APPENDIX K: HYDROGEOMORPHIC APPROACH (HGM) REPORT FOR THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE

K-1: Modifying the East Texas HGM for the Lower Bois d'Arc Creek Reservoir Project

K-2: Functional Assessment of Forested Wetlands at Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

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TO: Robert McCarthy, North Texas Municipal Water District

CC: Simone Kiel, P.E., Steve Watters, PWS

FROM: Michael Votaw, PWS, CWB

SUBJECT: Functional Assessment of Forested Wetlands at the Lower Bois d'Arc Creek Reservoir Site using the Modified East Texas HGM

DATE: 6/22/2016

PROJECT: NTD06128 - Lower Bois d'Arc Creek Reservoir

INTRODUCTION

At the request of the Tulsa District U.S. Army Corps of Engineers (USACE), the North Texas Municipal Water District (NTMWD) has completed a functional assessment of forested wetlands located within the footprint of the proposed Lower Bois d'Arc Creek Reservoir project (Figure 1). The functional assessment method utilized is a modification of the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams, et al., 2010). Modifications to the guidebook were completed as a joint effort between the Tulsa District USACE, the U.S. Army Corps of Engineers Research and Development Center (ERDC), and Stephen F. Austin State University (SFA). Documentation of how the guidebook was modified can be found in *Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016). The purpose of conducting the functional assessment was to develop indices for the wetland functions being performed by the forested wetlands within the proposed reservoir site and to estimate potential impacts to those forested wetlands resulting from reservoir construction. The six functions assessed using the modified hydrogeomorphic (HGM) assessment method include, Detain Floodwater, Detain Precipitation, Cycle Nutrients, Export Organic Carbon, Maintain Plant Communities, and Provide Habitat for Fish and Wildlife. The following information describes the application of the modified HGM method and the results from this effort.

METHODS

The methods used for this assessment followed the protocol as described in the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Regional Guidebook) (Williams, et al. 2010) and from *Modifying the East Texas Regional HydroGeoMorphic Guidebook for Use in Fannin County, TX, in the Lower Bois D'Arc Creek Reservoir Project* (Camp et al., 2016).

The 4,602 acres of forested wetlands within the footprint of the proposed Lower Bois d'Arc Creek Reservoir site would be classified as riverine wetlands according to the Regional Guidebook. Riverine wetlands are a class of wetlands that occur within the 5-year floodplains and riparian corridors associated with stream channels. Their primary source of water comes from overbank or backwater flow from the channel. Other sources of hydrology include interflow, overland flow from adjacent uplands, tributary inflow, and direct precipitation. The forested wetlands within the proposed reservoir site and associated 5-year floodplain are shown on Figure 2.

Following the HGM methodology, riverine wetlands are further refined into two sub-classes: low-gradient riverine, and mid-gradient riverine. Low-gradient riverine wetlands occur within the floodplains of major rivers. The floodplains can be very wide even along relatively narrow channels, a common feature of modern coastal plain river systems (Bridge 2003). Typically, these systems have large, distinctive geomorphic features and often receive both backwater and overbank flooding. Their typical hydrogeomorphic setting includes point bars, backswamps, and natural levee deposits associated with meandering streams within the 5-year floodplain (Williams et al. 2010). Based on these characteristics, it was determined that the forested wetlands within the footprint of the proposed reservoir would fall within the sub-class, low-gradient riverine.

The Wetland Assessment Area (WAA) utilized for this functional assessment includes all of the forested wetlands identified within the footprint of the proposed reservoir (4,602 acres). According to the Regional Guidebook, each WAA belongs to a single regional wetland sub-class and is relatively homogenous with respect to the criteria used to assess wetland functions (i.e., hydrologic regime, vegetation structure, topography, soils, successional stage). All of the forested wetlands within the footprint of the proposed reservoir were identified as sub-class low-gradient riverine, are contiguous, and are located within the 5-year floodplain of Bois d'Arc Creek (Figure 2). Additionally, these wetlands are strongly associated with the Tinn Clay, 0-1 percent slopes, frequently flooded and Tinn Clay, 0-1 percent slopes, occasionally flooded soil map units (Figure 3) and all are dominated by three primary tree species including, green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*). Based on these data, one WAA was identified that included all forested wetlands within the project area.

Following the identification of the WAA to designate the project boundary, sample plot locations were identified to collect field data. The plot locations were reviewed by all cooperating agencies involved in the project prior to data collection efforts. From December 15 through 17, 2015, FNI environmental scientists, regulatory staff from the Tulsa District USACE, and NTMWD representatives collected field data at 12 sample plot locations within the footprint of the proposed Lower Bois d'Arc Creek Reservoir site (Figure 4). Data collection was performed utilizing the modified low-gradient riverine data collection form and following the protocol described in the Regional Guidebook. At each sample plot location, data forms were completed, GPS coordinates were recorded, and photographs were taken. Photographs from each sample plot are located in Attachment A.

Field data collected during the December 2015 field efforts at the proposed Lower Bois d'Arc Creek Reservoir site were entered into the modified East TX HGM calculator provided by ERDC. Once data were entered, the calculator provided an average measure for each variable and its associated sub-index score. The average measure and sub-index scores for each variable evaluated for the forested wetlands at the proposed Lower Bois d'Arc Creek Reservoir site are summarized in Table 1. The sub-index scores for each variable were then utilized in the formulas (assessment models) for each of the six functions assessed to calculate a functional capacity index (FCI) value for each function. The FCI value represents the ability of a wetland to perform a specific function relative to the ability of reference standard wetlands to perform the same function. The theoretical FCI value ranges from 0.0 to 1.0, where wetlands with an FCI of 1.0 perform the assessed function at a level that is characteristic of reference standard wetlands. A lower FCI indicates that the wetland is performing a function at a level below that characteristic of reference standard wetlands. The FCI values for each function were then multiplied by the area (acreage) of forested wetlands in the WAA to determine functional capacity units (FCU) for each function, as shown in the following equation:

Functional Capacity Unit (FCU) = Functional Capacity Index (FCI) x Area (acres)

RESULTS

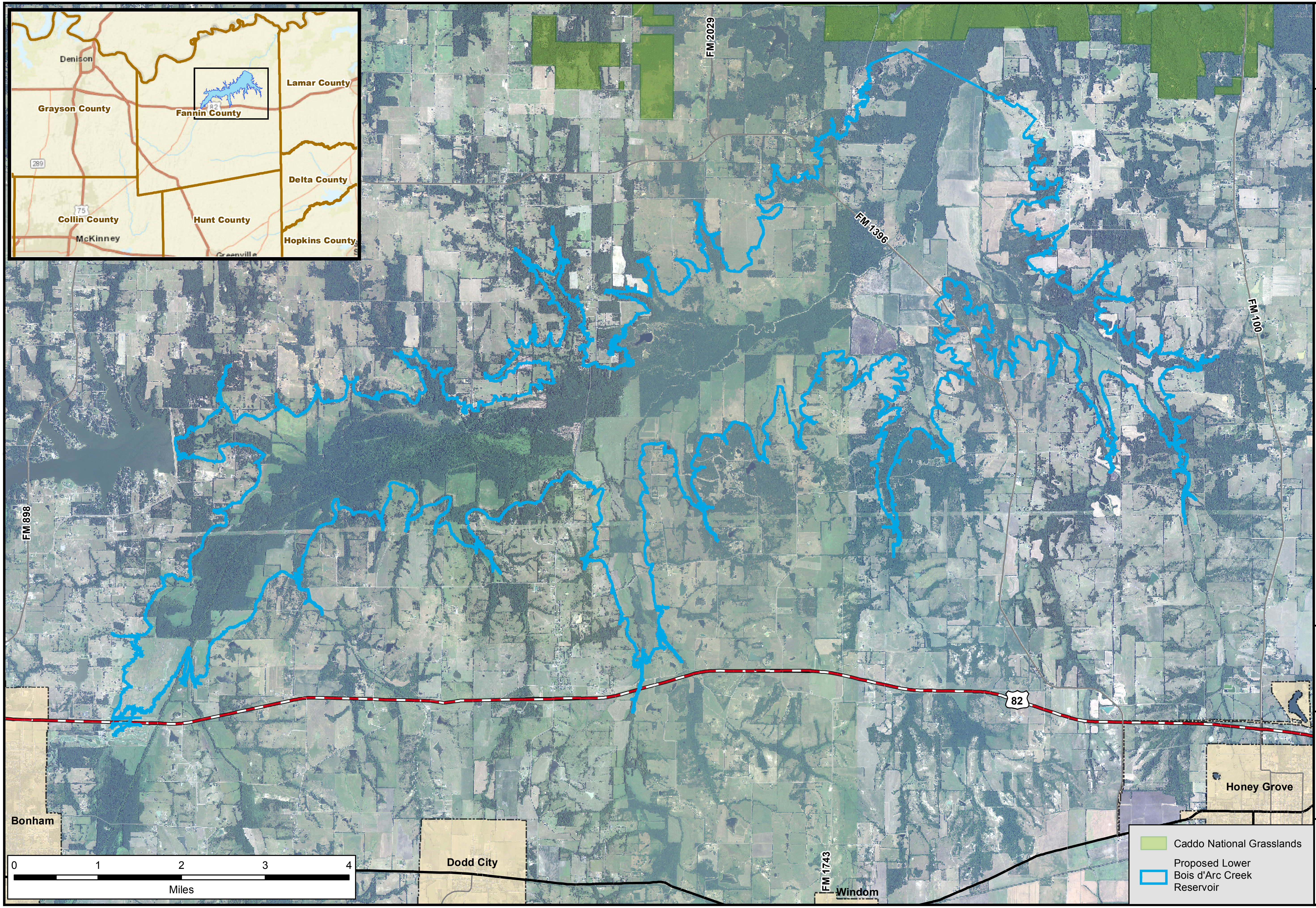
In the case of the proposed reservoir site, the WAA was determined to be the total acreage of forested wetlands within the footprint of the reservoir, which was 4,602 acres. The FCI values and resulting FCU's for each function are summarized in Table 2. Output from the modified East TX HGM calculator, including the FCI calculator and Data Summary by Plot tabs, are located in Attachment B.

Table 1. Average Measure and Sub-Index Values of the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Variable	Name	Average Measure	Sub-Index
V_{PATCH}	Forest Patch Size (ha)	2,500	1.00
V_{FREQ}	Change in Frequency of Flooding (years change)	0	1.00
V_{DUR}	Change in Growing Season Flood Duration (weeks change)	0	1.00
V_{POND}	Total Ponded Area (%)	30	1.00
V_{STRATA}	Number of Vegetation Strata	4	1.00
V_{SOIL}	Soil Integrity (%)	0	1.00
V_{TBA}	Tree Basal Area (m^3/ha)	29	1.00
V_{TDEN}	Tree Density (stems/ha)	690	0.81
V_{SNAG}	Snag Density (stems/ha)	79	1.00
V_{OHOR}	O Horizon Accumulation (cm)	0	0.20
V_{COMP}	Composition of Tallest Woody Stratum (%)	0.70	0.70
V_{TCOMP}	Tree Composition (%)	0.70	0.70
V_{SSD}	Shrub-Sapling Density (stems/ha)	875	0.88
V_{GVC}	Ground Vegetation Cover (%)	29	1.00
V_{LITTER}	Litter Cover (%)	57	0.92
V_{LOG}	Log Biomass (m^3/ha)	29	1.00
V_{WD}	Woody Debris Biomass (m^3/ha)	51	1.00

Table 2. Functional Capacity Index (FCI) Values and Functional Capacity Units (FCU) of the Forested Wetlands within the Proposed Lower Bois d'Arc Creek Reservoir Site.

Function	Functional Capacity Index (FCI)	Functional Capacity Units (FCU)
Detain Floodwater	0.92	4,233.84
Detain Precipitation	0.78	3,589.56
Cycle Nutrients	0.85	3,911.70
Export Organic Carbon	0.87	4,003.74
Maintain Plant Communities	0.90	4,141.80
Provide Habitat for Fish and Wildlife	0.86	3,957.72



North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site Location Map

F&N JOB NO. NTD06128
DATE: June, 2016
SCALE: 1:65,000
DESIGNED: HHM
DRAFTED: HHM

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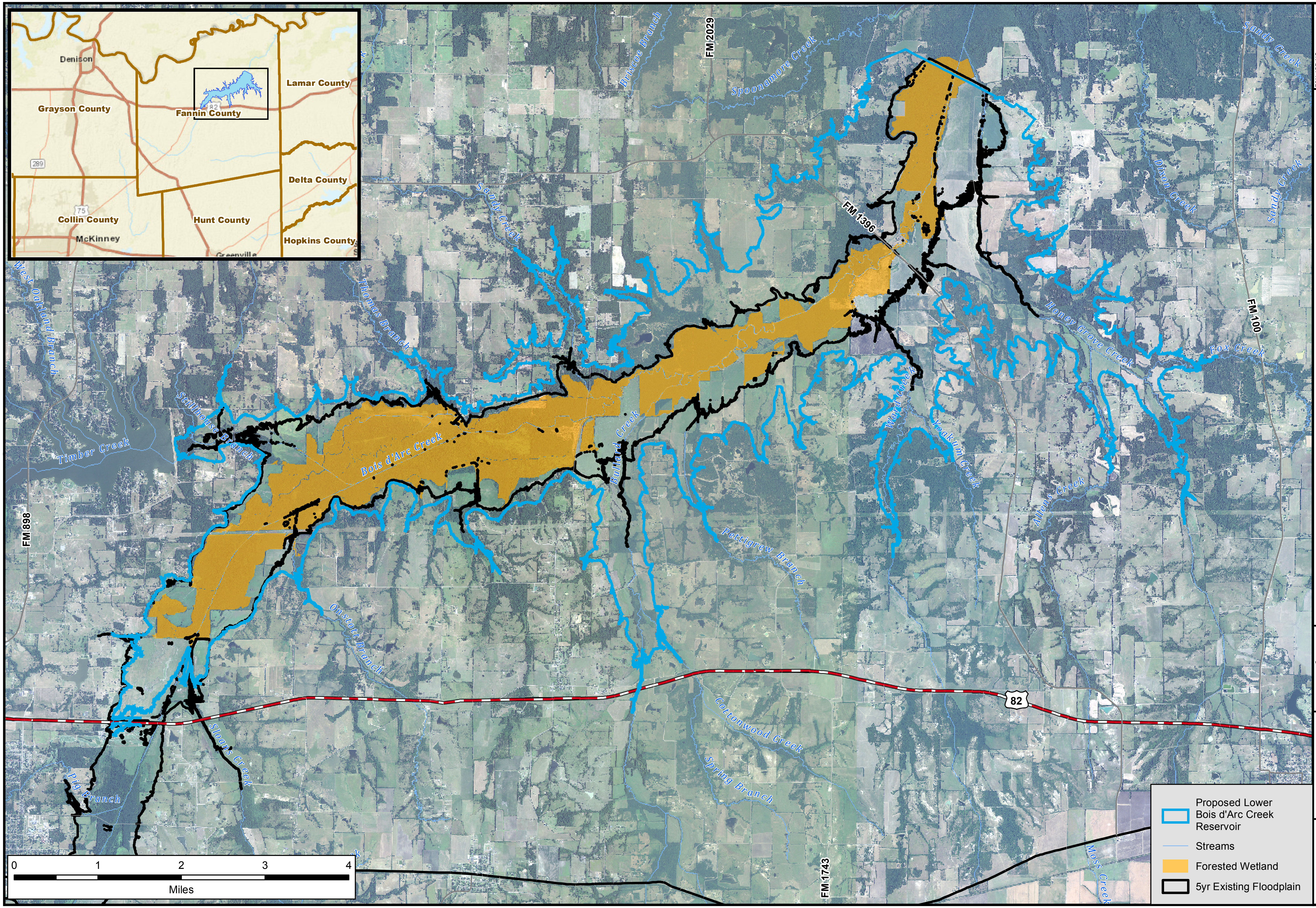
FIGURE 1



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Proposed Lower Bois d'Arc Reservoir Site
Existing 5-Yr Floodplain

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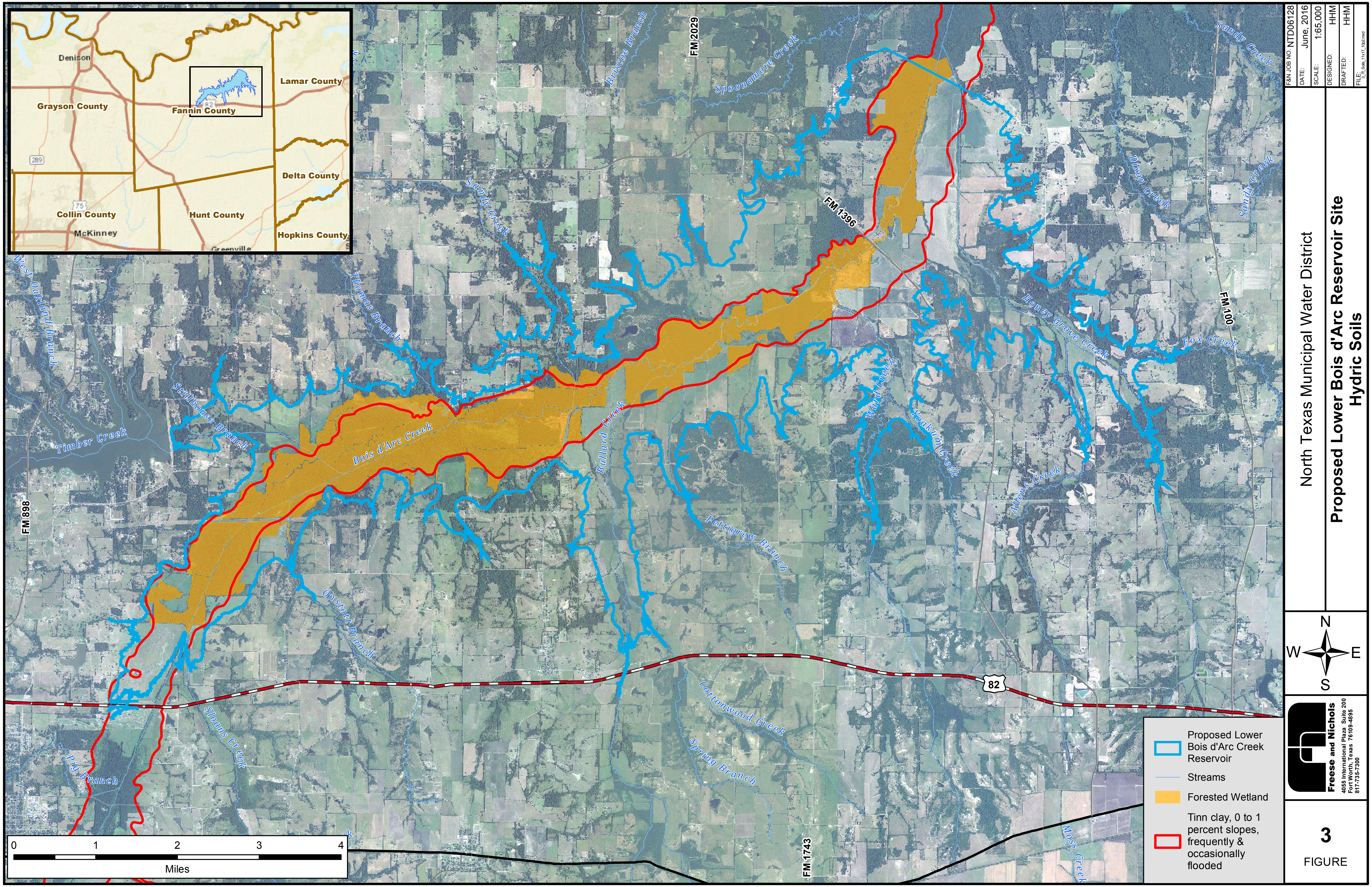
FIGURE



Denison
Grayson County
Fannin County
Lamar County
Delta County
Collin County
Hunt County
Hopkins County
McKinney
Greenville
289
75
82
Sandy Creek
Briscoe Branch
FM 2029
Spoonamore Creek
Dixon Creek
FM 1396
Smith Creek
Thomas Branch
West Oakland Branch
Honey Grove Creek
FM 100
Fox Creek
Scarborough Branch
Timber Creek
Bois d'Arc Creek
Ballard Creek
Ward Creek
Allen's Creek
FM 898
Pettigrew Branch
Onstott Branch
Cottonwood Creek
Sloans Creek
Spring Branch
Pig Branch
FM 1743
Moss Creek
0
1
2
3
4
Miles
Proposed Lower Bois d'Arc Creek Reservoir
Streams
Forested Wetland
Tinn clay, 0 to 1 percent slopes, frequently & occasionally flooded
N
W
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F&N JOB NO: NTD06128
DATE: June, 2016
SCALE: 1:65,000
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Proposed Lower Bois d'Arc Reservoir Site
Hydric Soils
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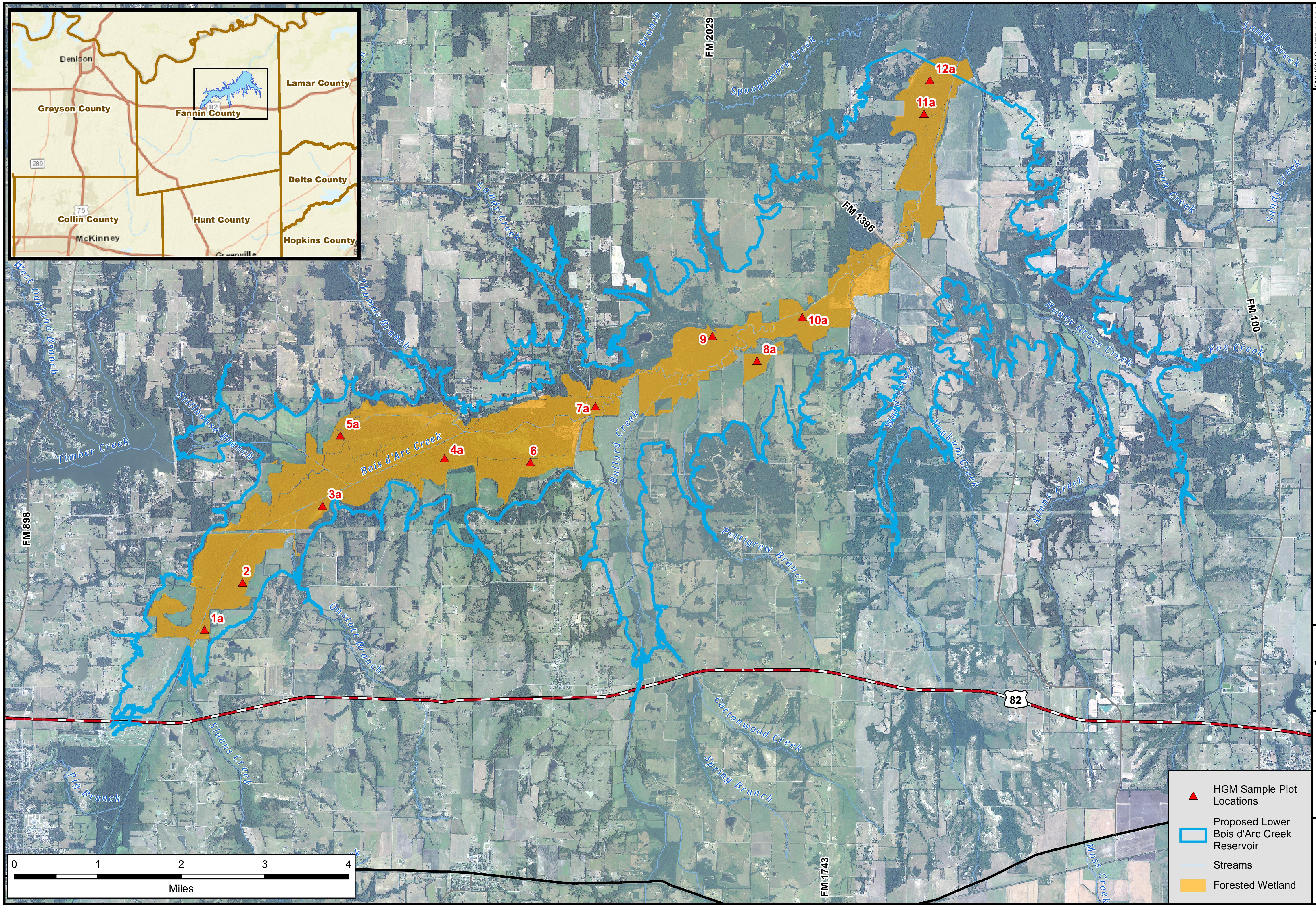
3
FIGURE



F&N JOB NO.	NTD06128
DATE:	June, 2016
SCALE:	1:65,000
DESIGNED:	HHM
DRAFTED:	HHM
FILE:	4_HGM_Points_11x17.mxd

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Site
HGM Sample Plot Locations

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FIGURE

ATTACHMENT A
Photographs

Photo 1. Site 1A, view looking north

Photo 2. Site 1A, view looking south

Photo 3. Site 1A, view looking east

Photo 4. Site 1A, view looking west

Photo 5. Site 2, view looking north

Photo 6. Site 2, view looking south

Photo 7. Site 2, view looking east

Photo 8. Site 2, view looking west

Photo 9. Site 3A, view looking north

Photo 10. Site 3A, view looking south

Photo 11. Site 3A, view looking east

Photo 12. Site 3A, view looking west

Photo 13. Site 4A, view looking north

Photo 14. Site 4A, view looking south

Photo 15. Site 4A, view looking east

Photo 16. Site 4A, view looking west

Photo 17. Site 5A, view looking north

Photo 18. Site 5A, view looking south

Photo 19. Site 5A, view looking east

Photo 20. Site 5A, view looking west

Photo 21. Site 6, view looking north

Photo 22. Site 6, view looking south

Photo 23. Site 6, view looking east

Photo 24. Site 6, view looking west

Photo 25. Site 7A, view looking north

Photo 26. Site 7A, view looking south

Photo 27. Site 7A, view looking east

Photo 28. Site 7A, view looking west

Photo 29. Site 8A, view looking north

Photo 30. Site 8A, view looking south

Photo 31. Site 8A, view looking east

Photo 32. Site 8A, view looking west

Photo 33. Site 9, view looking north

Photo 34. Site 9, view looking south

Photo 35. Site 9, view looking east

Photo 36. Site 9, view looking west

Photo 37. Site 10A, view looking north

Photo 38. Site 10A, view looking south

Photo 39. Site 10A, view looking east

Photo 40. Site 10A, view looking west

Photo 41. Site 11A, view looking north

Photo 42. Site 11A, view looking south

Photo 43. Site 11A, view looking east

Photo 44. Site 11A, view looking west

Photo 45. Site 12A, view looking north

Photo 46. Site 12A, view looking south

Photo 47. Site 12A, view looking east

Photo 48. Site 12A, view looking west

ATTACHMENT B
Modified East TX HGM Calculator Output

FCI/FCU Calculator for the Fannin County, Texas Adaptation of the East Texas HGM Guidebook

Start with the Project Level Data Entry below. Enter in the yellow cells the number and size of the Wetland Assessment Area (WAA) being sampled, the project name, and location. Use the drop down menus to indicate whether this WAA represents the Project Site or Mitigation Site, before project or after project. Then go to the Data Entry tabs to enter individual field measurements for the tract and each plot. For information on determining how to split a project into WAAs, see A Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas (Williams *et al.* 2010). This spreadsheet calculator only allows for ten plots per WAA. If the WAA merits more plots, it must be subdivided to use this tool. Functional Results are automatically calculated based on the data entered into the Data Entry sheets. If the analysis includes mitigation sufficiency assessment, you may enter the functional results into the sufficiency calculator at http://el.erdc.usace.army.mil/wetlands/datanal.html.

Project Level Data Entry

Enter information in yellow cells, and select HGM Subclass and Site information from dropdown menus. A Subclass must be selected prior to printing out data sheets.

Project Name: **Lower Bois d'Arc Creek Modified HGM Functional Assessment**
Location: **Proposed Lower Bois d'Arc Creek Reservoir Site**
Sampling Dates: **4/28/16 through 4/29/16**

HGM Subclass present at this WAA: Low Gradient Riverine

WAA number: **1**

Project Site: Project Site **Project Timing:** Before Project

WAA size (ha): **4602**

Final Summaries

All summaries of results are automatically calculated based on data entered into the individual plot entry data sheets.

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index	Functional Capacity Units
Detain Floodwater	0.92	4233.84
Detain Precipitation	0.78	3589.56
Cycle Nutrients	0.85	3911.70
Export Organic Carbon	0.87	4003.74
Maintain Plant Communities	0.90	4141.80
Provide Habitat for Fish and Wildlife	0.86	3957.72

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
V_{PATCH}	Forested Patch Size (ha)	2500	1.00
V_{FREQ}	Change in Frequency of Flooding (years change)	0	1.00
V_{DUR}	Change in Growing Season Flood Duration (weeks change)	0	1.00
V_{POND}	Total Ponded Area (%)	30	1.00
V_{STRATA}	Number of Vegetation Strata	4	1.00
V_{SOIL}	Soil Integrity (%)	0	1.00
V_{TBA}	Tree Basal Area (m^2/ha)	29	1.00
V_{TDEN}	Tree Density (stems/ha)	690	0.81
V_{SNAG}	Snag Density (stems/ha)	79	1.00
V_{OHOR}	O Horizon Organic Accumulation (cm)	0	0.20
V_{COMP}	Composition of Tallest Woody Vegetation Stratum (%)	0.70	0.70
V_{TCOMP}	Tree Composition (%)	0.70	0.70
V_{SSD}	Shrub-Sapling Density (stems/ha)	875	0.88
V_{GVC}	Ground Vegetation Cover (%)	29	1.00
V_{LITTER}	Litter Cover (%)	57	0.92
V_{LOG}	Log Biomass (m^3/ha)	29	1.00
V_{WD}	Woody Debris Biomass (m^3/ha)	51	1.00

WAA Data Summary:	**WAA Number :**	**1**	**Low-Gradient Riverine**

Variable		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Number of Plots Used	Average Measure
1	V_{PATCH}	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	12	2500
2	V_{FREQ}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
3	V_{DUR}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
4	V_{POND}	30	30	30	30	30	30	30	30	30	30	30	30	12	30
5	V_{STRATA}	4	4	4	4	4	4	4	4	4	4	4	4	12	4
6	V_{SOIL}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
7	V_{TBA}	36.8	20.7	25.3	36.8	23.0	23.0	25.3	23.0	23.0	36.8	37	32	12	28.6
8	V_{TDEN}	550	725	1075	675	550	700	625	850	650	575	625	675	12	690
9	V_{SNAG}	50	100	125	75	25	100	50	75	100	75	125	50	12	79
10	V_{OHOR}	0	0	0	0	0	0	0	0	0	0	0	0	12	0
11	V_{COMP}	0.51	0.66	0.55	1.00	0.72	0.66	1.00	0.51	1.00	0.44	1	1	12	0.70
12	V_{TCOMP}	0.51	0.66	0.55	1.00	0.72	0.66	1.00	0.51	1.00	0.44	1	1	12	0.70
13	V_{SSD}	625.0	750.0	1375.0	875.0	2875.0	375.0	875.0	375.0	750.0	750.0	625	250	12	875.0
14	V_{GVC}	42.5	22.5	18.8	52.5	3.8	27.5	17.5	37.5	53.8	33.8	13	21	12	28.6
15	V_{LITTER}	61.3	57.5	15.0	60.0	70.0	20.0	67.5	47.5	83.8	22.5	89	90	12	57.0
16	V_{LOG}	21.9	20.9	0.0	0.0	2.9	47.7	10.9	92.7	13.3	6.5	62	71	12	29.2
17	V_{WD}	72.3	83.3	17.3	24.9	13.3	56.8	63.6	96.1	35.4	10.7	64	78	12	51.3