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Comparison of Wetland Impact Assessment Methodologies:

Charleston Method SOP

versus

Regional Hydrogeomorphic Models

Henry W. Langston

Final Report

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Abstract

Best professional judgment has been used historically during the Section 404 permitting process for assessing impacts and required mitigation for wetlands on a per acre basis. In Arkansas, the U. S. Army Corps of Engineers Districts with regulatory responsibility currently utilize the Charleston Method Standard Operating Procedure, a rapid assessment methodology for determining wetland impact to mitigation ratios. During the past 15 years, the Arkansas Multi-agency Wetland Planning Team (MAWPT) has developed the Hydrogeomorphic Model (HGM), a true functional assessment methodology. The objectives of this study were to compare and contrast wetland impacts and wetland mitigation ratios utilizing the Charleston Method SOP and the HGM to determine which methodology is preferable in terms of effort to perform the analyses and effectiveness in achieving successful wetland mitigation. Two new location highway projects were compared, I-69 Segment of Independent Utility (SIU) 13, a 177-kilometer (110-mile) long segment that crosses the Ouachita River and Saline River floodplain wetlands, and the 7.9-kilometer (4.9-mile) long White River Bridge & Approaches (Clarendon) on U. S. Highway 79. The advantage of the HGM is that the models are calibrated to reference wetlands in the geographic area that are used to assess wetland functions. The HGM requires more time than the Charleston Method SOP, since the latter does not require the collection of any quantitative data. Based on this study of two linear highway construction projects, the Charleston Method SOP requires more mitigation than required to compensate for loss of wetland functions. For the 4-lane divided, new location, 9.0-kilometer (5.6-mile) long I-69 SIU 13 selected alignment crossing of the Ouachita River floodplain, Charleston Method SOP calculations require approximately 1.75 times more mitigation acres than the HGM calculations at an additional cost of $1.48M. For the 2-lane, new location, 7.9-kilometer (4.9-mile) long U.S. Highway 79 crossing of the White River floodplain, Charleston Method SOP calculations require approximately 3.6 times more mitigation acres than the HGM calculations at an additional cost of approximately $607,000. Results from this study suggest that the HGM, in addition to providing science based, data driven evaluation of wetland impacts and mitigation requirements to replace wetland functions, is more cost effective than the Charleston Method SOP despite the additional time and effort required for its utilization.

Introduction

Regulatory Guidance Letter 02-2 issued by the U.S. Army Corps of Engineers (COE) on December 24, 2002 encouraged the development and use of a functional assessment methodology to determine wetland impacts and compensatory mitigation ratios. The COE Districts with regulatory responsibility in Arkansas currently utilize the Charleston Method Standard Operating Procedure (SOP), a rapid assessment methodology that has little consideration of wetland function, for determining wetland impact to mitigation ratios.

In the recent past, the COE issued Section 404 permits for fills in wetlands without a data driven, scientific approach to determining an appropriate mitigation ratio. Recently, the COE began assessing and adopting different methodologies to provide rationale for determining appropriate mitigation ratios. Most of these methods provide no substantive measure of the ecological functions lost by the filling of wetlands. During the past 15 years, the Arkansas Multi-agency Wetland Planning Team (MAWPT) has developed the Hydrogeomorphic Model (HGM), a true functional assessment methodology. The Environmental Protection Agency (EPA) provided funding to collect data from each of the five major ecoregions of the state to develop appropriate HGMs. Over the past 10 years, the Arkansas MAWPT has sampled and classified wetlands across the state utilizing the HGM method, and now all five models for Arkansas are complete.

I-69 is a nationally designated corridor that extends from Port Huron, Michigan to the Texas/Mexico border with a total length of 2575 kilometers (1600 miles). A 233-kilometer (145-mile) long portion of this corridor will cross all or portions of Columbia, Ouachita, Union, Calhoun, Bradley, Ashley, Drew, and Desha counties in southern Arkansas. Within Arkansas, there are three segments of independent utility (SIU), SIUs 14, 13 and 12. Comparing the HGM to methods currently used by the COE on major highway projects presents an excellent opportunity to demonstrate the model's benefits and limitations.

The objectives of this study were to compare and contrast wetland impacts and wetland mitigation ratios utilizing the Charleston Method SOP and the HGM to determine which methodology is preferable in terms of effort to perform the analyses and effectiveness in achieving successful wetland mitigation. Two new location highway projects were compared, I-69 Segment of Independent Utility (SIU) 13, a 177-kilometer (110-mile) long segment that crosses the Ouachita and Saline river floodplain wetlands, and the 7.9-kilometer (4.9-mile) long White River Bridge & Approaches (Clarendon).

Functional Assessment Background

Under Section 404 of the Clean Water Act, the COE requires compensatory mitigation to replace functional losses to aquatic resources, including wetlands, unavoidably lost or adversely affected by authorized actions. In the early days of Section 404, best professional judgment was used for assessing impacts and required mitigation for wetlands and other aquatic resources on an acreage basis. The generally accepted ratio used in Arkansas during this time was 3:1 for impacted forested wetlands and 1:1 for herbaceous wetlands.

The National Academy of Science (2001) reviewed and critiqued compensatory mitigation programs and procedures used to address requirements of Section 404 of the Clean Water Act. As a result, a National Wetlands Mitigation Action Plan (2002) was developed. Under this plan, increased attention to mitigation planning, design, performance monitoring, and adaptive management was required. The Plan recommended the use of a functional assessment approach to guide and track wetland mitigation project planning and performance. Regulatory Guidance Letter No. 02-2 (Corps of Engineers 2002) encouraged the COE Districts to increase their reliance on functional assessment methods. However, it was left to the discretion of the Districts, on a case-by-case basis, whether to use some type of functional assessment or an acreage surrogate to describe authorized impacts and determine an appropriate mitigation replacement ratio. Regulatory Guidance Letter No. 08-03 (Corps of Engineers 2008) cited Government Accountability Office (GAO) and National Research Council (NRC) studies that suggested the COE was not providing adequate oversight to ensure that compensatory mitigation projects were successfully replacing the aquatic resource functions lost as a result of permitted activities.

Following release of the National Action Plan, there was an increase in the development of functional assessment methods. Some functional assessment methods were developed at the national level while many states developed their own. Fennessy et al. (2004) reviewed 41 functional assessment methods to identify the rapid methods most suitable for assessing the ecological conditions of wetlands. These methods could be used for regulatory purposes, to assess ambient conditions of wetlands on a watershed basis or to determine the success of a mitigation project. Of primary importance was finding a method that would provide an accurate assessment of conditions in a relatively short time period. Methods were defined as "rapid" when requiring no more than two people a half day to collect field data and no more than a half day of data analysis to reach conclusions. The ease of collection of data was also considered. Assessment procedures were divided into three levels that varied in intensity and scale. Methods included landscape-scale assessments (Level 1 methods), rapid field methods (Level 2), and intensive biological and physico-chemical measures (Level 3).

During the alignment phase of the I-69 EIS study, a general wetland function and value assessment was performed on potentially impacted wetlands using the Corps Descriptive Method (CDM) Evaluation (COE 1995) developed by the COE New England District. The CDM Evaluation (Corps of Engineers 2003) includes eight functions and five values. Functions are recognized as the physical, chemical, or biological properties performed by a wetland system while values are human-perceived benefits derived from functions of a wetland. Application of the CDM is a two-step process. First a site evaluation is required to determine if the wetland is suitable to perform each of the listed functions and values. This does not mean the site is performing each of these functions or values, but rather it has the potential to perform them. The second step is to determine which of the principal functions and values are being performed by the wetland based solely on "best professional judgment". Results from the CDM Evaluation indicated that, in general, the functions and values of potentially impacted wetlands crossed by each of the alignments were similar.

Charleston Method (SOP) vs. Hydrogeomorphic Method (HGM)

Two of the three COE Districts in Arkansas have adopted the use of the Charleston Method SOP. The Charleston Method SOP was implemented by the COE Charleston District in 1996. It can be used to evaluate impacts to wetlands and waters of the U.S. as well as compensatory mitigation proposals for these impacts. The Charleston Method SOP is applicable to regulatory actions requiring compensatory mitigation for adverse ecological effects where more rigorous, detailed studies (such as HGM, HEP) are not considered practical or necessary (COE 2003). The Charleston Method SOP is a basic written framework that provides predictability and consistency for the development, review, and approval of compensatory mitigation plans. As with the CDM Evaluation, this method requires no quantitative field data. It is another system in which the evaluator responds to a series of weighted questions by checking the ones most applicable to a site. Ultimately, values associated with each of the checked questions are added to determine an appropriate number of mitigation credits required to compensate for wetland impacts. The Charleston Method SOP is also applied to the proposed mitigation site to determine the number of available credits on the site.

Another wetland assessment method receiving considerable attention during the past 20 years was the Hydrogeomorphic Model (HGM). The HGM differs from the two previous methods in that collection of quantitative field data is required. Utilization of the HGM also depends on the availability of regional models. The Multi-Agency Wetland Planning Team (MAWPT) in Arkansas has completed HGM Regional Guidebooks for the wetland types found in the five eco-regions of Arkansas: Delta and Crowley's Ridge, West Gulf Coastal Plain, Ouachita Mountains, Arkansas River Valley, and Ozark Mountains.

Three basic points distinguish the HGM from other assessment methods (Corps of Engineers 2003). First, the HGM classifies wetlands based on ecological characteristics: (1) "landscape position or geomorphic setting", (2) water source and its transport such as precipitation, surface or near-surface flow, and (3) hydrodynamics or the direction of flow and strength of water movement within a wetland. Second, the HGM is calibrated to reference wetlands established in the ecoregion. Third, the HGM uses a relative index of functions, calibrated to reference wetlands, to assess wetland functions. Under the HGM, all wetlands fall in one of seven classes that are partitioned into subclasses that can be further divided by community types. Once a wetland site has been classified, the functions it performs are examined. Not all wetlands perform the same functions, and not all wetlands of the same type perform the same functions at the same level. Once the data has been collected for a Wetland Assessment Area (WAA) and summarized, it is transferred to the appropriate Functional Capacity Index (FCI) and Functional Capacity Unit (FCU) worksheets. Data entered into the

HGM software is used to calculate a subindex value for each of the variables as well as FCUs for the different functions in the WAAs.

A Wetland Assessment Area (WAA) belongs to a single regional wetland subclass and is relatively homogeneous with respect to the criteria used to assess wetland functions (Klimas et al. 2004). WAA delineation is based on the site's geomorphic landscape position as well as the vegetative cover type. The number of WAAs established depends on the size of the project, and the diversity of the geomorphic landscape and vegetative cover.

In 2007, a research project was undertaken to compare the different types of wetlands as well as functions associated with the four corridors originally proposed for the I-69 SIU13 crossing of the Ouachita River. An additional component of the project was to compare results from the Charleston Method SOP and the HGM evaluations of the impacts and required mitigation for the selected I-69 alignment in this area. A third part of the study was to compare the Charleston Method SOP and the HGM Delta Ecoregion) evaluations for a project to improve U.S. Highway 79 across the White River and its floodplain in eastern Arkansas.

<u>Study Area</u>

The study area included two new location highway construction projects and two previously established wetland mitigation bank sites, all in Arkansas (Figure 1). The highway study sites were portions of the 177-kilometer (110-mile) long I-69 SIU 13 which extends from U. S. Highway 82 west of El Dorado, Union County to U. S. Highway 65 north of McGehee, Desha County and the 7.9-kilometer (4.9-mile) long U. S. Highway 79 White River Bridge and Approaches project at Clarendon, Monroe County. The Arkansas State Highway and Transportation Department (AHTD) mitigation sites were the Middle Ouachita River Mitigation Bank site near Arkadelphia, Clark County and the Brushy Lake Mitigation Bank site near Clarendon, Monroe County.

During the evaluation process of the I-69 SIU 13 Environmental Impact Statement, four 3.2 kilometer (2.0-mile) wide corridors, all of which crossed the floodplain and wetlands associated with the Ouachita River, were evaluated (Figure 2). Wetlands were determined based on photo interpretation of National Aerial Photography Program (NAPP) Color Infrared (CIR) photography with limited ground-truthing.

After the evaluation process, a preferred corridor was chosen, Corridor A (Figure 3). Within the preferred corridor, four 91-meter (300-foot) wide alignments were evaluated to choose a preferred alignment. During the Alignment Study, CIR photography was used again, as well as USDA Soil Survey maps to identify potential wetland sites. Field verification depended on the accessibility of the sites, and potential wetland areas with limited access were verified based on aerial photography and soil survey information. Acreage of wetland impacts were reported in the EIS based on vegetation cover type; forested versus herbaceous.

The total length of the alignment for this study was 9.0 kilometers (5.6 miles). Limits of the study area were defined by elevation 30.5 meter (100 feet) mean sea level (msl) that defines the current floodplain of the Ouachita River. Figure 3 also illustrates the 30.5 meter (100 foot) msl topographic limits of the study area within Corridor A. Within the study area, there are ridges and islands that are at or above 30.5 meter (100 feet) msl elevation. Due to the size of the study area, it was assumed that everything between the 30.5 meter (100 foot) elevation contour lines was wetland, including the areas above the 30.5 meter (100 foot) elevation within each corridor. While there are some ridges and natural levees in the project area that are not wet, field reconnaissance showed that the majority of the study area would meet wetland criteria.

The 5-year floodplain elevation in Corridor A was determined to be approximately 29 meter (95 feet) msl based on stream gauge data. The 5-year floodplain elevation for Corridor B was determined as 27.43 (90 feet) msl, while 25.9 meter (85 feet) msl was chosen as the 5-year floodplain elevation for Corridors C and D. The break between what is considered the 5-year floodplain and the terraces is fairly evident. As shown in Figure 3, the obvious change in vegetation cover types is well correlated to change in the geomorphic landscape.

In the project area, Fleetwood (1969) divided the landscape into two different levels: Holocene (recent) Floodplain and Pleistocene Terraces (Deweyville 1 - 3) (Figure 4). The landscape positions illustrated by Fleetwood are consistent with well defined changes in the topographic maps (see Figure 4) as well as changes in vegetation (see Figure 3). This change in the geomorphic landscape was used in the HGM analysis to define the type of wetlands in the project area.

Since the project area is fairly homogenous, the same soil series were generally found across similar landscape surfaces. The following descriptions were taken from the NRCS Surrgo Soil Data site.

There were large areas of natural levees along the Ouachita River floodplain, and the dominant soil was the well drained, non-hydric Ouachita Series. These sites were generally dominated by upland hardwood species such as American holly (*Ilex opaca),* American sycamore (*Platanus occidentalis)*, cherrybark oak (*Quercus pagoda),* water oak (*Quercus nigra)* and American hornbeam (*Carpinus caroliniana*).

On the floodplain, there were three different series encountered, all of which are classified as hydric. The most common was the Guyton series that is normally found on floodplains of streams draining silty Pleistocene terraces and parts of the Coastal Plains. The Una series is poorly drained and normally found on floodplains or along streams that drain the Coastal Plains and Blackland Prairie Land Resource Areas. The Chastain series is also poorly drained. Sites with these series were generally dominated by willow oak (*Quercus phellos)* with common persimmon (*Diospyros virginiana)* and water oak. Loblolly pine was often found on slightly higher knolls scattered about the landscape. Overcup oak (*Quercus lyrata)* and water hickory (*Carya aquatica)* were generally found in the lower portions of the landscape.

Away from the floodplain on the flats (Pleistocene terraces), the most common soil series encountered was the Amy Series. Amy is listed as hydric and is normally found on level to nearly level Pleistocene terraces of the Western and Southern Coastal Plains. Another series similar to the Amy series is the Myatt. Like Amy, Myatt is listed as hydric and is mapped on level to nearly level broad stream terraces that occasionally to frequently flood and uplands in the Coastal Plains. Smithton is another hydric soil series found quite extensively across the Pleistocene and younger stream terraces of the Western and Southern Coastal Plains. Small depressions and flats that are ponded for several days during the wet season can be found scattered across this landscape surface. The flats were generally dominated by loblolly pine with scattered willow oak. Extensive areas of the flats are being bedded for the establishment of loblolly pine plantations.

Slightly higher on the landscape, series that are loamier in nature are present. While some of these series are wet and have high seasonal water tables late in the spring, they are not listed as hydric. Additional non-hydric soil series encountered at higher elevations within the study area included Bibb, Pheba, Ruton, Stough, Savannah, and Kalmia.

Methods

Four parallel transects, 0.8-kilometer (0.5-mile) apart, were established within each corridor of the I-69 SIU 13 study area. Along each transect, sampling plots were established at 0.4-kilometer (0.25-mile) intervals (see Figure 3). Sampling plot locations were transferred to hand-held GPS units for field application. Additional sampling plots were collected, both on and off transect, if the evaluator determined that additional sampling was necessary. Within the U. S. Highway 79 study area, a single transect on the proposed construction centerline was established with sampling plots at 0.4-kilometer (0.25-mile) intervals.

Plots were sampled using the protocol established in the HGM guidebooks for the Lower Mississippi River Alluvial Valley (Delta) and Western Gulf Coastal Plain ecoregions (Klimas et al. 2004, 2005). Data was collected for 22 variables from the Western Gulf Coastal Plain sites (I-69 SIU 13 and Lower Ouachita River Mitigation Bank) and for 20 variables from the Delta sites (U. S. Highway 79 and Brushy Lake Mitigation Bank). Variables included: "A" horizon organic matter, cation exchange capacity (Delta only, D), percent contiguous 30-meter buffer (98.4 feet)(Western Gulf only, WG), percent contiguous 250-meter (820.2 feet) buffer (WG), composition of tallest woody vegetation stratum, habitat connectivity (D), fire-maintained forest patch size (WG), core area (D), frequency of flooding, ground vegetation composition (WG), ground vegetation cover, litter cover, log biomass, O horizon organic accumulation, surface water outflow (WG), forest patch size (WG), total ponded area, snag density, soil integrity, shrub-sapling density, number of vegetative strata, tree basal area, tree composition, tree density, wetland tract (D), and woody debris biomass.

For detailed descriptions of data collection methods, refer to Klimas et al. (2004, 2005). Figure 5 illustrates the layout of a typical sampling plot. A hand held laser range finder was used when performing the stem count of trees larger than 10.1-cm (4-inches) diameter at breast height (dbh) within the 11.3-meter (37.2-foot) radius plot. Trees tallied were marked with a chalk-filled leather marking paddle. When struck against the tree, it left a visible chalk mark to help prevent repeat counts. A custom-made four inch feeler gauge was utilized to quickly assess whether stems were < 10.2 cm (4 inches) dbh. A pre-measured nylon rope was utilized to define the perimeter of both the large (0.04 ha, 0.1 acre) and small (0.004 ha, 0.01 acre) circular plots.

Results

Data from a total of 524 sample plots was collected for the I-69 SIU 13 analysis that included 120 plots from Corridor A, 138 plots from Corridor B, 124 plots from Corridor C, 115 plots from Corridor D, and 27 plots from the Middle Ouachita River Mitigation Bank site. Data from a total of 91 sample plots was collected for the Hwy. 79 crossing of the White River floodplain that included 42 plots along the new location alignment and 49 plots from the Brushy Lake Mitigation Bank site. Approximately 150 man-days were expended collecting field data for this study.

I-69 SIU 13 Corridor Analysis

Three of the seven wetland classes defined in the West Gulf Coastal Plain Region HGM guidebook (Klimas et al. 2005), depression, riverine, and flats, were encountered in the project area. Depression wetlands in the study area were considered connected if they were located within the five-year floodplain. In the project area, connected depressions fall into the floodplain depression community, and these areas were generally dominated by bald cypress/or buttonbush. Riverine class wetlands in the project area were found within the 5-year floodplain, and they belong to the low-gradient subclass. Three different WAAs were defined for this area: low-gradient backwater dominated by hardwoods (RB), low-gradient backwater dominated by loblolly pine (natural) (RBP), and low-gradient backwater dominated by loblolly pine plantations (RBPP). Wetland flats in the project area were in the non-alkali subclass further divided into two community classes: hardwood flats (HF) and pine flats. The pine flat community class can be further subdivided into loblolly pine flats (natural) (PF) and pine plantation flats (PPF). This classification scheme was utilized in both the corridor study as well as the preferred alignment study. Table 1 provides an acreage comparison of the WAAs found within each of the corridors. The distribution of the different WAAs within Corridor A is illustrated in Figure 6.

The HGM assessment model was used to generate the Functional Capacity Index (FCI) for a WAA with values ranging between 0 and 1, where 1.0 represents a fairly functional condition. The FCI value is multiplied by the WAA size (acres or hectares) to yield the Functional Capacity Unit (FCU) (Klimas 2006). Table 2 presents the functional comparison between the four original corridors proposed for the Ouachita River crossing.

Mitigation

Completion of the analysis comparing the Charleston Method SOP to the HGM on the preferred alignment required data collection from the 121.4 hectare (300 acre) mitigation area in Clark County, Arkansas (Figure 7). Farmed wetlands located within the 5-year floodplain of the Ouachita River (riverine low-gradient backwater) occupied 102.8 hectares (254 acres) of the site resulting in the classification of only one WAA. The site was purchased by AHTD in 2001 and subsequently planted according to a COE approved wetland mitigation plan.

I- 69 Preferred Alignment: Charleston Method SOP vs. the HGM

The Charleston Method SOP analysis determined there were six different wetland areas impacted (Table 3): hardwoods below elevation 28.9 meter (95 feet) msl, bridged hardwoods, bridged depression, filled depression, hardwood flats, and pine flats. The Charleston Method analysis found that 4380.3 credits would be required to mitigate for project wetland impacts. Also using the Charleston Method, 1118.4 credits could be obtained from the Middle Ouachita River Mitigation Site which is 3261.9 credits short. The credits-per-acre ratio at the mitigation site was 4.4 (1118.4 credits/254 restored wetland acres), and using this ratio, a total of 402.9 hectares (995.5 acres) of wetland restoration at a cost of $3,484,330 would be required for project wetland mitigation.

Mitigation requirements using the HGM method can be assessed in two ways. One option is apply the HGM methodology to determine the FCUs (Table 4) lost due to highway construction and how many FCUs would be available at the mitigation site (Table 5). The second approach is to determine the acres of mitigation required to offset losses in the project area. Using this approach would require out-of-kind mitigation for these two wetland classes (connected depressions and flats), and finding potential replacement in-kind acreage for the connected depressions could be difficult.

Mitigation ratios were determined based on the assumption that the mitigation area began as farmed wetlands that were reforested with the appropriate species and micro-topographic relief was restored. For the HGM, the mitigation ratio was calculated by dividing the mean annualized FCI for the project impact area (equals the current FCI) (Table 4) by the mean annualized FCI for the proposed mitigation site (Table 5). The annualization of the mitigation site is based on a 50-year life of the project. Using a “life of the project” allows for calculation of annualized losses which can be offset by annualized gains (Klimas personal communication). A “50-year life of the project” was chosen because that is the estimated time frame for the mitigation site to be fully functional, thus offsetting the losses from the impacted site. As an example, the mean FCI for the riverine backwater (hardwood) WAA is 0.89, and the mean annualized FCI for the mitigation site is 0.86 yielding a ratio of 1.03. Multiplying the area of impacts for the riverine backwater (hardwood) WAA, 10.6 hectares (26.2 acres), by 1.03 yields the required mitigation, 10.92 hectares (27.0 acres). Performing similar calculations for riverine backwater (pine) and riverine backwater (pine plantation) yields ratios of 0.84 and 0.88, respectively. The required mitigation would be 1.26 hectares (3.1 acres) for the riverine backwater (pine) WAA and 2.02 hectares (5.0 acres) for the riverine backwater (pine plantation). For the riverine backwater class overall, there were 14.4 hectares of impacts requiring 14.2 hectares of mitigation. To compare the HGM method to the Charleston Method SOP, the average FCI for each WAA was multiplied by the area of impacts to calculate the number of impacted FCUs.

The HGM analysis revealed that the I-69 SIU 13 project would impact 12.26 FCUs of the riverine class, 49.22 of the flat class, and 6.39 of the connected depression class (Table 4). Analysis of the mitigation area found that there are currently 88.2 annualized FCUs of riverine backwater mitigation available (Table 5) leaving a balance of 75.89 FCUs. There are no areas of the mitigation site that would serve to mitigate in-kind for the impacts to the connected depressions and flats, so additional acreage would be required. Using the HGM calculations, a total of 231.8 hectares (572.7 acres) of mitigation would be required, and at $3500 per acre, the total mitigation cost would be $2,004,409.

Compared to the Charleston Method SOP calculations, a cost reduction of $1,479,921 is realized using the HGM, and the total mitigation acreage required is reduced from 402.9 hectares (995.5 acres) to 231.8 hectares (572.7 acres). A more accurate determination of acreage required to replace the flats and depressions and thus a true cost, would require analysis of the site chosen for the additional acreage to determine how many FCUs would be available.

There are enough FCUs and acreage of the riverine backwater remaining at the mitigation site to cover the mitigation requirement for these two classes, if the regulatory agencies agreed to out-of-kind mitigation for the impacts to the connected depressions and flats,.

<u>Hwy. 79 Crossing of the White River and Floodplain – Charleston Method SOP vs. the HGM</u>

This project consists of the construction of a new bridge and approaches across the White River and its associated floodplain in Monroe County (Figure 8). In the project area, this roadway serves as the boundary between the Cache River National Wildlife Refuge (to the north) and White River National Wildlife Refuge (to the south). The total length of the project is 7.8 kilometers (4.9 miles), primarily on new location. The impact area was divided into six different areas for the Charleston Method SOP analysis Table 6.   A total of 1009.3 credits would be required as mitigation for wetland impacts. Using the Charleston Method SOP, the 129.5 hectare (320 acre) Brushy Lake Mitigation Bank yielded a total of 1149.9 available credits from the 110.5 hectares (273 acres) of farmed wetland and forested oxbow at the site for a credit/acre ratio of 4.2.

Using HGM classification, two wetland classes are associated with the impacted area; riverine backwater and connected depressions. The impact area was divided into four WAAs; low-gradient riverine backwater (logged), low-gradient riverine backwater (forested), low-gradient riverine backwater (farmed wetland), and connected depressions (Table 7). A total of 22.19 FCUs will be needed to offset impacts to the riverine backwater wetlands and 1.11 FCUs will be required for the impacts to the connected depression.

The 129.5 hectare (320 acre) AHTD Brushy Lake Mitigation Bank Site was divided into four WAAs; forested connected depression, scrub-shrub connected depression, cypress-tupelo forested connected depression, and forested low-gradient riverine backwater wetlands. The distribution of the WAAs at the Brushy Lake Mitigation Bank Site is illustrated in Figure 9.

Charleston Method SOP analysis yielded a total 1149.9 credits available at the Brushy Lake Mitigation Bank Site. A total of 1009.3 credits are required to mitigate the wetland impacts resulting from construction of the White River Bridge and Approaches. Using 4.2 credits/acre, 97.1 hectares (240.0 acres) would be required to mitigate for project wetland impacts, and at $8,660/hectare ($3,500/acre), the total mitigation cost would be $841,083.

Using the HGM, the mitigation site has enough FCUs to cover the impacts to the riverine backwater wetlands as well as the connected depressions (Table 8). Using a 50-year life of the project, a total of 25.75 hectares (63.63 acres) of mitigation are required to mitigate for impacts to the riverine backwater wetlands and 1.33 hectares (3.29 acres) are needed for the impacts to the connected depressions. A total of 22.19 FCU's would be needed to replace the lost functions of the riverine backwater wetlands, leaving a balance of 6.65 FCUs. Mitigation for impacted FCUs of the connected depressions (1.11) removed from the 50.43 FCUs available leaves a balance of 49.32 FCUs. A total of 27.0 hectares (66.9 acres) would be required for mitigation of project impacts, and at $8,660/hectare ($3,500/acre), the total mitigation cost for project impacts would be $234,150

Discussion

Results of the I-69 SIU 13 corridor study using HGM found substantial differences in the wetlands and functions among the four corridors. There are two ways to interpret or utilize the data presented in Tables 1 and 2. One method would be to compare the acreage of the different wetland WAAs present within each corridor. If connected floodplain depressions dominated by cypress were the main area of interest, Corridor B, which had more acreage of this wetland class than the other corridors, would have been eliminated in the initial stages of corridor comparison. If pine flat wetlands were deemed unimportant, then those corridors with the most acreage of this class could be considered for the preferred alternative. Another way to interpret Table 2 is to examine FCI values for each of the individual functions for the different WAAs. The function of greatest concern or the most impacted function for a WAA can be compared among the different corridors. If a substantial difference is apparent, the evaluator can reassess data used to calculate the function value to determine the possible cause of the difference. Examining the "provide wildlife habitat function" for the riverine backwater (hardwood) WAAs finds that this function is similar between each of the corridors. However, this same function in the hardwood flat class shows a noticeable difference between Corridors C and D and Corridors A and B. The other method is to examine the average FCI for the WAA and the total FCUs for a WAA class. An example would be comparing the FCUs for the riverine backwater (hardwood) class among corridors. Corridor A has a substantially smaller number of FCU's for this wetland class and would obviously be the preferred corridor if riverine backwater was the primary wetland concern within the project area.

Wetland assessment is generally conducted in one of two ways. The generally preferred method is to evaluate functions individually, either selecting the function that is of most interest or the function that is most impacted. Mitigating for the most impacted function will compensate for the other functions as well. The combined scores method for all functions to get a single "bottom line" score or average FCI value is generally discouraged. The FCI is then multiplied by the area of the WAA to get an average FCU value for the site.

Comparison of required mitigation for wetland impacts found substantial differences between the HGM and the Charleston Method SOP for the selected I-69 SIU 13 alternative. Using the Charleston Method SOP and an AHTD-owned mitigation site to determine mitigation ratios, approximately 4380 total mitigation credits would be required at a cost of approximately $3,484,330. The HGM results indicated the mitigation site would provide sufficient FCUs to compensate for the riverine backwater class (12.26 needed, 88.15 available); however, no acreage was available at the bank site to mitigate in-kind for lost FCUs associated with the connected depression or flat classes. Additional acreage would be required for in-kind mitigation that would include 140.82 acres for the flats and 18.43 for the connected depressions.

Using the HGM calculations, a total of 231.5 hectares (572.7 acres) of mitigation would be required, and at $8,660/hectare ($3,500/ acre), the total mitigation cost would be $2,004,409. In this case, the HGM resulted in a cost savings of approximately $1.48M when compared with using the Charleston Method SOP. If the regulatory agencies allowed out-of-kind mitigation, there were enough FCUs and acreage of the riverine backwater class remaining at the Middle Ouachita River Bank Site to mitigate for impacts to the connected depressions and flats.

The difference between the two methods was equally striking at the AHTD project crossing the White River floodplain. Using the Charleston Method SOP, 1009.3 mitigation credits were required for construction related wetland impacts, and the Brushy Lake Mitigation Bank Site yielded 4.2 credits/acre. Total mitigation cost at $8,660/hectare ($3,500/acre) would be $841,083. The HGM evaluation showed that 22.06 FCUs of the riverine backwater class and 1.11 FCUs of the connected depression class would be required for mitigation which equates to 27.0 hectares (66.9 acres) at the Brushy Lake Mitigation Bank Site. Total mitigation cost at $8,660/hectare ($3,500/acre) would be $234,150.

The HGM requires preliminary evaluations in the office to organize the sampling protocol before going to the field. Vegetation cover affected the rate of sampling for the HGM. Open sites could be sampled in 15 minutes or less with two people or 20 to 30 minutes with one person. There is little difference between sampling one of these plots and sampling a wetland delineation plot; however, dense vegetative cover such as a pine thicket or pine plantation thicket slowed the sampling time substantially.

Tallying trees within the 11.3-meter (37.2-foot) radius takes little time in open stands, but when the plot falls in stands with dense understory, the process slows substantially. Sampling shrubs/saplings within the 3.6-meter (11.8-foot) radius plot can also be very time consuming as. Some plots encountered had over 10,000 stems per hectare (25,000/acre). When sampling the shrub/sapling stem count, a point is reached when it is not be necessary to count any more. The shrub/sapling count for the two 3.6-m (11.8-foot) diameter subplots is added and multiplied by 125 to obtain a stem/hectare value. The distribution curve for the shrub/sapling variable from the Coastal Plains Regional Guidebook (Klimas et al. 2005) reaches the maximum sub-index value of 1.0 with a stem count between 500 - 2000 stems/ha (1250 – 5000/acre). This range is achieved with a stem count of 4-16/3.6-meter (11.8-foot) plot. A stem count from 16–32 causes the sub-index value to decline from 1.0 to 0.5; however continuing a stem count above 32 is unnecessary because the sub-index value levels off at 0.5. Often in the bottomlands, plots were encountered with no stems on either plot or just one or two total.

The HGM requires more time than the Charleston SOP, since the latter does not require the collection of any quantitative data. The advantage of the HGM is that the models are calibrated to reference wetlands in the geographic area, and it also uses a relative index of functions, calibrated to reference wetlands, to assess wetland functions. The Charleston SOP's appeal is that it is quick, easy to apply, and can be performed with a minimum of field evaluation. The HGM provided a good comparative analysis of the four corridors across the Ouachita River floodplain, as well as very interesting results when compared to the Charleston SOP comparing impacts and mitigation requirements associated with the preferred alignment. The results were similar when the comparison was made on the AHTD project over the White River and its floodplain in eastern Arkansas. This project was smaller in scale so the cost difference between the two methods was not as dramatic. The HGM method worked well on a large scale project. The majority of highway projects are on the small scale so the HGM method would probably not be needed as the Charleston SOP provided satisfactory results.

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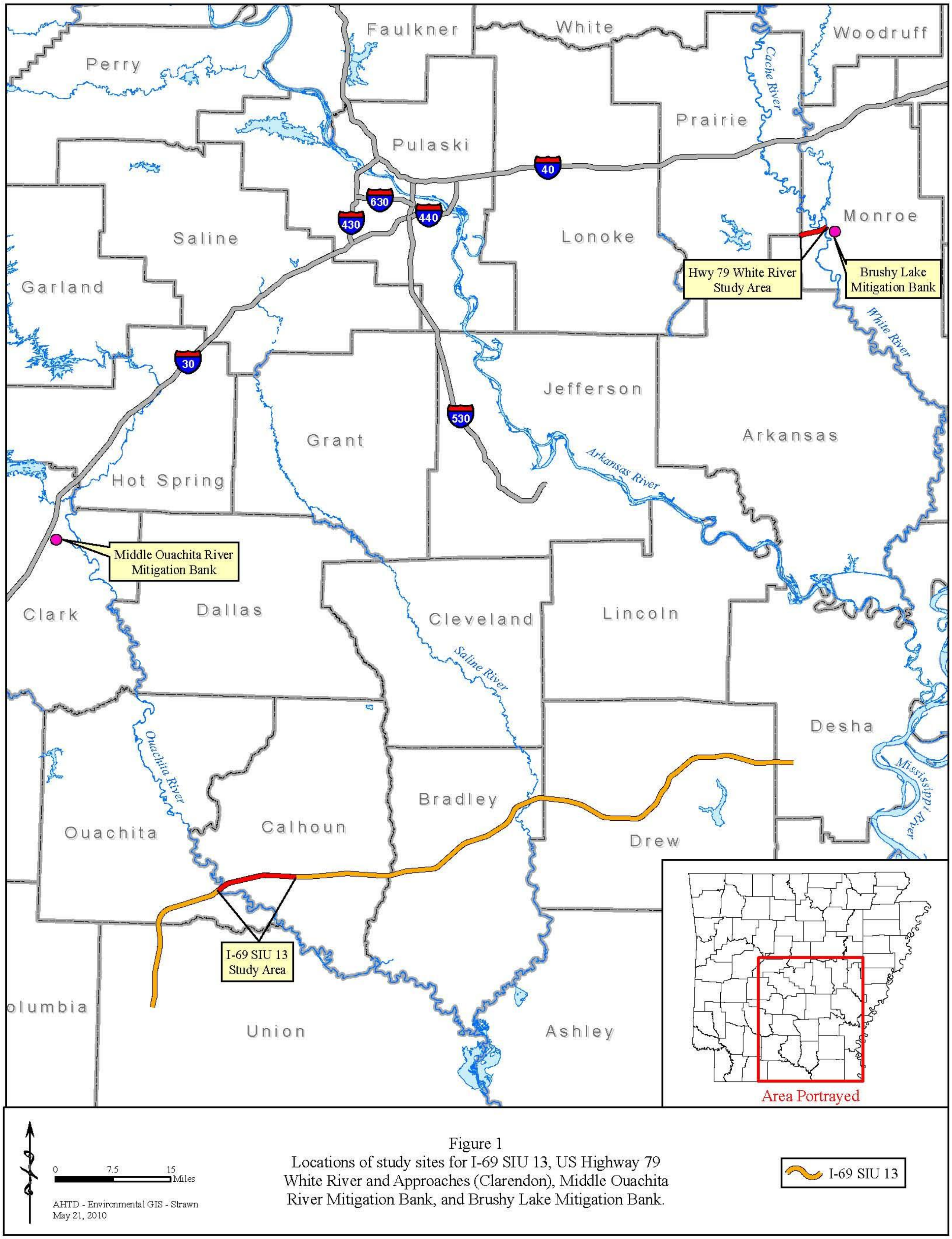

Figure 1
Locations of study sites for I-69 SIU 13, US Highway 79 White River and Approaches (Clarendon), Middle Ouachita River Mitigation Bank, and Brushy Lake Mitigation Bank.

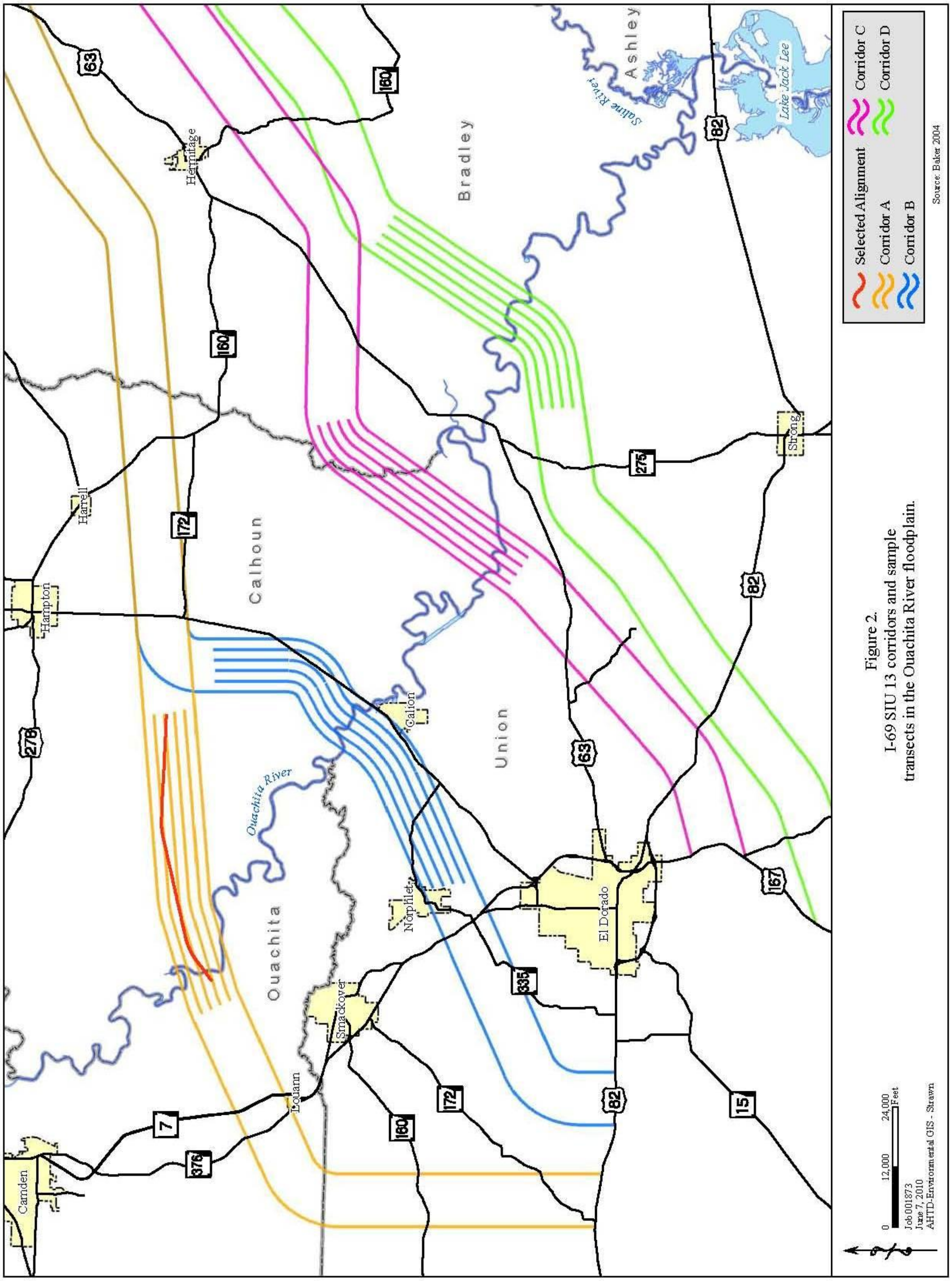

Figure 2.
I-69 SIU 13 corridors and sample
transects in the Ouachita River floodplain.

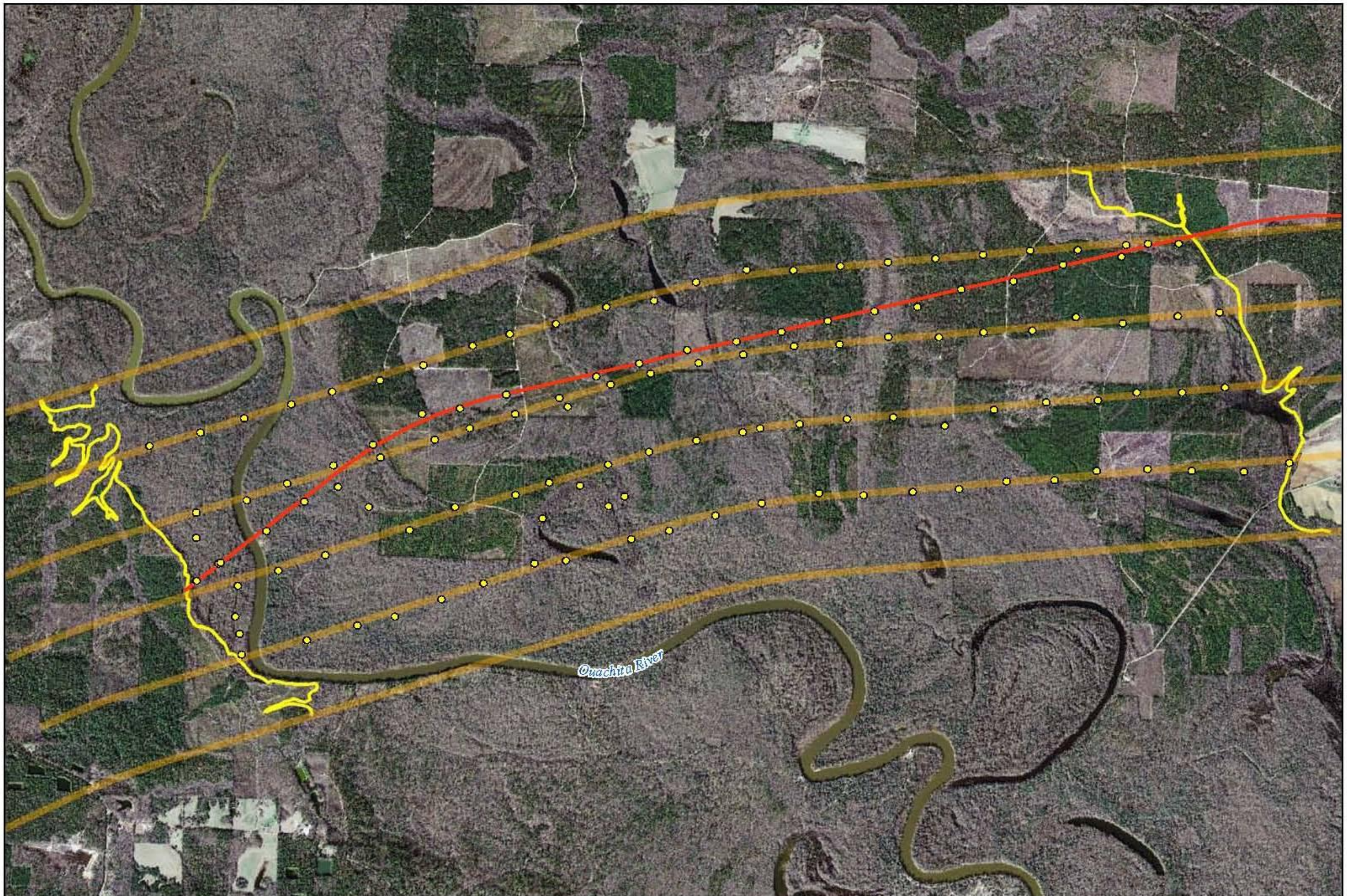

Figure 3.
I-69 SIU 13 Corridor A with selected alignment
and sample locations in the Ouachita River floodplain.

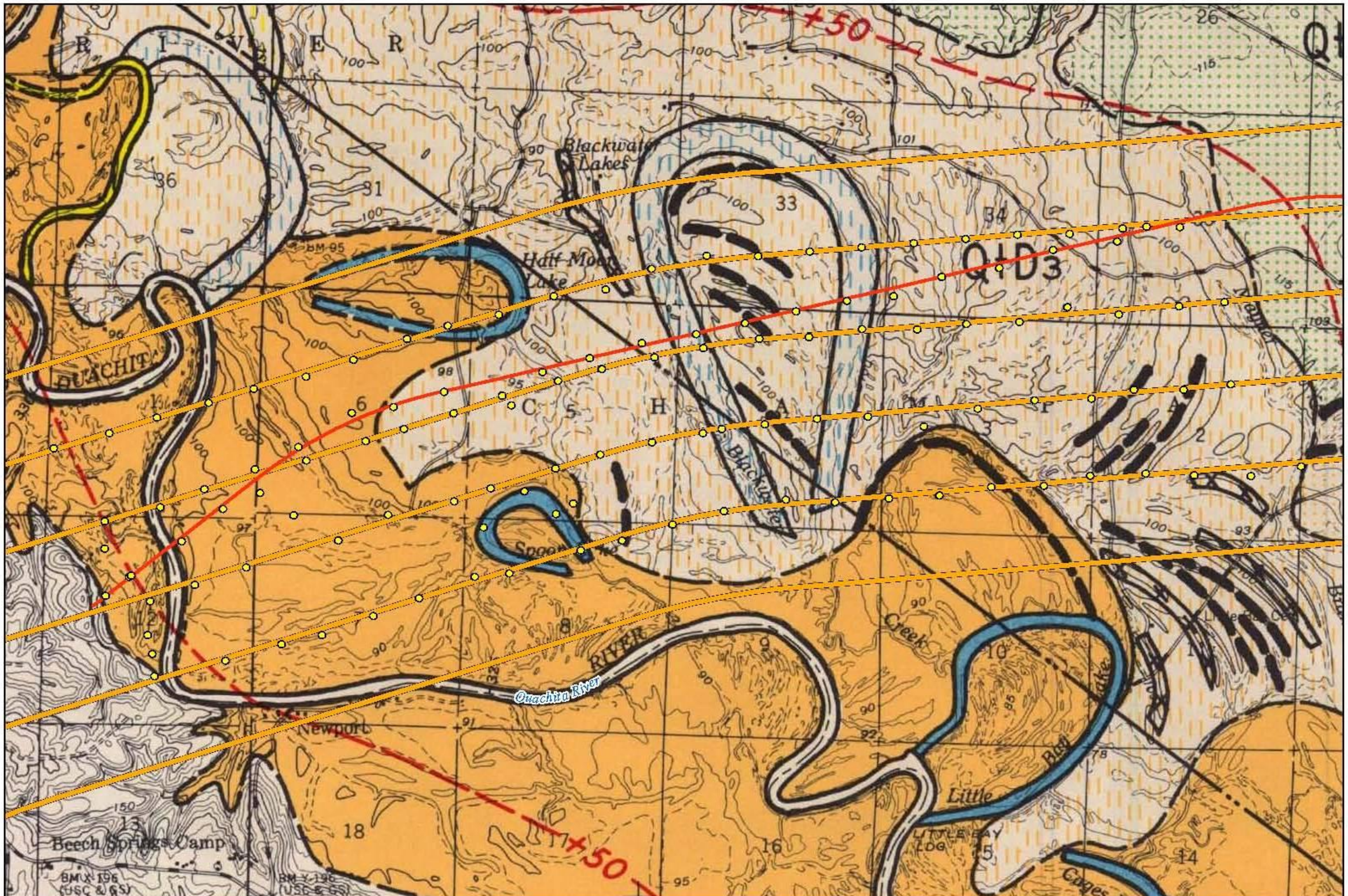

Figure 4.
I-69 SIU 13 Corridor A geomorphic
landscape in the Ouachita River floodplain.

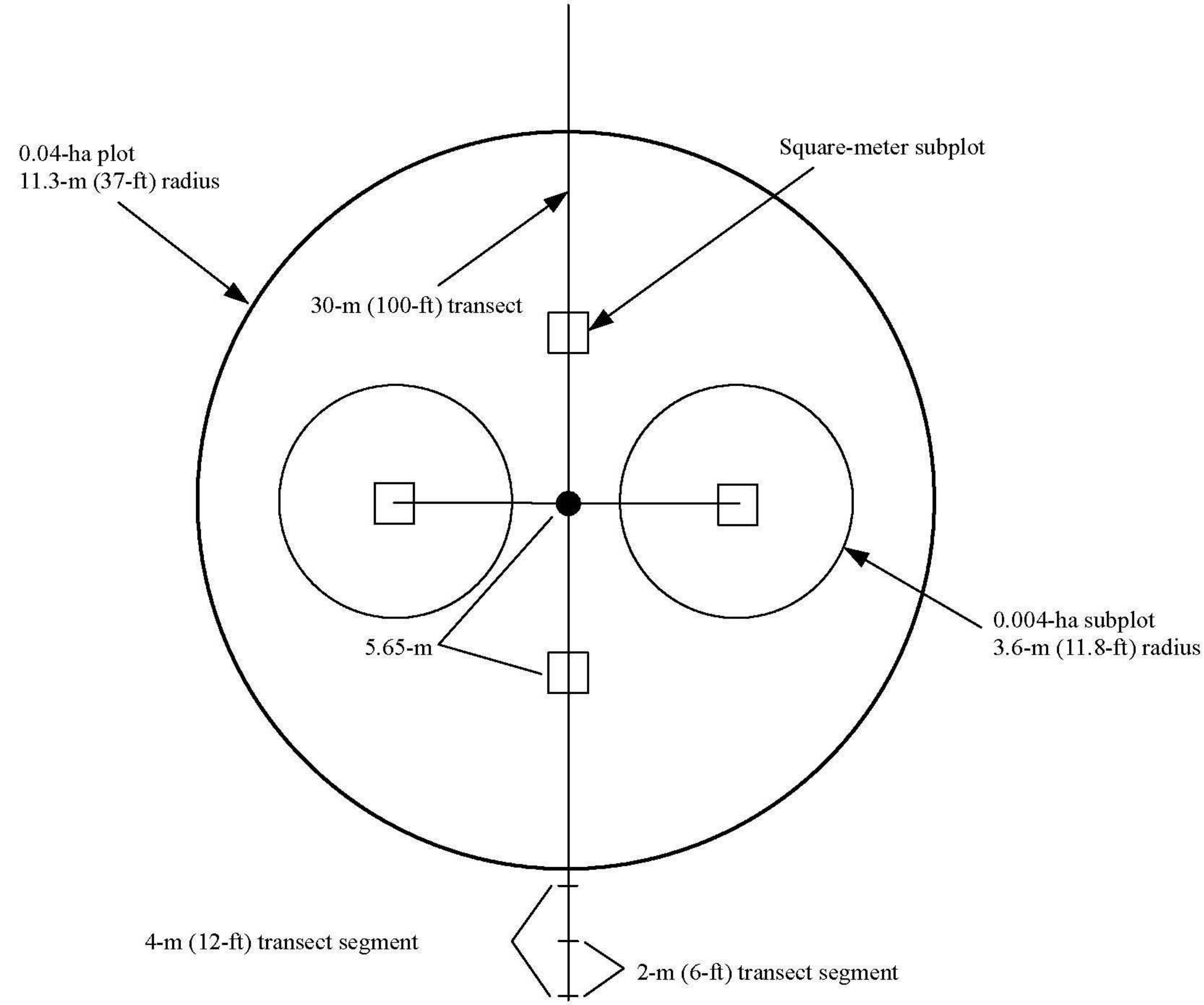

Figure 5.
Layout of sampling plot.

Job 001873
June 7, 2010
AHTD - Environmental GIS - Strawn

Source: Klimas et al., 2005

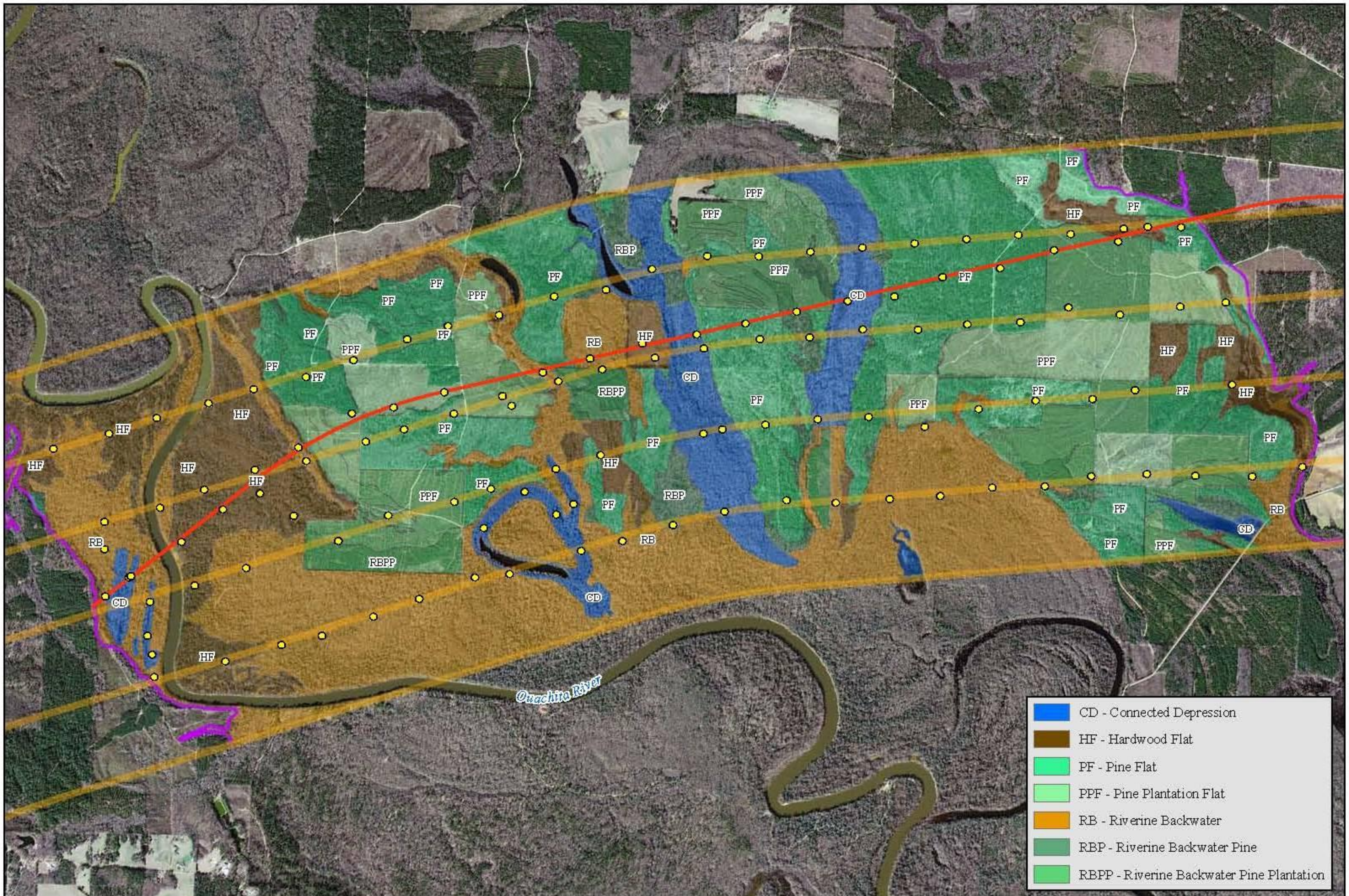

Figure 6.
Wetland Assessment Areas defined for I-69
SIU 13 Corridor A in the Ouachita River floodplain.

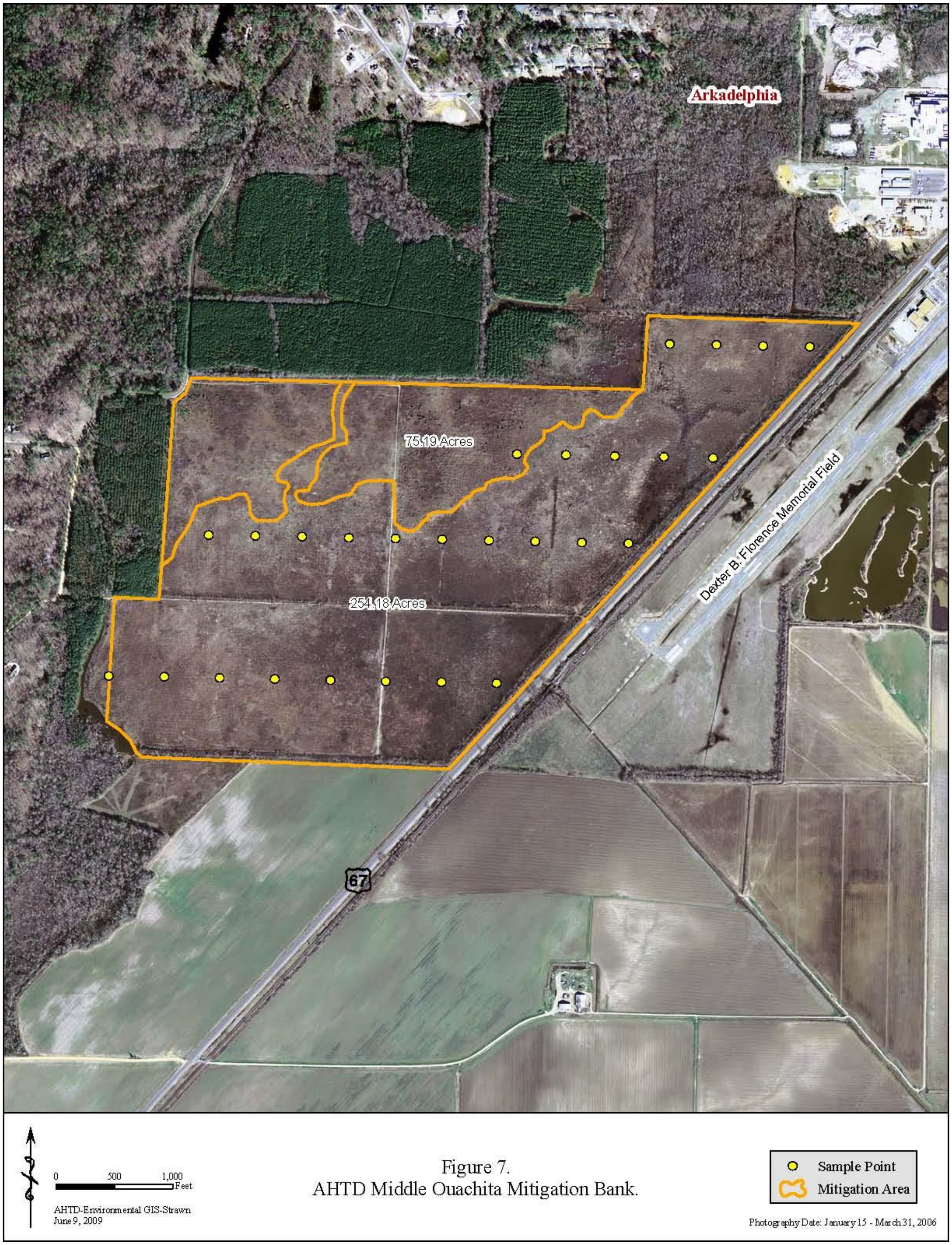

Figure 7.
AHTD Middle Ouachita Mitigation Bank.

AHTD-Environmental GIS-Strawn
June 9, 2009

Photography Date: January 15 - March 31, 2006

Figure 8.
AHTD's Highway Project 110123 (Hwy. 79)
Across the White River and its Floodplain
in Western Monroe County, Arkansas.

Figure 9.
Wetland Assessment Areas defined
at the Brushy Lake Mitigation Bank site.

Table 1. Wetland Assessment Areas (WAAs) of the I-69 SIU 13 Corridors

Wetland Assessment Area (WAA)	Corridor A Acres (Hectares)	Corridor B Acres (Hectares)	Corridor C Acres (Hectares)	Corridor D Acres (Hectares)
Connected Depression (CD)	596.6 (241.4)	1102.3 (446.1)	788.4 (319.1)	467.2 (189.1)
Riverine Backwater (Hardwood)	2036.9 (824.4)	5614.8 (2272.3)	3952.0 (1599.4)	3628.1 (1468.3)
Riverine Backwater (Pine)	180.1 (72.9)	255.1 (103.2)	269.6 (109.1)	1386.0 (560.9)
Riverine Backwater Pine Plantation	191.4 (77.4)	57.9 (23.4)	148.7 (60.2)	395.3 (159.9)
Hardwood Flat	863.0 (349.3)	247.2 (100.0)	208.6 (84.4)	581.6 (235.4)
Pine Flat (Natural)	1878.5 (760.2)	447.6 (181.1)	2776.7 (1123.8)	1693.9 (685.5)
Pine Flat (Plantation)	1282.6 (519.1)	353.8 (143.2)	1438.6 (582.2)	1079.8 (436.9)
Total	7029.1 (2844.7)	8078.7 (3269.5)	9582.7 (3878.1)	9231.8 (3736.1)

Table 2A. Functional Capacity Index Values for Wetland Assessment Areas in I-69 SIU 13 Corridor A.

Function	Riverine Backwater (Hardwood)	Riverine Backwater Pine	Riverine Backwater Pine Plant	Connected Depression	Pine Flat	Pine Plantation Flat	Hardwood Flat
Detain Floodwater	1.000	0.849	0.389	1.000	N/A	N/A	N/A
Detain Precipitation	1.000	0.972	1.000	N/A	0.771	0.875	0.793
Biogeochemical Cycling	0.979	0.875	0.739	0.974	0.760	0.836	0.728
Export Organic Carbon	0.979	0.875	0.739	0.974	N/A	N/A	N/A
Maintain Plant Communities	0.969	0.920	0.735	0.945	0.853	0.863	0.602
Provide Wildlife Habitat	0.984	0.946	0.834	0.984	0.506	0.499	0.886
Sum	5.911	5.437	4.436	4.877	2.89	3.073	3.009
Average FCI	0.985	0.906	0.739	0.975	0.723	0.768	0.752
Hectares	824.4	72.9	77.4	241.4	760.2	519.1	349.3
FCU	812.17	66.06	57.22	235.46	549.24	398.80	262.76

Table 2B. Functional Capacity Index Values for Wetland Assessment Areas in I-69 SIU 13 Corridor B.

Function	Riverine Backwater (Hardwood)	Riverine Backwater Pine	Riverine Backwater Pine Plant	Connected Depression	Pine Flat	Pine Plantation Flat	Hardwood Flat
Detain Floodwater	1.000	0.791	0.653	1.000	N/A	N/A	N/A
Detain Precipitation	1.000	1.000	1.000	N/A	0.625	0.737	0.922
Biogeochemical Cycling	0.932	0.759	0.737	1.000	0.729	0.807	0.804
Export Organic Carbon	0.932	0.759	0.737	1.000	N/A	N/A	N/A
Maintain Plant Communities	0.938	0.978	0.774	0.964	0.866	0.928	0.886
Provide Wildlife Habitat	0.962	0.949	0.824	0.9694	0.427	0.498	0.934
Sum	5.764	5.236	4.725	4.933	2.647	2.970	3.546
Average FCI	0.961	0.873	0.788	0.987	0.662	0.743	0.887
Hectares	2272.3	103.2	23.4	446.1	143.2	143.2	100
FCU	2182.92	90.06	18.43	440.16	94.76	106.33	88.65

Table 2C. Functional Capacity Index Values for Wetland Assessment Areas in I-69 SIU 13 Corridor C.

Function	Riverine Backwater (Hardwood)	Riverine Backwater Pine	Riverine Backwater Pine Plant	Connected Depression	Pine Flat	Pine Plantation Flat	Hardwood Flat
Detain Floodwater	0.885	0.823	0.750	0.922	N/A	N/A	N/A
Detain Precipitation	1.000	0.875	1.000	N/A	0.570	0.728	0.583
Biogeochemical Cycling	0.854	0.834	0.653	0.943	0.740	0.756	0.770
Export Organic Carbon	0.854	0.834	0.653	0.943	N/A	N/A	N/A
Maintain Plant Communities	0.952	0.724	0.650	0.958	0.802	0.801	0.756
Provide Wildlife Habitat	0.965	0.905	0.593	0.992	0.422	0.458	0.553
Sum	5.510	4.995	4.299	4.758	2.534	2.743	2.662
Average FCI	0.918	0.833	0.717	0.952	0.634	0.686	0.666
Hectares	1599.4	109.1	60.2	319.1	1123.8	582.2	84.4
FCU	1468.78	90.83	43.13	303.66	711.93	399.24	56.17

Table 2D. Functional Capacity Index Values for Wetland Assessment Areas in I-69 SIU 13 Corridor D.

Function	Riverine Backwater (Hardwood)	Riverine Backwater Pine	Riverine Backwater Pine Plant	Connected Depression	Pine Flat	Pine Plantation Flat	Hardwood Flat
Detain Floodwater	0.944	0.896	0.720	1.000	N/A	N/A	N/A
Detain Precipitation	0.902	0.907	1.000	N/A	0.517	0.505	0.463
Biogeochemical Cycling	0.910	0.821	0.769	0.948	0.718	0.779	0.693
Export Organic Carbon	0.860	0.821	0.769	0.948	N/A	N/A	N/A
Maintain Plant Communities	0.943	0.920	0.729	0.961	0.734	0.695	0.682
Provide Wildlife Habitat	0.954	0.921	0.871	0.982	0.397	0.350	0.311
Sum	5.513	5.286	4.858	4.839	2.366	2.329	2.149
Average FCI	0.919	0.881	0.810	0.968	0.592	0.582	0.537
Hectares	1468.3	560.9	159.9	189.1	685.5	436.9	235.4
FCU	1349.12	494.15	129.47	183.01	405.47	254.39	126.47

Table 3. Required mitigation for I-69 SIU 13 selected alternative determined by the Charleston Method SOP.

Factor	Bottomland Hardwoods (bridged)	Depression (bridged)	Depression (filled)	Hardwood Flats	Pine Flats	Hardwoods (< 95 feet msl)
Lost Type	3.0	2.0	2.0	2.0	2.0	3.0
Priority Category	0.5	0.5	0.5	0.5	0.5	0.5
Existing Condition	2.5	2.5	2.5	2.5	2.5	2.5
Duration	2.0	2.0	2.0	2.0	2.0	2.0
Dominant Impact	1.0	1.0	3.0	3.0	3.0	3.0
Cumulative Impact	10.6	10.6	10.6	10.6	10.6	10.6
Sum of r Factors	R1=19.6	R2=18.6	R3=20.6	R4=20.6	R5=20.6	R6=21.6
Impacted Area	AA1=14.7	AA2=5.0	AA3=15.4	AA4=27.4	AA5=120.3	AA6=29.6
R x AA=	288.1	93.0	317.2	564.4	2478.2	639.4

Total Required Credits = $\sum$ (R x AA) = 4380.3

Table 4. Functional Capacity Index values for the selected alternative of I-69 SIU 13.

	Connected Depression	Riverine Backwater Hardwood	Riverine Backwater Pine	Riverine Backwater Pine Plantation	Hardwood Flats	Pine Flatwoods	Pine Flat Plantation
Detain Floodwater	0.583	0.819	0.506	0.625	N/A	N/A	N/A
Detain Precipitation	N/A	1.000	1.000	1.000	1.000	0.805	0.875
Biogeochemical Cycling	0.706	0.806	0.557	0.750	0.906	0.679	0.793
Export Organic Carbon	0.706	0.806	0.557	0.750	N/A	N/A	N/A
Maintain Plant Communities	0.904	0.972	0.820	0.721	0.884	0.830	0.901
Provide Wildlife Habitat	0.982	0.953	0.880	0.706	0.951	0.491	0.470
Sum	3.881	5.356	4.32	4.55	3.74	2.81	3.04
Mean FCI	0.78	0.89	0.72	0.76	0.94	0.70	0.76
Hectares	8.2	10.6	1.5	2.3	14.7	26.9	21.8
FCU	6.39	9.43	1.08	1.75	13.82	18.83	16.57

Table 5. Mean Functional Capacity Index values annualized over 50 years for Riverine backwater class at the Middle Ouachita River Mitigation Bank site.

	Wetland Functions					
Age	Detain Floodwater	Detain Precipitation	Nutrient Cycling	Export Organic Carbon	Plant Community Maintenance	Wildlife Habitat Maintenance
	Functional Capacity Index (FCI)					
10	0.375	0.721	0.447	0.366	0.703	0.453
20	0.600	0.895	0.623	0.623	0.906	0.771
30	0.796	0.930	0.779	0.779	0.949	0.924
40	0.935	0.963	.0912	0.912	0.980	0.971
50	0.975	1.000	0.983	0.983	1.000	1.000
60	0.988	1.000	0.992	0.992	1.000	1.000
Mean Annualized FCI	0.7975	0.9297	0.8033	0.7952	0.9373	0.8785
Overall Mean Annualized FCI 0.8569 x 102.87 hectares = 88.1493 FCU						

Table 6A. Charleston Method SOP required mitigation credits for White River Bridge & Approaches (Hwy. 79).

Factor	Forested (Fill)	Forested (Bridge)	Farmed (Fill)	Forested (Bridge)	Forested (Fill)	Forested (Bridge)	Forested (Bridge)	Forested Depression (Bridge)	Borrow Pits (Fill)
Lost Type	**3.0**	**3.0**	**0.2**	**3.0**	**3.0**	**3.0**	**0.2**	**3.0**	**0.2**
Priority Category	**2.0**	**2.0**	**0.5**	**2.0**	**2.0**	**2.0**	**0.5**	**0.5**	**0.5**
Existing Condition	**2.5**	**2.5**	**2.0**	**2.5**	**2.5**	**2.5**	**2.5**	**2.0**	**2.5**
Duration	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
Dominant Impact	**3.0**	**0.2**	**3.0**	**0.2**	**3.0**	**0.2**	**0.2**	**0.2**	**3.0**
Cumulative Impact	**3.79**	**3.79**	**3.79**	**3.79**	**3.79**	**3.79**	**3.79**	**3.79**	**3.79**
Sum of r Factors	R_1=16.29	R_2=13.49	R_3=11.49	R_4=13.49	R_5=16.29	R_6=13.49	R_7=9.19	R_8=11.49	R_9=11.99
Impacted Area	A_1=1.5	A_2=7.4	A_3=12.1	A_4=5.1	A_5=10.1	A_6=29.6	A_7=2.1	A_8=0.9	A_9=7.9
R x A=	24.4	99.8	139	68.8	164.5	399.3	19.3	10.3	83.9

Total Required Mitigation Credits = $\sum$(R x AA) = 1009.3

Table 6B. Charleston Method SOP available mitigation credits for Brushy Lake Mitigation Bank site.

Factor	**Farmed Wetland**	**Forested Oxbow**
Net Improvement	3.0	2.0
Control	0.6	0.6
Temporal lag	-0.2	0
Credit Schedule	0.2	0.3
Kind	0.4	0.2
Location	0.4	0.4
Credits per Acre	M_1 = **4.4**	M_2 = **3.5**
Mitigation Area	A_1 = **216**	A_2 = **57**
M x A=	**950.4**	**199.5**

Total Mitigation Credits Available = 1149.9

Table 7. Functional Capacity Index values for Wetland Assessment Areas at the White River Bridge & Approaches (Hwy. 79).

Functions	FCI Riverine Backwater (Logged)	FCI Riverine Backwater (Forested)	FCI Riverine Backwater (Farmed Wetland)	FCI Depressions Connected
Detain Floodwater	0.915	1.00	0.24	0.77
Detain Precipitation	0.977	0.99	0.59	n/a
Cycle Nutrients	0.744	0.86	0.24	0.53
Export Organic Carbon	0.795	0.91	0.21	0.13
Maintain Plant Communities	0.847	0.92	0.00	0.10
Provide Wildlife Habitat	0.890	0.96	0.22	0.26
Sum	5.168	5.64	1.5	1.79
Mean FCI	0.86	0.94	0.25	0.358
Hectares	4.20	18.60	4.40	3.10
Annualized FCU	3.61	17.48	1.1	1.11

Table 8. Mean annualized Functional Capacity Index over 50 years for Riverine backwater class at the Brushy Lake Mitigation Bank site.

	Wetland Functions					
Age	Detain Floodwater	Detain Precipitation	Nutrient Cycling	Export Organic Carbon	Plant Community Maintenance	Wildlife Habitat Maintenance
	Functional Capacity Index (FCI)					
10	0.427	0.924	0.483	0.507	0.625	0.639
20	0.531	1.000	0.547	0.610	0.851	0.767
30	0.701	1.000	0.800	0.863	0.886	0.911
40	0.864	1.000	0.917	0.979	0.925	0.981
50	0.950	1.000	0.938	1.000	0.975	0.986
60	1.000	1.000	0.938	1.000	1.000	0.986
Mean Annualized FCI	0.7519	0.9924	0.7825	0.8411	0.8899	0.8915
Overall Mean Annualized FCI 0.8582 x 33.6 hectares = 28.84 FCU						