APPENDIX C: REVISED MITIGATION PLAN

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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

MITIGATION PLAN

January 2017

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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;

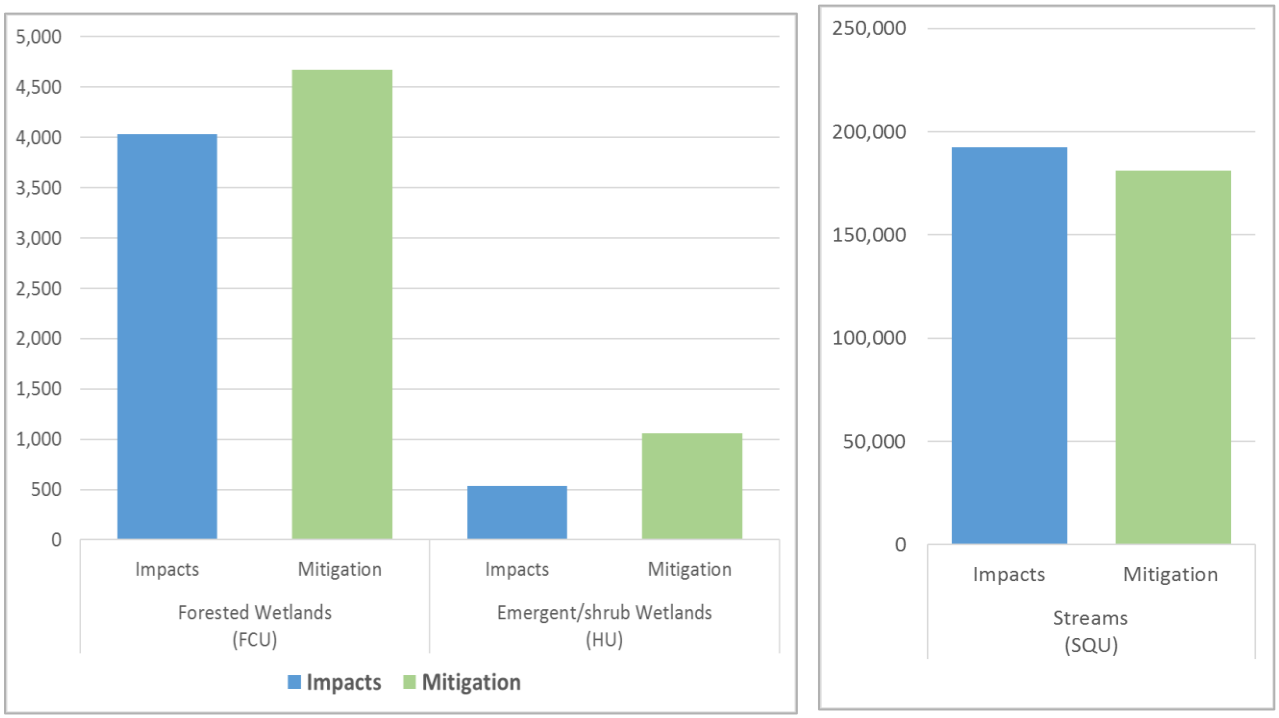
- A net gain of 640 FCUs of forested wetlands, 80.5 HUs of shrub wetlands, and 443 HUs of emergent wetlands; and

- 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

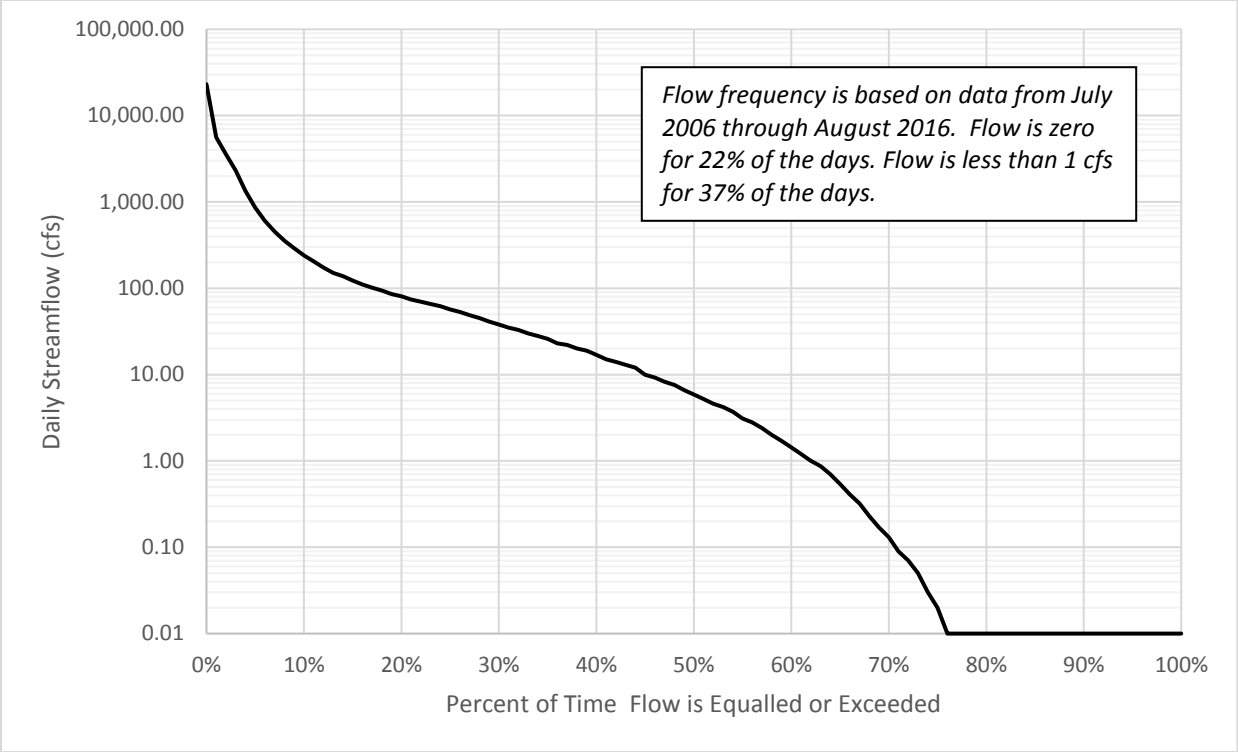
2.3 EXISTING HYDROLOGY

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

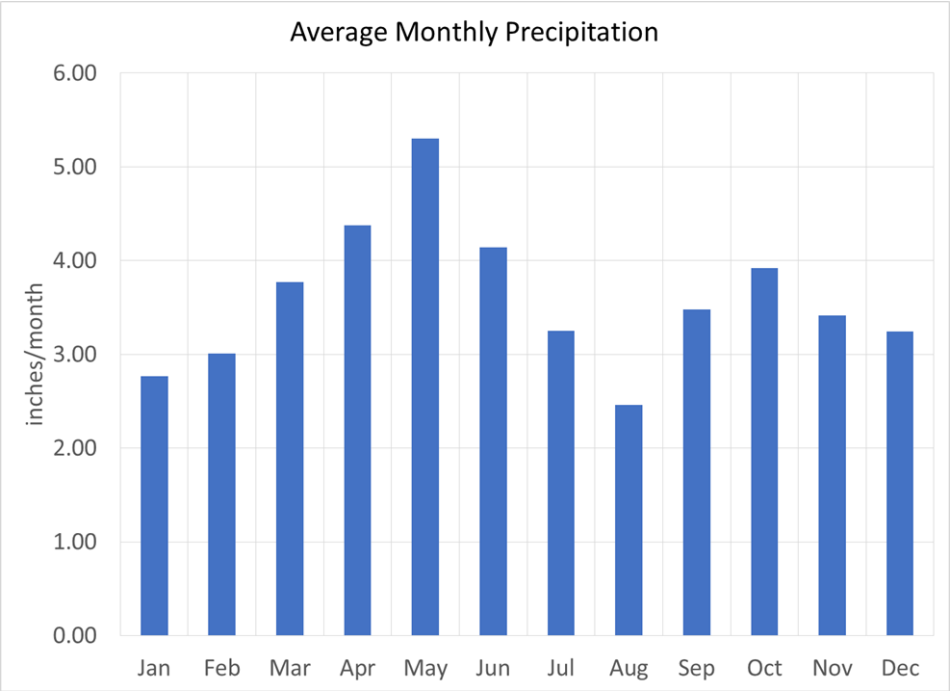
Sustainable sources of water for this mitigation site would be provided by naturally occurring sources such as precipitation, normal stream flow, flood events, overland flow, and ground-water discharge. The goal is to avoid, to the extent practicable, the need to rely on artificial water sources

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*		

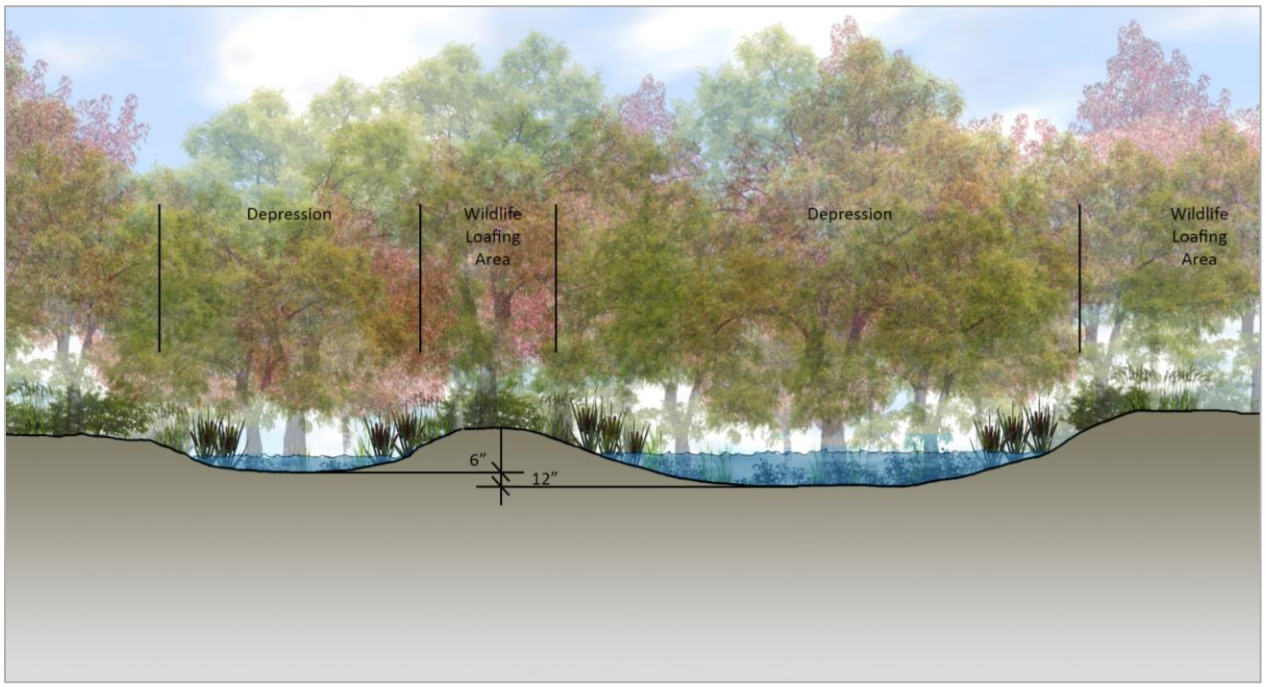
Group 1 = Common dominants in reference standard sites
Group 2 = Species commonly present in reference standard sites, but dominance generally indicates man-made or natural disturbance
Group 3 = Uncommon, minor or shrub species in reference standard sites, but may dominate in degraded systems

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

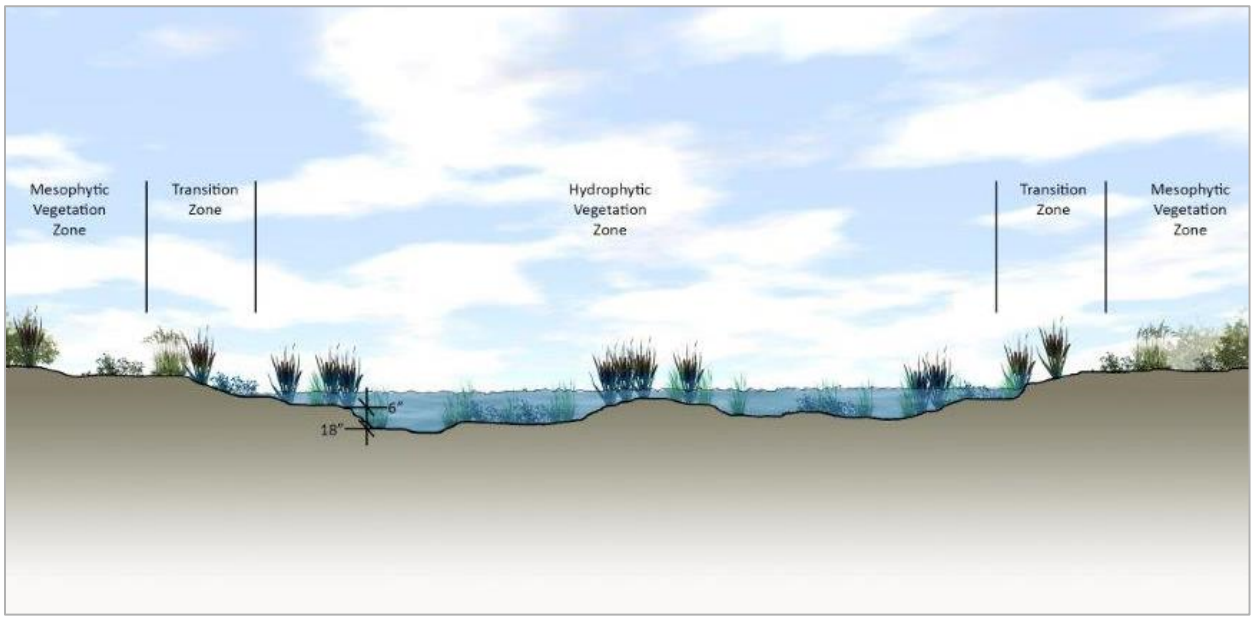
Two primary approaches will be utilized for establishing vegetation within the restored emergent wetland areas. One approach would include planting of these sites with a mixture of species listed in Table 6.2. This species list would be used as a guide for the selection of species based upon site conditions 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

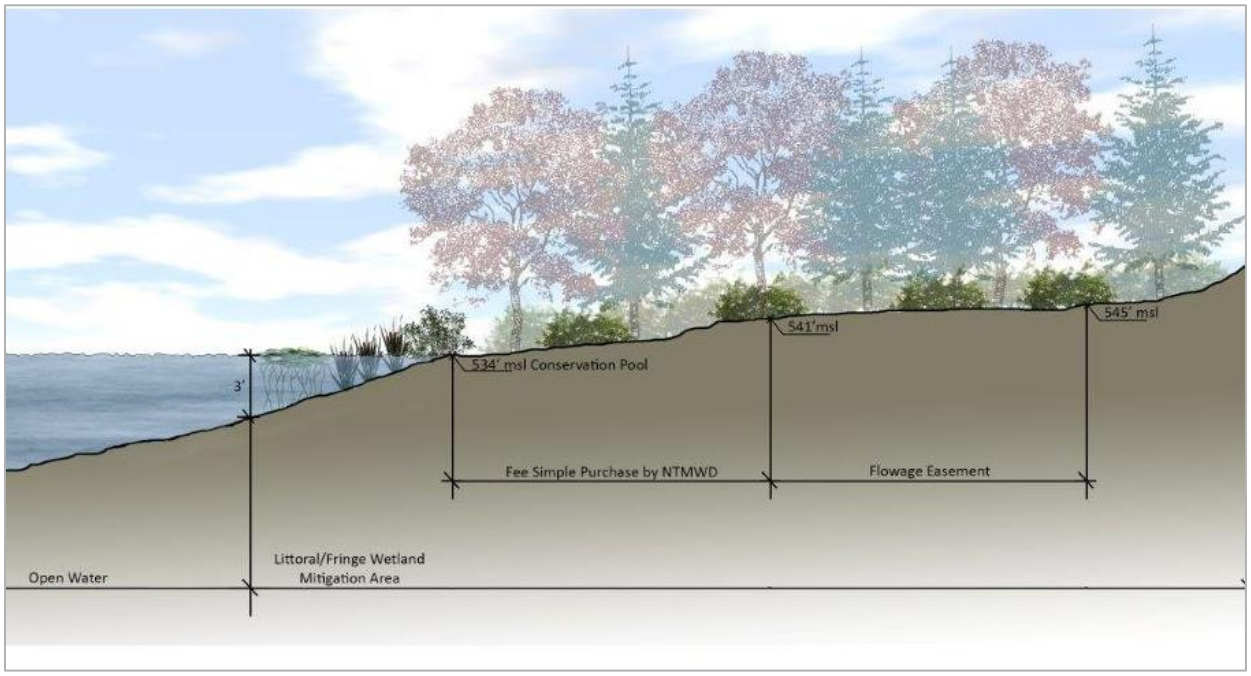
Common Name	Scientific Name	Region 6 Wetland Indicator Status
Bushy Bluestem	*Andropogon glomeratus*	FACW
Green Flatsedge	*Cyperus virens*	FACW
Eared Redstem	*Ammannia auriculata*	OBL
Grassleaf Rush	*Juncus marginatus*	FACW
Mockbishop Weed	*Ptilimnium nuttalli*	FACW
Water Lily	*Nymphaea odorata*	OBL
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.

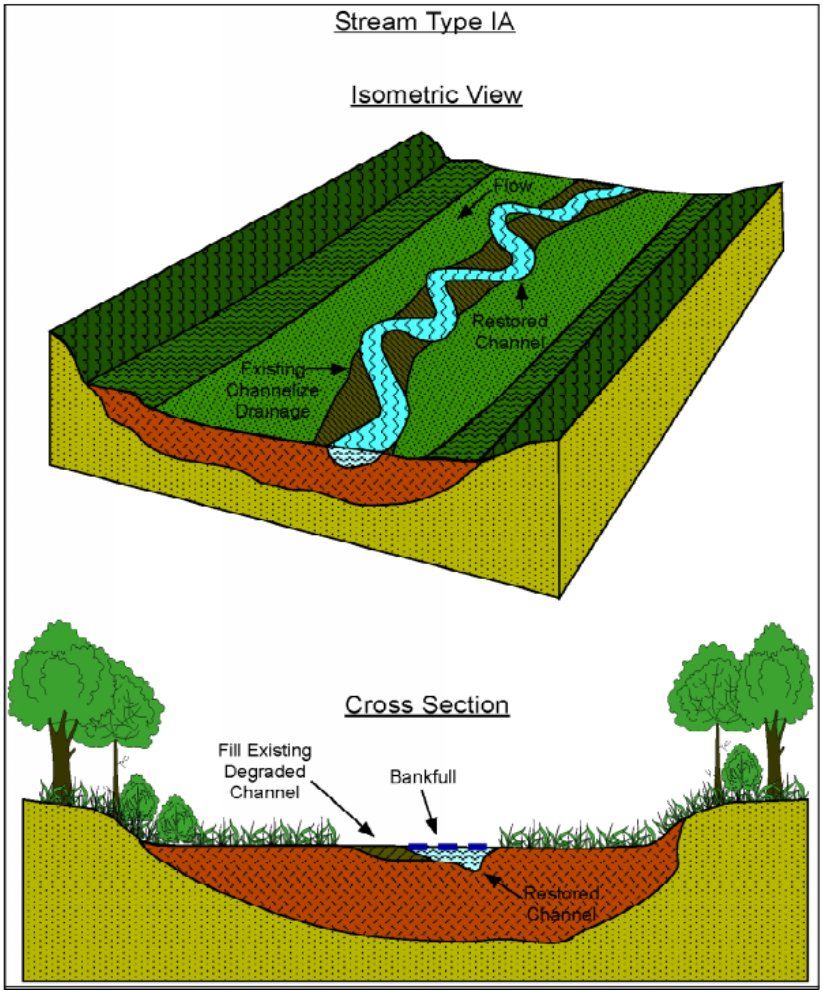
Establishing a treed riparian buffer will improve streambank stability, reduce bank erosion, provide shade to the stream, and generate wood debris storage/habitat. In-stream work is not being proposed within the WRP. However, fluvial geomorphic principles support the hypothesis that as upstream reaches 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.

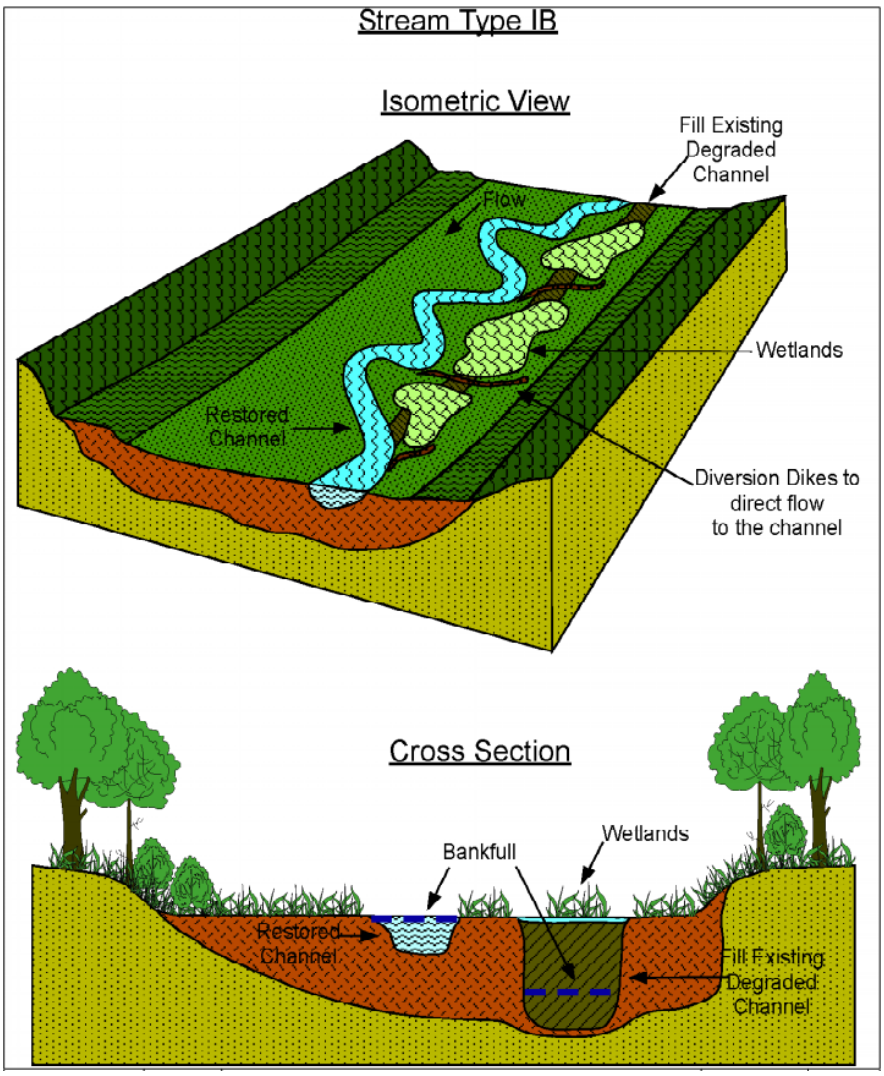


Graphic 6.5 Stream Restoration Type 1A

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.



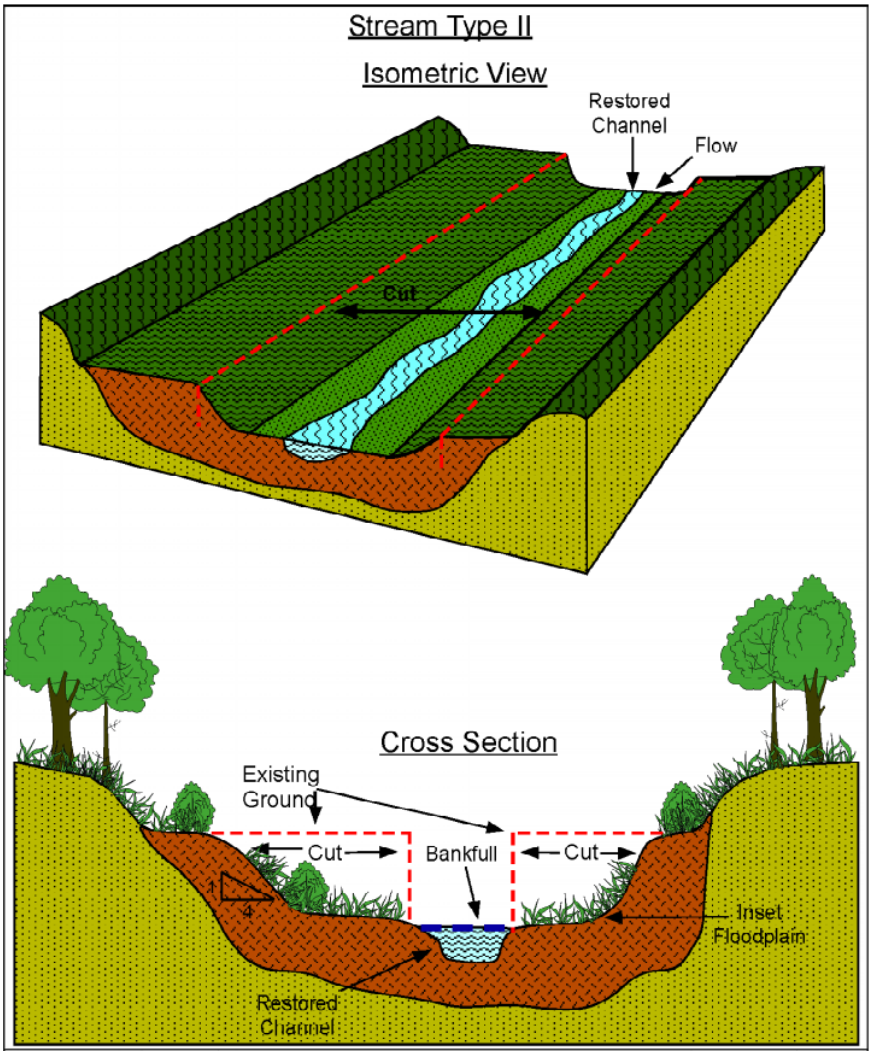
Graphic 6.6 Stream Restoration Type 1B

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

Function	Functional Capacity Indices (FCI)							
	WAA 1		WAA 2		WAA 3		WAA 4	
	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

Function	Functional Capacity Indices (FCI)	
	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

	Future FCU Uplift Produced by Year	
Mitigation Activities	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

	Future Habitat Units (HUs) Produced by Year (Net)	
Mitigation Activities	**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

	Riverby Stream Restoration		Riverby Stream Creation		WRP Stream Enhancement	
SQF	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.

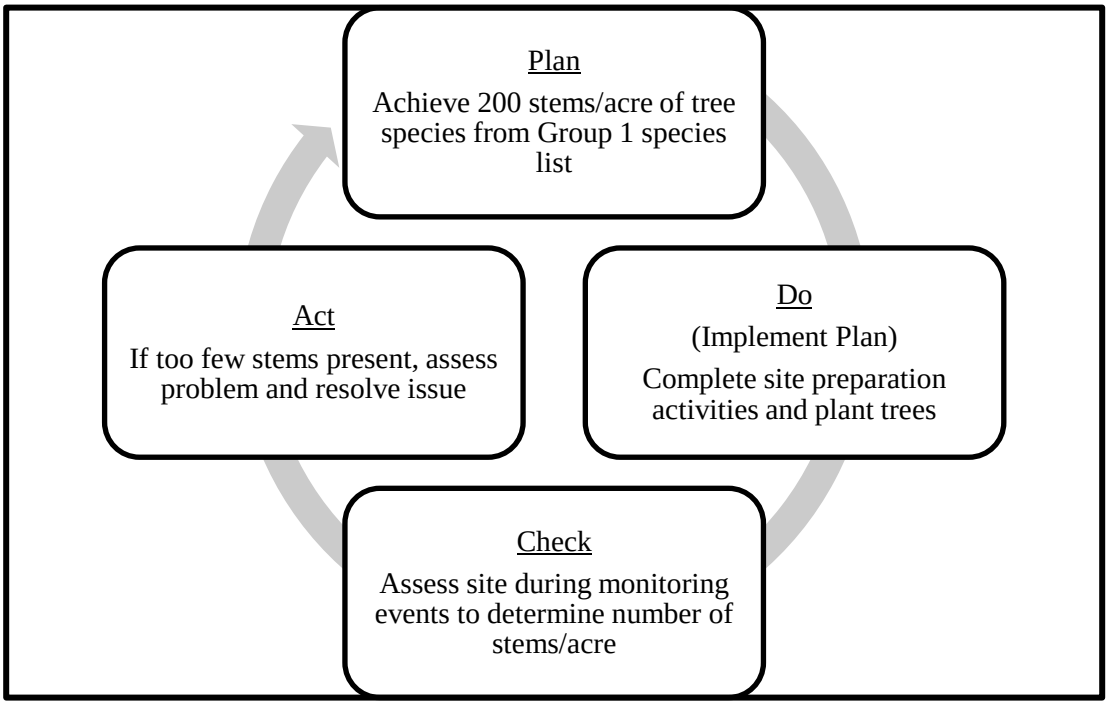
To meet the purpose of the adaptive management plan, NTMWD proposes to implement a method known as the "Plan-Do-Check-Act" cycle. This model was developed for use when implementing change, developing a new product, or starting a new improvement project and it acts as a model for continuous improvement 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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