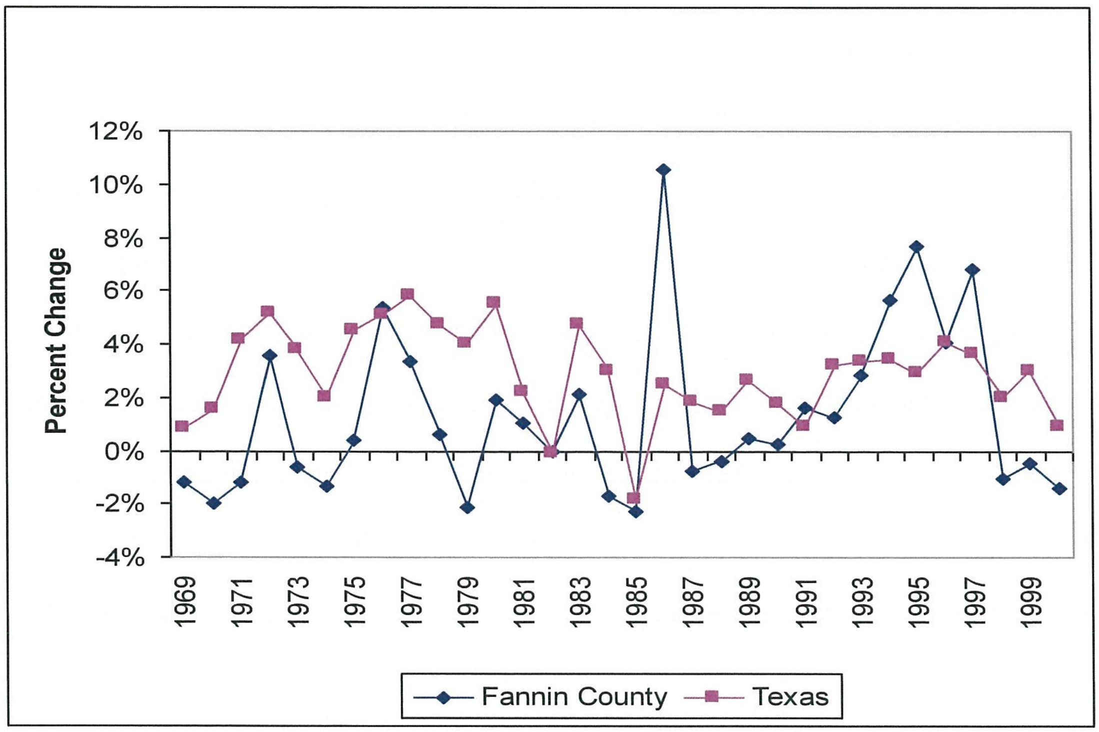
[1] Data are based on 1999 IMPLAN modeling output.

by construction projects related to the reservoir over a multi-year period, the new lake would attract recreational users whose spending, in turn, would spur investment in new hospitality venues. By supporting new residents and hosting new recreation-based industries, the proposed reservoir offers an excellent diversification opportunity for Fannin County.

Figure 1

Year-to-Year Percentage Change
Total Employment State of Texas and Fannin County
1969-2001



Source: US Department of Commerce.

Section 3: Economic impacts of dam and related infrastructure construction.

In this section we examine the economic impacts of the construction of the proposed Lower Bois d'Arc Reservoir dam and related infrastructure. These estimates are based on the latest cost projections for the facilities expressed in current year (2004) dollars.

Economic impact assessments for the dam and reservoir construction projects are examined in two models. The first looks at the impacts that will likely remain in Fannin County. However, based on the size of the development projects, businesses and residents of nearby counties will also benefit from the economic activity associated with the construction of the dam. For purposes of this analysis, we have included an estimate of the total impacts that will likely occur in a wider economic area defined by Fannin, Delta, Lamar, and Hunt counties.

Constructing the dam for the Lower Bois d'Arc Reservoir and intake pump station is expected to cost between $181 million and $200 million and take four to five years to complete. Based on the relative presence, or absence, of industries providing materials and supporting services to dam construction projects, some of the economic activity will "leak" out of the local area. Even so, the construction of the dam and intake pump station will generate between $226 and $250 million in economic activity in Fannin County over the construction period. This activity will support somewhere between 1,940 and 2,140 person years[2] of employment paying $56 million to $62 million in earnings. (See Table 1.)

Looking at the expanded economic region defined by Fannin, Lamar, Delta, and Hunt counties, the impacts are slightly larger reflecting these additional counties' abilities to attract a portion of the jobs and business activity related to the dam and intake pump station construction. The expanded region should see an overall increase in economic

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[2] One person employed in one full-time-equivalent job for one year. In this case, we expect an average of about 400 jobs per year for the 5-year construction period.

activity totaling between $231 million and $256 million accompanied by an increase in area earnings of $60 million to 66.7 million and a gain of between 2,069 and 2,287 person years of employment.

Property owners for the land that will be consumed by the lake and the additional acreage that may be set aside for flood easements and environmental mitigation purposes will be compensated. These payments to land owners represent a transfer of income to the local economy.

In examining the impacts of the construction and development of pipeline, storage, and treatment facilities accompanying the impoundment of the new reservoir, we use an economic region defined by Fannin and Collin counties. (At the time of this analysis, a final determination of the precise location or route of the facilities has not been made). Capital expenditures to build water transfer and treatment facilities are expected to range from $233 million to $257 million and take three to four years to complete. These expenditures will boost the Fannin-Collin counties area economic activity by $320 million to $353.7 million, boost local earnings during the construction period by $94 million to $104 million, and create 2,000 to 2,200 person-years of employment (see Table 1).

Table 1

Temporary Local Economic Impacts of Dam, Pipeline, and Related Infrastructure Construction

Description	Impact
Dam Construction Impacted counties: Fannin. Construction period: 4-5 years.	
Construction costs	\$ 181,070,000 to \$ 200,130,000
Total economic activity	\$ 225,859,000 to \$ 249,634,000
Total salaries and wages	\$ 56,286,000 to \$ 62,211,000
Total person-years of employment	1,937 to 2,141
Dam Construction Impacted counties: Fannin, Hunt, Lamar, Delta. **Construction period: 4-5 years.**	
Total economic activity	\$ 231,393,000 to \$ 255,750,000
Total salaries and wages	\$ 60,339,000 to \$ 66,690,000
Total person-years of employment	2,069 to 2,287
Pipeline, Storage, and Treatment Facilities Construction Impacted counties: Fannin, Collin. Construction period: 3-4 years.	
Construction costs	\$ 233,035,000 to \$ 257,670,000
Total economic activity	\$ 319,982,000 to \$ 353,664,000
Total salaries and wages	\$ 94,334,000 to \$ 104,264,000
Total person-years of employment	2,009 to 2,220

Sources: North Texas Municipal Water District, authors' estimates.

Section 4: On-going economic impacts of dam and pipeline operations

Once the dam and pipeline are built, on-going operations and maintenance of these infrastructures will continue to provide a modest number of jobs and a minor boost to local economic activity. Recurring maintenance and operating expenditures for the dam and related infrastructures are expected to increase local economic activity by $3.7 million each year in Fannin and Collin counties combined. This activity will support 20 full-time-equivalent (FTE) direct and indirect jobs paying about $770,000 in annual wages and salaries (see Table 2).

Table 2

Recurring Annual Local Economic Impacts of Dam, Pipeline and Related Infrastructure Operations (Fannin and Collin Counties)

Description	Impact
Total economic activity	$ 3,726,000
Total salaries and wages	$ 773,000
Total full-time-equivalent employment	20
Indirect state and local business taxes	$ 141,000

Source: Authors' estimates

Section 5: Developmental impacts of the proposed reservoir

In addition to the one-time and recurring impacts described above, the impoundment of a 22,702 acre reservoir in Fannin County would have substantial spillover benefits on the local economy. In this section we consider the impacts that will follow new recreational spending based at the reservoir and the economic and fiscal consequences for the region from attracting new permanent and weekend residents.

5.1 Impacts of recreational users

The "field of dreams" scenario often works for lakes. If you build a publicly accessible water recreation resource, visitors use it. The north Texas region currently has many excellent reservoirs supporting water-based recreational activities. However, some of these reservoirs are so overcrowded that water accidents occur with increasing frequency. As the DFW population continues to grow over the next 30 years, demand for water recreation sites will increase, and Fannin county is ideally situated to capture more than a fair share of this recreational activity.

Unfortunately, few studies offer specific guidance on estimating the magnitude of the economic impacts that will attend increased recreational visitors to Fannin County when the proposed reservoir is fully developed. However, in the mid-1990s, Texas A&M, working for the Texas Parks and Wildlife Department and the Sabine River Authority, surveyed anglers at Lake Fork to assess their levels of local spending. Over two-thirds of the survey respondents were non-local residents, with about one-third hailing from outside of Texas. Non-local angler-visitors to Lake Fork spent an estimated $14.5 million in Wood, Rains, and Hopkins counties during their fishing trips for food, lodging, and supplies. This level of spending encourages business development and supports jobs. While some of this employment will be seasonal, north Texas weather patterns permit water-based recreation on a year-round basis.

Other lake-based recreation activities will draw additional out-of-area visitors to the region. We are not suggesting that the proposed reservoir will rise to Lake Fork's national reputation as a fishing lake, but when combined with non-angler spending, we estimate that non-local recreation visitors will add $15 million to $20 million in new spending for dining, food, retail goods, and lodging to the Fannin County economy. This spending will generate between $15.2 million and $20.2 million in economic activity, support 300 to 400 new jobs, and increase local earnings by $5.6 to $7.4 million (see Table 3). Undoubtedly, bringing new recreational visitors to the area will present opportunities for businesses located in adjacent counties, especially Lamar County. However, given existing amenities and attractions in the City of Bonham, we expect that most of the recreational spending will stay in Fannin County.

Table 3

Recurring Annual Local Economic Impacts of Recreational Out-of-Area Visitor Spending

Description	Impact
Total annual spending: recreational visitors	$ 15,000,000 to $ 20,000,000
Total economic activity	$ 18,871,000 to $ 25,160,000
Total salaries and wages	$ 5,577,000 to $ 7,437,000
Total full-time-equivalent employment	295 to 393

Source: Authors' estimates

5.2 Impacts of new permanent and weekend residents

One trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have enjoyed greater population growth than counties without these important amenities. Many recreational lake visitors eventually decide to move close to their favorite reservoirs. Carefully managed residential development can prove to be a tremendous economic boon for lake county economies.

Fannin County is well-positioned to take full advantage of opportunities to attract new permanent and weekend residents to the reservoir. The proposed dam, which will be on the north side of the reservoir, will be only 50 miles from McKinney and 80 miles from downtown Dallas. Already, as indicated earlier, spillover growth from the Dallas-Fort Worth Metroplex is reaching the Bonham area. Within reasonable reach of big-city amenities, yet removed from most urban disamenities, we expect the proposed reservoir to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Though this may not seem like a huge number of new households, at least by urban development standards, these new households will bring $57 million in new income to the area.

In addition, at least 2,100 new dwellings will be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. Our estimate of these weekender residences is likely understated. However, we caution that while relative proximity to the Metroplex will encourage permanent residents, that proximity will lower demand for weekend/vacation housing. Nonetheless, we estimate that weekend and vacation resident will bring an equivalent of $9 million in household income that will be used for local purchases.

Modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, we find the Fannin County economy will realize a net increase of between $72 million and $79.5 million each year once full development is reached. This activity will support 517 to 572 permanent jobs paying $11.9 million to $13.1 million in salaries and wages (see Table 4).

It is likely that businesses located in Hunt, Lamar, and Delta counties, as well as Fannin county, will offer goods and services to the new permanent and weekend residents. Including the economic activity that is likely to go to these other counties, spending by households drawn to the new reservoir will increase economic output in the broader region by $76.8 million to $84.9 million, boost local income by $16 million to $17.7 million, and support between 701 to 775 permanent jobs.

We strongly emphasize that the pace and quality of development will depend on many market-related factors. **One of the most critical factors will be the extent to which counties, cities, and towns adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand.** Examples of infrastructures would include such things as electric services, roads, water services, and public safety and other municipal services.

Table 4

Recurring Annual Local Economic Impacts of New Resident Spending

Description	Impact
Fannin County Impacts	
Total annual spending	$ 63,175,000 to $ 69,300,000
Total economic activity	$ 71,939,000 to $ 79,512,000
Total salaries and wages	$ 11,881,000 to $ 13,132,000
Total full-time-equivalent employment	517 to 572
Fannin, Hunt, Delta, and Lamar County Impacts	
Total economic activity	$ 76,775,000 to $ 84,857,000
Total salaries and wages	$ 15,998,000 to $ 17,682,000
Total full-time-equivalent employment	701 to 775

Source: Authors' estimates

5.3 Impacts of new housing construction

In our projections we have assumed that the new permanent and weekend resident households will be single-family units. This is consistent with most of the development trends experienced in other lake counties. Even if residential real estate demand shifts to the inclusion of multi-family properties, the costs of development, and hence the economic and fiscal impacts, will be within the range of possibilities projected below. We estimate the average cost of land and improvements for permanent-resident dwellings will be about $127,000. Based on the findings of nationwide housing studies, vacation and weekend homes will likely be valued somewhat less than those of permanent residents. We assume an average market value of $115,000 per weekend dwelling. About 25 percent of the housing values will represent land; therefore, based on our earlier estimates of the number of households that will eventually occupy the areas around the proposed reservoir, we expect almost $288 million in new residential construction activity to occur primarily in Fannin county over a 30 year period. These construction activities will boost the local economy by about $13.5 million per year, on average,[3] support an average of 133 long-term FTE jobs, and boost local income by $3.2 million (see Table 5).

Table 5

Local Economic Impacts of Housing Construction
(30-year development)

Description	Impact	
	Total	Average Annual
Construction spending	$ 287,805,000	$ 9,594,000
Total economic activity	$ 403,487,000	$ 13,450,000
Total salaries and wages	$ 95,264,000	$ 3,175,000
Total full-time-equivalent employment	3,997	133

Source: Authors' estimates

5.4 Business development and recruitment

One of the key attractions for new residents, including business people making location choices for plant sites, distribution centers, and other industrial land uses, is the presence of recreational amenities and quality-of-life features. These characteristics have become critical in the site selection process. Given Fannin County's existing locational advantages, the presence of the new reservoir providing a reliable source of water for industrial uses will enhance the county's ability to attract and retain businesses. To estimate the magnitude of the economic activity that could be gained through expanded business activities, we utilized projected water demand estimates from the Texas Water Development Board (TWDB)[4] and the previously described IMPLAN model.

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[3] Housing construction will not be evenly distributed across the period of development.
[4] Though the TWBD estimates do not specifically include the proposed reservoir, they provide a reasonable basis for conservatively estimating future economic activity.

Based on its latest published estimates, the TWDB expects manufacturing industry water use to rise in Fannin County by 8 acre feet per year between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 acre feet per year. Livestock and irrigation uses are not expected to increase over this period, which is reasonable given the impact of the lake's impoundment on these land uses. Mining industry activities are also not expected to increase.[5] Municipal uses are expected to rise by 1,326 acre feet per year. While much of this increase in municipal usage will be accounted for by the increase in households described earlier, some of the increase will be due to increased commercial and other non-manufacturing business activities not previously described in this analysis.

Using 2000 usage data for Fannin County and adjusted commodity production estimates from IMPLAN,[6] we estimated the current economic value of production per acre foot of water used by use-category. Multiplying these values by projected increase in water usage suggests that manufacturing, commercial,[7] and electricity generating activities will increase by $112.6 million annually in Fannin County. While there are many factors that drive economic development, without the water resources made available by the proposed reservoir, it is unlikely that Fannin County will see this increase in economic activity.

Increasing Fannin County's direct economic activity would also create spin-off indirect and induced economic impacts as described earlier in this report. However, two adjustments are required to improve the accuracy of estimating these indirect and induced

[5] Projected water usage for livestock and irrigation purposes are substantially lower than current usage estimates.
[6] Adjusted for the loss of the local meat packing operation.
[7] We assumed that no more than 20 percent of municipal water usage is for commercial business activities.

impacts. First, we will not include the induced (household spending) impacts to avoid double counting the impacts of permanent resident spending described above that would be employed through this new business activity. Secondly, current economic models of Fannin County do not adequately represent how the economy will operate 25 years from now. We therefore used impact multipliers for Rockwall County, which currently has a population about equal to TWBD's projected population for Fannin County in 2020. [Local officials in Fannin County suggest that the TWBD population projections are substantially underestimated. We concur with these officials; however, using the TWBD data enhances the conservative nature of our estimates.] Increasing Fannin County's industrial and commercial output by $112.6 million will result in $138.7 million in economic activity, boost area labor income by $46 million, and support over 1,600 jobs (see Table 6).

Table 6

Economic Impacts of New Industrial and Commercial Activities
(10-year increase after reservoir development)

Description	Annual Impact
New Direct Activity	$ 112,610,000
Total economic activity	$ 138,710,000
Total salaries and wages	$ 45,961,000
Total full-time-equivalent employment	1,607

Source: Authors' estimates

Section 6: Local fiscal impacts

In this section, we estimate some of the new tax revenues that will be enjoyed by counties and school districts. We will also consider the impacts on local property taxes from the loss of taxable land in the lake impoundment and mitigation areas.

Taxable value of permanent and weekend resident housing at full development is estimated at $326.2 million[8]. Of course, some diminution of taxable values will occur as a result of land inundation and environmental mitigation. Most of the land to be inundated is agricultural. Fannin County assess taxable values for agricultural land according to the nature of the land, the use of the land, and irrigation status. These valuations range from $65 per acre for native grasslands that are not irrigated to $323 per acre for irrigated land or land in horticultural uses. We have assumed that of the 52,700 acres that will be either inundated or in the mitigation area, 50 percent is irrigated crop land valued at $323 per acre for tax purposes, 30 percent is valued at $157 per acre, and that 20 percent is improved land at $88 per acre. Therefore, the inundation of land and mitigation areas for the reservoir will remove $11.9 million in taxable value from the local tax rolls. Therefore, the net increase in taxable value will be $314.3 million, an increase of 22 percent over Fannin County 2003 total taxable property values. This increase in valuation will generate about $1.9 million per year to the county and almost $5 million per year to area school districts under current law. Importantly, much of this gain in school district revenues will not be accompanied by a proportionate increase in students since a large percentage of the estimated valuations are for weekend or vacation residences. Area municipalities and townships could also benefit from increased property tax revenues depending on the degree to which their taxing jurisdictions are expanded to include land adjacent to the proposed reservoir (see Table 7).

Taxable retail sales in Fannin County will increase as new residents and visitors come to the area. Taking a very conservative approach, we estimate that local sales tax

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[8] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

revenues could increase by $290,000 or more per year. Hotel revenues for room rentals are expected to be at least $3.5 million per annum. Based on a local bed-tax rate of 5 percent, these expenditures will boost local tax receipts by an additional $175,000 annually. Our estimates do not consider the additional taxable property value that will be created as stores, bait shops, hotels/resorts, restaurants, and other businesses locate around the lake.

Table 7

Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending

Description	Impact	
Total taxable value of housing (permanent and weekend residents)	$	326,200,000
Reduction in property value due to inundation and mitigation	($	11,921,000)
Net gain in taxable property values	$	314,279,000
Estimated new county property tax revenues	$	1,886,000
Estimated new school district property tax revenues	$	4,902,000
Total potential* municipal sales taxes (0.01 rate)	$	290,000
Hotel occupancy tax revenues*	$	175,000

* Value will be impacted by land annexation and business location decisions. Source: Authors' estimates

Section 7: Conclusions

The proposed Lower Bois d'Arc Reservoir will provide tremendous short-term economic gains to Fannin County that will certainly spill over to residents and businesses in surrounding counties as the dam and related infrastructures are constructed over a multi-year period. Construction of the dam will add over $225 million to local economic activity and provide more than 1,900 person-years of employment. The dam will also create new opportunities for local businesses by adding $3 million in annual local economic activity and supporting about 20 permanent jobs.

Once impounded, the lake will attract substantial new private investment by hospitality firms anxious to provide services, meals, and specialty retail goods to the lake's recreational users. Out-of-area recreational users are projected to spend $15 million to $20 million per year in the local economy. In addition, as seen with other Texas lakes, residents will be attracted to the region to take advantage of the new recreational amenities, bringing substantial new local spending to the area at full development. These new personal outlays will increase local economic activity by over $75 million per year and support more than 500 permanent jobs. The reservoir will provide water resources that will support additional business development in Fannin County. Using conservative TWBD usage estimates, $138.7 million in new economic activity would be supported in the county adding an additional 1,600 jobs to area payrolls. Any comparable industrial investment offering this magnitude of economic benefit would probably require exceptional incentive packages from state, county, and municipal governments. Construction of housing units for permanent and weekend residents will likely be spread over a 30-year period providing long-term job and business opportunities in the construction trades.

An expanded tax base will be another payoff from the ancillary development that will attend construction of the reservoir, allowing local governments to provide a broader range of public services while maintaining competitive tax rates. In sum, the economic opportunities supported by the proposed reservoir will promote sustainable development while diversifying the local job base.

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APPENDIX F: WATER RIGHTS PERMIT (WATER USE PERMIT) FROM TEXAS COMMISSION ON ENVIRONMENTAL QUALITY FOR BOIS D'ARC CREEK RESERVOIR

F-1: SIGNED TEXAS COMMISSION ON ENVIRONMENTAL QUALITY WATER USE PERMIT FOR LOWER BOIS D'ARC CREEK RESERVOIR

F-2: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, WATER AVAILABILITY ANALYSIS

F-3: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, REVISED WATER AVAILABILITY ANALYSIS

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

WATER USE PERMIT

PERMIT NO. 12151 TYPE §§ 11.121, 11.085, 11.046

Permittee:	North Texas Municipal Water District	Address:	P.O. Box 2408 Wylie, TX 75098
Filed:	June 26, 2007	Granted:	June 26, 2015
Purposes:	Municipal, Industrial, Agricultural, and Recreation	Counties:	Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains and Rockwall Counties
Watercourse:	Lower Bois d'Arc Creek, tributary of the Red River	Watershed:	Red, Trinity, and Sulphur River Basins

WHEREAS, North Texas Municipal Water District (NTMWD, Applicant or Permittee) seeks a Water Use Permit to construct and maintain a dam and reservoir (Lower Bois d'Arc Creek Reservoir) with a maximum normal operating capacity of 367,609 acre-feet of water and a surface area of 16,526 acres on Bois d'Arc Creek, tributary of the Red River, Red River Basin in Fannin County for recreation purposes; and

WHEREAS, Applicant also seeks authorization to divert and use not to exceed 175,000 acre-feet of water per year from any point on the perimeter of the proposed reservoir at a maximum combined diversion rate of 365.15 cfs (163,889 gpm) for municipal, industrial and agricultural purposes; and

WHEREAS, Applicant seeks authorization to reuse the return flows generated from the diversion and use of water from the proposed reservoir and until facilities are developed to reuse diverted water, such water will be returned to the Red , Sulphur, and Trinity River Basins; and

WHEREAS, Applicant also seeks an interbasin transfer authorization to use the water within the Trinity River Basin, and within that portion of Fannin County located in the Sulphur River Basin. NTMWD's service area is currently located within Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains and Rockwall Counties; and

WHEREAS, Applicant indicates the proposed Lower Bois d'Arc Creek Reservoir will be located 15.2 miles in a northeast direction from City of Bonham and 9.7 miles in a north-northwest direction from the Town of Honey Grove. Station 42+33 on the centerline of the proposed dam will be S 23.2677° E, 514 feet from the southeast corner of O.H.P. Wood Survey, Abstract No. 1177, in Fannin County, Texas, also being at 33.7180° N Latitude, 95.9822° W

Longitude. The proposed dam will be located in the George W. King Original Survey, Abstract No. 604; the James Kerr Original Survey, Abstract No. 614; and the John Reynolds Original Survey, Abstract 931 in Fannin County, Texas. The proposed dam and reservoir will be located on the land of the Applicant, which will be acquired prior to construction; and

WHEREAS, Applicant indicates that diversions may overdraft the firm yield of the reservoir as part of a system operation with existing NTMWD supplies to achieve maximum conservation of limited water resources; and

WHEREAS, this application is subject to the obligations of the state of Texas pursuant to the terms of the Red River Compact; and

WHEREAS, the Texas Commission on Environmental Quality (TCEQ) finds that jurisdiction over the application is established; and

WHEREAS, Applicant submitted the *Proposed Lower Bois d'Arc Creek Reservoir Mitigation Plan*, which was accepted and approved by the Executive Director; and

WHEREAS, Applicant submitted the *North Texas Municipal Water District Reservoir Accounting Plan*, which was accepted and approved by the Executive Director; and

WHEREAS, Applicant submitted the *North Texas Municipal Water District Monitoring Plan for Proposed Lower Bois d'Arc Creek Reservoir*, which was accepted and approved by the Executive Director; and

WHEREAS, the Executive Director recommends that special conditions be included in the permit; and

WHEREAS, multiple requests for a contested case hearing on the application were granted; and

WHEREAS, as a result of negotiations with all parties, all hearing requests were withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this water use permit;

NOW, THEREFORE, this Water Use Permit No. 12151 is issued to North Texas Municipal Water District subject to the following terms and conditions:

1. IMPOUNDMENT

Permittee is authorized to construct and maintain a dam and reservoir (Lower Bois d'Arc Creek Reservoir) with a maximum normal operating capacity of 367,609 acre-feet of water on Bois d'Arc Creek, tributary of the Red River, Red River Basin in Fannin County located 15.2 miles in a northeast direction from City of Bonham and 9.7 miles in a north-northwest direction from the Town of Honey Grove. Station 42+33 on the centerline of the proposed dam will be S 23.2677° E, 514 feet from the southeast corner of O.H.P. Wood Survey, Abstract No. 1177, in Fannin County, Texas, also being at 33.7180° N Latitude, 95.9822° W Longitude. The proposed dam will be located in the George W. King Original Survey, Abstract No. 604 the James Kerr Original Survey, Abstract No. 614; and the John Reynolds Original Survey, Abstract 931 in Fannin County, Texas.

2. USE

A. Permittee is authorized to use the impounded water for recreation purposes.

B. Permittee is authorized to divert and use not to exceed 175,000 acre-feet of water per year for municipal, industrial and agricultural purposes within its service area in Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains and Rockwall Counties.

C. Permittee is authorized an interbasin transfer to use the water appropriated hereunder within the Trinity River Basin, and within that portion of Fannin County located in the Sulphur River Basin.

D. Permittee is authorized to divert and reuse the return flows resulting from the diversion and use of water from the Lower Bois d'Arc Creek Reservoir as authorized under this permit, subject to the Permittee's compliance with Special Condition 6.Y.

3. DIVERSION

A. Permittee is authorized to divert the water authorized herein from any point on the perimeter of Lower Bois d'Arc Creek Reservoir.

B. Permittee is authorized to divert the water authorized herein at a maximum combined diversion rate of 365.15 cfs (163,889 gpm).

4. TIME PRIORITY

The time priority for this right is June 26, 2007.

5. CONSERVATION

Permittee shall fully implement water conservation plans, developed in accordance with this provision, that provide for the utilization of those reasonably available practices, techniques, and technologies that reduce the consumption of water for municipal use on a gallons per-capita per day basis within NTMWD's service area and that, for each category of use authorized by this permit not including recreation use, prevent the waste of water, prevent or reduce the loss of water, improve the efficiency in the use of water, increase the recycling and reuse of water, and prevent the pollution of water, so that a water supply is made available for future or alternative uses. Permittee shall develop, submit and implement water conservation plans as required by law. Each water conservation plan submitted to the Executive Director shall be designed to comply with relevant state conservation standards then in effect, and, at the time of submission, shall be designed to achieve, for each category of authorized uses, the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the Permittee. Permittee shall report annually to the Executive Director on the implementation of its water conservation plans and shall make both its most current water conservation plan and the annual reports on the implementation of its conservation plans easily accessible to the public through electronic and other means.

Such plans shall ensure that every water supply contract entered into, on or after the effective date of this permit, including any contract extension or renewal, requires that each successive wholesale customer shall develop and implement conservation measures that will result in the highest practicable levels of water conservation and efficiency in order to comply with TWC § 11.085 (l)(2), and that each wholesale customer will report, no less frequently than once every year, to Permittee on the implementation of those conservation measures. If Permittee enters into a water supply contract on or after the effective date of this permit that authorizes the resale of water, such contract shall require that each successive customer in the resale of the authorized water implement water conservation measures at least as stringent as those included in Permittee's approved water conservation plan.

6. SPECIAL CONDITIONS

A. Permittee shall only impound and divert water authorized by this permit in accordance with the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*. Permittee shall maintain said plan in electronic format and make the data available to the Executive Director upon request. Any modifications to the *North Texas Municipal Water District Reservoir Accounting Plan* shall be approved by the Executive Director. Only modifications that would result in a change to a permit term must be in the form of an amendment to the permit. Should Permittee fail to maintain the accounting plan or timely notify the Executive Director of any modifications to the plan, Permittee shall immediately cease impoundments and diversions authorized in Paragraph 1. IMPOUNDMENT and Paragraph 2. USE, and either apply to amend the permit, or voluntarily forfeit the permit. Permittee shall provide prior notice to the Executive Director of any proposed modifications to the accounting plan and provide copies of the appropriate documents effectuating such changes.

B. All mitigation plans and monitoring required herein shall comply with requirements set forth in 33 United States Code §1341, commonly known as the federal Clean Water Act (CWA), §401 and 30 TAC Chapter 279. Mitigation and monitoring plans shall also comply with the requirements in §404 of the CWA as implemented through the U.S. Army Corps of Engineers permit for the Lower Bois d'Arc Creek Reservoir.

C. Impoundment of water and diversion under this permit is contingent upon the initiation of implementation of the approved *Mitigation Plan for the Proposed Lower Bois d'Arc Creek Reservoir*. Permittee's continued authorization of impoundment and diversion of water under this permit is contingent on timely completion of implementation in accordance with the terms of that plan. Modifications or changes to the plan must be approved by the Executive Director. Only modifications that would result in a change to a permit term must be in the form of an amendment to the permit.

D. Permittee shall document compliance with the terms and conditions of this permit relating to environmental flow requirements, as set out in Special Conditions 6.E. through 6.R., in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*.

E. Permittee shall determine compliance with pulse flow conditions and subsistence period freshet conditions using measured flows at USGS Gage 07332622, Bois d'Arc Creek at FM 409 near Honey Grove, TX or, in the case of deliberate releases to pass qualifying pulse flow events or qualifying subsistence period freshets, measurements of the releases from the reservoir as documented in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan.*

F. If calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan,* constitute a qualifying pulse flow event as defined in Special Condition 6.L., the pulse flow requirement for the season has not been met, and the flows at USGS gage 07332622 for the same time period do not exceed the pulse flow trigger requirement, the pulse shall be passed through the reservoir in a manner as close as practicable to the applicable seasonal release pattern identified in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan.* Permittee may release water to augment naturally occurring high flow events so that flows at the USGS Gage 07332622 meet or exceed the pulse flow trigger requirement, subject to the requirements of Special Condition 6.J.

G. Consistent with Special Condition 6.F., when calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*, equal or exceed the pulse flow trigger requirements of Special Condition 6.R. and the pulse flow requirement for the season has not been met, inflows to the reservoir in excess of applicable base flow requirements may be temporarily impounded. Consistent with Special Condition 6.F, if the calculated volume or duration criterion for an applicable qualifying pulse flow event, as specified in Special Condition 6.L., is met, Permittee shall promptly release the temporarily impounded water in a manner as close as practicable to the applicable seasonal release pattern identified in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan.*

H. Permittee is not required to release stored water, except temporarily impounded water as described in Special Condition 6.G. or a qualifying subsistence period freshet required to be released pursuant to Special Condition 6.Q., to meet the environmental flow requirements in this permit. All requirements for pass-throughs of inflows or releases of temporarily impounded water pursuant to Special Conditions 6.E. through 6.R. are limited to the volume of calculated inflows to the reservoir.

I. Subject to compliance with the subsistence and base flow requirements of Special Conditions 6.Q and 6.R, inflows may be stored if either: (i) the pulse flow requirement for a season has been met; or (ii) inflows to the reservoir are below the applicable pulse flow trigger; or (iii) inflows equal or exceed the applicable pulse flow trigger but the calculated volume and duration criteria for a qualifying pulse flow event are both not met. If Permittee has stored water, other than temporarily stored water pursuant to Special Condition 6.G. that is part of a qualifying pulse flow event or water that is part of a qualifying subsistence period freshet required to be passed pursuant to Special Condition 6.Q., then in accordance with the terms and conditions of this permit, including any applicable environmental flow requirements in effect at the time the water was stored, Permittee may divert and use that stored water, even if the applicable environmental flow requirement is not met at the time of the subsequent diversion and use of that stored water.

J. If a naturally occurring qualifying pulse flow event is recorded at USGS gage 07332622, such pulse flow event shall satisfy a pulse flow requirement for that event within the respective season. In addition, a pulse flow requirement for an event within a season may be satisfied by a naturally occurring high flow event which has been augmented by reservoir releases as authorized in Special Condition 6.F., but only if the applicable trigger, duration and volume criteria are all met as measured at that gage.

K. Each season is independent of the preceding and subsequent seasons with respect to the pulse flow requirements of Special Condition 6.R.

L. Except as otherwise provided in Special Condition 6.J., a pulse flow is considered to be a qualifying pulse flow event if the pulse flow trigger requirement is met and either the pulse flow volume or duration requirement is met, as specified in Special Condition 6.R.

M. Permittee shall determine compliance with the requirement to pass reservoir inflows up to the applicable subsistence or base flow values of Special Condition 6.R. based on measured flows at the outlet works of the dam.

N. Seasons are defined as Fall-Winter (November - February), Spring (March – June), and Summer (July - October).

O. Reservoir storage is the trigger for determining the applicable instream flow requirements in Special Conditions 6.E. through 6.R. Subsistence flow requirements apply when storage is less than 40% of the authorized conservation storage. Base flow and pulse flow requirements apply when conservation storage is equal to or greater than 40%.

P. Pulse flow requirements are not applicable under subsistence flow conditions.

Q. When subsistence flow requirements are in effect, as provided in Special Condition 6.O., inflows into the reservoir up to 1 cfs shall be passed downstream and a subsistence period freshet pass-through requirement shall be in effect.

A qualifying subsistence period freshet is characterized by a trigger flow of at least 20 cfs and either a volume of at least 69 acre-feet or a duration of at least three days. Volume will be determined based on cumulative flows occurring over a three-day period, beginning with the day during which the trigger flow occurs. Duration will be determined based on the number of days of inflow greater than 1 cfs, beginning with the day on which the trigger flow occurs. During the time that subsistence flow requirements are in effect pursuant to Special Condition 6.O., Permittee shall track flows at USGS gage 07332622, Bois d'Arc Creek at FM 409, and inflows to the reservoir, to determine if a qualifying subsistence period freshet has occurred at either location.

If, while subsistence flow requirements are in effect pursuant to Special Condition 6.O., a 60-day period occurs without a qualifying subsistence period freshet at USGS gage 07332622, Bois d'Arc Creek at FM 409, but, during which, a qualifying subsistence period freshet has occurred as reservoir inflow, the subsistence period freshet shall be promptly passed through the dam. If a qualifying subsistence period freshet has not occurred as reservoir inflow during such 60-day period, flows will continue to be monitored to determine when a qualifying subsistence period freshet occurs at the FM 409 gage or a qualifying subsistence period freshet has occurred as inflow to the reservoir. During that period of continued monitoring, a qualifying subsistence period freshet will be passed as soon as such an event occurs as inflow into the reservoir unless a qualifying subsistence period freshet has occurred at the FM 409 gage.

As closely as practicable, the subsistence period freshet pass-through shall average 20 cfs the first day, 10 cfs the second day, and 5 cfs the third day. As long as subsistence flow requirements are in effect, once a qualifying subsistence period freshet has occurred at USGS gage 07332622, Bois d'Arc Creek at FM 409, or such flow has been passed through the dam, a new 60-day period will be started for the purpose of determining when a qualifying subsistence flow event must be passed through the dam. In passing an individual subsistence period freshet through the dam, Permittee shall never be required to pass a volume of more than 69 acre-feet.

R. Impoundment or diversion of reservoir inflows when flows are at or below the following values, at the applicable measurement points described in Special Conditions 6.E. and 6.M., is authorized only in compliance with Special Conditions 6.A. and 6.D. through 6.Q., above:

Season	**Subsistence**	**Base**	**Pulse**
Fall-Winter	1 cfs*	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 af Duration: 7 days
Spring	1 cfs*	10 cfs	2 per season Trigger: 500 cfs Volume: 3,540 af Duration: 10 days
Summer	1 cfs*	3 cfs	1 per season Trigger: 100 cfs Volume: 500 af Duration: 5 days

cfs = cubic feet per second
af = acre-feet
*A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 af, and a duration of 3 days, as further defined in Special Condition 6.Q., also applies.

This special condition is subject to adjustment by the commission if the commission determines, through an expedited public review process, that such adjustment is appropriate to achieve compliance with applicable environmental flow standards adopted pursuant to Texas Water Code § 11.1471. Any adjustment shall be made in accordance with the provisions of Texas Water Code § 11.147(e-1).

S. Permittee shall implement measures to minimize impacts to aquatic resources due to entrainment or impingement including, but not limited to, the installation of screens at the diversion facilities. Such measures shall include intake diversion facilities designed and operated to result in a velocity of water into the diversion facility of no greater than 1 foot-per-second. At all times that diversions are occurring, the intake diversion facilities shall be equipped with screens resulting in individual openings no larger than 1 square inch in size.

T. After commencing deliberate impoundment in the reservoir, Permittee shall conduct hydrologic and water quality monitoring in accordance with the approved North Texas Municipal Water District Monitoring Plan. Permittee shall submit a summary of hydrologic and water quality monitoring data to the Executive Director on an annual basis. Permittee shall submit to the Executive Director a summary report of hydrologic and water quality data in the fifth and tenth years following deliberate impoundment in the reservoir and every five years thereafter for as long as monitoring under Special Condition 6.U. continues. Hydrologic and water quality monitoring for all sites and parameters, other than daily flows at USGS Gage 07332622, Bois d'Arc Creek at FM 409 near Honey Grove, TX, and water quality monitoring associated with reservoir releases undertaken pursuant to Special Condition 6.W., may cease after ten years, or when instream monitoring specified in Special Condition 6.U. ceases, whichever is later.

U. Permittee shall conduct instream monitoring of Bois d'Arc Creek at the FM 409 Site and, at a minimum, one additional site within the non-channelized portion of the Creek farther downstream, in the first, third, fifth and tenth years following deliberate impoundment of water in the reservoir. In addition, if diversions from the reservoir, as calculated on an annualized basis, have not reached 100,000 acre-feet prior to the fifth year following deliberate impoundment, instream monitoring shall continue every fifth year thereafter until instream monitoring has been undertaken during two years following the year that diversions reach 100,000 acre-feet per year. Instream monitoring during any year in which it is required shall include a twice per year assessment of fish and macroinvertebrate communities and physical habitat assessment at each site, plus a twice per year analysis of water quality data collected at the USGS Gage 07332622, Bois d'Arc Creek at FM 409 near Honey Grove, TX. All aquatic biological monitoring and physical habitat assessments shall take place in the index period (March 15 – October 15) with at least one of the twice per year monitoring events taking place in the critical period (July 1 – September 15). Aquatic biological monitoring and habitat characterization shall follow TCEQ protocols set forth in the most recently approved *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data*.

V. Permittee shall submit a report to the Executive Director summarizing the twice per year monitoring activities in Special Condition 6.U. within six months after the second monitoring event in any year is completed. The report shall detail all monitoring efforts and shall include an assessment of the fish and macroinvertebrate communities and the biological metric scoring criteria used to assess aquatic life uses. Should aquatic life use not meet the water quality standards for Segment 0202A or future segment designation, Permittee shall develop and implement remedial management strategies, subject to Executive Director approval, to meet the designated aquatic life use. Permittee shall also submit summary reports to the Executive Director no later than six months after the end of the fifth and tenth year monitoring events, and any subsequent year's monitoring events, that compare all monitoring data to baseline conditions.

W. Permittee shall construct and operate a multilevel outlet tower and regulate releases to ensure that water released from the reservoir maintains DO and temperature levels that meet the surface water quality standards for Segment 0202A or future segment designation. Permittee shall monitor water quality near the outlet tower in accordance with the approved Monitoring Plan during the life of the permit.

X. Permittee shall install and maintain measuring devices which account for, within 5% accuracy, the quantity of water diverted from the points authorized above in Paragraph 3. DIVERSION. Permittee shall allow representatives of the TCEQ reasonable access to the property to inspect the measuring device.

Y. Prior to the diversion and reuse of the return flows authorized pursuant to Paragraph 2.D. USE, resulting from the diversion and use of water from the Lower Bois d'Arc Creek Reservoir as authorized under this permit, Permittee shall apply for and be granted an amendment to identify all specific points of discharge and diversion, and secure the appropriate authorizations to transfer such return flows through state watercourses pursuant to TWC §11.042, except to the extent such points of discharge, diversion, and transfer may be authorized by separate grant of authority from the Commission.

7. TIME LIMITATIONS

A. Construction of the dam for Lower Bois d'Arc Creek Reservoir must be in accordance with plans approved by the Executive Director. Construction of the dam without final approval of the construction plans is a violation of this authorization.

B. Construction shall begin within two years of issuance of this permit and be completed within seven years of the issuance of this permit, unless Permittee applies for and is subsequently granted an extension of time before the expiration of these time limitations.

This water use permit is issued subject to all superior and senior water rights in the Red River Basin.

This permit is issued subject to the obligations of the State of Texas pursuant to the terms of the Red River Compact.

Permittee agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this permit.

All other matters requested in the application which are not specifically granted by this water use permit are denied.

This water use permit is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State resources exercised by the Commission.

For the Commission

ISSUED: **June 26, 2015**

SWIFT Funding Information

North Texas Municipal Water District

Lower Bois D'Arc Creek Reservoir
Project No. 317

Vol. 2

- Part D #53 & #54 Revised DEIS - pt. B (continued)
- Part D #54 - Narrative
- FY 17 SWIFT Application Project Table
- Part D #54 Final Transportation Report 5-3-11
- Part D #54 LBCR RWPL Final PDR
- Part D #54 LBCR Conflicts Map
- Part D #54 Final Dam PDR
- Part D #54 LBCR Project Location Map

APPENDIX F: WATER RIGHTS PERMIT (WATER USE PERMIT) FROM TEXAS COMMISSION ON ENVIRONMENTAL QUALITY FOR BOIS D'ARC CREEK RESERVOIR

F-1: SIGNED TEXAS COMMISSION ON ENVIRONMENTAL QUALITY WATER USE PERMIT FOR LOWER BOIS D'ARC CREEK RESERVOIR

F-2: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, WATER AVAILABILITY ANALYSIS

F-3: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, REVISED WATER AVAILABILITY ANALYSIS

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Ron Ellis, Manager
Water Rights Permitting & Availability Section

Date: February 14, 2014

From: Kathy Alexander, Ph.D.
Technical Specialist
Water Availability Division

Subject: North Texas Municipal Water District
WRPERM 12151
CN 601365448
Bois d'Arc Creek, Red River Basin
Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall Counties

WATER AVAILABILITY ANALYSIS ADDENDUM

The initial hydrology memorandum was completed November 22, 2013 and a draft permit was sent to the applicant on November 22, 2013. The applicant submitted comments on December 16, 2013 and January 23, 2014. Staff reviewed the information and recommend the Special Conditions in the draft permit be modified as follows. These recommended modifications are considered to be non-substantive and provided solely for clarification.

In lieu of Special Condition 6.X.

Prior to the diversion and reuse of the return flows authorized pursuant to Paragraph 2.C. USE, resulting from the diversion and use of water from the Lower Bois d'Arc Creek Reservoir as authorized under this permit, Permittee shall apply for and be granted an amendment to identify all specific points of discharge and diversion, and secure the appropriate authorizations to transfer such return flows through state watercourses pursuant to TWC §11.042, except to the extent such points of discharge, diversion, and transfer may be authorized by separate grant of authority from the Commission.

All other recommendations in the original memo dated November 22, 2013 remain unchanged unless specifically addressed in the addendum.

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Ron Ellis, Section Manager
Water Rights Permitting & Availability Section

Date: February 14, 2014

Through: CL Chris Loft, Team Leader
2/14/14 Resource Protection Team
Water Rights Permitting & Availability Section

From: RH 2/14/14 Robert Hansen, Aquatic Scientist
Resource Protection Team
Water Rights Permitting & Availability Section

Subject: North Texas Municipal Water District
WRPERM 12151
CN601365448
Water Right Application No. 12151
Lower Bois d'Arc Creek Reservoir, Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall Counties

ENVIRONMENTAL ANALYSIS ADDENDUM

INSTREAM USES

The initial environmental memorandum was completed November 19, 2013 and a draft permit was sent to the applicant on November 22, 2013. The applicant submitted comments on December 16, 2013 and January 23, 2014. The additional information provided by the applicant was reviewed by Resource Protection Staff. Staff recommend the Special Conditions in the November 22, 2013 draft permit be modified as follows. These recommended modifications are considered to be non-substantive and provided solely for clarification.

In lieu of Special Condition 6.F.

If calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*, constitute a qualifying pulse flow event as defined in Special Condition 6.L., the pulse flow requirement for the season has not been met, and the flows at USGS gage 07332622 do not exceed the pulse flow trigger requirement, the pulse shall be passed through the reservoir in a manner as close as practicable to the applicable seasonal release pattern identified in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan.* Permittee may release water so that flows at the USGS gage 07332622 meet or exceed the pulse flow trigger requirement.

In lieu of Special Condition 6.G.

Consistent with Special Condition 6.F., when calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*, equal or exceed the pulse flow trigger requirements of Special Condition 6.Q. and the pulse flow requirement for the season has not been met, inflows to the reservoir may be temporarily impounded until the calculated volume or duration criteria for a qualifying pulse flow event, as specified in Special Condition 6.L., have been met.

In lieu of Special Condition 6.H.

Permittee is not required to release stored water, except temporarily impounded water as described in Special Condition 6.G., to meet the environmental flow requirements in this permit. All pass-throughs of inflows or releases of temporarily impounded water required by Special Conditions 6.E. through 6.Q. are limited to the volume of calculated inflows to the reservoir.

In lieu of Special Condition 6.I.

If the pulse flow requirement for a season has been met or if the calculated volume or duration criteria for a qualifying pulse flow event are not met, then inflows may be stored. If Permittee has stored water in accordance with the terms and conditions of this permit, including any applicable environmental flow requirements in effect at the time the water was stored, Permittee may divert and use that stored water, even if the applicable environmental flow requirement is not met at the time of the subsequent diversion and use of that stored water.

In lieu of Special Condition 6.Q.

Consistent with Special Conditions 6.A. and 6.D. through 6.P., storage and diversion of water under this permit shall be authorized when streamflows exceed the following values, at measurement points described in Special Conditions 6.E. and 6.M. above:

Season	**Subsistence**	**Base**	**Pulse**
Fall-Winter	1 cfs	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 af Duration: 7 days
Spring	1 cfs	10 cfs	2 per season

			Trigger: 500 cfs Volume: 3,540 af Duration: 10 days
Summer	1 cfs	3 cfs	1 per season Trigger: 100 cfs Volume: 500 af Duration: 5 days

cfs = cubic feet per second
af = acre-feet

This special condition is subject to adjustment by the commission if the commission determines, through an expedited public review process, that such adjustment is appropriate to achieve compliance with applicable environmental flow standards adopted pursuant to Texas Water Code §11.471. Any adjustment shall be made in accordance with the provisions of Texas Water Code §11.471(e-1).

All other recommendations in the original memo dated November 19, 2013 remain unchanged unless specifically addressed in the addendum.

APPENDIX F: WATER RIGHTS PERMIT (WATER USE PERMIT) FROM TEXAS COMMISSION ON ENVIRONMENTAL QUALITY FOR BOIS D'ARC CREEK RESERVOIR

F-1: SIGNED TEXAS COMMISSION ON ENVIRONMENTAL QUALITY WATER USE PERMIT FOR LOWER BOIS D'ARC CREEK RESERVOIR

F-2: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, WATER AVAILABILITY ANALYSIS

F-3: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY MEMORANDUM, REVISED WATER AVAILABILITY ANALYSIS

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Ron Ellis, Section Manager
Water Rights Permitting & Availability Section

Date: September 5, 2014

From: Kathy Alexander, Ph.D.
Technical Specialist
Water Availability Division

Subject: North Texas Municipal Water District
WRPERM 12151
CN 601365448
Bois d'Arc Creek, Red River Basin
Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall Counties

WATER AVAILABILITY ANALYSIS ADDENDUM

Application Summary

The initial Water Availability Analysis was completed November 22, 2013 and a draft permit was sent to the North Texas Municipal Water District (District) on November 22, 2013. The District submitted comments on December 16, 2013 and January 23, 2014 and staff prepared an addendum to its Water Availability Analysis on February 14, 2014. On August 15, 2014, the District proposed revisions to the draft permit as a result of a settlement agreement. In support of its revisions, the District submitted a revised draft accounting plan on August 15, 2014. After discussions with staff, the District submitted a draft final accounting plan on September 3, 2014, and a final accounting plan description document on September 5, 2014. The District also submitted a revised Water Availability Model (WAM) on August 20, 2014.

Water Availability Analysis

In addition to the requirements in Resource Protection staff's November 19, 2013 memorandum, the District proposed an additional environmental flow requirement for a subsistence period freshet, which is discussed in more detail in Resource Protection staff's September 5, 2014 addendum. Both the accounting plan and the WAM were revised to include the freshet requirement.

Staff reviewed the revised model submitted by the District and finds that the modifications to include the subsistence freshet are appropriate. Staff also agrees with the District's non-substantial changes to water rights and control point identifiers in the existing model code, which were necessary to incorporate the freshet requirement into the model. Staff used the revised model to re-evaluate the firm yield request. The simulation results indicate that 120,590 acre-feet of water is available 100 percent of the time, a reduction of 75 acre-feet of firm water per year from the value reported in the original Water Availability Analysis. Staff then used the same simulation to re-evaluate the full requested diversion of 175,000 acre-feet of less than firm water. The simulation results continue to indicate that if the District diverts 175,000 acre-feet per year when that water is available, 100 percent of the total annual demand of 175,000 acre-feet would be met in 78 percent of the years, and 75 percent of the monthly demand would be met in 92 percent of the months.

The District provided a revised accounting plan, *North Texas Municipal Water District Reservoir Accounting Plan* that incorporates the freshet requirements, improves the compliance checks for environmental flows, and includes additional minor changes to conform to modifications in permit language in the District's proposed August 15, 2014 revised draft permit. Staff reviewed the accounting plan and found it adequately documents compliance with the terms and conditions of the permit. Staff also reviewed the hydrologic monitoring components in the revised *North Texas Municipal Water District Monitoring Plan* and finds that the proposed hydrologic monitoring continues to be adequate to document the flow regime in Lower Bois D'Arc Creek after deliberate impoundment in the reservoir.

Conclusion

Hydrology staff can support granting the application, including all revisions to the draft permit.

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To:	Ron Ellis, Section Manager Water Rights Permitting & Availability Section	Date:	September 5, 2014
Through:	Chris Loft, Team Leader Resource Protection Team Water Rights Permitting & Availability Section		
From:	Robert Hansen, SeniorAquatic Scientist Resource Protection Team Water Rights Permitting & Availability Section		
Subject:	North Texas Municipal Water District WRPERM 12151 CN601365448 Water Right Application No. 12151 Lower Bois d'Arc Creek Reservoir, Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall Counties		

ENVIRONMENTAL ANALYSIS ADDENDUM

INSTREAM USES

The initial environmental memorandum was completed November 19, 2013 and a draft permit was sent to the Applicant on November 22, 2013. The Applicant submitted comments on December 16, 2013 and January 23, 2014. The additional information provided by the Applicant was reviewed by Resource Protection Staff and recommendations for modifications to the Special Conditions in the November 22, 2013 draft permit were provided by Staff in an Environmental Analysis Addendum dated February 14, 2014. On August 15, 2014, the Applicant proposed revisions to the draft permit as a result of a settlement agreement. The Applicant also submitted supporting information concerning the rationale for the proposed subsistence freshet releases and revised monitoring requirements for Lower Bois d'Arc Creek Reservoir. Staff reviewed the information provided in support of the subsistence freshet releases and concurs that these short duration releases would refresh pools and provide moisture to sustain instream and riparian vegetation. Staff also reviewed revisions to the monitoring requirements. Staff determined that the revised monitoring requirements are reasonable. Detailed discussion of the *North Texas Municipal Water District Reservoir Accounting Plan* and associated hydrologic concerns will be addressed in the Water

Availability Analysis. Additional recommendations for modification of the November 22, 2013 draft permit are provided below.

Proposed modifications for Special Conditions 6.B. through 6.D., 6.K. and 6.O. are minor and intended to provide for clarification purposes only. The recommended modifications beginning with Special Condition 6.E. provide more detail with respect to subsistence period freshets, pass-throughs and pulse flow requirements, minimization of impacts to aquatic resources, hydrologic and water quality monitoring, and biological monitoring and water quality data reporting requirements. Staff reviewed the proposed revisions and recommends the draft permit be modified as follows:

In lieu of Special Condition 6.E.

Permittee shall determine compliance with pulse flow conditions and subsistence period freshet conditions using measured flows at USGS Gage 07332622, Bois d'Arc Creek at FM 409 near Honey Grove, TX or, in the case of deliberate releases to pass qualifying pulse flow events or qualifying subsistence period freshets, measurements of the releases from the reservoir as documented in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan.*

In lieu of Special Condition 6.F.

If calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*, constitute a qualifying pulse flow event as defined in Special Condition 6.L., the pulse flow requirement for the season has not been met, and the flows at USGS Gage 07332622 for the same time period do not exceed the pulse flow trigger requirement, the pulse shall be passed through the reservoir in a manner as close as practicable to the applicable seasonal release pattern identified in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*. Permittee may release water to augment naturally occurring high flow events so that flows at the USGS Gage 07332622 meet or exceed the pulse flow trigger requirement, subject to the requirements of Special Condition 6.J.

In lieu of Special Condition 6.G.

Consistent with Special Condition 6.F., when calculated reservoir inflows, as determined in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*, equal or exceed the pulse flow trigger requirements of Special Condition 6.R. and the pulse flow requirement for the season has not been met, inflows to the reservoir in excess of applicable base flow requirements may be temporarily impounded. Consistent with Special Condition 6.F., if the calculated volume or duration criterion for an applicable qualifying pulse flow event, as specified in Special Condition 6.L., is met, Permittee shall promptly release the temporarily impounded water in a manner as close as practicable to the applicable seasonal release pattern identified in the most recently approved *North Texas Municipal Water District Reservoir Accounting Plan*.

In lieu of Special Condition 6.H.

Permittee is not required to release stored water, except temporarily impounded water as described in Special Condition 6.G. or a qualifying subsistence period freshet required to be released pursuant to Special Condition 6.Q., to meet the environmental flow requirements in this permit. All requirements for pass-throughs of inflows or releases of temporarily impounded water pursuant to Special Conditions 6.E. through 6.R. are limited to the volume of calculated inflows to the reservoir.

In lieu of Special Condition 6.I.

Subject to compliance with the subsistence and base flow requirements of Special Conditions 6.Q and 6.R, inflows may be stored if either: (i) the pulse flow requirement for a season has been met; or (ii) inflows to the reservoir are below the applicable pulse flow trigger; or (iii) inflows equal or exceed the applicable pulse flow trigger but the calculated volume and duration criteria for a qualifying pulse flow event are both not met. If Permittee has stored water, other than temporarily stored pursuant to Special Condition 6.G that is part of a qualifying pulse flow event or water that is part of a qualifying subsistence period freshet required to be passed pursuant to Special Condition 6.Q., then in accordance with the terms and conditions of this permit, including any applicable environmental flow requirements in effect at the time the water was stored, Permittee may divert and use that stored water, even if the applicable environmental flow requirement is not met at the time of the subsequent diversion and use of that stored water.

In lieu of Special Condition 6.J.

If a naturally occurring qualifying pulse flow event is recorded at USGS Gage 07332622, such pulse flow event shall satisfy a pulse flow requirement for that event within the respective season. In addition, a pulse flow requirement for an event within a season may be satisfied by a naturally occurring high flow event which has been augmented by reservoir releases as authorized in Special Condition 6.F., but only if the applicable trigger, duration and volume criteria are all met as measured at that gage.

In lieu of Special Condition 6.L.

Except as otherwise provided in Special Condition 6.J., a pulse flow is considered to be a qualifying pulse flow event if the pulse flow trigger requirement is met and either the pulse flow volume or duration requirement is met, as specified in Special Condition 6.R.

In lieu of Special Condition 6.M.

Permittee shall determine compliance with the requirement to pass reservoir inflows up to the applicable subsistence or base flow values of Special Condition 6.R. based on measured flows at the outlet works of the dam.

New Special Condition 6.Q to be added:

When subsistence flow requirements are in effect, as provided in Special Condition 6.O., inflows into the reservoir up to 1 cfs shall be passed downstream and a subsistence period freshet pass-through requirement shall be in effect. A qualifying subsistence period freshet is characterized by a trigger flow of at least 20 cfs and either a volume of at least 69 acre-feet or a duration of at the least three days. Volume will be determined based on cumulative flows occurring over a three-day period, beginning with the day during which the trigger flow occurs. Duration will be determined based on the number of days of inflow greater than 1 cfs, beginning with the day on which the trigger flow occurs. During the time that subsistence flow requirements are in effect pursuant to Special Condition 6.O., Permittee shall track flows at USGS Gage 07332622, Bois d'Arc Creek at FM 409, and inflows to the reservoir, to determine if a qualifying subsistence period freshet has occurred at either location.

If, while subsistence flow requirements are in effect pursuant to Special Condition 6.O, a 60-day period occurs without a qualifying subsistence period freshet at USGS Gage 073326222, Bois d'Arc at FM 409, but, during which, a qualifying subsistence period freshet has occurred as reservoir inflow, the subsistence period freshet shall be promptly passed through the dam. If a qualifying subsistence period freshet has not occurred as reservoir inflow during such 60-day period, flows will continue to be monitored to determine when a qualifying subsistence period freshet occurs at the FM 409 gage or a qualifying subsistence period freshet has occurred as inflow to the reservoir. During that period of continued monitoring, a qualifying subsistence period freshet will be passed as soon as such an event occurs as inflow into the reservoir unless a qualifying subsistence period freshet has occurred at the FM 409 gage.

As closely as practicable, the subsistence period freshet pass-through shall average 20 cfs the first day, 10 cfs the second day, and 5 cfs the third day. As long as subsistence flow requirements are in effect, once a qualifying subsistence period freshet has occurred at USGS Gage 07332622, Bois d'Arc Creek at FM 409, or such flow has been passed through the dam, a new 60-day period will be started for the purpose of determining when a qualifying subsistence flow event must be passed through the dam, Permittee shall never be required to pass a volume of more than 69 acre-feet.

In lieu of Special Condition 6.Q. (now Special Condition 6.R.)

Impoundment or diversion of reservoir inflows when flows are at or below the following values, at the applicable measurement points described in Special Conditions 6.E. and 6.M., is authorized only in compliance with Special Conditions 6.A. and 6.D. through 6.Q., above:

Season	Subsistence	Base	Pulse
Fall-Winter	1 cfs*	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 af Duration: 7 days
Spring	1 cfs*	10 cfs	2 per season Trigger: 500 cfs Volume: 3,540 af Duration: 10 days
Summer	1 cfs*	3 cfs	1 per season Trigger: 100 cfs Volume: 500 af Duration: 5 days

cfs = cubic feet per second
af = acre-feet
*A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 acre-feet, and a duration of 3 days, as further defined in Special Condition 6.Q., also applies.

This special condition is subject to adjustment by the commission if the commission determines, through an expedited public review process, that such adjustment is appropriate to achieve compliance with applicable environmental flow standards adopted pursuant to Texas Water Code §11.1471. Any adjustment shall be made in accordance with the provisions of Texas Water Code §11.147(e-1).

In lieu of Special Condition 6.R. (now Special Condition 6.S.)

Permittee shall implement measures to minimize impacts to aquatic resources due to entrainment or impingement including, but not limited to, the installation of screens at the diversion facilities. Such measures shall include intake diversion facilities designed and operated to result in a velocity of water into the diversion facility of no greater than 1 foot-per-second. At all times that diversions are occurring, the intake diversion facilities shall be equipped with screens resulting in individual openings no larger than 1 square inch in size.

~~In lieu of Special Condition 6.S. (now Special Condition 6.T.)~~

After commencing deliberate impoundment in the reservoir, Permittee shall conduct hydrologic and water quality monitoring in accordance with the approved North Texas Municipal Water District Monitoring Plan. Permittee shall submit a summary of hydrologic and water quality monitoring data to the Executive Director on an annual basis. Permittee shall submit to the Executive Director a summary report of hydrologic and water quality data in the fifth and tenth years following deliberate impoundment in the reservoir and every five years thereafter for as long as monitoring under Special Condition 6.U continues. Hydrologic and water quality monitoring for all sites and parameters, other than daily flows at USGS Gage 07332622, Bois d'Arc Creek at FM 409, near Honey Grove, TX, and water quality monitoring associated with reservoir releases undertaken pursuant to Special Condition 6.W., may cease after ten years, or when instream monitoring specified in Special Condition 6.U. ceases, which is later.

In lieu of Special Condition 6.T. (now Special Condition 6.U.)

Permittee shall conduct instream monitoring of Bois d'Arc Creek at the FM 409 site and, at a minimum, one additional site within the non-channelized portion of the creek farther downstream, in the first, third, fifth, and tenth years following deliberate impoundment of water in the reservoir. In addition, if diversions from the reservoir, as calculated on an annualized basis, have not reached 100,000 acre-feet prior to the fifth years following deliberate impoundment, instream monitoring shall continue every fifth year thereafter until instream monitoring has been undertaken during two years following the year that diversion reach 100,000 acre-feet per year. Instream monitoring during any year in which it is required shall include a twice-per-year assessment of fish and macroinvertebrate communities, and physical habitat assessment, at each site, plus a twice-per-year analysis of water quality data collected at the USGS Gage 07332622, Bois d'Arce Creek at FM 409 near Honey Grove, TX. All aquatic biological monitoring and physical habitat assessments shall take place in the index period (March 15 – October 15) with at least one of the twice-per-year monitoring events taking place in the critical period (July 1 – September 15). Aquatic biological monitoring and habitat characterization shall follow TCEQ protocols set forth in the most recently approved *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data.*

In lieu of Special Condition 6.U. (now Special Condition 6.V.)

Permittee shall submit a report to the Executive Director summarizing the twice-per-year monitoring activities in Special Condition 6.U. within six months after the second monitoring event in any year is completed. The report shall detail all monitoring efforts and shall include an assessment of the fish and macroinvertebrate communities and the biological metric scoring criteria used to assess aquatic life uses. Should aquatic life use not meet the water quality standards for Segment 0202A or future segment designation, Permittee shall develop and implement remedial management strategies, subject to Executive Director approval, to meet the designated aquatic life use. Permittee shall also submit summary reports to the Executive Director no later than six months after the end of the fifth and tenth year monitoring events, and any subsequent year's monitoring events, that compare all monitoring data to baseline conditions.

In lieu of Special Condition 6.V. (now Special Condition 6.W.)

Permittee shall construct and operate a multilevel outlet tower and regulate releases to ensure that water released from the reservoir maintains DO and temperature levels that meet the surface water quality standards for Segment 0202A or future segment designation. Permittee shall monitor water quality near the outlet tower in accordance with the approved Monitoring Plan during the life of the permit.

All other recommendations in the original memo dated November 19, 2013 and addendum dated February 14, 2014 remain unchanged unless specifically addressed in this addendum.

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Ron Ellis, Section Manager
Water Rights Permitting Team
Water Rights Permitting and Availability Section

Date: September 4, 2014

Thru: CL 9/4/14 Chris Loft, Team Leader
Resource Protection Team
Water Rights Permitting and Availability Section

Thru: JA 9/4/14 Jennifer Allis, Senior Water Conservation Specialist
Resource Protection Team
Water Rights Permitting and Availability Section

From: KW 9/4/2014 Kristin Wang, Senior Water Conservation Specialist
Resource Protection Team
Water Rights Permitting and Availability Section

Subject: North Texas Municipal Water District
WRPERM 12151
CN601365448
Water Conservation Review Addendum

The initial water conservation review memorandum was completed November 22, 2013 and a draft permit was sent to the Applicant on November 22, 2013. On August 15, 2014, North Texas Municipal Water District proposed revisions to the water conservation language in the draft permit. Staff have reviewed the proposed modification and recommend the following water conservation language be included in the permit in lieu of the language in the November 22, 2013 draft permit:

Permittee shall fully implement water conservation plans, developed in accordance with this provision, that provide for the utilization of those reasonably available practices, techniques, and technologies that reduce the consumption of water for municipal use on a gallons per-capita per day basis within NTMWD's service area and that, for each category of use authorized by this permit not including recreation use, prevent the waste of water, prevent or reduce the loss of water, improve the efficiency in the use of water, increase the recycling and reuse of water, and prevent the pollution of water, so that a water supply is made available for future or alternative uses. Permittee shall develop, submit and implement water conservation plans as required by law. Each water conservation plan submitted to the Executive Director shall be designed to comply with relevant state conservation standards then in effect, and, at the time of submission, shall be designed to achieve, for each category of authorized uses, the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the

Permittee. Permittee shall report annually to the Executive Director on the implementation of its water conservation plans and shall make both its most current water conservation plan and the annual reports on the implementation of its conservation plans easily accessible to the public through electronic and other means.

Such plans shall ensure that every water supply contract entered into, on or after the effective date of this permit, including any contract extension or renewal, requires that each successive wholesale customer shall develop and implement conservation measures that will result in the highest practicable levels of water conservation and efficiency in order to comply with TWC § 11.085 (l)(2), and that each wholesale customer will report, no less frequently than once every year, to Permittee on the implementation of those conservation measures. If Permittee enters into a water supply contract on or after the effective date of this permit that authorizes the resale of water, such contract shall require that each successive customer in the resale of the authorized water implement water conservation measures at least as stringent as those included in Permittee's approved water conservation plan.

All other analyses and recommendations in the memo dated November 22, 2013 remain unchanged unless specifically addressed in this addendum.

APPENDIX G: PROGRAMMATIC AGREEMENT ON CULTURAL RESOURCES MANAGEMENT BETWEEN NORTH TEXAS MUNICIPAL WATER DISTRICT, U.S. ARMY CORPS OF ENGINEERS – TULSA DISTRICT, TEXAS HISTORICAL COMMISSION, AND THE CADDO NATION

PROGRAMMATIC AGREEMENT

AMONG

THE NORTH TEXAS MUNICPAL WATER DISTRICT;

THE U.S. ARMY CORPS OF ENGINEERS, TULSA DISTRICT;

THE TEXAS HISTORICAL COMMISSION; AND

THE CADDO NATION OF OKLAHOMA

REGARDING COMPLIANCE WITH SECTION 106 OF THE NATIONAL HISTORIC

PRESERVATION ACT OF 1966 (AS AMENDED) FOR THE

PROPOSED CONSTRUCTION OF THE LOWER BOIS d'ARC RESERVOIR

TO BE LOCATED NORTHEAST OF THE CITY OF BONHAM, FANNIN COUNTY, TEXAS

AND REQUIRING AN INDIVIDUAL PERMIT ISSUED UNDER

SECTION 404 OF THE CLEAN WATER ACT

WHEREAS, the North Texas Municipal Water District (NTMWD) has proposed to construct the Lower Bois d'Arc Creek Reservoir, which will be located on Bois d'Arc Creek near the city of Bonham in Fannin County, northeastern Texas; and

WHEREAS, NTMWD is a political subdivision of the State of Texas, and as such, is subject to compliance with the Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code); and

WHEREAS, the U.S. Army Corps of Engineers, Tulsa District, (hereafter, Tulsa District) has Federal responsibility and review authority to evaluate applications for permits issued under the national U.S. Army Corps of Engineers (USACE) regulatory program, pursuant to Section 404 of the Clean Water Act; and

WHEREAS, construction of the Lower Bois d'Arc Creek Reservoir will require a permit in order to comply with Section 404 of the Clean Water Act; and

WHEREAS, issuing a permit pursuant to Section 404 of the Clean Water Act qualifies as an undertaking under Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended); and

WHEREAS, Section 106 and its implementing regulation 36 CFR Part 800 require the Tulsa District to ensure that historic properties are identified, and that adverse effects to those historic properties are identified and resolved prior to the issuance of a permit (the Section 106 Process); and

WHEREAS, the Area of Potential Effect (APE) for this project consists of the reservoir footprint itself to the elevation of the planned top of floodpool (elevation 541 ft. amsl at crest of emergency spillway), , the planned location of the dam and all associated construction and staging areas, the planned new water treatment facility at Leonard, Texas, the pipeline from the new water treatment facility to the discharge point into Pilot Grove Creek, all raw water pipelines between the reservoir and associated existing water treatment facilities, lands manipulated for impact mitigation, plus the full horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project component boundaries and associated impact areas; and

WHEREAS, the effects of this undertaking on historic properties cannot be fully determined prior to approval of the undertaking; and

WHEREAS, Texas Historical Commission (THC) is the agency that administers the Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code) and has responsibilities under the Chapter 711 of the Texas Health and Safety Code regarding the discovery and disposal of abandoned or unknown cemeteries; and

WHEREAS, the Executive Director of the THC serves as the State Historic Preservation Officer (SHPO) for Texas and has the authority to enter into Section 106 agreements; and

WHEREAS, NTMWD, the Tulsa District, and the SHPO agree that it is advisable to accomplish compliance with Section 106 through the development and execution of this Programmatic Agreement (hereinafter "PA") in accordance with 36 CFR 800.6 and 36 CFR 800.14(b)(3); and

WHEREAS, the Tulsa District notified the Advisory Council on Historic Preservation (ACHP) about this project and requested that the agency participate in the development of this Programmatic Agreement (PA); and

WHEREAS, the ACHP declined to participate in the development of this PA except in an advisory role; and

WHEREAS, prior to contact with Europeans, the lower Bois d'Arc Creek and Red River drainages in northeastern Texas were occupied by ancestors of the Caddo Nation of Oklahoma (hereinafter, Caddo Nation) and thus may retain historic properties of importance to the Caddo Nation; and

NOW, THEREFORE, the NTMWD; the Tulsa District; the SHPO, and the Tribal Historic Preservation Officer (THPO) of the Caddo Nation agree that the proposed undertaking shall be implemented and administered in accordance with the following stipulations in order for Tulsa District to take into account the effects of the permit on historic properties as required by Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended).

STIPULATIONS

The Tulsa District shall ensure that the following measures will be carried out. All work conducted under this PA will be performed in a manner consistent with the Secretary of Interior's "Standards and Guidelines for Archeology and Historic Preservation" (48 FR 44716-44740; September 23, 1983), as amended, or the Secretary of the Interior's "Standards for the Treatment of Historic Properties" (36 CFR 68), as appropriate.

I. TASKS TO ACCOMPLISH IDENTIFICATION, EVALUATION, EFFECT DETERMINATION AND RESOLUTION.

A. RESEARCH DESIGN. NTMWD will produce a research design to guide the cultural resources investigations that will be conducted within the entire Area of Potential Effect (APE). As noted above, the APE primarily includes the proposed 17,000-acre reservoir area, but also includes a new water treatment facility to be located at Leonard, Texas, and the connecting pipeline between that facility and the reservoir. Additionally, the pipeline that will be constructed to convey water from the reservoir to Pilot Grove Creek, a tributary to Lake Lavon, is also included in the APE. All construction and staging areas directly associated with the construction of the dam and reservoir are included in the APE as well. Beyond these project elements, the APE includes lands acquired or manipulated for impact mitigation, and the horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project elements and their associated impact areas, including the boundary defined by the planned top of the flood pool (elevation 541 ft. amsl at crest of emergency spillway).

The Research Design will synthesize current knowledge about the prehistory and history of the project area using existing records on historic resources, including but not limited to archaeological sites and historic standing structures in the APE. It will include information on National Register listings and historical makers in and near the APE and survey regional archeological and historical literature. Additionally, archival and aerial photographic documentation will be utilized as appropriate in the development of the research design. Information will be sought from consulting parties, and individuals and organizations likely to have knowledge of, or concerns about, historic properties in the area. The goal of the research design is to develop a survey methodology appropriate for the landscape encompassed by the APE and to develop research questions pertinent to the APE that can guide testing and data recovery efforts. The Research Design will thus present and develop arguments for the selection of an appropriate stratified random sampling method for the cultural resources investigations within the entire APE. Cultural resources investigations will follow State of Texas guidelines, which specify the methods to be employed in certain types of settings.

B. RESEARCH DESIGN REVIEW. The draft research design will be submitted to the SHPO, the Caddo Nation Tribal Historic Preservation Officer (THPO), and Tulsa District for review. The reviewing parties will submit comments to NTMWD within 30 days of receipt of the draft Research Design. NTMWD will address comments and produce a final version of the Research Design within 30 days of receipt. The second draft will be reviewed in the same manner and time frame as the first.

C. INITIAL CULTURAL RESOURCES INVESTIGATIONS. Once the Research Design is completed, NTMWD will use the sampling methods set forth in that document to locate cultural resources. These methods will include, but not be limited to, pedestrian survey conducted at appropriate intervals and excavation of shovel tests at appropriate intervals, including screening of excavated material. In certain instances subsurface testing will be conducted by soil coring or backhoe trenching. Additionally, archival research will be necessary to establish chain of title or to establish historical significance to support National Register eligibility determinations for sites dating to the historic period.

D. NATIONAL REGISTER ELIGIBILITY DETERMINATIONS. When historic or cultural resources are identified within the APE, their eligibility for inclusion in the National Register of Historic Places (NRHP) will be assessed using the criteria outlined in 36 CFR Part 60. If in the event a historic or cultural resource is intersected by the limits of a project element or adjacent to the boundary of a project element, the entire property will be considered when determining National Register eligibility of that property. In some instances, information beyond that readily available from survey and archival research may be necessary to complete an eligibility determination. In these instances, additional work in the form of subsurface test excavations or further archival research may be necessary. The actual amount of work conducted will vary from resource to resource, but it must obtain data sufficient to allow an independent assessment as to whether a resource can or cannot be expected to address the research questions set forth in the Research Design.

Should NTMWD, Tulsa District, and SHPO agree that a property is or is not eligible, such consensus shall be deemed conclusive for the purpose of this PA. Should NTMWD, Tulsa District, or SHPO disagree regarding the eligibility of a property, Tulsa District, shall obtain a determination of eligibility from the Keeper of the National Register pursuant to 36 CFR 63. Cultural resources determined to be ineligible for inclusion in the NRHP shall require no further protection or evaluation. Historic resources that are eligible for listing on the NRHP are "historic properties," consistent with terminology defined in 36 CFR Part 800.16.

E. DETERMINATION OF ADVERSE EFFECT. Tulsa District shall ensure that NTMWD shall make a reasonable and good faith effort to evaluate the effect of the undertaking on historic properties in the APE.

1. *Finding of No Adverse Effect.* NTMWD, in consultation with the Tulsa District, the SHPO, the THPO, and other consulting parties, shall apply the criteria of adverse effect to historic properties within the APE in accordance with 36 CFR 800.5.

NTMWD may propose a finding of no adverse effect if the undertaking's effects do not meet the criteria of 36 CFR 800.5(a)(1) or the undertaking is modified to avoid adverse effects in accordance with 36 CFR 68. NTMWD shall provide to the Corps and SHPO documentation of this finding meeting the requirements of 36 CFR 800.11(e). The SHPO shall have 30 calendar days in which to review the findings and provide a written response to NTMWD. NTMWD may proceed upon receipt of written concurrence from the SHPO. Failure of the SHPO to respond within 30 days of receipt of the finding shall be considered agreement with the finding. NTMWD shall maintain a record of the finding and provide information on the finding to the public upon request, consistent with the confidentiality requirements of 36 CFR 800.11(c).

2. *Finding of Adverse Effect.* The signatories to this agreement concur that all historic properties identified within or at the elevation of the proposed flood pool of the Lower Bois d'Arc Creek Reservoir, in or near the dam site, in or near the site of the water treatment facility at Leonard, TX, within the pipeline right-of-way, or in or near proposed equipment staging areas or borrow areas are presumed to be adversely affected by the undertaking. NTMWD, in consultation with the Tulsa District, the SHPO, the THPO, and other consulting parties, shall apply the criteria of adverse effect to historic properties identified in any other areas within the APE on a case-by-case basis in accordance with 36 CFR 800.5.

F. RESOLUTION OF ADVERSE EFFECT. NTMWD and the Tulsa District, shall consult with the SHPO, the THPO and other consulting parties to resolve adverse effects in accordance with 36 CFR 800.6. Tulsa District will consult with the parties to develop and evaluate alternatives or modifications to the undertaking that could avoid or minimize the adverse effects. Adverse effects to historic properties resulting from the construction of the reservoir or pipelines or from any activities associated with construction of the reservoir or pipelines that cannot be avoided will be mitigated in order to offset the loss of those properties. NTMWD shall prepare a historic properties treatment plan (Plan) that describes the mitigation measures NTMWD proposes to resolve the undertaking's adverse effects and shall provide this Plan for review and comment to the Tulsa District, the SHPO, the THPO, and other consulting parties. All parties will have 30 calendar days in which to provide a written response to NTMWD. The Plan shall include, as appropriate, excavation and recordation strategies; work and report schedules; and curation of artifacts and records. It shall take into account all research questions set forth in the Research Design and specify at a minimum: a) the historic property or properties where data recovery is to be conducted; b) the excavation or recordation that will be performed; c) the methods to be used with an explanation of their relevance to the Research Design; and d) the methods to be used in analysis, data management, and dissemination of data, including a schedule of work and report submission.

If NTMWD and the Tulsa District, the SHPO, and the Caddo Nation fail to agree on how adverse effects will be resolved, the Tulsa District, shall request that the Council join the consultation and provide the Council and all consulting parties with documentation pursuant to 36 CFR 800.11(g).

II. CURATION AND DISPOSITION OF RECOVERED MATERIALS, RECORDS, AND REPORTS.

A. CURATION. NTMWD materials and associated records owned by the State of Texas or NTMWD are governed by Texas Historical Commission Rules (Chapter 29, Rules of Management and Care of Artifacts and Collections). Therefore, NTMWD shall ensure that all such materials and records that result from identification, evaluation, and treatment efforts conducted under this PA, are accessioned into a curatorial facility that has been certified, or granted provisional status, by the THC in accordance with Chapter 29.6, except as specified for human remains in Stipulation V.

B. REPORTS. NTMWD shall provide copies of final technical reports of investigations to the signatories and consulting parties. The signatories and consulting parties shall withhold from the public all site location information and other data that may be of a confidential or sensitive nature pursuant to 36 CFR 800.11(c).

III. TECHNICAL REPRESENTATIVES OF THE SIGNATORIES.

The parties to this Agreement will designate technical representatives which will engage in communication to fulfill the terms outlined in order to comply with the Section 106 process. Technical representatives will conduct consultation required to establish determinations of eligibility for the National Register, determinations of adverse effect, and the methods for resolving adverse effects to historic properties.

IV. EXECUTION AND APPLICABILITY OF THIS AGREEMENT.

This Agreement will go into effect when signed by all parties, and when a fully executed version is received by the Advisory Council on Historic Preservation (ACHP).

V. TREATMENT OF HUMAN REMAINS.

A. PRIOR CONSULTATION. If NTMWD's investigations conducted pursuant to Stipulation I of this PA indicate a high likelihood that human remains may be encountered, NTMWD shall develop a treatment plan for these remains in consultation with the Tulsa District, the SHPO, and the THPO and other consulting parties. NTMWD shall ensure that parties indicating an interest in the undertaking are afforded a reasonable opportunity to identify concerns, advise on identification and evaluation, and participate in the resolution of adverse effects in compliance with the terms of this PA.

B. INADVERTENT DISCOVERY. Immediately upon the inadvertent discovery of human remains during historic properties investigations or construction activities conducted pursuant to this PA, NTMWD shall ensure that all ground disturbing activities cease in the vicinity of the human remains and any associated grave goods, and that the site is secured from further disturbance or vandalism. NTMWD will be responsible for immediately notifying local law enforcement officials, and within 48 hours of the discovery, shall initiate consultation with the Tulsa District, the SHPO, and the THPO and other consulting parties to develop a plan for resolving the adverse effects. The course of action shall comport with Title 13, Part II, Chapter 22, Cemeteries, which are the rules regarding abandoned cemeteries and the disinterment of graves, as well as any other requirements under Chapter 711 of the Texas Health and Safety Code.

VI. INADVERTENT DISCOVERIES OF HISTORIC PROPERTIES.

If historic properties (aside from pre-contact burials or other human remains discussed in Stipulation V) are inadvertently discovered during any activities directly related to construction of the reservoir (including staging areas, borrow areas, and dam construction), water treatment facility, or the pipeline, or if there are other unanticipated effects on historic properties within the proposed reservoir area, water treatment facility, or pipeline, NTMWD shall ensure that all construction activity ceases within 150 ft. of the find, ensure the area is secured and the historic property is protected, and will notify the Tulsa District, the SHPO, and the THPO within 48 hours of discovery. The parties to this Agreement will consult and formulate an appropriate course of action to address the effect on the discovery, consistent with a defendable determination of National Register eligibility.

A. DISCOVERIES ON FEDERAL OR INDIAN LANDS. If historic properties are discovered on Indian or Federal lands, Tulsa District shall comply with the Native American Graves Protection and Repatriation Act (NAGPRA [P.L. 101-601; 104 Stat. 3048; 25 U.S.C. Section 3001-13]) and its applicable regulations, the Archeological Resources Protection Act and its applicable regulations, and any other applicable tribal, federal, or state law, as appropriate to the discovery.

B. DISCOVERIES ON NON-INDIAN, NON-FEDERAL OR STATE LANDS. For discoveries on non-Indian, non-Federal lands or State lands, applicable laws and regulations of the State of Texas statutes shall be followed, including the Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code).

VII. PROFESSIONAL QUALIFICATIONS.

All historic preservation-related investigations specified in this Agreement shall be carried out by principal investigators meeting the pertinent professional qualifications of the Secretary of the Interior's (SOI) *Professional Qualification Standards* (36 CFR Part 61) in a discipline appropriate for the task and the nature of the historic properties. Since this project will be conducted on land controlled by the NTMWD, principal investigators must also meet the professional qualifications standards found in Title 13, Part II, Chapter 26, Rules of Practice and Procedure, and must be eligible to receive an Antiquities Permit.

VIII. DISPUTE RESOLUTION.

Should any signatory or concurring party to this Agreement object at any time to any actions proposed or the manner in which the terms of this Agreement are implemented, the objector is encouraged to consult the other signatories in resolving the objection. If that objector determines that such objection cannot be resolved, Tulsa District shall perform the following tasks.

A. CONSULT ACHP. Forward all documentation relevant to the dispute, including proposed resolution, to the ACHP. The ACHP shall provide the agency with its advice on the resolution of the objection within thirty (30) days of receiving adequate documentation. Prior to reaching a final decision on the dispute, the agency shall prepare a written response that takes into account advice or comments regarding the dispute from the ACHP, signatories and concurring parties, and provide them with a copy of this written response. The agency will then proceed according to its final decision.

B. FINAL DECISION. If the ACHP does not provide its advice regarding the dispute within the thirty (30) day time period, the agency may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, Tulsa District shall prepare a written response that takes into account any timely comments regarding the dispute from the signatories and concurring parties to the Agreement, and provide them and the ACHP with a copy of such written response.

IX. ANTI-DEFICIENCY ACT.

It is understood that the implementation of this Agreement is subject to Federal and State anti-deficiency statutes.

X. DURATION, AMENDMENT, WITHDRAWAL, AND TERMINATION.

A. DURATION. Unless terminated or amended as outlined below, this Agreement shall remain in effect for a period of 10 years from the date that the Agreement goes into effect and may be extended for a second ten-year term with the written concurrence of all of the signatories.

B. AMENDMENT. If any signatory to the Agreement determines that the Agreement cannot be fulfilled or that modification of the Agreement is warranted, that signatory shall consult with the other signatories to seek amendment of the Agreement. The Agreement may be amended after consultation among the signatories and all parties agree in writing with such amendment.

C. WITHDRAWAL. Any signatory may withdraw their involvement in this Agreement by providing 30 days written notice to the other parties, provided that the parties will consult during this period to seek amendments or other actions that would prevent withdrawal.

D. TERMINATION. This Agreement will be fully terminated if any of the signatories provides notice of termination and after 30 days or more of unsuccessful consultations to amend the Agreement. This Agreement may also be terminated by the implementation of a subsequent Programmatic Agreement under 36 CFR Part 800 that explicitly supersedes this Agreement.

XI. COMPLIANCE WITH 36 CFR PART 800.

Execution of this Programmatic Agreement and implementation of its terms is evidence that Tulsa District, in the conduct of the agency's permit authority as an agent for the U.S. Army Corps of Engineers, has taken into account the effects of the agency's undertakings on historic properties and has afforded the ACHP an opportunity to comment.

James M. Parks, Executive Director
North Texas Municipal Water District

Mr. Mark Wolfe, Executive Director
Texas Historical Commission

Brenda Shemayme Edwards

Chairperson Brenda Shemayme Edwards
Caddo Nation of Oklahoma 10-01-10

Michael J. Teague
Colonel, U.S. Army
District CommanderU.S. Army Corps of Engineers, Tulsa District

APPENDIX H: APPROVED JURISDICTIONAL DETERMINATIONS FOR PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE, RIVERBY RANCH, AND NORTH WATER TREATMENT PLANT SITE NEAR LEONARD

H-1: APPROVED JURISDICTIONAL DETERMINATION FOR LOWER BOIS D'ARC CREEK RESERVOIR

H-2: APPROVED JURISDICTIONAL DETERMINATION FOR RIVERBY RANCH MITIGATION SITE

H-3: APPROVED JURISDICTIONAL DETERMINATION FOR NORTH WTP AT LEONARD

H-4: APPROVED JURISDICTIONAL DETERMINATION FOR FM 1396 RELOCATION - FM 897 EXTENSION

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): August 27, 2015

B. DISTRICT OFFICE, FILE NAME, AND NUMBER: SWT-0-14659

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State: Texas County/parish/borough: Fannin City: Bonham
Center coordinates of site (lat/long in degree decimal format): Lat. 33.718° N, Long. -95.982° W.
Universal Transverse Mercator:
Name of nearest waterbody: Bois d Arc Creek
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Red River
Name of watershed or Hydrologic Unit Code (HUC): 11140101
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☒ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: August 2015
☒ Field Determination. Date(s): August 2015

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** "*navigable waters of the U.S.*" within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
   ☐ TNWs, including territorial seas
   ☐ Wetlands adjacent to TNWs
   ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
   ☒ Non-RPWs that flow directly or indirectly into TNWs
   ☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
   ☒ Impoundments of jurisdictional waters
   ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
   Non-wetland waters: 651,140 linear feet of streams and 78 acres of open waters (open waters within wetlands and on-channel ponds).
   Wetlands: 5874 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **Pick List**
   Elevation of established OHWM (if known): Varies throughout the review area.

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: None in the project area.

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: .

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: 441 **square miles**
   Drainage area: 327 **square miles**
   Average annual rainfall: 41-44 inches
   Average annual snowfall: 3 inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☒ Tributary flows through **2** tributaries before entering TNW.

   Project waters are **30 (or more)** river miles from TNW.
   Project waters are **1 (or less)** river miles from RPW.
   Project waters are **30 (or more)** aerial (straight) miles from TNW.
   Project waters are **1 (or less)** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: No.

   Identify flow route to TNW[5]: Bois d'Arc Creek flows through the review area to flow into the Red River, which then flows into the designated TNW of the Red River.

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):
Tributary is: ☒ Natural
☐ Artificial (man-made). Explain: .
☒ Manipulated (man-altered). Explain: Sections of Bois d'Arc Creek within the review area have been channelized in the past.

Tributary properties with respect to top of bank (estimate):
Average width: 40 feet
Average depth: 20 feet
Average side slopes: **2:1.**

Primary tributary substrate composition (check all that apply):
☒ Silts ☒ Sands ☐ Concrete
☒ Cobbles ☒ Gravel ☐ Muck
☐ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: In general, Bois d'Arc Creek has steep banks and little vegetation throughout the project area. Most of the creek is incised, with little access to a floodplain during frequent storm events causing sloughing along the banks. There is a high sediment load in the lower reaches due to unstable sections.
Presence of run/riffle/pool complexes. Explain: Variable throughout review area.
Tributary geometry: **Relatively straight**
Tributary gradient (approximate average slope): 0.05-0.08 %

(c) Flow:
Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **20 (or greater)**
Describe flow regime: Flows received from an average of 41-44 inches of precipitation annually and contributing tributaries from within the watershed.
Other information on duration and volume: Monitoring occurs at two USGS stream gauge stations (07332620 and 07332622).

Surface flow is: **Confined.** Characteristics: .

Subsurface flow: **Unknown**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☒ Bed and banks
☒ OHWM[6] (check all indicators that apply):
☒ clear, natural line impressed on the bank ☒ the presence of litter and debris
☐ changes in the character of soil ☒ destruction of terrestrial vegetation
☒ shelving ☒ the presence of wrack line
☒ vegetation matted down, bent, or absent ☒ sediment sorting
☒ leaf litter disturbed or washed away ☒ scour
☒ sediment deposition ☒ multiple observed or predicted flow events
☐ water staining ☐ abrupt change in plant community
☐ other (list):
☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
☐ High Tide Line indicated by: ☐ Mean High Water Mark indicated by:
☐ oil or scum line along shore objects ☐ survey to available datum;
☐ fine shell or debris deposits (foreshore) ☐ physical markings;
☐ physical markings/characteristics ☐ vegetation lines/changes in vegetation types.
☐ tidal gauges
☐ other (list):

(iii) Chemical Characteristics:

[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).

Explain: Prior to storm events, water color is clear to slightly turbid. Water color is highly turbid following storm events. The designated water uses assigned by the TCEQ for segment 0202A- Bois D' Arc Creek (unclassified water body) are aquatic life, contact recreation, and fish consumption use. The aquatic life and contact recreation uses for this segment classified as "fully supporting", while the fish consumption use was not assessed. In addition, this segment is classified as "fully supporting" for overal use (TCEQ, 2002).

Identify specific pollutants, if known: Unknown.

(iv) Biological Characteristics. Channel supports (check all that apply):

☒ Riparian corridor. Characteristics (type, average width): The riparian corridor along Bois d'Arc Creek is dominated by green ash (*Fraxinus pennsylvanica*), elm (*Ulmus* spp.), and sugarberry (*Celtis laevigata*). Others species occur but in less frequent numbers. Portions of the corridor have been removed by logging and other agricultural activities.

☐ Wetland fringe. Characteristics: .

☒ Habitat for:

☐ Federally Listed species. Explain findings: .

☒ Fish/spawn areas. Explain findings: See aquatic/wildlife diversity discussion below..

☐ Other environmentally-sensitive species. Explain findings: .

☒ Aquatic/wildlife diversity. Explain findings: The Bois d'Arc Creek watershed, including its channels, tributaries, wetlands, open water areas, grasslands, upland and bottomland forests, support a variety of wildlife species by providing water, cover, food, and den or nesting sites. A study reported by Texas Parks and Wildlife Department indicated that a survey conducted in 1982, which found over 20 species of fish living in Bois d'Arc Creek.

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:

Properties:

Wetland size: 5,874 acres

Wetland type. Explain: 4,602 acres of forested wetland, 1,223 acres of emergent wetland, and 49 acres of shrub wetland were identified within the study area.

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Intermittent flow**. Explain: .

Surface flow is**: Overland sheetflow**

Characteristics: .

Subsurface flow: **Unknown**. Explain findings: .

☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

☒ Directly abutting

☐ Not directly abutting

☐ Discrete wetland hydrologic connection. Explain: .

☐ Ecological connection. Explain: .

☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **30 (or more)** river miles from TNW.

Project waters are **30 (or more)** aerial (straight) miles from TNW.

Flow is from: **Wetland to navigable waters.**

Estimate approximate location of wetland as within the **2-year or less** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: Observations during site investigations found that water color within wetlands was relatively clear.

Identify specific pollutants, if known: Unkown.

(iii) Biological Characteristics. Wetland supports (check all that apply):

☒ Riparian buffer. Characteristics (type, average width): The riparian corridor along Bois d'Arc Creek wetlands is dominated by green ash (*Fraxinus pennsylvanica*), elm (*Ulmus* spp.), and sugarberry (*Celtis laevigata*). Other species occur but in less frequent numbers. Portions of the corridor have been removed by logging and other agricultural activities.

☒ Vegetation type/percent cover. Explain: 4,602 acres of forested wetland, 1,223 acres of herbaceous wetland, and 49 acres of shrub wetland were identified within the study area.

☒ Habitat for:

☐ Federally Listed species. Explain findings: .

☒ Fish/spawn areas. Explain findings: See aquatic/wildlife diversity below.

☐ Other environmentally-sensitive species. Explain findings: .

☒ Aquatic/wildlife diversity. Explain findings: The wetlands support a variety of wildlife species by providing water, cover, food, and den or nesting sites.

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **1**

Approximately (5874) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)
Yes	5874		

Summarize overall biological, chemical and physical functions being performed: Functions evaluated include groundwater recharge, groundwater discharge, flood flow alteration, sediment stabilization, sediment/toxin retention, nutrient transformation/remediation, production export, wildlife diversity and abundance, aquatic diversity and abundance.

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D:

Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs. Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D:

There are a total of approximately 365,001 linear feet of non-RPW tributaries within the 16,641-acre project review area. These non-RPW's contribute flow to 16 named RPW tributaries within the review area and are evident on historical satellite imagery in addition to being indicated on the USGS National Hydrography Dataset and the USGS 7.5 Minute Quadrangle Maps as dash blue line intermittent streams. Within the review area, unnamed tributaries contribute ~ 1,842 linear feet (lf) of flow to Allens Creek, ~ 172,908 lf to Bois d'Arc Creek, ~ 6,620 lf to Bullard Creek, ~ 24,126 lf to Burns Branch, ~ 6,124 lf to Fox Creek, ~ 61,967 lf to Honey Grove Creek, ~ 350 lf to Onstott Branch, ~ 4,040 lf to Pettigrew Branch, ~ 3,578 lf to Sandy Branch, ~ 15,264 lf to Sandy Creek, ~ 655 lf to Sloans Creek, ~ 1,163 to Stillhouse Branch, ~ 31,837 to Thomas Branch, ~ 19,448 lf to Timber Creek, ~ 14,927 lf to Ward Creek, and ~ 151 lf to Yoakum Creek.

These headwater streams strongly influence the water quality of downstream creeks, rivers, lakes, and estuaries. These streams efficiently remove and transform nutrients, such as inorganic nitrogen derived from agriculture, human and animal waste, and fossil fuel combustion, before they reach downstream waters where they may cause disruption to forest ecoystems, acidify lakes and streams, and degrade coastal waters through eutrophication, algal blooms, and hypoxia. Scientific research suggests that the smallest streams provide the most rapid uptake and transformation of inorganic nitrogen. In particular, ephemeral and intermittent streams maintain water quality despite their lack of continuous flow because fertililzers and other pollutants are most likely to enter stream systems during storms and other times of high runoff, the same times when ephemeral and intermittent streams are likely or have a contnuous waer flow and are processing nutrients. These headwater streams also play an important role in regulating water flow and reducing erosion and sedimentation. Streams absorb runoff and snowmelt, providing water storage that reduces downstream flooding. Natural streambeds, which provide rough and uneven passages for water, reduce the velocity of water moving over the landscape, not only allowing for increased infiltration, but also reduce the ability of moving water to erode streambanks and carry sediment downstream. Small streams also maintain biodiversity in downstream waters by providing both movement corridors for plants and animals across the landscape and a source of colonists for recovery of downstream systems following a disturbance.

The unnamed tributaries described above and depicted on USGS 7.5 Minute Topographic Quadrangle Maps and the USGS National Hydrography Dataset have been determined to have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the TNW, the Red River, and therefore are waters of the U.S.

2. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☐ TNWs: linear feet width (ft), Or, acres.
   - ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: The USGS stream gauge data for Bois d' Arc Creek (stations 07332620 and 07332622), USGS Topographic Quadrangle Maps, USGS National Hydrography Dataset, and historical satellite imagery were referenced in addtion to observations during site visits that showed portions of Bois d'Arc Creek and Honey Grove Creek displayed perennial characteristics. Honey Grove Creek also receives flow from discharges associated from an upstream waste water treatment plant.

   - ☒ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: Review of USGS Topographic Quadrangle Maps, USGS National Hydrography Dataset, historical satellite imagery, along with observations during site visits, showed flows on named tributaries are sustained during certain times of the year after precipitation events and from the number of unnamed tributaries contributing flow from within the watershed.

   Provide estimates for jurisdictional waters in the review area (check all that apply):
   - ☒ Tributary waters: **286,139** linear feet width (ft).
   - ☒ Other non-wetland waters: **48** acres.
     Identify type(s) of waters: **Open waters within abutting wetlands**.

3. **Non-RPWs[8] that flow directly or indirectly into TNWs.**
   - ☒ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide estimates for jurisdictional waters within the review area (check all that apply):
   - ☒ Tributary waters: **365,002** linear feet width (ft).
   - ☒ Other non-wetland waters: **30** acres.
     Identify type(s) of waters: **On-Channel Impoundments.**

4. **Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.**
   - ☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
     - ☒ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: Observations during site visits and review of USFWS NWI maps, USGS Topographic Quadrangle Maps, NRCS SSURGO database, FEMA Maps, and the "Final Jurisdictional Determination Report, Lower Bois d'Arc Creek Reservoir dated June 2008, Prepared by Feese and Nichols, Inc.," show wetlands abutting Bois d'Arc Creek.

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[8]See Footnote # 3.

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: **5874** acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.

☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.

☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]

As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.

☒ Demonstrate that impoundment was created from "waters of the U.S.," or

☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or

☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.

☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.

☐ which are or could be used for industrial purposes by industries in interstate commerce.

☐ Interstate isolated waters. Explain: .

☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):

☐ Tributary waters: linear feet width (ft).

☐ Other non-wetland waters: acres.

Identify type(s) of waters: .

☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):

☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.

☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.

☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).

☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .

☒ Other: (explain, if not covered above): **There are 57 acres of upland stock tanks (ponds) within the review area that are non-jurisdictional.**

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[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.

[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):

☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):

☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):

☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: **Final Jurisdictional Determination Report, Lower Bois d'Arc Creek Reservoir dated June 2008, Prepared by Feese and Nichols, Inc.**
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  ☒ Office concurs with data sheets/delineation report.
  ☒ Office does not concur with data sheets/delineation report.
☒ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
  ☒ USGS NHD data.
  ☒ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name: **USGS 7.5 Minute Topographic Quadrangle Maps - Selfs, Lamasco, Lake Bonham, Bonham, Dodd City; Texas.**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **NRCS Soil Survey of Fannin County, Texas, issued 2001. NRCS SSURGO database.**
☒ National wetlands inventory map(s). Cite name: **USFWS NWI.**
☐ State/Local wetland inventory map(s): .
☒ FEMA/FIRM maps: **Panels 40013C0725E, 48147C0250C, 48147C0275C, 48147C03360C, 48147C0400C** .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): **Google Earth Historical Imagery and NAIP Texas 2014.**
  or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify):

B. ADDITIONAL COMMENTS TO SUPPORT JD:

The review area is the approximately 16,641-acre proposed Bois d'Arc Reservoir project area at the pool elevation 534 MSL. The review area consists of 17 named tributaries and contributing unnamed tributaries that are indicated on the USGS 7.5 Minute Topographic Quadrangle Maps: Selfs, Lamasco, Lake Bonham, Bonham, and Dodd City - Texas.

The named tributaries are as follows:

1. Allens Creek
2. Bois d'Arc Creek
3. Bullard Creek
4. Burns Branch
5. Cottonwood Creek
6. Fox Creek
7. Honey Grove Creek
8. Onstott Branch
9. Pettigrew Branch
10. Sandy Branch
11. Sandy Creek
12. Sloans Creek
13. Stillhouse Branch

14. Thomas Branch
15. Timber Creek
16. Ward Creek
17. Yoakum Creek

The USACE Jurisdictional Determination Guidebook, 33 CFR 328.3, 33 CFR 328.5, and Regulatory Guidance Letter No. 05-05, were referenced to support the conclusion that the non-relatively permanent waters, on-channel impoundments, abutting wetlands to relatively permanent waters, and relatively permanent waters within the review area, cumulatively have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the Traditional Navigable Waterway (TNW) known as the Red River and are waters of the United States. There were erosional features and upland stock tanks (ponds) within the review area that are not regulated by definition.

The "NRCS Soil Survey of Fannin County, Texas, issued 2001," was referenced for annual precipitation estimates for the proposed project area.

APPENDIX H: APPROVED JURISDICTIONAL DETERMINATIONS FOR PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE, RIVERBY RANCH, AND NORTH WATER TREATMENT PLANT SITE NEAR LEONARD

H-1: APPROVED JURISDICTIONAL DETERMINATION FOR LOWER BOIS D'ARC CREEK RESERVOIR

H-2: APPROVED JURISDICTIONAL DETERMINATION FOR RIVERBY RANCH MITIGATION SITE

H-3: APPROVED JURISDICTIONAL DETERMINATION FOR NORTH WTP AT LEONARD

H-4: APPROVED JURISDICTIONAL DETERMINATION FOR FM 1396 RELOCATION - FM 897 EXTENSION

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): August 27, 2015

B. DISTRICT OFFICE, FILE NAME, AND NUMBER: SWT-0-14659

C. PROJECT LOCATION AND BACKGROUND INFORMATION:

State: Texas County/parish/borough: Fannin City: NE of Bonham
Center coordinates of site (lat/long in degree decimal format): Lat. 33.828593° N, Long. 95.908652° W.
Universal Transverse Mercator:
Name of nearest waterbody: Bois d'Arc Creek & Red River
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Red River
Name of watershed or Hydrologic Unit Code (HUC): 11140101
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☒ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc...) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☒ Office (Desk) Determination. Date: August 2015
☒ Field Determination. Date(s): August 2015

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Pick List** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]

☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Pick List** *"waters of the U.S."* within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Require*

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
      ☐ TNWs, including territorial seas
      ☐ Wetlands adjacent to TNWs
      ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
      ☒ Non-RPWs that flow directly or indirectly into TNWs
      ☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
      ☒ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
      ☒ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
      ☒ Impoundments of jurisdictional waters
      ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
      Non-wetland waters: 180,672 linear feet of streams and 19 acres of open waters (open waters within wetlands and on-channel ponds).
      Wetlands: 1927 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **Pick List**
      Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: .

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: .

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) General Area Conditions:
   Watershed size: 1983 **square miles**
   Drainage area: 443 **square miles**
   Average annual rainfall: 41-44 inches
   Average annual snowfall: 3 inches

   (ii) Physical Characteristics:
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☒ Tributary flows through **2** tributaries before entering TNW.

   Project waters are **30 (or more)** river miles from TNW.
   Project waters are **1 (or less)** river miles from RPW.
   Project waters are **30 (or more)** aerial (straight) miles from TNW.
   Project waters are **1 (or less)** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: N/A.

   Identify flow route to TNW[5]: Bois d'Arc Creek flows through the review area, to flow into the Red River, which then flows into the desginated TNW of the Red River.

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[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☒ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: 130 feet
Average depth: 20 feet
Average side slopes: **Pick List.**

Primary tributary substrate composition (check all that apply):

☒ Silts ☒ Sands ☐ Concrete
☒ Cobbles ☒ Gravel ☐ Muck
☐ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: Bois d' Arc Creek has steep banks with some undercutting and vegetation. There is a high sediment load during flood events.
Presence of run/riffle/pool complexes. Explain: Variable throughout review area.
Tributary geometry: **Meandering**
Tributary gradient (approximate average slope): 2.5 %

(c) Flow:
Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **20 (or greater)**
Describe flow regime: Perennial.
Other information on duration and volume: Bois d' Arc Creek in the review area exhibits perennial flow from precipitation events and from contributing unnamed tributaries.

Surface flow is: **Confined.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☒ Bed and banks
☒ OHWM[6] (check all indicators that apply):
☒ clear, natural line impressed on the bank
☐ changes in the character of soil
☒ shelving
☒ vegetation matted down, bent, or absent
☒ leaf litter disturbed or washed away
☒ sediment deposition
☐ water staining
☐ other (list):
☒ the presence of litter and debris
☒ destruction of terrestrial vegetation
☒ the presence of wrack line
☒ sediment sorting
☒ scour
☒ multiple observed or predicted flow events
☐ abrupt change in plant community
☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
☐ High Tide Line indicated by:
☐ oil or scum line along shore objects
☐ fine shell or debris deposits (foreshore)
☐ physical markings/characteristics
☐ tidal gauges
☐ other (list):
☐ Mean High Water Mark indicated by:
☐ survey to available datum;
☐ physical markings;
☐ vegetation lines/changes in vegetation types.

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: The water is stained tan from high sediment loads from the upstream reach and eroding banks.
Identify specific pollutants, if known: Unkown.

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[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) **Biological Characteristics. Channel supports (check all that apply):**

☒ Riparian corridor. Characteristics (type, average width): 0-300 ft.
☐ Wetland fringe. Characteristics: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☒ Fish/spawn areas. Explain findings: See aquatic/wildlife diversity discussion below.
☐ Other environmentally-sensitive species. Explain findings: .
☒ Aquatic/wildlife diversity. Explain findings: The Bois d'Arc Creek watershed, including its channels, tributaries, wetlands, open water areas, grasslands, upland and bottomland forests, support a variety of wildlife species by providing water, cover, food, and den or nesting sites. A study reported by Texas Parks and Wildlife Department indicated that a survey conducted in 1982, which found over 20 species of fish living in Bois d'Arc Creek.

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) **Physical Characteristics:**

(a) General Wetland Characteristics:
Properties:
Wetland size: 1,927 acres
Wetland type. Explain: There are 452 acres of forested wetlands, 1,377 acres of herbaceous/emergent wetlands, and 98 acres of shrub wetlands within the review area for a total of 1,927 acres of wetlands..
Wetland quality. Explain: .
Project wetlands cross or serve as state boundaries. Explain: N/A.

(b) General Flow Relationship with Non-TNW:
Flow is: **Intermittent flow**. Explain: .

Surface flow is**: Overland sheetflow**
Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:
☒ Directly abutting
☒ Not directly abutting
☒ Discrete wetland hydrologic connection. Explain: Within the 1,377 acres of herbaceous/emergent wetlands, approximately 425 acres consist of wetlands as part of small linear wetland/ non-wetland mosaics within the western and southern review areas that contribute flow to the larger abutting wetland complexes.
☐ Ecological connection. Explain: .
☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW
Project wetlands are **30 (or more)** river miles from TNW.
Project waters are **30 (or more)** aerial (straight) miles from TNW.
Flow is from: **Wetland to navigable waters.**
Estimate approximate location of wetland as within the **50 - 100-year** floodplain.

(ii) **Chemical Characteristics:**
Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .
Identify specific pollutants, if known: .

(iii) **Biological Characteristics. Wetland supports (check all that apply):**
☒ Riparian buffer. Characteristics (type, average width): Varies based on wetland type and tributary area.
☐ Vegetation type/percent cover. Explain: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☐ Fish/spawn areas. Explain findings: .
☐ Other environmentally-sensitive species. Explain findings: .
☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)
All wetland(s) being considered in the cumulative analysis: **1**
Approximately 1927 acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)
Y	1927		

Summarize overall biological, chemical and physical functions being performed: Functions evaluated include groundwater recharge, groundwater discharge, flood flow alteration, sediment stabilization, sediment/toxin retention, nutrient transformation/remediation, production export, wildlife diversity and abundance, aquatic diversity and abundance. .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D:

There are a total of approximately 108,982 linear feet of non-RPW tributaries within the 14,958-acre project review area. These non-RPW's contribute flow to the named RPW tributaries Bois d' Arc Creek, Black Branch, the Red River, and are evident on historic satellite imagery in addition to being indicated on the USGS National Hydrography Dataset and the USGS 7.5 Minute Quadrangle Maps as dashed blue line intermittent streams.

These headwater streams strongly influence the water quality of downstream creeks, rivers, lakes, and estuaries. These streams efficiently remove and transform nutrients, such as inorganic nitrogen derived from agriculture, human and animal waste, and fossil fuel combustion, before they reach downstream waters where they may cause disruption to forest ecoystems, acidify lakes and streams, and degrade coastal waters through eutrophication, algal blooms, and hypoxia. Scientific research suggests that the smallest streams provide the most rapid uptake and transformation of inorganic nitrogen. In particular, ephemeral and intermittent streams maintain water quality despite their lack of continuous flow because fertililzers and other pollutants are most likely to enter stream systems during storms and other times of high runoff, the same times when ephemeral and intermittent streams are likely to have a continuous water flow and are processing nutrients. These headwater streams also play an important role in regulating water flow and reducing erosion and sedimentation. Streams absorb runoff and snowmelt, providing water storage that reduces downstream flooding. Natural streambeds, which provide rough and uneven passages for water, reduce the velocity of water moving over the landscape, not only allowing for increased infiltration, but also reduce the ability of moving water to erode streambanks and carry sediment downstream. Small streams also maintain biodiversity in downstream waters by providing both movement corridors for plants and animals across the landscape and a source of colonists for recovery of downstream systems following a disturbance.

The unnamed tributaries described above and depcited on USGS 7.5 Minute Topographic Quadrangle Maps and the USGS National Hydrography Dataset have been determined to have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the TNW, the Red River, and therefore are waters of the U.S.

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   ☐ TNWs: linear feet width (ft), Or, acres.
   ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: Review of USGS Topographic Quadrangle Maps, USGS National Hydrography Dataset, historical satellite imagery, and observations during site visits revealed that ~ 26,352 linear feet within portions of Black Branch and an unnamed tributary of the Red River displayed perennial characteristics.

   ☒ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: Review of USGS Topographic Quadrangle Maps, USGS National Hydrography Dataset, historical satellite imagery, along with observations during site visits, showed flows on ~ 45,337 linear feet of unnamed tributaries within the review area are sustained during certain times of the year after precipitation events and from the number of unnamed tributaries contributing flow from within the watershed.

   Provide estimates for jurisdictional waters in the review area (check all that apply):
   ☒ Tributary waters: **71,689** linear feet width (ft).
   ☐ Other non-wetland waters: acres.
   Identify type(s) of waters: .

3. **Non-RPWs[8] that flow directly or indirectly into TNWs.**
   ☒ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide estimates for jurisdictional waters within the review area (check all that apply):
   ☒ Tributary waters: **108,982** linear feet width (ft).
   ☒ Other non-wetland waters: **19** acres.
   Identify type(s) of waters: **Open waters within wetlands and on-channel ponds.**

4. **Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.**
   ☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
   ☒ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: Observations during site visits and review of USFWS NWI maps, USGS Topographic Quadrangle Maps, NRCS SSURGO database, FEMA Maps, and the "Draft Jurisdictional Determination Report, Riverby Land and Cattle Company, LLC., dated July 2011, Prepared by Feese and Nichols, Inc.," showed wetlands abutting the unnamed tributary of the Red River.

   ☒ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: Observations during site visits and review of USFWS NWI maps, USGS Topographic Quadrangle Maps, NRCS SSURGO database, FEMA Maps, and the "Draft Jurisdictional Determination Report, Riverby Land and Cattle Company, LLC., dated July 2011, Prepared by Feese and Nichols, Inc.," showed wetlands abutting the unnamed tributaries of the Red River and unnamed tributaries of Bois d' Arc Creek.

   Provide acreage estimates for jurisdictional wetlands in the review area: ~**261** acres.

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[8]See Footnote # 3.

5. **Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.**
   ☒ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide acreage estimates for jurisdictional wetlands in the review area: ~ **10** acres.

6. **Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.**
   ☒ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide estimates for jurisdictional wetlands in the review area: ~ **1,656** acres.

7. **Impoundments of jurisdictional waters.**[9]
   As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
   ☒ Demonstrate that impoundment was created from "waters of the U.S.," or
   ☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
   ☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .
Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
   Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):

☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
   ☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☒ Other: (explain, if not covered above): **There are 16 acres of upland stock tanks (ponds) and approximately 13,000 linear feet of man-made ditches that are non-jurisdictional by regulation.**

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.

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[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):

☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: **Draft Jurisdictional Determination Report, Riverby Land and Cattle Company, LLC., dated July 2011, Prepared by Freese and Nichols, Inc.**
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☒ Office concurs with data sheets/delineation report.
☒ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☒ USGS NHD data.
☒ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name: **USGS 7.5 Minute Topgraphic Quadrangle Maps - Monkstown and Direct, Texas.**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **NRCS Soil Survey of Fannin County, Texas, issued 2001. NRCS SSURGO database.**
☒ National wetlands inventory map(s). Cite name: **USFWS NWI.**
☐ State/Local wetland inventory map(s): .
☒ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): **Google Earth Historical Imagery and NAIP Texas 2014.**
or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD:

The review area is the approximately 14,958-acre project site (Riverby Land and Cattle Company Ranch). There are 452 acres of Forested wetlands, 1,377 acres of herbaceous/emergent wetlands, and 98 acres of shrub wetlands within the review area for a total of 1,927 acres of wetlands. Within the 1,377 acres of herbaceous/emergent wetlands, approximately 425 acres consist of wetlands as part of small linear wetland/ non-wetland mosaics within the western and southern review areas that flow to the larger abutting wetland complexes. Due to the linear nature and small size of each individual wetland, these wetlands were difficult to depict spatially. According to the applicant's consultant, "data forms were completed for the 'ridges' or 'hummocks' and for the 'troughs' or 'swales.' Data collected using this methodology were then used to calculate the percentage of wetlands in the wetland/non-wetland mosaic using the following formula:"

$$\% \text{ wetland} = \frac{\text{Total distance of wetland along transect}}{\text{Total length of transect}} \times 100$$

The Corps concurs with the delineation of the linear wetland mosaics within the review area. The streams, open waters, and wetlands within the WRP area are not calculated in the waters of the United States totals. There were man made upland ditches within the floodplain that connected to improved jurisdictional tributaries and upland stock tanks (ponds) within the review area that are not regulated by definition.

The USACE Jurisdictional Determination Guidebook, 33 CFR 328.3, 33 CFR 328.5, and Regulatory Guidance Letter No. 05-05, were referenced to support the conclusion that the relatively permanent waters, non-relatively permanent waters, wetlands directly abutting relatively permanent waters, wetlands adjacent to relatively permanent waters and non-relatively permanent waters, and impoundments within the review area, have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the Traditional Navigable Waterway (TNW) known as the Red River and are waters of the United States.

The "NRCS Soil Survey of Fannin County, Texas, issued 2001," was referenced for annual precipitation estimates for the proposed project area.

APPENDIX H: APPROVED JURISDICTIONAL DETERMINATIONS FOR PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE, RIVERBY RANCH, AND NORTH WATER TREATMENT PLANT SITE NEAR LEONARD

H-1: APPROVED JURISDICTIONAL DETERMINATION FOR LOWER BOIS D'ARC CREEK RESERVOIR

H-2: APPROVED JURISDICTIONAL DETERMINATION FOR RIVERBY RANCH MITIGATION SITE

H-3: APPROVED JURISDICTIONAL DETERMINATION FOR NORTH WTP AT LEONARD

H-4: APPROVED JURISDICTIONAL DETERMINATION FOR FM 1396 RELOCATION - FM 897 EXTENSION

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): August 27, 2015

B. DISTRICT OFFICE, FILE NAME, AND NUMBER: SWT-0-14659

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State: Texas County/parish/borough: Fannin City: Leonard
Center coordinates of site (lat/long in degree decimal format): Lat. 33.387604° N, Long. 96.271256° W.
Universal Transverse Mercator:
Name of nearest waterbody: Lee Creek & Bear Creek

Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Trinity River
Name of watershed or Hydrologic Unit Code (HUC): HUC12 - 120301060101 & 120301060102
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☒ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc...) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: 27 August 2015
☒ Field Determination. Date(s): 29 February 2016

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** "*navigable waters of the U.S.*" within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
      ☐ TNWs, including territorial seas
      ☐ Wetlands adjacent to TNWs
      ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
      ☒ Non-RPWs that flow directly or indirectly into TNWs
      ☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
      ☒ Impoundments of jurisdictional waters
      ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
      Non-wetland waters: 9736 linear feet of streams and 21.6 acres of open waters (on-channel impoundment).
      Wetlands: .42 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **Pick List**
      Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: None in project area.

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: .

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: 27,097 & 33,871 **acres**
   Drainage area: ~1,400 & ~1,850 **acres**
   Average annual rainfall: 41-44 inches
   Average annual snowfall: 3 inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☒ Tributary flows through **4** tributaries before entering TNW.

   Project waters are **30 (or more)** river miles from TNW.
   Project waters are **1 (or less)** river miles from RPW.
   Project waters are **30 (or more)** aerial (straight) miles from TNW.
   Project waters are **1 (or less)** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: N/A.

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

Identify flow route to TNW[5]: Lee Ceek, which flows through the review area, flows into Arnold Creek, which then flows into Indian Creek, which flows into Pilot Grove Creek, which then flows into Lake Lavon, which flows into the East Fork Trinity River and into Lake Ray Hubbard Lake, which then flows into the East Fork Trinity River, which flows into the TNW, the Trinity River.

The unnamed tributary of Bear Creek flows through the review area, flows into Bear Creek, which then flows into Indian Creek, which flows into Pilot Grove Creek, which then flows into Lake Lavon, which flows into the East Fork Trinity River and into Lake Ray Hubbard Lake, which then flows into the East Fork Trinity River, which flows into the TNW, the Trinity River.

Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):

Tributary is:
☒ Natural
☒ Artificial (man-made). Explain: Lee Creek Impoundment.
☐ Manipulated (man-altered). Explain:.

Tributary properties with respect to top of bank (estimate):
Average width: 25 - 43 feet
Average depth: feet
Average side slopes: **Vertical (1:1 or less).**

Primary tributary substrate composition (check all that apply):
☐ Silts ☐ Sands ☐ Concrete
☐ Cobbles ☐ Gravel ☐ Muck
☒ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: More stable where intact riparian corridor exists, eroding banks evident where there is no riparian area.
Presence of run/riffle/pool complexes. Explain: Lee Creek Impoundment within the review area.
Tributary geometry: **Meandering**
Tributary gradient (approximate average slope): 2.4 %

(c) Flow:

Tributary provides for: **Seasonal flow**
Estimate average number of flow events in review area/year: **Pick List**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Confined.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☒ Bed and banks
☒ OHWM[6] (check all indicators that apply):
☒ clear, natural line impressed on the bank
☐ changes in the character of soil
☐ shelving
☒ vegetation matted down, bent, or absent
☐ leaf litter disturbed or washed away
☐ sediment deposition
☐ water staining
☐ other (list):
☐ the presence of litter and debris
☒ destruction of terrestrial vegetation
☐ the presence of wrack line
☐ sediment sorting
☒ scour
☐ multiple observed or predicted flow events
☐ abrupt change in plant community
☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
☐ High Tide Line indicated by: ☐ Mean High Water Mark indicated by:

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[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.
[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

☐ oil or scum line along shore objects
☐ fine shell or debris deposits (foreshore)
☐ physical markings/characteristics
☐ tidal gauges
☐ other (list):
☐ survey to available datum;
☐ physical markings;
☐ vegetation lines/changes in vegetation types.

(iii) Chemical Characteristics:

Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: Water color slightly stained.
Identify specific pollutants, if known: .

(iv) Biological Characteristics. Channel supports (check all that apply):

☒ Riparian corridor. Characteristics (type, average width): Mature Forrested, 0-700ft.
☒ Wetland fringe. Characteristics: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☐ Fish/spawn areas. Explain findings: .
☐ Other environmentally-sensitive species. Explain findings: .
☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:
Properties:
Wetland size: 0.42 acres
Wetland type. Explain: Emergent.
Wetland quality. Explain: Emergent, primarily consisting of spikerush.
Project wetlands cross or serve as state boundaries. Explain: N/A.

(b) General Flow Relationship with Non-TNW:
Flow is: **Intermittent flow**. Explain: .

Surface flow is**: Pick List**
Characteristics: .

Subsurface flow: **Pick List.** Explain findings: .
☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:
☒ Directly abutting
☐ Not directly abutting
☐ Discrete wetland hydrologic connection. Explain: .
☐ Ecological connection. Explain: .
☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW
Project wetlands are **30 (or more)** river miles from TNW.
Project waters are **30 (or more)** aerial (straight) miles from TNW.
Flow is from: **Wetland to navigable waters.**
Estimate approximate location of wetland as within the **50 - 100-year** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .
Identify specific pollutants, if known: .

(iii) Biological Characteristics. Wetland supports (check all that apply):

☐ Riparian buffer. Characteristics (type, average width): .
☐ Vegetation type/percent cover. Explain: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☐ Fish/spawn areas. Explain findings: .
☐ Other environmentally-sensitive species. Explain findings: .
☐ Aquatic/wildlife diversity. Explain findings: .

3. **Characteristics of all wetlands adjacent to the tributary (if any)**
All wetland(s) being considered in the cumulative analysis: **2**
Approximately (8.42) acres in total are being considered in the cumulative analysis.
For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)
Y	0.42 (Lee Creek reach)	Y	~8.0 (u.t. of Bear Creek reach)

Summarize overall biological, chemical and physical functions being performed: The wetlands assist in trapping and filtering potential pollutants, by slowing/storing flood waters, and help maintain water quality through nutrient and contaminant uptake by the plant speciess adapted to hydric soil conditions.

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D:

There are four non-RPW tributaries within the 661-acre review area with a significant nexas to the TNW and are described as follows:

The unamed tributary of Bear Creek is indicated as a dashed blue line intermittent stream on the USGS 7.5 Minute Topographic Quadrangle Map - Trenton, Texas, and is observable on multiple years of historical satellite imagery. The unnamed tributary of Bear Creek begins to receive flow from its watershed north of Highway 69 which then flows south through a culvert underneath Highway 69 for ~5,425 feet where it meets the review area boundary. It enters the review area boundary under County Road 4945 through a large culvert and maintains an average OHWM width of 25 feet for its entire course within the limits of the review area. Its channel banks are steep and deeply incised, and the channel bottom substrate is bedrock. The tributary receives flow from precipitation events. In addition, due to size of the tributaries drainage area as well as it being highly incised, ground water influence may be present. Flow continues for ~9,100 feet downstream of the review area to a L1UBHh impoundment and the downstream limit of the relevant reach, where a first order, an unnamed tributary of Bear Creek enters the impoundment from the east. In addition, a ~8.0 acre PFO1Ah wetland area on the USFWS NWI Map is indicated to surround the tributary on each side, beginning north of the impoundment.

There are three unnamed tributaries of Lee Creek that are non-RPW tributaries within the review area. The first tributary enters the review area from the western project boundary within the HUC12 - 120301060102 and flows for approximately 680 linear feet within the review area before converging with Lee Creek from the west. The flow from this tributary begins from an on-channel pond that receives flow for ~350 linear feet until it converages with a ~950 linear feet channel that begins west of County Road 4965. From this convergance, the tributary flows for an additional ~800 linear feet within the 100 year flood plane (according to FEMA panel No. 48147C0500C) where it meets the review area boundary. This unamed tributary of Lee Creek is indicated on the USGS Topographic Quadrangle Map as a dashed blue line intermittent stream connected to an on-channel pond and is observable on multiple years of historical satellite imagery. The ~950 linear foot channel (outside the review area) is not indicated on the USGS Topograpic Map but was likely created by agricultural practices of the surrounding land area that has altered the stream hydrology. This tributary has an OHWM averaging 5ft within the review area and receives flow from precipitation events that contribute flow to the Lee Creek RPW.

The second unnamed tributary of Lee Creek enters from the east of Lee Creek within the review area. It begins to receive flow north of Highway 69 and flows approximately ~1,700 linear feet until it meets the review area boundary. Within the review area, this stream flows additional 1,935 linear feet until it converges with Lee Creek, just north of the Lee Creek Impoundment. This tributary is not exhibited on a USGS 7.5 Minute Topographic Map, but does exhibit a clear OHWM bed and bank observable on multiple years of historical satellite imagery. The tributary was delineated as having a 6 -11 foot OHWM within the review area and receives flow from precipitation events that contribute flow to the Lee Creek RPW.

The third unnamed tributary of Lee Creek enters from the east of Lee Creek within the review area. It begins to receive flow from the northeast side of a culvert under the Missouri Kansas Texas railroad. It flows within the review area for ~2,380 before converging with the Lee Creek Impoundment. This unnamed tributary of Lee Creek is indicated on the USGS Topographic Quadrangle Map as dashed blue line intermittent stream connecting to Lee Creek from the east and is observable on multiple years of historical satellite imagery. The Lee Creek Impoundment is not indicated on the USGS Topographic Map, but is indicated on the USGS NHD. The average OHWM is 4 feet and receives flow from precipitation events. The stream channel is located south of where it is depicted on the USGS Topo and USGS NHD, for approximately ~800 linear feet from where the tributary enters the review area.

These headwater streams strongly influence the water quality of downstream rivers, lakes, and estuaries. These streams efficiently remove and transform nutrients, such as inorganic nitrogen derived from agriculture, human and animal waste, and fossil fuel combustion, before they reach downstream waters where they may cause disruption to forest ecoystems, acidify lakes and streams, and degrade coastal waters through eutrophication, algal blooms, and hypoxia. Scientific research suggests that the smallest streams provide the most rapid uptake and transformation of inorganic nitrogen. In particular, ephemeral and intermittent streams maintain water quality despite their lack of continuous flow because fertililzers and other pollutants are most likely to enter stream systems during storms and other times of high runoff, the same times when ephemeral and intermittent streams are likely or have a contnuous waer flow and are processing nutrients. These headwater streams also play an important role in regulating water flow and reducing erosion and sedimentation. Streams absorb runoff and snowmelt, providing water storage that reduces downstream flooding. Natural streambeds, which provide rough and uneven passages for water, reduce the velocity of water moving over the landscape, not only allowing for increased infiltration, but also reduce the ability of moving water to erode streambanks and carry sediment downstream. Small streams also maintain biodiversity in downstream waters by providing both movement corridors for plants and animals across the landscape and a source of colonists for recovery of downstream systems following a disturbance.

The unnamed tributary of Bear Creek and the three unnamed tributaries of Lee Creek described above have been determined to have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the TNW and therefore are waters of the U.S.

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   ☐ TNWs: linear feet width (ft), Or, acres.
   ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   ☐ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: .
   ☒ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: Lee Creek is a named tributary on the USGS NHD and USGS Topographic Quadrangle Map - Trenton, Texas,

and is indicated as a dashed blue line intermittent stream. Within the review area, Lee Creek has 3 tributaries contributing flow during precipitation events. In addition, seasonal flow evidence on 4 out of 6 years of available satellite imagery ~ .25 miles above the relative reach is observable.

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **2075** linear feet width (ft).
☒ Other non-wetland waters: **21.6** acres.
Identify type(s) of waters: Lee Creek Impoundment.

3. Non-RPWs[8] that flow directly or indirectly into TNWs.
☒ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☒ Tributary waters: **7661** linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.
☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

☒ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: The 0.42 acre emergent wetland directly abuts the Lee Creek Impoundment, which is a man-made impoundment of Lee Creek. The wetland area is distinguishable from the surrounding upland area on multiple years of historical satellite imagery. The wetland met all three criteria of hydrophytic vegetation, hydric soil, and wetland hydrology on the conducted "Preliminary Jurisdictional Determination of Waters of the United States, North Texas Municipal Water District's, Proposed Water Treatment Plant site, City of Leonard, Fannin County, Texas," dated 11 June 2010.

Provide acreage estimates for jurisdictional wetlands in the review area: **0.42** acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☒ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

[8]See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):

☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☒ Other: (explain, if not covered above): There are ~ 1595 linear feet of upland erosional features that are not indicated on a USGS 7.5 Minute Topographic Quadrangle Map as a tributary. The ~ 6.88 acres of upland stock tanks (ponds) are not located on-channel of a tributary. The other ~ 0.9 acre depressional upland features were likely created by agricultural related activities.

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource:.
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):

☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: **"Preliminary Jurisdictional Determination of Waters of the United States, North Texas Municipal Water District's, Proposed Water Treatment Plant site, City of Leonard, Fannin County, Texas," dated 11 June 2010.**
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☒ Office concurs with data sheets/delineation report.
☒ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☒ USGS NHD data.
☒ USGS 8 and 12 digit HUC maps.

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[10] Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.*

☒ U.S. Geological Survey map(s). Cite scale & quad name: **USGS 7.5 Minute Topographic Quadrangle Maps; Trenton, Texas and Pike, Texas.**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **Soil Survey of Fannin County, Texas, issued 2001.**
☒ National wetlands inventory map(s). Cite name: **USFWS NWI .**
☐ State/Local wetland inventory map(s): .
☒ FEMA/FIRM maps: **Panel 48147C0500C eff. 2/18/2011.**
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): **Google Earth Historical Imagery and NAIP Texas 2014.**
or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD:.

The review area is an approximately 661-acre tract of land near the City of Leonard, Fannin County, Texas. The size of waters of the U.S. in the review area is based on multiple waters delineated within the 661-acre tract. The review area is bisected by HUC12-120301060101 and HUC12 - 120301060102. The waters of the U.S. within HUC12-120301060101 is an unnamed tributary of Bear Creek. The waters of the U.S. within HUC12 - 120301060102 are Lee Creek, three unnamed tributaries of Lee Creek, an impoundment of Lee Creek, and an abutting emergent wetland of the Lee Creek impoundment. The relevant reach for Lee Creek is ~ 1.15 miles downstream of the review area and the relevant reach for the unnamed tributary of Bear Creek is ~1.85 miles downstream of the review area.

The waters of the U.S. identified on the "Preliminary Jurisdictional Determination of Waters of the United States, North Texas Municipal Water District's, Proposed Water Treatment Plant site, City of Leonard, Fannin County, Texas," dated 11 June 2010, are indicated as the following:

Tributary streams: Lee Creek, LCT2, LCT3, LCT4, TBC

On-channel impoundments: Lee Creek Impoundment

Wetlands: EW4

The Corps will not assert jurisdiction on the features denoted as the following:

Erosional Features: LCT1, LCT4-A, TBCT1, TBCT2, and WS1

Depressional Upland Features: EW1, EW2, EW3, EW5, EW6, EW7, WW1, WW2, WW3, WW4, WW5, WW6, WW7, WW8, WW9, WW10, and WS2

Upland Stock Tanks (Ponds): EI1, EI2, EI3, EI4, EI5, EI6, WI1, WI2, LCTI1, LCWI2, and LCWI3

The USACE Jurisdictional Determination Guidebook, 33 CFR 328.3, 33 CFR 328.5, and Regulatory Guidance Letter No. 05-05, were referenced to support the conclusion that the non-relatively permanent waters, on-channel impoundment, abutting emergent wetland to an on-channel impoundment, and relatively permanent waters within the review area, have more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the Traditional Navigable Waterway (TNW) known as the Trinity River and are waters of the United States.

The "NRCS Soil Survey of Fannin County, Texas, issued 2001," was referenced for annual precipitation estimates for the proposed project area.

APPENDIX H: APPROVED JURISDICTIONAL DETERMINATIONS FOR PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE, RIVERBY RANCH, AND NORTH WATER TREATMENT PLANT SITE NEAR LEONARD

H-1: APPROVED JURISDICTIONAL DETERMINATION FOR LOWER BOIS D'ARC CREEK RESERVOIR

H-2: APPROVED JURISDICTIONAL DETERMINATION FOR RIVERBY RANCH MITIGATION SITE

H-3: APPROVED JURISDICTIONAL DETERMINATION FOR NORTH WTP AT LEONARD

H-4: APPROVED JURISDICTIONAL DETERMINATION FOR FM 1396 RELOCATION - FM 897 EXTENSION

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): 7/28/16

B. DISTRICT OFFICE, FILE NAME, AND NUMBER: SWT-0-14659

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State: Texas County/parish/borough: Fannin City: Near Bonham
Center coordinates of site (lat/long in degree decimal format): Lat. 33.647781° N, Long. -96.052371° W.
Universal Transverse Mercator:
Name of nearest waterbody: Burns Branch

Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Red River
Name of watershed or Hydrologic Unit Code (HUC): 11140101
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☒ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: July 22, 2016
☒ Field Determination. Date(s): 5 July 2016

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** *"waters of the U.S."* within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
   ☐ TNWs, including territorial seas
   ☐ Wetlands adjacent to TNWs
   ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
   ☐ Non-RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
   ☐ Impoundments of jurisdictional waters
   ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
   Non-wetland waters: 169 linear feet: 8 width (ft) and/or acres.
   Wetlands: 0 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **Established by OHWM.**
   Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☒ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: See Section III.F.

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[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: .

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: 50 **square miles**
   Drainage area: 5.3 **square miles**
   Average annual rainfall: 41-44 inches
   Average annual snowfall: 3 inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☒ Tributary flows through **2** tributaries before entering TNW.

   Project waters are **30 (or more)** river miles from TNW.
   Project waters are **1 (or less)** river miles from RPW.
   Project waters are **30 (or more)** aerial (straight) miles from TNW.
   Project waters are **1 (or less)** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: N/A.

   Identify flow route to TNW[5]: Burns Branch flows through the review area, to flow into Bois d'Arc Creek, which then flows into the Red River (TNW).

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[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☒ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: **8 feet**
Average depth: **Not measured**
Average side slopes: **3:1**.

Primary tributary substrate composition (check all that apply):

☒ Silts ☒ Sands ☐ Concrete
☐ Cobbles ☐ Gravel ☐ Muck
☐ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: Mostly stable within riparian areas.
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: **Meandering**
Tributary gradient (approximate average slope): 2.6 %

(c) Flow:

Tributary provides for: **Seasonal flow**
Estimate average number of flow events in review area/year:
Describe flow regime: Burns Branch receives flows from an average of 41-44 inches of precipitation annually within its ~ 5.3 mile drainage area which includes the contributing unnamed tributaries of Burns Branch.
Other information on duration and volume: .

Surface flow is: **Confined.** Characteristics: .

Subsurface flow: **N/A** Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☒ Bed and banks
☒ OHWM[6] (check all indicators that apply):

☒ clear, natural line impressed on the bank
☐ changes in the character of soil
☐ shelving
☒ vegetation matted down, bent, or absent
☒ leaf litter disturbed or washed away
☐ sediment deposition
☐ water staining
☐ other (list):
☒ the presence of litter and debris
☒ destruction of terrestrial vegetation
☐ the presence of wrack line
☒ sediment sorting
☒ scour
☒ multiple observed or predicted flow events
☐ abrupt change in plant community

☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):

☐ High Tide Line indicated by:
☐ oil or scum line along shore objects
☐ fine shell or debris deposits (foreshore)
☐ physical markings/characteristics
☐ tidal gauges
☐ other (list):

☐ Mean High Water Mark indicated by:
☐ survey to available datum;
☐ physical markings;
☐ vegetation lines/changes in vegetation types.

(iii) **Chemical Characteristics:**

Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: Water color is slightly stained tan.
Identify specific pollutants, if known: None known.

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[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) **Biological Characteristics. Channel supports (check all that apply):**
- ☒ Riparian corridor. Characteristics (type, average width): Varies within reach.
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) **Physical Characteristics:**

(a) General Wetland Characteristics:

Properties:

Wetland size: acres

Wetland type. Explain: .

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Pick List**. Explain: .

Surface flow is: **Pick List**

Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .

- ☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:
- ☐ Directly abutting
- ☐ Not directly abutting
  - ☐ Discrete wetland hydrologic connection. Explain: .
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **Pick List** river miles from TNW.

Project waters are **Pick List** aerial (straight) miles from TNW.

Flow is from: **Pick List.**

Estimate approximate location of wetland as within the **Pick List** floodplain.

(ii) **Chemical Characteristics:**

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .

Identify specific pollutants, if known: .

(iii) **Biological Characteristics. Wetland supports (check all that apply):**
- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **Pick List**

Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   ☐ TNWs: linear feet width (ft), Or, acres.
   ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   ☐ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: .
   ☒ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: Review of the USGS Topographic Quadrangle Maps and the USGS National Hydrography Dataset indicates Burns Branch as intermittent blue line tributary of Bois d'Arc Creek. Review of historical satellite imagery, along with observation during site visits, showed flows on Burns Branch are sustained during certain times of the year after precipitation events and from unnamed tributaries of Burns Branch contributing flow from within the tributary's drainage area.

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **169** linear feet, **8** width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. Non-RPWs[8] that flow directly or indirectly into TNWs.
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]
☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

[8]See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
- ☐ Tributary waters: linear feet width (ft).
- ☐ Other non-wetland waters: acres.
  Identify type(s) of waters: .
- ☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):

- ☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
- ☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
  - ☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
- ☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain:

- ☒ Other: (explain, if not covered above): The delineation by Berg-Oliver Associates, Inc., identified 35 features within the review area. There were 13 features identified as potential tributary waters of the United States. Of these 13 features, 12 are not indicated as a tributary on the USGS 7.5 Minute Topographic Quadrangle Maps or the USGS National Hydrography Dataset (NHD). These 12 erosional features are characterized by low volume, infrequent, and short duration flow without a significant nexus to downstream traditional navigable waters. There were 10 depressional features with wetland characteristics identified within the review area that are not indicated on the U.S. Fish and Wildlife Service - National Wetland Inventory, and are not situated adjacent to or abutting a tributary on the USGS 7.5 Minute Topographic Quadrangle Maps or the NHD. These depressional features are geographically located entirely in uplands and were likely created by agricultural land use practices or poor drainage along the existing FM 2945 roadside ditches. There were 12 features identified as 6 impoundments and 6 ponds within the review area that are not indicated on the USGS 7.5 Minute Topographic Quadrangle Maps or the NHD as on-channel or as an impoundment of a tributary. These features are considered upland pond/stock tanks which are not jurisdictional. The site visit by Regulatory personnel confirmed all the features, with the exception of Burns Branch (RPW), identified on the Berg-Oliver Associates, Inc., Impact Maps are not within Section 404 of the CWA jurisdiction, as defined in 33 CFR part 328, within the review area.

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource:.
- ☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource: .
- ☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
- ☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: **Berg-Oliver Associates, Inc., Impact Maps**
- ☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - ☐ Office concurs with data sheets/delineation report.
  - ☐ Office does not concur with data sheets/delineation report.
- ☐ Data sheets prepared by the Corps: .
- ☐ Corps navigable waters' study: .
- ☒ U.S. Geological Survey Hydrologic Atlas: .
  - ☒ USGS NHD data.
  - ☒ USGS 8 and 12 digit HUC maps.
- ☒ U.S. Geological Survey map(s). Cite scale & quad name: **7.5 Minute Quadrangle Maps; Dodd City, Texas and Lamasco, Texas.**
- ☐ USDA Natural Resources Conservation Service Soil Survey. Citation: .
- ☒ National wetlands inventory map(s). Cite name: **USFWS NWI mapper.**

☐ State/Local wetland inventory map(s): .
☒ FEMA/FIRM maps: **Panels 48147C0400C & 48147C0250C**.
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): **Google Earth Imagery, NAIP Texas 2014 1m**.
or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: The review area consists of the proposed FM 897 roadway and associated right-of-way beginning at State Highway 82, then north for approximately 6.4 miles to FM1396, as depicted on the Berg-Oliver Associates, Inc., Impacts Map Overview. The review area excludes the proposed Bois d' Arc Reservoir project area at the pool elevation of 534 msl.

The following are the delineation identifiers that are not waters of the United States within the review area:

Depressional Features
Wet 1, Wet 2, Wet 3, Wet 4, Wet 5, Wet 6, Wet 7, Wet 8, Wet 9, Wet 10

Upland Ponds/Stock Tanks
Imp 1, Imp 2, Imp 3, Imp 4, Imp 5, Imp 6, Pond 1, Pond 2, Pond 3, Pond 4, Pond 5, Pond 6

Erosional Features
Water 1, Water 2, Water 3, Water 4, Water 5, Water 6, Water 7, Water 8, Water 9, Water 10, Water 11, Water 12

The following delineation identifier is a water of the United States within the review area:

Relatively Permanent Water
Water 13 - Burns Branch

The "NRCS Soil Survey of Fannin County, Texas, issued 2001," was referenced for annual precipitation estimates for the review area.

PRELIMINARY JURISDICTIONAL DETERMINATION OF WATERS OF THE UNITED STATES

PROPOSED BOIS D'ARC RESERVOIR'S

RAW WATER TRANSMISSION PIPELINE

SPONSOR:

NORTH TEXAS MUNICIPAL WATER DISTRICT

PREPARED BY

ALAN PLUMMER ASSOCIATES, INC.

ALAN PLUMMER
ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS • DESIGNERS • SCIENTISTS

MARCH 26, 2008

TABLE OF CONTENTS

<u>Page</u>

LIST OF TABLES

Preliminary Jurisdictional Determination of Waters of the United States
Proposed Bois d'Arc Reservoir – Raw Water Transmission Pipeline
Fannin, Hunt, and Collin Counties, Texas

1) Purpose

The North Texas Municipal Water District (NTMWD) is proposing and sponsoring the Bois d'Arc Reservoir, which would be located in Fannin County, Texas. This roughly 16,600-acre proposed reservoir's primary purpose would be for water supply for customers in the NTMWD's service area within Collin, Dallas, Rockwall, Hunt, Kaufman, Ellis, Rains, and Fannin Counties. As such, a raw water transmission pipeline would be necessary to convey water from Fannin County to Collin County. The outfall location for the proposed pipeline would be located along Pilot Grove Creek, a major tributary to Lavon Lake. The purpose of this Preliminary Jurisdictional Determination (PJD) is to document the extent of waters of the United States (U.S.) within the proposed raw water transmission pipeline's project area. The information from this PJD report will be utilized during the planning stages of the project in order to evaluate layout and designs that will avoid and minimize impacts (to the maximum extent practicable) to any identified waters of the U.S. within the limits of the proposed project area. This report will address the area affected by the proposed raw water transmission pipeline and its associated temporary and permanent easements. This report represents the current preferred pipeline route alternative. Adjustments to the proposed route may occur to accommodate property owners, provide further minimization of environmental impacts, and to avoid identified construction restraints. If the pipeline route deviations warrant further investigation, supplemental information will be provided as addendums to this report.

The proposed project involves approximately 44 miles of pipeline. The total areas of the temporary and permanent easements associated with the proposed pipeline are approximately 210 acres and 420 acres, respectively. The reservoir would provide additional water supply to the NTMWD and subsequently its customer cities. The NTMWD service area is one of the most rapidly growing areas of North Texas and Texas in general. Bois d'Arc Lake is a component of NTMWD's long range water supply plan.

2) Methods

a) Contact Information

Freese and Nichols, Incorporated (FNI), as agent for the NTMWD, has contracted with Alan Plummer Associates, Incorporated (APAI) to provide environmental documentation services including this PJD report for the proposed raw water transmission pipeline project area. Questions concerning the content of this PJD report should be directed toward either FNI or APAI. Information regarding contacts for FNI and APAI are as follows:

Entity	Contact	Address	Telephone	Fax
Freese and Nichols, Inc.	Mr. Steven Watters	4055 International Plaza, Suite 200 Fort Worth, Texas 76109	(817) 735-7300	(817) 735-7492
Alan Plummer Associates, Inc.	Mr. Jason Voight	1320 S. University Drive, Suite 300 Fort Worth, Texas 76107-5764	(817) 806-1700	(817) 870-2536

b) Delineation Methods

APAI conducted on-site investigations for potential waters of the U.S. in February and March 2008. The delineation of waters of the U.S. was conducted in accordance with the current regulatory procedures outlined in the U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual (the Manual), Technical Report Y-87-1 (on-line edition). Preliminary data (including but not limited to USGS topographic maps, aerial photographs, and soil survey maps) suggested the potential for waters of the U.S.; therefore, the procedures for a routine on-site determination (as outlined in the Manual) were followed to determine the extent of waters of the U.S. within the limits of the project.

c) Mapping Techniques

Prior to the on-site investigation, a review of the available resources was conducted to identify potential wetlands or waters of the U.S. within the limits of the project area. The resources reviewed included aerial photographs, the USGS topographic maps, the Soil Surveys of Collin, Hunt, and Fannin Counties, and the National Wetlands Inventory maps associated with the USGS topographic maps.

Once located during the onsite investigation, the limits of the identified, accessible jurisdictional areas were determined using the guidelines outlined in the Manual, then mapped using a hand-held global positioning system (GPS) receiver (Garmin GPSMAP 76CSx with 3-meter accuracy; field tested to 5-foot accuracy). Waypoints recorded during the investigation were cross-referenced with the topographic maps and aerial photographs to determine the limits of waters of the U.S. In inaccessible areas, actual field delineation of the identified waters of the U.S. has not been performed for the proposed pipeline crossings. Instead, streams, rivers, impoundments (both on- and off-channel), and potential wetlands were investigated both up and downstream of the proposed crossing at road or other public access points. A formal, in depth delineation will be performed at a later date as the permit process progresses. The estimates provided within this PJD report should be conservative, erring on over summation and spatial quantification.

3) Results

a) <u>Project Location</u>

The proposed reservoir footprint is located northeast of the City of Bonham in Fannin County, Texas and north of U.S. Highway 82. The proposed dam for the reservoir would be centered on Bois d'Arc Creek at river mile XX. The pump station facility is proposed to be located along the south shores of the reservoir approximately one mile south of the confluence of Yoakum and Bois d'Arc Creeks. From this location, the proposed 44-mile pipeline would traverse the north Texas Counties of Fannin, Hunt, and Collin sequentially trending in a southwesterly direction. The proposed pipeline would near the towns of Dodd City, Bailey, Leonard, and Blue Ridge. The outfall for the proposed pipeline would be located along Pilot Grove Creek immediately south of the town of Blue Ridge, north of Lavon Lake, and west of State Highway 73. Figure A-1 in Appendix A shows the general location of the proposed project site.

b) Description of the Proposed Project and Project Area

Proposed Project: The proposed pipeline alignment traverses approximately 44-miles of north Texas in a southwesterly direction from the proposed Bois d'Arc reservoir to an outfall structure located along Pilot Grove Creek. The proposed pipeline varies in diameter. A 90-inch diameter pipeline is proposed from the planned pump station to a future planned NTMWD water treatment plant and a 66-inch diameter pipeline from the future proposed NTMWD water treatment plant to the outfall structure located along Pilot Grove Creek. The proposed permanent easement for the pipeline would be 100 feet for the 90-inch diameter segment and 40 feet for the 66-inch diameter segment. A temporary construction easement would increase the total width of easements along the alignment to 120 feet. The outfall structure associated with the pipeline would consist of a velocity dissipation wall, followed with flow retarding structures to further dissipate the water's velocity. Beyond the flow retarding structures, water would continue to cascade over rock rip-rap providing both energy dissipation and aeration prior to its confluence with Pilot Grove Creek.

Project Area: The entire proposed pipeline route would be located in lands characterized as rural with agriculture as the predominant land use. The agricultural land uses consist of crop production and pastureland for livestock. Areas that remain treed are located along fence lines and streams. No independent stands of trees (trees occurring outside of riparian corridors or fence lines) were identified along the proposed pipeline route. The pipeline route, to the extent practicable, parallels county and farm to market roads and existing power line easements to provide minimal environmental and infrastructural disturbances. For descriptive purposes, the pipeline route will be divided into two sections based on the two proposed pipeline diameters.

90-Inch Diameter Segment

The 90-inch diameter segment of the proposed pipeline route is approximately 29 miles in length commencing at the proposed pump station and terminating at its junction with the proposed 66-inch diameter segment. The terminus of the 90-inch diameter segment is in close proximity to State Highway 272 immediately east of U.S. Highway 69 near the town of Leonard. The initial leg of the 90-inch diameter portion of the pipeline route is located in the Bois d'Arc Creek drainage basin, which is a component of the Red River drainage basin. Various named and unnamed streams and tributaries to Bois d'Arc Creek are crossed with this segment of the proposed pipeline. Immediately south of the former U.S. Highway 82, the pipeline follows the ridge dividing the Bois d'Arc Creek drainage basin from the Sulphur River drainage basin. From the former U.S. Highway 82 to the terminus of the proposed 90-inch diameter segment of the pipeline, agricultural croplands dominate the landscape.

66-Inch Diameter Segment

The 66-inch diameter segment of the proposed pipeline is approximately 15 miles in length commencing at its junction with the 90-inch diameter pipeline near the town of Leonard and terminating at Pilot Grove Creek immediately south of the town of Blue Ridge. As this portion of the pipeline crosses U.S. Highway 69, it enters the East Fork of the Trinity River drainage basin. This portion of the proposed pipeline follows existing power line easements for the majority of its course and parallels U.S. Highway 73 for a limited distance. This portion of the proposed pipeline crosses various named and unnamed streams which eventually discharge into Lavon Lake. The primary land uses for this segment of the pipeline are agricultural in nature.

Figures A-2 through A-25 in Appendix A show the proposed project area and the limits of the PJD superimposed on the USGS topographic maps associated with the project area. Figures A-26 through A-49 show the limits of the PJD superimposed onto 2004 and 2007 aerial photographs. Photographs taken during the site investigations are located in Appendix B.

c) Hydrology

The proposed raw water transmission pipeline would be located within three drainage basins: the Red River Basin, the Sulphur River Basin, and the Trinity River Basin. The hydrologic units associated with the drainage basins encountered by the proposed pipeline are as follows:

Red River Drainage Basin (Bois d'Arc Island) – 11140101

Sulphur River Drainage Basin (Sulphur Headwater) – 11140301

Trinity River Drainage Basin (East Fork Trinity) – 12030106

The predominant hydrology within these basins is from surface runoff following rain events. Areas do exist within or adjacent to floodplains that appear to retain water. Specific hydrologic indicators were not recorded for the identified aquatic resources during this initial reconnaissance. If necessary, the specific hydrologic indicators will be recorded during the more intensive investigation as the permit process progresses. Lastly, a multitude of on- and off-channel impoundments of various acreages are located within the aforementioned drainage basins. These impoundments capture surface runoff and influence downstream flows.

d) Vegetation

Table 1 lists notable species observed during the reconnaissance. The Region 6 indicator status is noted for each observed species on Table 1. Table 2 explains the U.S. Environmental Protection Agency's Region 6 Wetland Indicator Status categories. Most tree species were identified along streams or creeks and fence lines. Canopy tree species were also identified as sapling shrub species although not relisted in the table. Most land within the limits of the proposed pipeline is either in cultivation for crops or consists of improved pasture grasses for livestock.

TABLE 1: VEGETATION LIST

Common Name	Scientific Name	Region 6 Indicator Status
	Canopy Species	
Boxelder	*Acer negundo*	FACW-
Black Willow	*Salix nigra*	FACW+
American Elm	*Ulmus americana*	FAC
Hackberry	*Celtis laevigata*	FAC
Bois d' Arc	*Maclura pomifera*	UPL
Post Oak	*Quercus stellata*	NA*
Cottonwood	*Populus deltoides*	FAC
	Sapling/Shrub/Vine Species	
Rough-Leaf Dogwood	*Cornus drummondii*	FAC
Greenbriar	*Smilax rotundifolia*	FAC
Southern Dewberry	*Rubus trivialis*	FAC
Grapevine	*Vitis spp.*	FAC-

TABLE 1: VEGETATION LIST (Cont.)

Herbaceous Species		
Bermudagrass	*Cynodon dactylon*	FACU+
Bushy Bluestem	*Andropogon glomeratus*	FACW+
Inland Sea Oats	*Chasmanthium latifolium*	FAC
Little Bluestem	*Schizachyrium scoparium*	FACU+
Cherokee Sedge	*Carex cherokeensis*	FACW-
Lovegrass	*Eragrostis spp.*	OBL-FACU+
Nut Sedge	*Cyperus esculentus*	FACW
Smartweed	*Polygonum spp.*	FAC-OBL
Switchgrass	*Panicum virgatum*	FACW
Camphorweed	*Pluchea camphorata*	FACW-
Threeawn	*Aristida spp.*	FAC-UPL
Virginia Wildrye	*Elymus virginicus*	FAC

TABLE 2: EXPLANATION OF PLANT INDICATOR STATUS CATEGORIES[1]

Indicator Category	Indicator Symbol	Definition
Obligate Wetland Plants	OBL	Plants that occur almost always (estimated probability >99 percent) in wetlands under natural conditions, but which may also occur rarely (estimated probability <1 percent) in nonwetlands. Examples: *Spartina alterniflora, Taxodium distichum.*
Facultative Wetland Plants	FACW	Plants that occur usually (estimated probability >67 percent to 99 percent) in wetlands, but also occur (estimated probability 1 percent to 33 percent) in nonwetlands. Examples: *Fraxinus pennsylvanica, Cornus stolonifera.*
Facultative Plants	FAC	Plants with a similar likelihood (estimated probability 33 percent to 67 percent) of occurring in both wetlands and nonwetlands. Examples: *Gleditsia triacanthos, Smilax rotundifolia.*
Facultative Upland Plants	FACU	Plants that occur sometimes (estimated probability 1 percent to <33 percent) in wetlands, but occur more often (estimated probability >67 percent to 99 percent) in nonwetlands. Examples: *Quercus rubra, Potentilla arguta.*
Obligate Upland Plants	UPL	Plants that occur rarely (estimated probability <1 percent) in wetlands, but occur almost always (estimated probability >99 percent) in nonwetlands under natural conditions. Examples: *Pinus echinata, Bromus mollis.*
No Indicator	NI	No definition for the specific vegetation is provided.
No Agreement	NA	The regional panel was not able to reach a unanimous decision on this species.

[1] Categories were originally developed and defined by the USFWS National Wetlands Inventory and subsequently modified by the National Plant List Panel. The three facultative categories are subdivided by (+) and (-) modifiers. (+) is considered to be species adapted to wetter conditions whereas (–) is considered to be species adapted to drier conditions.

e) Soils

According to the information obtained from the Soil Surveys of Fannin, Hunt, and Collin Counties (United States Department of Agriculture (USDA), Soil Conservation Service in cooperation with the Texas Agriculture Experiment Station), a total of 21 mapped soil types are traversed by the proposed pipeline route and its associated easements. The soil types are summarized in Table 3. Maps showing the locations of the soil types relative to the proposed 120-foot temporary construction and permanent easement area are included as Figures C-1 through C-24 in Appendix C. The shape files identifying the locations of the soil types were obtained from the Natural Resource Conservation Service website.

Descriptions of the mapped soil types are also included in Appendix C. Two of the mapped soil types are listed as hydric soils for the counties traversed by the proposed pipeline. These soils are Tinn clay, frequently flooded and Trinity clay, occasionally flooded.

TABLE 3: SOIL TYPE AND DESCRIPTIONS

Map Unit	Soil Type and Description	Depth to High Water Table
AuB	Austin silty clay, 1 to 3 percent slopes	>6 feet
CrB	Crockett loam, 1 to 3 percent slopes	>6 feet
EsD2	Ellis clay, 5 to 12 percent slopes, eroded	>6 feet
FaA	Fairlie clay, 0 to 1 percent slopes	>6 feet
FdB	Fairlie-Dalco complex, 1 to 3 percent slopes	>6 feet
FeD2 (10)	Ferris clay, 5 to 12 percent slopes, eroded	>6 feet
FeE3	Ferris-Houston clays, 5 to 12 percent slopes, severely eroded	>6 feet
Fr	Frioton silty clay loam, occasionally flooded	>6 feet
HcC2	Houston clay, 3 to 5 percent slopes, eroded	>6 feet
HcD2	Houston clay, 5 to 8 percent slopes, eroded	>6 feet
HfC2	Heiden-Ferris complex, 2 to 6 percent slopes, eroded	>6 feet
HoB (17)	Houston black clay, 1 to 3 percent slopes	>6 feet
HoB2	Houston black clay, 2 to 4 percent slopes, eroded	>6 feet
HwC	Howe-Whitewright complex, 3 to 5 percent slopes	>6 feet
LeB (21)	Leson clay, 1 to 3 percent slopes	>6 feet
NoB	Normangee clay loam, 1 to 3 percent slopes	>6 feet
ShB	Stephen silty clay, 1 to 3 percent slopes	>6 feet
Tc and To	Trinity clay, occasionally flooded	0-3.0 feet
Tf	Tinn clay, frequently flooded	0-3.0 feet
W	Water (no soil type)	--
WcB	Wilson clay loam, 1 to 3 percent slopes	0-1.0 feet
WwD2	Whitewright-Howe complex, 5 to 12 percent slopes, eroded	>6 feet

4) Conclusions

a) Description of Potential Waters of the U.S.

Wetlands

15 areas were identified as potential wetlands. These areas were identified by comparing the USGS topographic maps, soil types, and color infrared aerial imagery in relation to apparent waters of the U.S. From the aerial imagery, these areas appear to contain either emergent vegetation adapted to prolonged periods of inundation or areas occupied by trees adjacent to substantial streams or rivers (forested wetlands). It should be noted that the identified signatures require further field investigation including determination using

the routine wetland determination data forms. In addition to the abovementioned areas, fringe wetlands may exist along impoundments encountered by the proposed pipeline and its associated easements. These potential wetland areas are summarized in Table 4 including their classification as either emergent or forested wetlands.

TABLE 4: SUMMARY OF POTENTIAL WETLANDS WITHIN THE PROJECT AREA

Identification	Aquatic Resource	Classification	120-Foot Temporary Easement
			Area (Acres)
W 1	Along Tributary to Pettigrew Branch	Emergent	0.12
W 2	Along Pettigrew Branch	Emergent	0.35
W 3	Bullard Creek Watershed	Emergent	0.77
W 4	Along Tributary to Tributary to Sloans Creek	Emergent	0.42
W 5	Along Tributary to South Sulphur River	Emergent	0.32
W 6	Boney and Lee Creeks Floodplain	Forested	5.87
W 7	Tributary to Bear Creek	Emergent	0.14
W 8	Tributary to Bear Creek	Emergent	0.25
W 9	Along Tributary to Bear Creek	Forested	0.92
W 10	Indian Creek Floodplain	Forested	1.72
W 11	Tributary to Pot Rack Creek	Emergent	0.08
W 12	Headwaters to Tributary to Pot Rack Creek	Emergent	0.48
W 13	Tributary to Pilot Grove Creek	Emergent	0.27
W 14	Pilot Grove Creek Floodplain	Forested/Emergent	0.12
W 15	Pilot Grove Creek Floodplain	Forested/Emergent	0.11
Total			**11.94**

Streams and Rivers

The proposed pipeline will have 87 crossings of streams, rivers, or their associated tributaries. These waters vary in size and character. Notable named streams or rivers to be crossed include Pettigrew Branch, Cottonwood Creek, Spring Branch, Bullard Creek, Burnett Creek, Long Branch, Loring Creek, South Sulphur River, Arnold Creek, Boney Creek, Lee Creek, Bear Creek, Indian Creek, Pot Rack Creek, and Pilot Grove Creek. Table 5 summarizes the streams and rivers that would be potentially encountered by the proposed pipeline and its associated easements. This table identifies both length of stream or river at its ordinary high water mark and total area of the stream to be potentially encountered by the proposed pipeline alignment. These calculations are based

TABLE 5: SUMMARY OF STREAMS WITHIN THE PROJECT AREA

Identification	Aquatic Resource	USGS Classification	Proposed 120-Foot Temporary Easement		
			Width at OHWM (Feet)	Length (L.F.)	Area (Acres)
S 1	Tributary to Yoakum Creek	Ephemeral	2.5	164.20	0.0100
S 2	Tributary to Ward Creek	Ephemeral	6.0	125.82	0.0173
S 3	Tributary to Ward Creek	Ephemeral	4.0	142.47	0.0131
S 4	Tributary to Ward Creek	Ephemeral	6.0	131.19	0.0181
S 5	Tributary to Ward Creek	Ephemeral	5.0	121.10	0.0139
S 6	Tributary to Ward Creek	Intermittent	6.5	215.48	0.0322
S 7	Tributary to S 8	Ephemeral	7.0	124.80	0.0201
S 8	Tributary to Ward Creek	Intermittent	5.0	358.12	0.0411
S 9	Tributary to Bois d'Arc Creek	Intermittent	7.0	152.18	0.0245
S 10	Tributary to Bois d'Arc Creek	Intermittent	6.0	300.86	0.0414
S 11	Tributary to S 10	Ephemeral	3.0	71.65	0.0049
S 12	Tributary to S 13	Ephemeral	5.0	130.25	0.0150
S 13	Pettigrew Branch	Intermittent	5.0	201.03	0.0231
S 14	Tributary to S 17	Intermittent	3.0	123.75	0.0085
S 15	Tributary to S 17	Ephemeral	3.0	209.13	0.0144
S 16	Tributary to S 17	Ephemeral	4.0	154.06	0.0141
S 17	Cottonwood Creek	Intermittent	10.5	129.20	0.0311
S 18	Tributary to S 17	Ephemeral	6.0	123.07	0.0170
S 19	Spring Branch	Intermittent	10.5	195.10	0.0470
S 20	Tributary to S 19	Ephemeral	3.0	108.24	0.0075
S 21	Tributary to S 19	Ephemeral	3.0	963.94	0.0664
S 22	Bullard Creek	Intermittent	10.5	137.69	0.0332
S 23	Burnett Creek	Intermittent	10.5	107.51	0.0259
S 24	Tributary to S 22	Ephemeral	3.0	250.37	0.0172
S 25	Tributary to Tributary to S 22	Ephemeral	5.0	148.27	0.0170
S 26	Tributary to S 25	Ephemeral	2.5	133.26	0.0076
S 27	Tributary to Tributary to S 22	Ephemeral	2.0	71.66	0.0033
S 28	Tributary to S 22	Intermittent	7.0	152.58	0.0245
S 29	Tributary to Tributary to S 28	Ephemeral	5.0	128.72	0.0148
S 30	Tributary to S 33	Ephemeral	7.0	130.82	0.0210
S 31	Tributary to S 33	Ephemeral	10.0	167.64	0.0385
S 32	Tributary to S 33	Ephemeral	8.5	133.49	0.0260
S 33	Long Branch	Ephemeral	10.0	145.59	0.0334

TABLE 5 (CONT.): SUMMARY OF STREAMS WITHIN THE PROJECT AREA

Identification	Aquatic Resource	USGS Classification	Proposed 120-Foot Temporary Easement		
			Width at OHWM (Feet)	Length (L.F.)	Area (Acres)
S 34	Long Branch	Ephemeral	7.0	141.51	0.0227
S 35	Tributary to Sloans Creek	Intermittent	13.0	379.65	0.1133
S 36	Tributary to S 35	Ephemeral	10.0	352.55	0.0809
S 37	Tributary to S 35	Ephemeral	3.0	167.05	0.0115
S 38	Tributary to S 40	Ephemeral	4.0	141.12	0.0130
S 39	Tributary to S 38	Ephemeral	4.0	128.00	0.0118
S 40	Tributary to Allen Creek	Ephemeral	5.0	134.03	0.0154
S 41	Tributary to S 40	Ephemeral	4.5	161.01	0.0166
S 42	Tributary to Tributary to Davis Creek	Ephemeral	7.0	127.71	0.0205
S 43	Tributary to S 42	Ephemeral	4.0	122.28	0.0112
S 44	Tributary to S 46	Intermittent	6.5	122.81	0.0183
S 45	Tributary to S 46	Intermittent	4.0	135.08	0.0124
S 46	Loring Creek	Intermittent	4.0	141.92	0.0130
S 47	Tributary to S 50	Intermittent	3.0	133.38	0.0092
S 48	Tributary to S 47	Intermittent	5.0	122.82	0.0141
S 49	Tributary to S 47	Ephemeral	2.0	124.53	0.0057
S 50	Mustang Creek	Intermittent	25.0	148.83	0.0854
S 51	Tributary to S 50	Intermittent	8.0	121.42	0.0223
S 52	South Sulphur River	Intermittent	8.0	391.99	0.0720
S 53	Tributary to S 52	Ephemeral	10.0	125.24	0.0288
S 54	Tributary to S 52	Ephemeral	3.5	134.64	0.0108
S 55	Tributary to S 54	Ephemeral	3.5	126.63	0.0102
S 56	Tributary to S 52	Intermittent	11.5	329.93	0.0871
S 57	Arnold Creek	Intermittent	12.0	132.39	0.0365
S 58	Tributary to S 57	Intermittent	5.0	132.70	0.0152
S 59	Tributary to S 57	Ephemeral	2.0	303.23	0.0139
S 60	Tributary to S 67	Intermittent	10.0	138.37	0.0318
S 61	Boney Creek	Intermittent	5.0	603.72	0.0693
S 62	Boney Creek	Intermittent	3.0	153.02	0.0105
S 63	Boney Creek	Intermittent	3.5	352.75	0.0283
S 64	Lee Creek	Intermittent	15.0	161.53	0.0556
S 65	Tributary to S 67	Ephemeral	6.5	128.58	0.0192

TABLE 5 (CONT.): SUMMARY OF STREAMS WITHIN THE PROJECT AREA

Identification	Aquatic Resource	USGS Classification	Proposed 120-Foot Temporary Easement		
			Width at OHWM (Feet)	Length (L.F.)	Area (Acres)
S 66	Tributary to S 67	Ephemeral	5.0	131.49	0.0151
S 67	Tributary to S 64	Intermittent	9.5	116.43	0.0254
S 68	Tributary to S 67	Ephemeral	5.0	189.72	0.0218
S 69	Tributary to S 70	Intermittent	3.5	189.45	0.0152
S 70	Bear Creek	Intermittent	7.5	167.21	0.0288
S 71	Tributary to S 70	Intermittent	6.0	150.06	0.0207
S 72	Tributary to S 71	Intermittent	3.5	160.92	0.0129
S 73	Tributary to S 70	Intermittent	5.0	122.55	0.0141
S 74	Tributary to S 76	Intermittent	5.0	129.42	0.0149
S 75	Secondary Indian Creek Channel	Perennial	10.0	157.27	0.0361
S 76	Indian Creek	Perennial	18.0	178.56	0.0738
S 77	Tributary to S 76	Intermittent	4.0	157.69	0.0145
S 78	Tributary to S 76	Ephemeral	3.0	125.43	0.0086
S 79	Tributary to S 76	Ephemeral	2.5	125.03	0.0072
S 80	Tributary to S 76	Intermittent	6.0	124.70	0.0172
S 81	Tributary to S 82	Intermittent	3.0	211.35	0.0146
S 82	Pot Rack Creek	Intermittent	16.0	165.21	0.0607
S 83	Tributary to Desert Creek	Intermittent	5.0	114.70	0.0132
S 84	Tributary to S 87	Intermittent	7.5	341.96	0.0589
S 85	Tributary to Tributary to S 87	Ephemeral	2.0	151.79	0.0070
S 86	Remnant Channel Pilot Grove Creek Floodplain	Ephemeral	5.0	127.80	0.0147
S 87	Pilot Grove Creek	Perennial	25.0	120.00	0.0689
Total				**15,532.38**	**2.29**

on the proposed pipeline's 120 feet temporary construction easement. The ordinary high water marks were estimated by observing the stream reach both up and downstream of the proposed crossing at accessible locations. In areas where the stream reach was not accessible near the proposed crossing, aerial photography was utilized to estimate an ordinary high water mark. During construction, impacts to stream crossings may be reduced by limiting construction to the pipeline's proposed permanent easement.

Other Water Types

Other water types to be potentially encountered by the proposed pipeline and its associated easements include open water bodies typically associated with the impoundment of streams or overland flows. 16 impoundments would be potentially encountered by the proposed pipeline and its associated easements. Ponds that capture overland flow exclusively should not be considered waters of the U.S. Table 6 summarizes the acreage of impoundments potentially encountered by the proposed pipeline and its associated easements.

TABLE 6: SUMMARY OF IMPOUNDMENTS WITHIN THE PROJECT AREA

Identification	Aquatic Resource	Classification	120-Foot Temporary Easement
			Area (Acres)
P 1	Yoakum Creek Watershed	Upland	0.06
P 2	Tributary to Ward Creek	On-channel	0.08
P 3	Near Tributary to Bullard Creek	Upland	0.04
P 4	Tributary to Mustang Creek	On-channel	0.21
P 5	Near South Sulphur River	Upland	0.05
P 6	Near Tributary to South Sulphur River	Upland	0.02
P 7	Tributary to Tributary to South Sulphur River	On-channel	0.25
P 8	Tributary to Lee Creek	On-channel	0.00
P 9	Boney Creek	On-channel	0.03
P 10	Tributary to Tributary to Lee Creek	On-channel	0.01
P 11	Near Tributary to Bear Creek	Upland	0.03
P 12	Near Tributary to Indian Creek	Upland	0.21
P 13	Tributary to Pot Rack Creek	On-channel	0.02
P 14	Stock Tank	Upland	0.07
P 15	Stock Tank (Near Desert Creek)	Upland	0.13
P 16	Tributary to Pilot Grove Creek	On-channel	0.02
Total			**1.23**

b) **Summary**

The following table is a comprehensive summary of the waters of the U.S. and their adjacent wetlands identified within the limits of the PJD. Only on-channel impoundments were included in the acreage calculation for impoundments. Impoundments that collect overland flow exclusively should not be considered waters of the U.S. Figures A-51 through A-73 in Appendix A identify the aquatic resources within the limits of the PJD. All of the listed waters of the U.S. should be considered jurisdictional due to their hydrologic connection to one of the following navigable waters of the U.S.: Red River, Sulphur River, and the Trinity River.

TABLE 7: SUMMARY OF AQUATIC RESOURCES IDENTIFIED WITHIN THE PROJECT AREA

Aquatic Resource	Type	Length (L.F.)	Area (Acres)
Streams or Rivers	Perennial	455.8	0.14
	Intermittent	7,927.5	1.34
	Ephemeral	7,149.1	0.78
Wetlands	Forested	N/A	8.52
	Emergent	N/A	3.20
	Forested/Emergent	N/A	0.22
Impoundments	On-channel	N/A	0.62
Total		**15,532.4**	**14.82**

5) Supporting Information

a) **References**

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon (1999). *Shinners and Mahler's Illustrated Flora of North Central Texas.* Fort Worth, Texas: Botanical Research Institute of Texas.

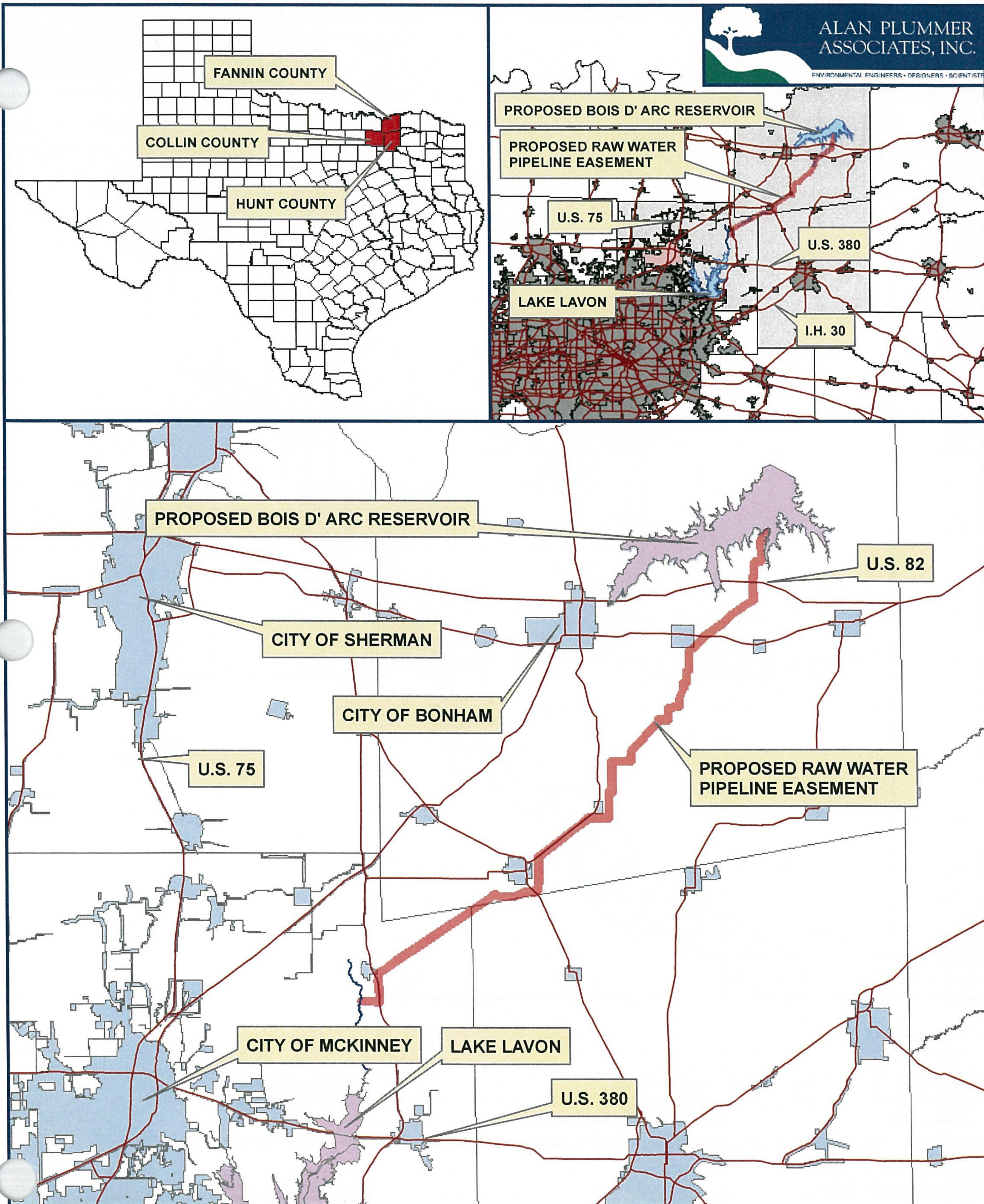
Environmental Laboratory (1987). "*Corps of Engineers Wetlands Delineation Manual*" Technical Report Y-87-1. U.S. Army Corps of Engineer Waterways Experiment Station, Vicksburg, MS.

Goerdel, A.R. (2002). *Soil Survey of Fannin County, Texas.* United States Department of Agriculture, Soil Conservation Service, In cooperation with the Texas Agriculture Experiment Station.

Hanson, Arthur and Frankie F. Wheeler (1969). *Soil Survey of Collin County, Texas.* United States Department of Agriculture, Soil Conservation Service, In cooperation with the Texas Agriculture Experiment Station.

Lane, Gaylan and Edward F. Janak, Jr. (1981). *Soil Survey of Hunt County, Texas.* United States Department of Agriculture, Soil Conservation Service, In cooperation with the Texas Agriculture Experiment Station.

APPENDIX A
FIGURES



10,000 0 10,000 Feet

FIGURE 1 OF 73

MARCH 25, 2008

A-1
PROJECT LOCATION
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

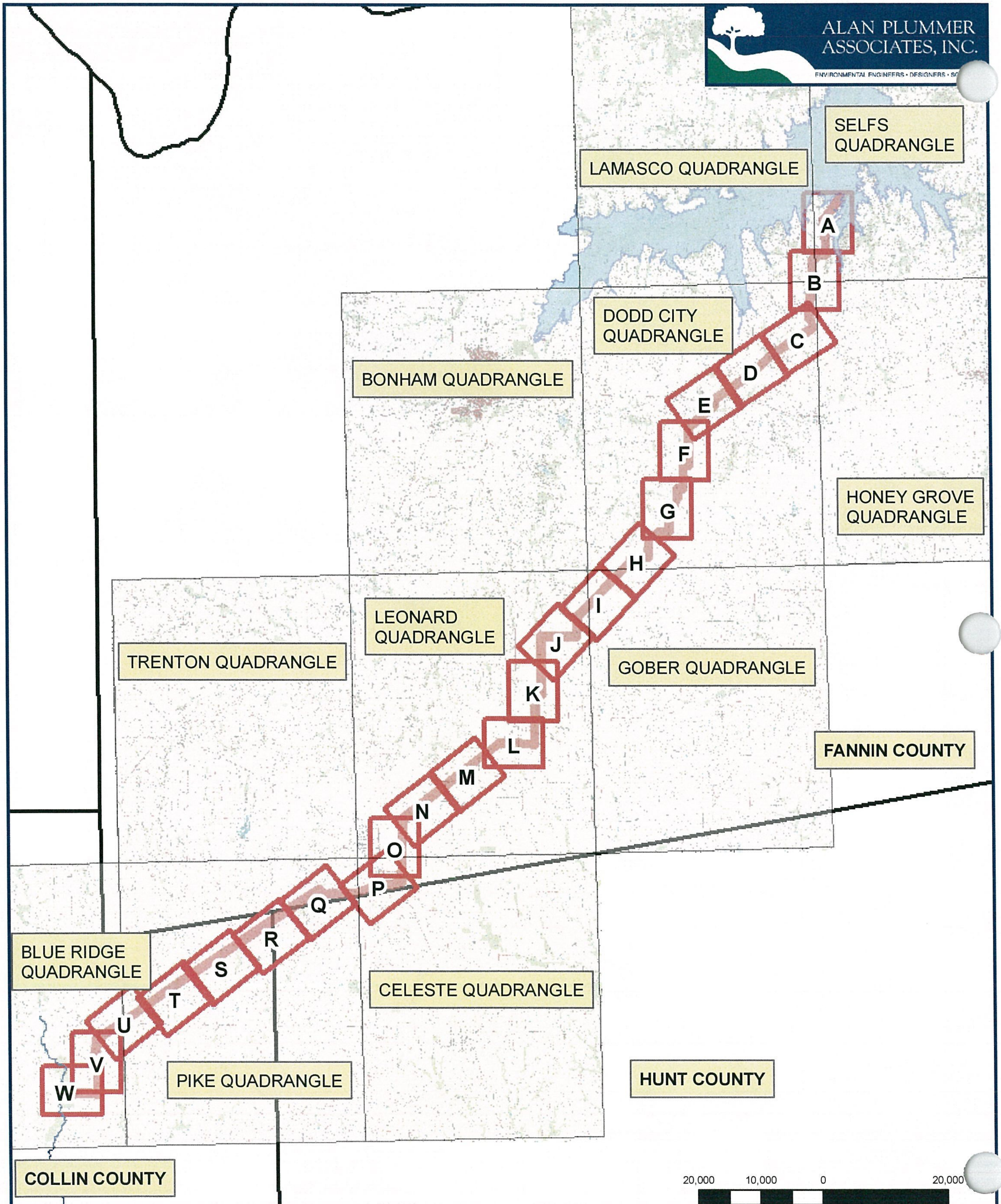
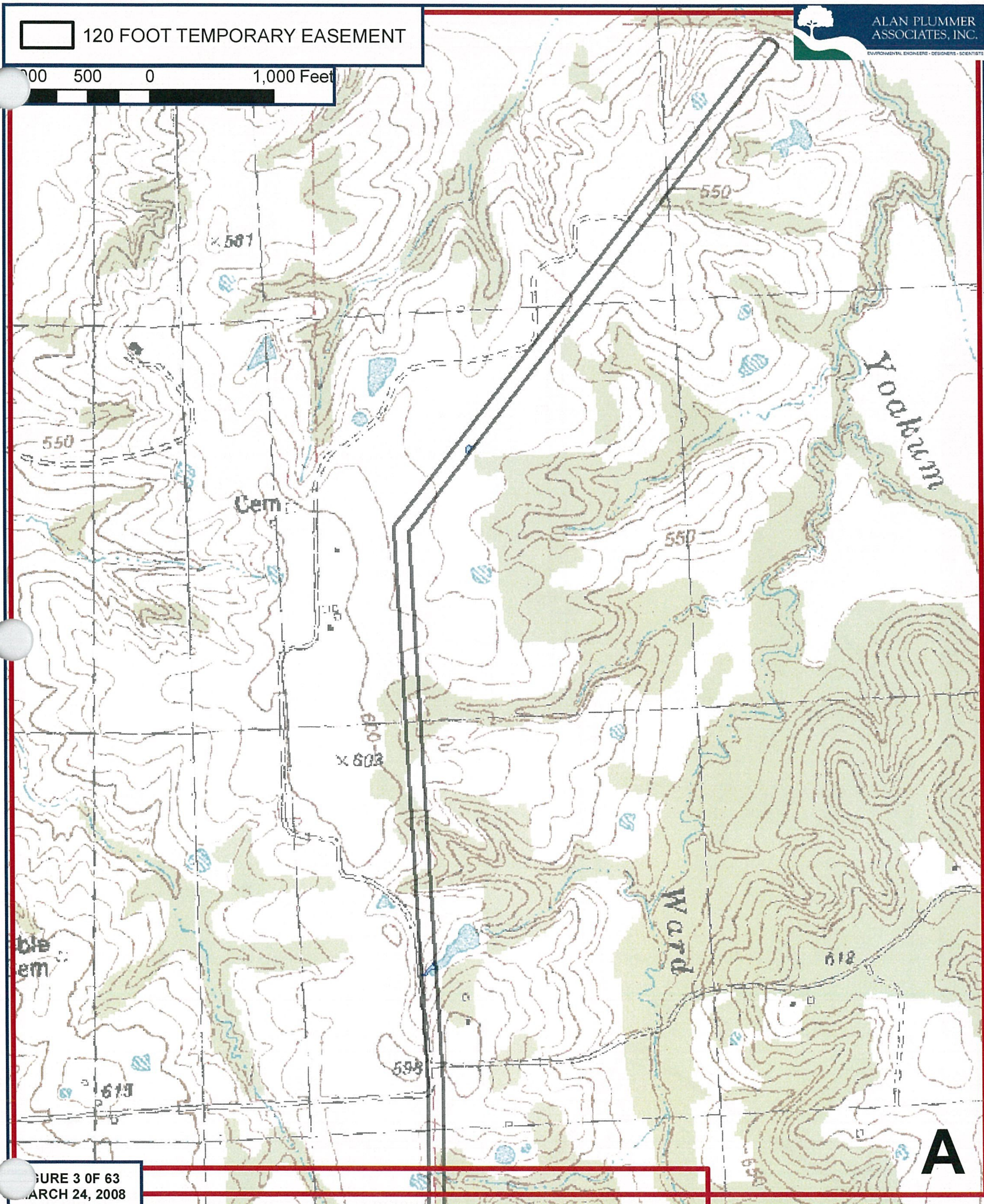


FIGURE 2 OF 73
MARCH 25, 2008

A-2
PJD LIMITS, PLATES AND USGS QUADRANGLES
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE



A-3

PJD LIMITS, USGS TOPOGRAPHIC MAP

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

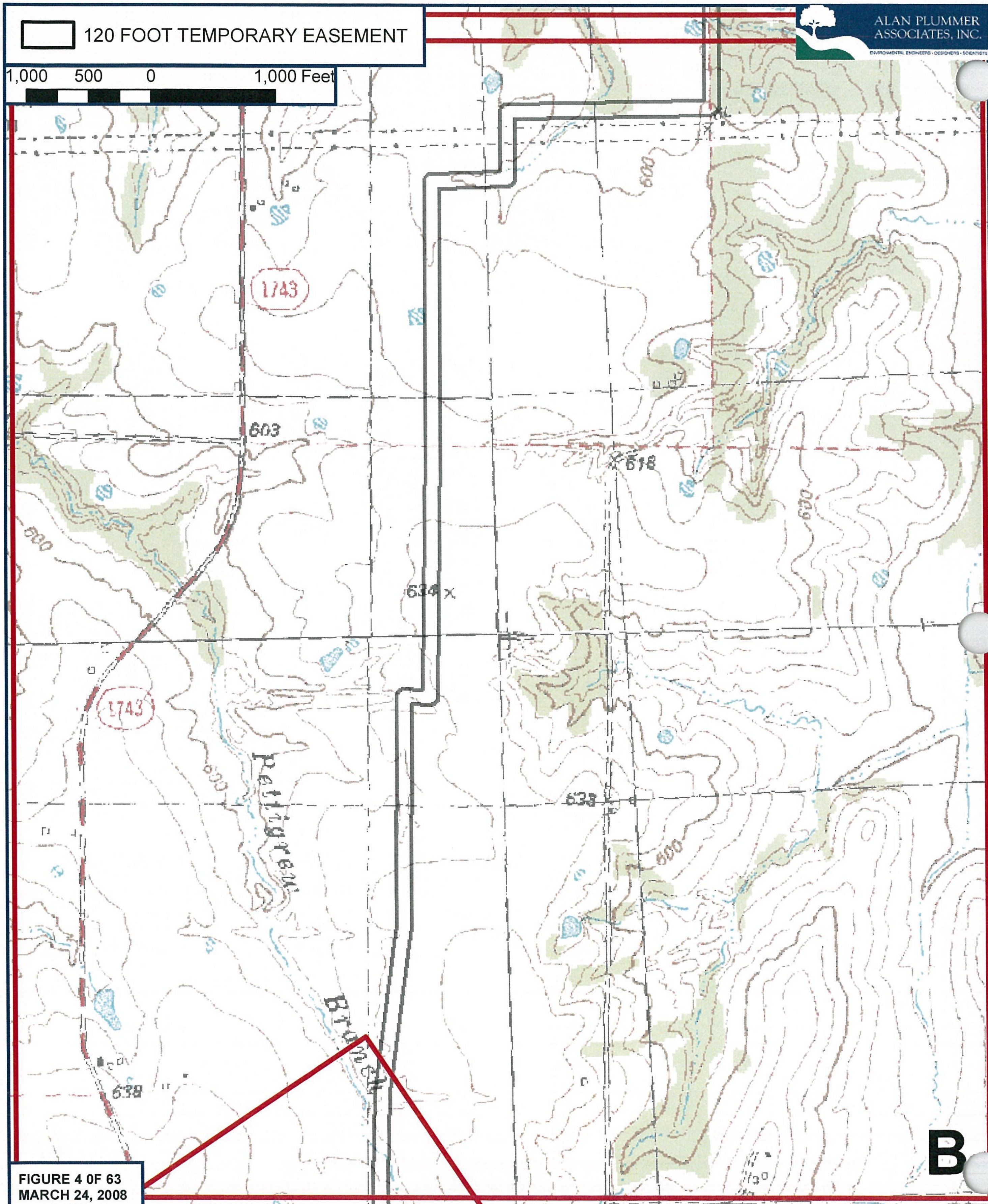
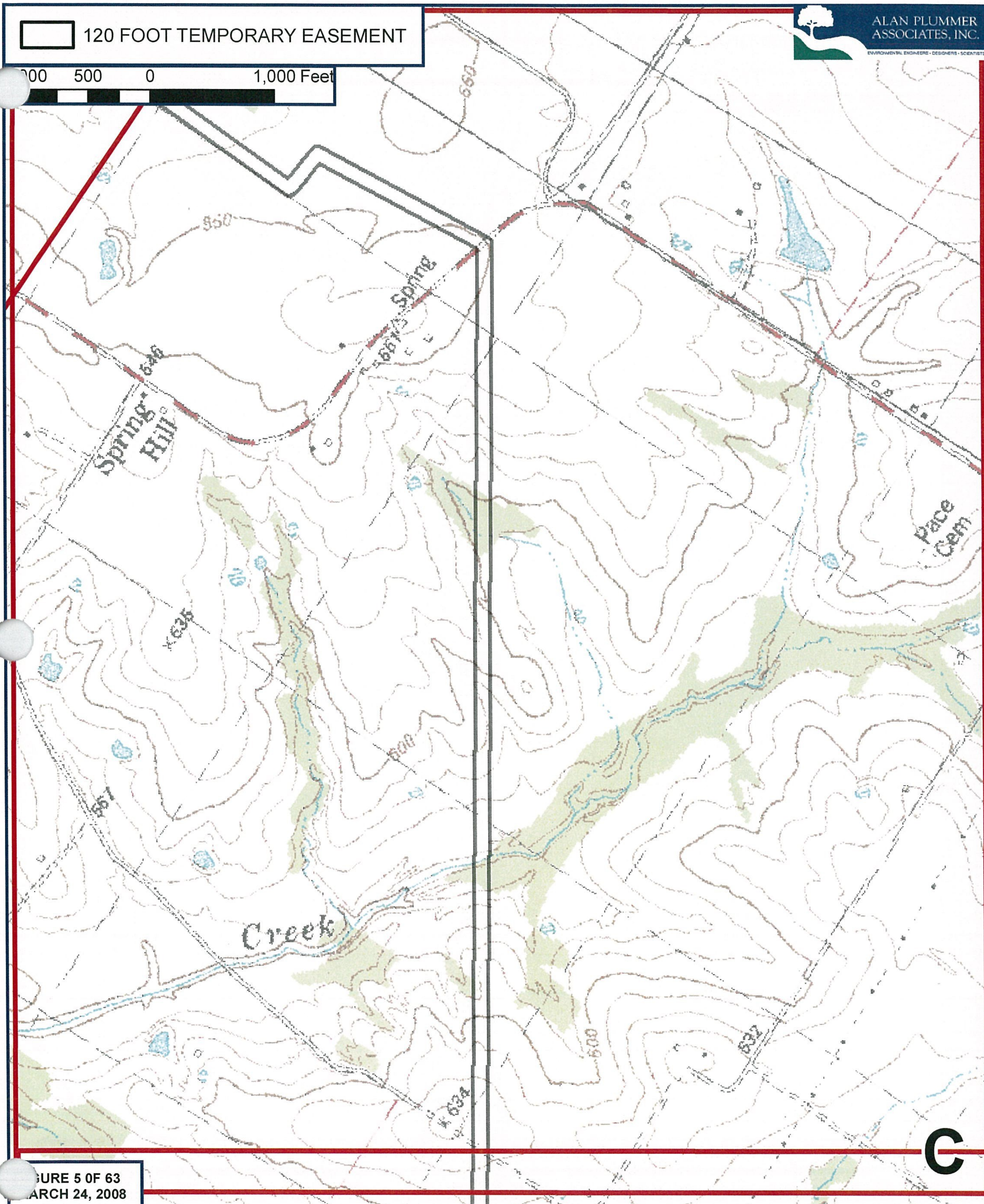


FIGURE 4 0F 63
MARCH 24, 2008

A-4
PJD LIMITS, USGS TOPOGRAPHIC MAP
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE



A-5
PJD LIMITS, USGS TOPOGRAPHIC MAP
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

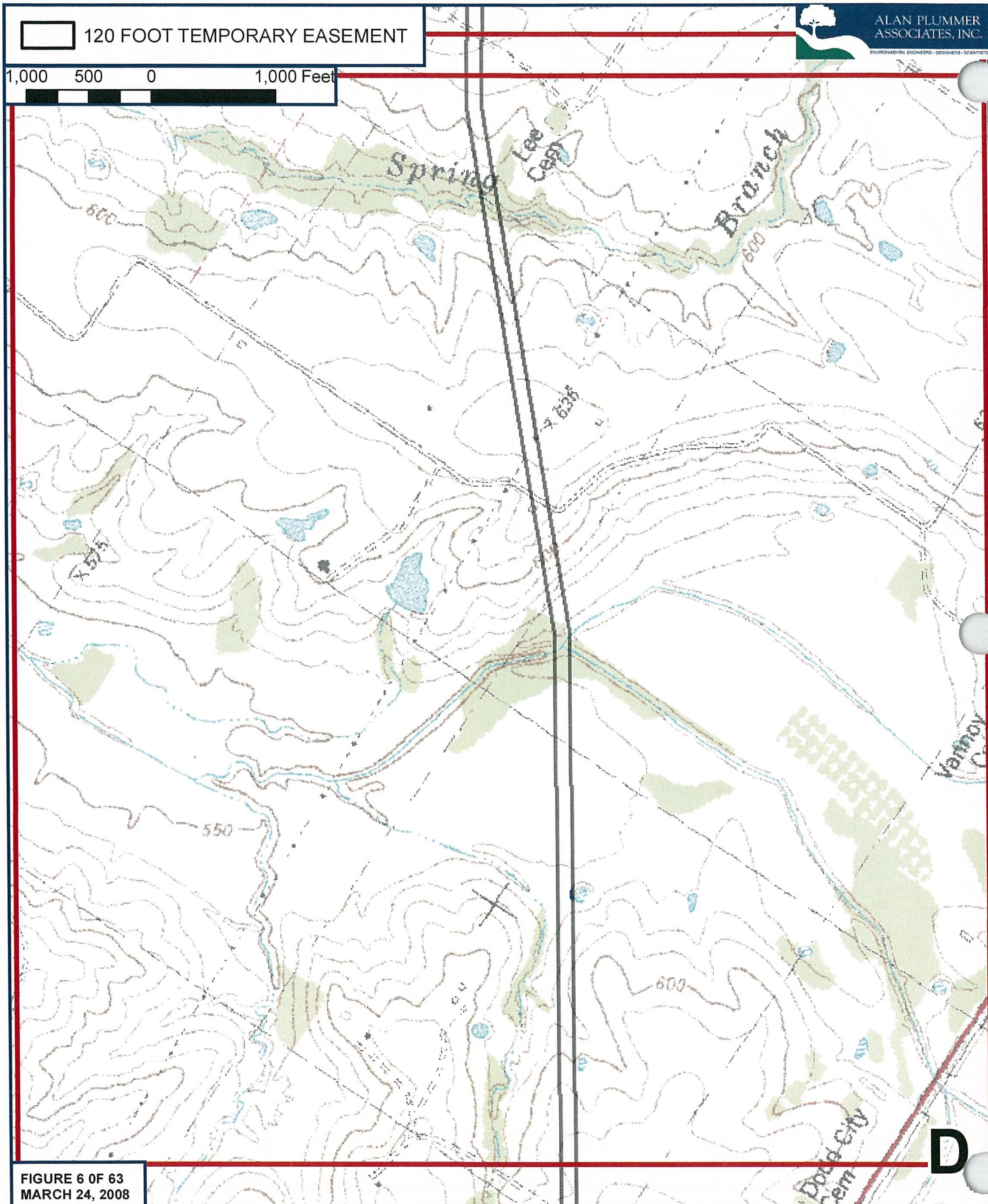
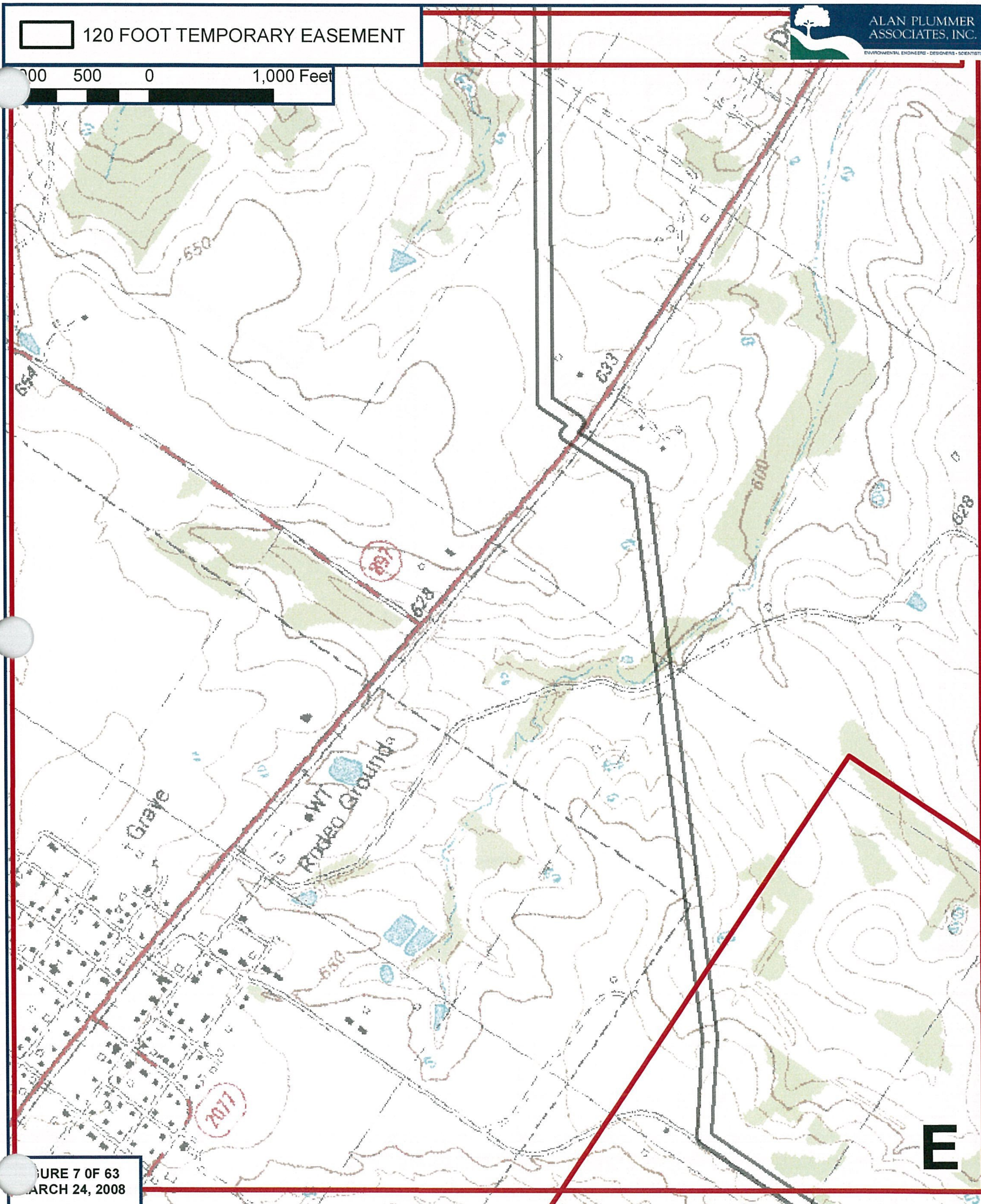


FIGURE 6 0F 63
MARCH 24, 2008

A-6
PJD LIMITS, USGS TOPOGRAPHIC MAP
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE



GURE 7 0F 63
ARCH 24, 2008

A-7
PJD LIMITS, USGS TOPOGRAPHIC MAP
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

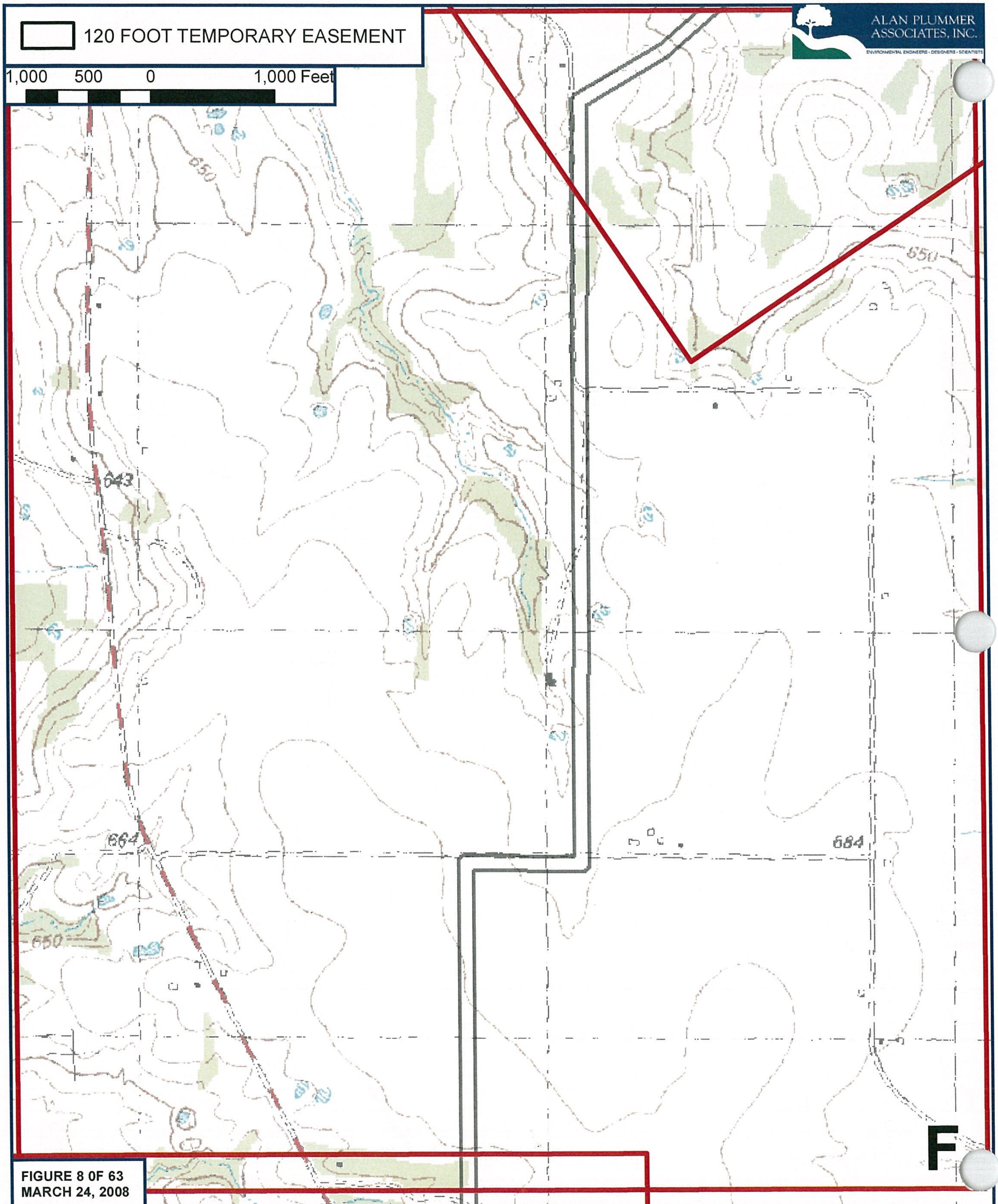


FIGURE 8 OF 63
MARCH 24, 2008

A-8
PJD LIMITS, USGS TOPOGRAPHIC MAP
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE