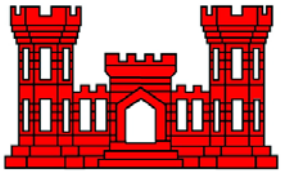
Appendix E
Part 4

Hydrogeomorphic (HGM) Assessment of Alternatives for the St. Johns Bayou Basin and New Madrid Floodway Project



U.S. Army Corps of Engineers
Memphis District

WORKING DRAFT AS OF 6-17-12

HYDROGEOMORPHIC (HGM) ASSESSMENT OF ALTERNATIVES FOR THE ST. JOHNS/NEW MADRID FLOOD ABATEMENT PROJECT

A Hydrogeomorphic (HGM) wetland assessment was requested by Memphis District on impacts associated with the St. Johns/New Madrid flood abatement project. The Arkansas Delta Regional Guidebook (Klimas et al. 2011, Appendix E, Part 5 of the EIS) was developed by the Arkansas Multi-Agency Planning Team and ERDC personnel in cooperation with EPA Region 6, which provided much of the funding. This Guidebook was originally developed for the Mississippi Alluvial Plain within Arkansas, which is located just south of the project area and comprises very similar geomorphology, soils and vegetation, so much so that the Reference Domain, that area for which the Guidebook is deemed applicable, has been officially extended to all areas within the lower Mississippi Alluvial Valley north of Arkansas. The Guidebook and its models were certified for use on this project, provided that changes were made to the HGM Functional Capacity Index (FCI) calculator that afforded fewer opportunities for data entry and hand calculation errors. The calculator was retooled to address these requirements, and was thoroughly tested during the data entry and FCI calculation portion of the analysis.

BACKGROUND: THE HGM ASSESSMENT APPROACH

The HGM assessment approach is described in detail in various documents (e.g. Smith et al. 1995) and the Arkansas Delta Regional Guidebook (Klimas et al. 2011) provides specifics relevant to the models and reference data that are used in this report. However, the brief overview below, taken from Klimas (2006), may be helpful for anyone unfamiliar with the terminology and process of the HGM approach.

The HGM approach incorporates several components. Wetlands are first grouped into regional subclasses based on functional similarities, as represented by hydrogeomorphic setting. Thus, wetlands in isolated depressions function differently than wetlands on river floodplains in various respects. For example, a functional riverine wetland exports organic materials to downstream aquatic systems during floods, whereas a depression that lacks a surface connection to a stream does not perform that function. Therefore, a group of functions can be identified for each regional subclass, and other regional subclasses may not perform those functions, or may perform them to different degrees.

In order to estimate the degree to which a wetland performs a particular function, HGM represents each function in terms of a simple logic model made up of variables that can be measured in the field or derived from existing information sources. In order to run the models, the variable values must be determined or estimated. The flood frequency and duration components for this project were supplied by the District. Information on living and dead vegetation is obtained using standard forest sampling methods. Models used to assess all of the other functions use similarly obtained information as model variables.

The FCI value generated by the assessment model is an index between zero and 1.0, where a value of 1.0 represents a fully functional condition. Under HGM methodology, the FCI is multiplied by a measure of the area of the wetland (e.g., acreage) to calculate the Functional Capacity Units (FCU) present for each function. This is essentially the same process used in the Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service 1980), where indicators of habitat quality are

combined into simple models to calculate a Habitat Suitability Index (HSI) and multiplied by a measure of area to produce Habitat Units (HU). There is one fundamental difference between the ways these two assessment approaches are developed, however. Whereas the indicators employed in HEP models are calibrated based on literature and expert opinion, the calibration curves for HGM indicators are derived from extensive field sampling of reference wetlands.

The model variables employed in the assessment models are calibrated based on field data collected in the applicable wetland subclass. The calibration curve (also called the "subindex curve") for each variable in each subclass relates the variable value to an index between zero and 1.0, where the maximum value is that found in wetlands that represent the least-disturbed examples of the wetland subclass within the region. The shape of the calibration curve is established by sampling a set of wetlands that represent a range of condition classes between the least-disturbed, and severely disturbed. Sets of curves for each variable and wetland subclass in the region are included in the Guidebook (Klimas et al. 2011), based on sampling of more than 100 field sites. Because each variable is calibrated separately for each subclass, functional comparisons across subclasses cannot be made quantitatively, though they can be addressed qualitatively.

As with all of the HGM guidebook development efforts, the Delta Region models, calibration curves, and application tools such as sampling methods and data summary spreadsheets were developed by a team of regional experts. Users of the guidebooks apply this information to specific assessment tasks, and can use the same models and reference data on various projects throughout the region. The models and calibration curves are applied in an assessment scenario by following detailed guidance presented in the Delta HGM Guidebook. The user collects field data from the assessment area, and compares that data to the calibration curve to derive a subindex. The subindex values are inserted into the model, generating an FCI for the function being assessed. Multiplying the FCI by acreage generates FCUs, which represent the functional units associated with the assessment area, and which can be compared among assessment areas of the same regional subclass. Pre- and post-project FCUs can be compared to determine impacts, and project alternatives can be compared to help identify the preferred alternative. However, in order to take into account the time required to recover functions following an impact or restoration actions an additional set of curves representing recovery trajectories is required. Recovery trajectories were developed and published as part of the Delta Region Guidebook (Klimas et al. 2011) and their use is discussed in detail in Klimas 2006.

The HGM guidebook used for this project (Klimas et al. 2011) is a modified version of the original 2004 document. It was changed in 2011 to address a defect in the hydrology variables, and the revised version was reviewed and certified for use on this project. The reviewers agreed that the reference data developed for the Delta Regional Guidebook is appropriate for application to the SJNM project area. The geomorphic processes and hydrology that formed the landscape of southeastern Missouri are the same as those that shaped adjacent areas in Arkansas, where the reference data set was collected. The project area supports the same wetland subclasses, on the same geomorphic surfaces and soil types, as the guidebook reference sites, and it has been subject to similar agricultural development and hydrologic changes. Field studies indicated some shift s in the relative dominance of certain tree species, as would be expected in an area at a higher latitude than the reference area, but the guidebook allows for modification of the species composition variables to accommodate just such an eventuality. Therefore, some minor changes were made to those variables based on field observations and professional experience in the region. Otherwise, the Delta regional guidebook was used without modification to its certified version.

DATA COLLECTION METHODS AND ASSUMPTIONS FOR THIS ASSESSMENT

This assessment is limited to all areas with direct impacts (e.g., clearing, widening of ditches, re-contouring, etc.), and all wetland areas within the 5-year floodplain that are by definition river-connected, and subject to changes in inundation regimes due to the project. Wetlands outside the 5-year floodplain are primarily precipitation driven, and are not affected by changes in river hydrology in a way that the HGM approach can ascertain; thus, they are not included in the analysis unless they are subject to direct impacts. This HGM analysis reports all results by basin.

Functional Capacity Indices (FCIs) were calculated based on data from field locations within the two basins, using the models and variable subindex curves found in Klimas et al. 2011. Sixty-one plots within twenty wetland assessment areas were used in the calculations, and an additional thirty locations were visually inspected from the road to ensure that the data already collected had captured the variation identified within the project area. Field data collection was conducted in September 2010 by Elizabeth Murray and Jody Pagan, following the field methods described in the Arkansas Delta Regional Guidebook (Klimas et al. 2011, Appendix E, Part 5). All data forms for all subclasses can be found in that report. Candidate sample sites were identified on GIS based on apparent subclass, condition class, and category of impact. The subclass of each wetland assessment area was verified in the field. Landscape level variables were assessed in the office after field sampling using GIS. Hydrologic variables for each plot (change in flood frequency and change in flood duration) were provided by Memphis District using their hydraulic modeling for project alternatives.

The sample plots were distributed throughout the 5-year floodplain within the project area. Three HGM subclasses were sampled: Low Gradient Riverine Backwater (LGRB), Low Gradient Riverine Overbank (LGRO), and Connected Depressions (CD). Project impacts are expected to occur in three basic forms: direct clearing of forests and site alteration, leading to a reduction of wetland functions to zero; modest indirect hydrologic impacts due to drainage improvements and pumping, resulting in changes to hydrologic variables only, which reduce but do not eliminate river-connected wetland functions; and finally major hydrologic impacts which result in a change in wetland subclass from a river-connected subclass to a non-river connected subclass. In these cases, LGRB and LGRO become Flats, a precipitation driven bottomland hardwood type, and CD wetlands become Unconnected Depressions (UCD), which are primarily maintained by direct precipitation and local runoff. Upon completion of field sampling in all subclasses and condition classes known to exist in the study area, an additional 30 wetland sites were identified and examined from the road to ensure that they were within the range of compositional and structural variation already represented in the sample database. These visual inspections verified that no further sampling was necessary.

Wetland jurisdictional determinations were not made as part of this assessment. Acreages of jurisdictional wetlands for the wetland assessment were provided by the Memphis District, CE. The acreage of agricultural areas deemed as jurisdictional “Farmed Wetlands” was provided to Memphis District by the Natural Resources Conservation Service (NRCS). Memphis District divided this total acreage by basin, and the resulting “Farmed Wetland” acreages for each basin were supplied to ERDC by Memphis District. It is assumed for the purposes of this analysis, that all of these “Farmed Wetlands” are within the 5-year floodplain and subject to the HGM analysis. All Farmed Wetlands are assumed to be LGRB under Existing Conditions for the purposes of this assessment.

Acreages of “Forested Wetlands” were developed for each basin by Memphis District and provided to ERDC. Geographic Information System (GIS) and sampling ratios were then employed to divide these Forested Wetland acreages into subtotals by HGM subclass.

All alternatives were assessed over a 50-year life of project. It is assumed here that the prevailing management and land use patterns will continue and result in no change in the average condition of existing resources (other than WRP) over the life of the project under the proposed project alternatives, including the No Action alternative. This is consistent with the approach used in the HEP analysis. Because it is assumed that there will be no variable changes for areas other than WRP, only the WRP results are annualized in the assessment of project impacts.

For the Authorized Project and alternatives, all impacts are assumed to be immediate upon project approval, and no mitigation is included in the analysis. However, annualized results for mitigation scenarios have been include to help guide the mitigation process, both in determining the amount necessary and the advantages of siting mitigation in some areas over others. All areas that will be cleared are assumed to remain cleared, and all changes to hydrology are assumed to remain constant. As with the No Action Alternative, all forest conditions are assumed constant over the life of the project in all alternatives. Because the impacts are assumed to take place immediately upon project decision and then remain constant over the 50-year life of the project, these results are also not annualized. The alternate approach, utilized in the HEP analysis, of having impacts occur over the course of the first year and then annualizing results in a mere 0.6% decrease in impacts associated with the alternative. Considering the multiple subclasses, and multiple functional models, each of which would have to be annualized separately, and the uncertainty regarding the implementation schedule for specific project components, annualization of year-one impacts implies a level of sensitivity in the HGM analysis that cannot be justified. Any other alternatives that include areas with expected forest maturation over the life of the project (i.e., WRP, mitigation areas, etc.) include annualized results for those portions of the assessment.

RESULTS

Alternative 1 - No Action

1.1. Existing Conditions

St. Johns Basin

Existing Conditions in the St. Johns Basin are documented in Tables 1a and 1b. Approximately 5233 acres of forested wetlands occur within the St. Johns Basin. Of these, approximately 76% (3848 acres) are LGRB HGM subclass, and 24% (1385 acres) are LGRO wetlands. There are also approximately 142 acres of “Farmed Wetlands” that fall into the LGRB HGM subclass. No CD wetlands were identified within the basin. The FCIs associated with forested LGRB wetlands ranged from 0.47 for the Provide Habitat for Fish and Wildlife function, to 0.90 for the Detain Precipitation function. Similarly, FCIs for “Farmed” LGRB wetlands in the basin ranged from 0.0 for Plant Communities and Habitat functions, to 0.54 for the Detain Precipitation function (Table 1a).

Table 1a and 1b: St. Johns Basin Existing Conditions FCIs and FCUs

HGM Assessment of Potential Wetlands: Existing Conditions By Basin below the 5-year floodplain FCIs

Basin	St. Johns Basin					
Vegetation Class	Ag Fields	Forested Area: 5233 ac				
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD[2]	UCD
Acreage[1]	792	3848	1385	0	0	0
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.25	0.65	0.97	0.00	0.00	0.00
Detain Precipitation	0.54	0.90	0.75	0.00	0.00	0.00
Cycle Nutrients	0.24	0.68	0.84	0.00	0.00	0.00
Export Organic Carbon	0.19	0.68	0.78	0.00	0.00	0.00
Maintain Plant Communities	0.00	0.79	0.82	0.00	0.00	0.00
Provide Habitat for Fish and Wildlife	0.00	0.47	0.49	0.00	0.00	0.00

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District.
Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.
2 No connected depressions were located or sampled within St. Johns Basin.

HGM Assessment of Potential Wetlands: Existing Conditions By Basins below the 5-year floodplain, FCUs

Basin	St. Johns Basin					
Vegetation Class	Ag Fields	Forested Area: 5233 ac				
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD[2]	UCD
Acreage[1]	792	3848	1385	0	0	0
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	198	2501	1343	0	0	0
Detain Precipitation	428	3463	1039	0	0	0
Cycle Nutrients	190	2617	1163	0	0	0
Export Organic Carbon	150	2617	1080	0	0	0
Maintain Plant Communities	0	3040	1136	0	0	0
Provide Habitat for Fish and Wildlife	0	1809	679	0	0	0

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District.
Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.
2 No connected depressions were located or sampled within St. Johns Basin.

The FCIs for LGRO forested wetlands ranged between 0.49 for the Habitat function to 0.97 for the Detain Floodwater function (Table 1a). When these FCIs are multiplied through by the representative acreages for each subclass, the highest FCUs for each subclass are 428 FCUs for “Farmed” LGRB wetlands for the Detain Precipitation function, 3463 FCUs for forested LGRB wetlands for the Detain Precipitation function, and 1343 FCUs for forested LGRO wetlands for the Detain Floodwater function (Table 1b). Under the current assumptions these FCUs remain constant over the 50-year life of project for the No Action alternative, and there are no functional losses or gains.

New Madrid Floodway.

Existing Conditions in the New Madrid Floodway are documented in Tables 2a and 2b. Approximately 8807 acres of forested wetlands occur within the New Madrid Floodway. Of these, approximately 83% (7344 acres) are LGRB HGM subclass, 13% (1163 acres) are LGRO wetlands, and 3.4% (300 acres) are Connected Depression (CD) wetlands. There are also approximately 375 acres of "Farmed Wetlands" that fall into the LGRB HGM subclass. The FCIs associated with forested LGRB wetlands ranged from 0.77 for the Provide Habitat for Fish and Wildlife function, to 0.97 for the Detain Precipitation function. Similarly, FCIs for "Farmed" LGRB wetlands in the basin ranged from 0.0 for Plant Communities and Habitat functions, to 0.54 for the Detain Precipitation function (Table 2a).

Table 2a and 2b: New Madrid Floodway Existing Conditions FCIs and FCUs

HGM Assessment of Potential Wetlands: Existing Conditions By Basin below the 5-year floodplain FCIs

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area: 8807 ac				
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD	UCD
Acreage[1]	306	7344	1163	0	300	0
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.25	0.88	0.82	NA	0.53	0.00
Detain Precipitation	0.54	0.97	0.58	0.00	NA	0.00
Cycle Nutrients	0.24	0.85	0.85	0.00	0.61	0.00
Export Organic Carbon	0.19	0.85	0.79	NA	0.57	0.00
Maintain Plant Communities	0.00	0.93	0.84	0.00	0.67	0.00
Provide Habitat for Fish and Wildlife	0.00	0.77	0.63	0.00	0.57	0.00

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

HGM Assessment of Potential Wetlands: Existing Conditions By Basin below the 5-year floodplain FCUs

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area: 8807 ac				
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD	UCD
Acreage[1]	306	7344	1163	0	300	0
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	77	6463	954	NA	159	0
Detain Precipitation	165	7124	675	0	NA	0
Cycle Nutrients	73	6242	989	0	183	0
Export Organic Carbon	58	6242	919	NA	171	0
Maintain Plant Communities	0	6830	977	0	201	0
Provide Habitat for Fish and Wildlife	0	5655	733	0	171	0

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

The FCIs for LGRO forested wetlands ranged between 0.58 for the Detain Precipitation function to 0.85 for the Cycle Nutrients function (Table 2a). The FCIs for CD forested wetlands ranged between 0.53 for the Detain Floodwater function to 0.67 for the Maintain Plant Communities function (Table 2a).

When these FCIs are multiplied through by the representative acreages for each subclass, the highest FCUs for each subclass are 165 FCUs for "Farmed" LGRB wetlands for the Detain Precipitation function, 7124 FCUs for forested LGRB wetlands for the Detain Precipitation function, 989 FCUs for forested LGRO wetlands for the Cycle Nutrients function, and 201 FCUs for forested CD wetlands for the Maintain Plant Communities function (Table 2b). Under the current assumptions these FCUs remain constant over the 50-year life of project for the No Action alternative, and there are no functional losses or gains.

1.2. Future enrollment of WRP without (w/o) the project

St. Johns Basin

The Memphis District has requested that No Action Alternative includes expected additional WRP acreage over the life of the project. According to figures provided by the District, this will add approximately 1445 acres of WRP wetlands within the 5-year floodplain to the St. Johns Basin, of which 1127 acres are Forested wetlands, assumed to be LGRB, and 318 acres are herbaceous wetlands, assumed to be CD wetlands. All these acres are assumed to come from current Prior Converted areas, and will not affect the Farmed Wetland totals. This is a conservative assumption.

The No Action Alternative varies from Existing Conditions only in the annualized gains in WRP (last two columns of Tables 3a and b). There are no gains or losses in the Ag Fields that qualify as wetlands, nor in the forested wetlands.

Based on information provided by the District, WRP was assumed to occur in small blocks, averaging 200 ha (roughly 500 acres) that are a mix of forest and herbaceous wetlands, and not connected to existing blocks of forest. The FCIs shown above for WRP assume that all WRP is planted in the first year of the project, and are annualized over the 50-year life of the project based on variable projects provided in the Guidebook. Time increments used included years 0, 1, 5, 15, 25, and 50, consistent with other assessment models for the project. Forested WRP was allowed to have all variables project to their Year-50 value, whereas herbaceous WRP had all vegetation-related variables stall at approximately a Year-5 value. It is assumed that these areas are managed for waterfowl, and woody vegetation would be suppressed.

The only difference between this Alternative 1.2 (Existing Conditions Plus Annualized Projected WRP Without Project) and Alternative 1.1 (Existing Conditions) is the annualized gain of the WRP. The highest FCUs for the LGRB wetlands are 1042 for the Detain Precipitation function. The highest FCUs for the CD wetlands are 135 for the Cycle Nutrients Function. Alternative 1.2 serves as the baseline against which the losses associated with the other alternatives are measured.

HGM Assessment of Potential Wetlands: No Action Alternative By Basin below the 5-year floodplain FCIs

Basin	St. Johns Basin							
EPA Vegetation Class	Ag Fields	Forested Area: 5233 ac					WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD[2]	UCD	LGRB	CD[4]
Acreage[1]	792	3848	1385	0	0	0	1127	318
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.25	0.65	0.97	0.00	0.00	0.00	0.60	0.21
Detain Precipitation	0.54	0.90	0.75	0.00	0.00	0.00	0.93	NA
Cycle Nutrients	0.24	0.68	0.84	0.00	0.00	0.00	0.72	0.42
Export Organic Carbon	0.19	0.68	0.78	0.00	0.00	0.00	0.72	0.41
Maintain Plant Communities	0.00	0.79	0.82	0.00	0.00	0.00	0.76	0.16
Provide Habitat for Fish and Wildlife	0.00	0.47	0.49	0.00	0.00	0.00	0.27	0.15

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: No Action Alternative By Basins below the 5-year floodplain, FCUs

Basin	St. Johns Basin							
EPA Vegetation Class	Ag Fields	Forested Area: 5233 ac					WRP3 : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD[2]	UCD	LGRB	CD[4]
Acreage	792	3848	1385	0	0	0	1127	318
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	198	2501	1343	0	0	0	674	67
Detain Precipitation	428	3463	1039	0	0	0	1042	NA
Cycle Nutrients	190	2617	1163	0	0	0	814	135
Export Organic Carbon	150	2617	1080	0	0	0	814	129
Maintain Plant Communities	0	3040	1136	0	0	0	855	51
Provide Habitat for Fish and Wildlife	0	1809	679	0	0	0	299	48

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Table 3a and 3b: St. Johns Basin No Action Alternative FCIs and FCUs

New Madrid Floodway

The Memphis District has requested that No Action Alternative includes expected additional WRP acreage over the life of the project. According to figures provided by the District, this will add approximately 765 acres of WRP wetlands within the 5-year floodplain to the New Madrid Floodway, divided into 595 acres of Forested wetlands, assumed to be LGRB, and 170 acres of herbaceous wetlands, assumed to be CD wetlands. All these acres are assumed to come from current Prior Converted areas, and will not affect the Farmed Wetland totals. This is a conservative assumption.

The No Action Alternative varies from Existing Conditions only in the annualized gains in WRP (last two columns of Tables 4a and b). There are no gains or losses in the Ag Fields that qualify as wetlands, nor in the forested wetlands.

WRP was assumed to occur in small blocks, averaging 200 ha (roughly 500 acres) that are a mix of forest and herbaceous wetlands, and not connected to existing blocks of forest. The FCIs shown above for WRP assume that all WRP is planted in the first year of the project, and are annualized over the 50-year life of the project based on variable projects provided in the Guidebook. Time increments used included years 0, 1, 5, 15, 25, and 50, consistent with other assessment models for the project. Forested WRP was allowed to have all variables project to their Year-50 value, whereas herbaceous WRP had all vegetation-related variables stall at approximately a Year-5 value. It is assumed that these areas are managed for waterfowl, and woody vegetation would be suppressed.

Table 4a and 4b: New Madrid Floodway No Action Alternative FCIs and FCUs

HGM Assessment of Potential Wetlands: No Action Alternative By Basin below the 5-year floodplain FCIs

Basin	New Madrid							
Vegetation Class	Ag Fields	Forested Area: 8807 ac					WRP[2] : 765 ac	
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD	UCD	LGRB	CD[3]
Acreage[1]	306	7344	1163	0	300	0	595	170
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.25	0.88	0.82	NA	0.53	NA	0.60	0.21
Detain Precipitation	0.54	0.97	0.58	0.00	NA	NA	0.93	NA
Cycle Nutrients	0.24	0.85	0.85	0.00	0.61	0.00	0.72	0.42
Export Organic Carbon	0.19	0.85	0.79	NA	0.57	NA	0.72	0.41
Maintain Plant Communities	0.00	0.93	0.84	0.00	0.67	0.00	0.76	0.16
Provide Habitat for Fish and Wildlife	0.00	0.77	0.63	0.00	0.57	0.00	0.27	0.15

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: No Action Alternative By Basin below the 5-year floodplain FCUs

Basin	New Madrid							
EPA Vegetation Class	Ag Fields	Forested Area: 8807 ac					WRP2 : 765 ac	
HGM Subclass	LGRB	LGRB	LGRO	Flat	CD	UCD	LGRB	CD[3]
Acreage[1]	306	7344	1163	0	300	0	595	170
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	77	6463	954	NA	159	NA	356	36
Detain Precipitation	165	7124	675	0	NA	NA	550	NA
Cycle Nutrients	73	6242	989	0	183	0	430	72
Export Organic Carbon	58	6242	919	NA	171	NA	430	69
Maintain Plant Communities	0	6830	977	0	201	0	452	27
Provide Habitat for Fish and Wildlife	0	5655	733	0	171	0	158	26

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

The only difference between this Alternative 1.2 (Existing Conditions Plus Annualized Projected WRP Without Project) and Alternative 1.1 (Existing Conditions) is the annualized gain of the WRP. The highest FCUs for the LGRB wetlands are 550 FCUs for the Detain Precipitation function. The highest FCUs for the CD wetlands are 72 FCUs for the Cycle Nutrients Function. Alternative 1.2 serves as the baseline against which the losses associated with the other alternatives are measured.

Alternative 2.1 – Authorized Project - St. Johns Basin

Details for the Authorized Project within St. Johns Basin can be found in the Alternatives Section of the EIS. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the Authorized Project are identified in Tables 5 and 6 below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after the authorized project is implemented in St. Johns basin are documented in Tables 5a and 5b. A total of 673 acres of LGRO forested wetlands are completely cleared, dredged, or filled, and lose all wetland function. The remaining acres of forested LGRO, all acres "Farmed" and forested LGRB wetlands, and all WRP areas suffer modest decreases in function due to hydrologic changes associated with the project. Total changes of FCIs and FCUs comparing the Authorized Project (Alternative 2.1), with the No Action alternative (Alternative 1.2) are shown in Tables 6a and 6b.

Tables 5a and 5b: Authorized Project Conditions – St. Johns Basin:

HGM Assessment of Potential Wetlands: Authorized Project Conditions By Basins below the 5-year floodplain: FCIs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	673	712	0	0	0	1127	318
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.23	0.63	0.00	0.97	NA	NA	NA	0.58	0.19
Detain Precipitation	0.54	0.90	0.00	0.75	NA	NA	NA	0.93	NA
Cycle Nutrients	0.24	0.68	0.00	0.84	NA	NA	NA	0.72	0.42
Export Organic Carbon	0.17	0.66	0.00	0.78	NA	NA	NA	0.70	0.39
Maintain Plant Communities	0.00	0.78	0.00	0.78	NA	NA	NA	0.75	0.15
Provide Habitat for Fish and Wildlife	0.00	0.47	0.00	0.48	NA	NA	NA	0.27	0.15

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year lif3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Authorized Project Conditions By Basin below the 5-year floodplain: FCUs

Basin	St. Johns								
EPA Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	673	712	0	0	0	1127	318
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	182	2424	0	691	NA	NA	NA	651	61
Detain Precipitation	428	3463	0	534	NA	NA	NA	1042	NA
Cycle Nutrients	190	2617	0	598	NA	NA	NA	814	135
Export Organic Carbon	135	2540	0	555	NA	NA	NA	791	123
Maintain Plant Communities	0	3001	0	555	NA	NA	NA	844	48
Provide Habitat for Fish and Wildlife	0	1809	0	342	NA	NA	NA	299	48

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year lif3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 6a and 6b: Losses Associated with the Authorized Project as compared with No Action Alternative – St. Johns Basin

HGM Assessment of Potential Wetlands:Difference between Authorized Project Conditions and No Action Alternative By Basin below the 5-year floodplain: FCIs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	673	712	0	0	0	1127	318
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	-0.02	-0.02	-0.97	0.00	NA	NA	NA	-0.02	-0.02
Detain Precipitation	0.00	0.00	-0.75	0.00	NA	NA	NA	0.00	NA
Cycle Nutrients	0.00	0.00	-0.84	0.00	NA	NA	NA	0.00	0.00
Export Organic Carbon	-0.02	-0.02	-0.78	0.00	NA	NA	NA	-0.02	-0.02
Maintain Plant Communities	0.00	-0.01	-0.82	-0.04	NA	NA	NA	-0.01	-0.01
Provide Habitat for Fish and Wildlife	0.00	0.00	-0.49	-0.01	NA	NA	NA	0.00	0.00

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2009. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands:Difference between Authorized Project Conditions and No Action Alternative By Basin below the 5-year floodplain: FCUs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	673	712	0	0	0	1127	318
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-16	-77	-653	0	NA	NA	NA	-23	-6
Detain Precipitation	0	0	-505	0	NA	NA	NA	0	NA
Cycle Nutrients	0	0	-565	0	NA	NA	NA	0	0
Export Organic Carbon	-16	-77	-525	0	NA	NA	NA	-23	-6
Maintain Plant Communities	0	-38	-552	-28	NA	NA	NA	-11	-3
Provide Habitat for Fish and Wildlife	0	0	-330	-7	NA	NA	NA	0	0

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2009. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Table 6c: Summary of FCU losses for the Authorized Alternative (2.1) in St. John's Basin.

	Losses in FCUs		
Function	**LGRB**	**LGRO**	**CD[1]**
Detain Floodwater	-116.0	-653.0	0.0
Detain Precipitation	0.0	-505.0	NA
Cycle Nutrients	0.0	-565.0	0.0
Export Organic Carbon	-116.0	-525.0	0.0
Maintain Plant Communities	-49.0	-580.0	0.0
Provide Habitat for Fish and Wildlife	0.0	-337.0	0.0

1 No connected depressions were located or sampled within St. Johns Basin.

Changes in FCIs and FCUs associated with the Authorized Project within the St. Johns basin are shown by category in Tables 6a and 6b, above. The majority of impacts are associated with the clearing and widening of ditches in the LGRO subclass (Direct Clearing, above). Much more modest impacts are associated with the changes in hydrology. Slight changes in both flood frequency and flood duration affected the Detain Floodwater, Export Organic Carbon and Maintain Plant Communities functions in the LGRB subclass, although this change does not show up in the Maintain Plant Communities function of the agricultural areas, since the function was already at an FCI of 0.0. Low Gradient Riverine Overbank wetlands only suffered a change in flood duration in this alternative, not flood frequency. Hence only the Maintain Plant Communities and the Provide Habitat for Fish and Wildlife Functions were affected. While these slight changes in hydrology affected the models in modest ways (changes in FCIs ranged between 0 and 0.04 where only indirect hydrological impacts were felt), nonetheless when multiplied across the relatively large acreages of the LGRB subclass, meaningful losses of FCUs result

The largest functional losses in the St. Johns Basin under the Authorized Project represent a loss of 653 LGRO FCUs in the Detail Floodwater subclass, resulting from direct clearing. The highest losses resulting from indirect hydrological changes were to the LGRB vegetated subclass, where 77 FCUs were lost to both the Detain Floodwater and Maintain Plant Communities functions.

Total losses of FCUs for this alternative are summarized by subclass in Table 6c. It should be noted that this mitigation debt is summarized in FCUs. The acreage required will depend on the rate of functional gain realized by the mitigation scenarios, which are subject to post-project hydrology.

Alternative 2.2 – Authorized Project - New Madrid Floodway

Details of the Authorized Project within the New Madrid Floodway may be found in the Alternatives Section of the EIS. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the Authorized Project are identified in Tables 7 and 8 below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after the authorized project is implemented in New Madrid Floodway are documented in Tables 7a and 7b. The vast majority of impacts are associated with indirect hydrologic changes; only 7 acres of LGRB are subjected direct clearing. Of the losses resulting from indirect hydrologic changes, the vast majority of those are from changes in frequency so severe that a fundamental shift from a river connected subclass to an unconnected subclass occurs. Hence, of the 7344 acres of naturally vegetated LGRB existing in the New Madrid Floodway currently, 6829 acres are cut off from the river sufficiently to qualify as Flats (Table 7). All functions associated with these areas as LGRB wetlands are lost, and though they still exist on the landscape as Flats, they no longer perform the functions of Detain Floodwater or Export Organic Compounds to the aquatic ecosystem in a measureable way.

Tables 7a and 7b: Authorized Project Conditions – New Madrid Floodway:

HGM Assessment of Potential Wetlands: Authorized Project Conditions By Basin below the 5-year floodplain: FCIs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas = 8807						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	21	285	7	508	1163	6829	27	273	42	553	12	158
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.20	NA	0.00	0.84	0.66	NA	0.54	NA	0.48	NA	0.17	NA
Detain Precipitation	0.54	0.35	0.00	0.90	0.58	0.77	NA	NA	0.93	0.71	NA	NA
Cycle Nutrients	0.24	0.19	0.00	0.84	0.85	0.79	0.63	0.64	0.72	0.67	0.42	0.53
Export Organic Carbon	0.15	NA	0.00	0.78	0.64	NA	0.63	NA	0.58	NA	0.33	NA
Maintain Plant Communities	0.00	0.00	0.00	0.81	0.73	0.89	0.63	0.75	0.68	0.68	0.09	0.39
Provide Habitat for Fish and Wildlife	0.00	0.00	0.00	0.59	0.58	0.72	0.77	0.51	0.25	0.24	0.13	0.09

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.
2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.
3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Authorized Project Conditions By Basin below the 5-year floodplain: FCUs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	21	285	7	508	1163	6829	27	273	42	553	12	158
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	4	NA	0	427	768	NA	15	NA	20	NA	2	NA
Detain Precipitation	11	100	0	457	675	5258	NA	NA	39	393	NA	NA
Cycle Nutrients	5	54	0	427	989	5395	17	175	30	371	5	84
Export Organic Carbon	3	NA	0	396	744	NA	17	NA	24	NA	4	NA
Maintain Plant Communities	0	0	0	412	849	6078	17	205	29	376	1	61
Provide Habitat for Fish and Wildlife	0	0	0	300	675	4917	21	139	11	133	2	14

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.
2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.
3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 8a and 8b: Gains and Losses Associated with the Authorized Project as compared with No Action Alternative – New Madrid Floodway.

HGM Assessment of Potential Wetlands: Gains and Losses between No Action Alternative and Authorized Project Conditions By Basins below the 5-year floodplain: FCUs

Losses due to wholesale conversion to non-river connected Subclass, or due to direct clearing

Basin	New Madrid										
Vegetation Class	Ag Fields		Forested Area					WRP			
HGM Subclass	LGRB	Flat	LGRB		Flat	CD	UCD	LGRB	Flat	CD	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	-285	285	-7	-6829	6829	-273	273	-553	553	-158	158
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-71	NA	-6	-6010	NA	-145	NA	-336	NA	-34	NA
Detain Precipitation	-154	100	-7	-6624	5258	NA	NA	-512	393	NA	NA
Cycle Nutrients	-68	54	-6	-5805	5395	-167	175	-399	371	-67	84
Export Organic Carbon	-54	NA	-6	-5805	NA	-156	NA	-405	NA	-65	NA
Maintain Plant Communities	0	0	-7	-6351	6078	-183	205	-423	376	-26	61
Provide Habitat for Fish and Wildlife	0	0	-5	-5258	4917	-156	139	-147	133	-24	14

Losses due to incremental decreases in function within remaining river-connected subclasses

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area			WRP	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD
Impacts	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	21	508	1163	27	42	12
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-1	-20	-186	0	-5	0
Detain Precipitation	0	-36	0	NA	0	NA
Cycle Nutrients	0	-5	0	-1	0	0
Export Organic Carbon	-1	-36	-174	-2	-6	-1
Maintain Plant Communities	0	-61	-128	-1	-3	-1
Provide Habitat for Fish and Wildlife	0	-91	-58	-1	-1	0

Table 8c. Summary of FCU losses for the Authorized Alternative (2.2) in New Madrid Floodway..

	Losses in FCUs		
Function	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-6449	-186	-179
Detain Precipitation	-7332	0	NA
Cycle Nutrients	-6283	0	-234
Export Organic Carbon	-6312	-174	-223
Maintain Plant Communities	-6845	-128	-211
Provide Habitat for Fish and Wildlife	-5503	-58	-181

Table 8a illustrates the functional losses due to wholesale conversion of wetland acres to a subclass unconnected to the river, or due to direct clearing. The 6829 acres converted from LGRB to flats results in a loss of 6010 FCUs in the Detain Floodwater function and 5805 FCUs in the Export Organic Carbon function that are in no way offset by the fact that some gains occurred in the Flats subclass. Even in the functions that both LGRB and Flat wetlands both perform, the fact that the indices are calibrated only within each subclass means that the FCUs cannot be added or subtracted across subclasses (e.g., Detain Precipitation), or represent fundamentally different conditions (i.e., the plants and habitat provided by different subclasses are different, and therefore cannot fully substitute for each other). As a result, although these acres are still considered to be jurisdictional wetlands and still occur within the landscape of the project area, they are treated as though they were cleared, because from a functional standpoint, they are no longer provided the same functions that they were before the project.

Those wetland areas not subject to a full scale removal from the 5-year floodplain and resultant subclass shift are still subject to an incremental decrease in function, summarized in Table 8b. For instance, the 508 acres of LGRB remaining after the Flats are removed are subject to decreases in FCIs ranging from 0.01 to 0.18, and the resulting losses of FCUs when multiplied by the acreages are provided in Table 8b. If the acreages are also small, in some cases these functional losses are negligible as compared with the losses due to subclass conversion. However, in order to be consistent with other alternatives, in which the changes to the 5-year floodplain are much less severe, we have added these areas to the overall mitigation debt for the alternative. LGRO wetlands were not converted to other subclasses, and so their incremental functional loss reported in Table 8b were relatively larger, the 186 FCUs lost in Detain floodwater function being the most severe impact.

Alternative 2.3 – Authorized Project - St. Johns Basin and New Madrid Floodway

This alternative is simply the sum of the losses to both basins under the Authorized Project (Tables 6c and 8c). The largest combined impact to LGRB was still to Detain Precipitation, which lost 7332 FCUs over the two basins. Detain Floodwater was the most impact function for LGRO wetlands, with a loss of 839 FCUs lost. Since no CD wetlands were found in the St Johns Basin, the losses for both basins is the same as that for New Madrid Floodway, with the largest impact to Cycle Nutrients, 234 FCUs lost.

Alternative 3 – Authorized Project with Avoid and Minimize Measures

St. Johns Basin

The Authorized Project with Avoid and Minimize Measures within the St. Johns Basin consists of smaller a smaller footprint for the direct clearing and the bottom width of the ditches (Alternatives Section, EIS). Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District. This alternative varies from the Authorized Project within the St. Johns Basin by having only 409 acres of the LGRO forest type subject to Direct Clearing, 264 acres fewer than in the Authorized Project. These acres are instead subject to the Indirect Hydrology impacts. The hydrology variables that affect indirect impacts are identical to those in the Authorized Project.

The conditions forecast after the Authorized Project with Avoid and Minimize Measures is implemented in St. Johns basin are documented in Tables 9a and 9b. A total of 409 acres of LGRO forested wetlands are completely cleared, dredged, or filled, and lose all wetland function. The remaining acres of forested LGRO, all acres “Farmed” and forested LGRB wetlands, and all WRP areas suffer modest decreases in function due to hydrologic changes associated with the project.

Total changes of FCIs and FCUs comparing the Authorized Project with Avoid and Minimize Measures with the No Action alternative are shown in Tables 10a and 10b, and are summarized by subclass in Table 10c. The majority of impacts are associated with the clearing and widening of ditches in the LGRO subclass. Much more modest impacts are associated with the changes in hydrology. Changes in both flood frequency and flood duration effected the Detain Floodwater, Export Organic Carbon and Maintain Plant Communities functions in the LGRB subclass, although this change does not show up in the Maintain Plant Communities function of the agricultural areas, since the function was already at an FCI of 0.0. Low Gradient Riverine Overbank wetlands only suffered a change in flood duration in this alternative, not flood frequency. Hence only the Maintain Plant Communities and the Provide Habitat for Fish and Wildlife Functions were affected.

The largest functional impacts within the St. Johns Basin include a loss of 397 LGRO FCUs in the Detain Floodwater function, and a total 116 LGRB FCUs, also in the Detain Floodwater function (Tables 10 b and 10c). This constitutes a decrease in impacts of approximately 256 LGRO FCUs as compared to the Authorized Project impacts.

Tables 9a and 9b: Authorized Project With Avoid and Minimize Measures Alternative Conditions – St. Johns Basin:

HGM Assessment of Potential Wetlands: Avoid and Minimize Alternative Conditions By Basins below the 5-year floodplain: FCIs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	409	976	0	0	0	1127	318
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.23	0.63	0.00	0.97	NA	NA	NA	0.58	0.19
Detain Precipitation	0.54	0.90	0.00	0.75	NA	NA	NA	0.93	N/A
Cycle Nutrients	0.24	0.68	0.00	0.84	NA	NA	NA	0.72	0.42
Export Organic Carbon	0.17	0.66	0.00	0.78	NA	NA	NA	0.70	0.39
Maintain Plant Communities	0.00	0.78	0.00	0.78	NA	NA	NA	0.75	0.15
Provide Habitat for Fish and Wildlife	0.00	0.47	0.00	0.48	NA	NA	NA	0.27	0.15

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Avoid and Minimize Alternative Conditions By Basin below the 5-year floodplain: FCUs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	409	976	0	0	0	1127	318
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	182	2424	0	947	NA	NA	NA	651	61
Detain Precipitation	428	3463	0	732	NA	NA	NA	1042	N/A
Cycle Nutrients	190	2617	0	820	NA	NA	NA	814	135
Export Organic Carbon	135	2540	0	761	NA	NA	NA	791	123
Maintain Plant Communities	0	3001	0	761	NA	NA	NA	844	48
Provide Habitat for Fish and Wildlife	0	1809	0	468	NA	NA	NA	299	48

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 10a and 10b: Gains and Losses Associated with the Authorized Project With Avoid and Minimize Measures Alternative as compared with No Action Alternative – St. Johns Basin

HGM Assessment of Potential Wetlands:Difference between Avoid & Minimize Alternative and No Action Alternative below the 5-year floodplain: FCIs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	409	976	0	0	0	1127	318
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	-0.02	-0.02	-0.97	0.00	NA	NA	NA	-0.02	-0.02
Detain Precipitation	0.00	0.00	-0.75	0.00	NA	NA	NA	0.00	N/A
Cycle Nutrients	0.00	0.00	-0.84	0.00	NA	NA	NA	0.00	0.00
Export Organic Carbon	-0.02	-0.02	-0.78	0.00	NA	NA	NA	-0.02	-0.02
Maintain Plant Communities	0.00	-0.01	-0.82	-0.04	NA	NA	NA	-0.01	-0.01
Provide Habitat for Fish and Wildlife	0.00	0.00	-0.49	-0.01	NA	NA	NA	0.00	0.00

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands:Difference between Avoid & Minimize Alternative and No Action Alternative below the 5-year floodplain: FCUs

Basin	St. Johns								
Vegetation Class	Ag Fields	Forested Area						WRP[3] : 1445 ac	
HGM Subclass	LGRB	LGRB	LGRO		Flat	CD[2]	UCD	LGRB	CD[4]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro				Indirect Hydro	Indirect Hydro
Acreage[1]	792	3848	409	976	0	0	0	1127	318
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-16	-77	-397	0	NA	NA	NA	-23	-6
Detain Precipitation	0	0	-307	0	NA	NA	NA	0	N/A
Cycle Nutrients	0	0	-344	0	NA	NA	NA	0	0
Export Organic Carbon	-15	-77	-319	0	NA	NA	NA	-23	-6
Maintain Plant Communities	0	-39	-335	-39	NA	NA	NA	-11	-3
Provide Habitat for Fish and Wildlife	0	0	-200	-10	NA	NA	NA	0	0

1 Forested acreage were provided by Memphis District. Agricultural acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 No connected depressions were located or sampled within St. Johns Basin.

3 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

4 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Table 10c. Summary of FCU losses for the Avoid and Minimize Alternative (3.1) in St. Johns Basin.

	Losses in FCUs		
Function	**LGRB**	**LGRO**	**CD[1]**
Detain Floodwater	-116	-397	0
Detain Precipitation	0	-307	NA
Cycle Nutrients	0	-344	0
Export Organic Carbon	-115	-319	0
Maintain Plant Communities	-50	-374	0
Provide Habitat for Fish and Wildlife	0	-210	0

1 No connected depressions were located or sampled within St. Johns Basin.

3.1. Management Scenario 1 New Madrid Floodway

Details of the Management Scenario 1 for the Authorized Project With Avoid and Minimize Measures Alternative within the New Madrid Floodway may be found in the Alternatives Section of the EIS. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the Authorized Project are identified in Tables 11 and 12 below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after the Authorized Project With Avoid and Minimize Measures Management Scenario 1 is implemented in New Madrid Floodway are documented in Tables 11a and 11b. The vast majority of impacts are associated with indirect hydrologic changes. Total changes of FCIs and FCUs comparing the Authorized Project With Avoid and Minimize Measures Management Scenario 1 (Alternative 3.1), with the No Action alternative (Alternative 1.2) are shown in Tables 12a and 12b.

Changes in FCIs and FCUs associated with the Authorized Project With Avoid and Minimize Measures Management Scenario 1 within the New Madrid Floodway are shown in Tables 12a and 12b, and summarized by subclass in Table 12c. The vast majority of impacts are associated with indirect hydrologic changes; only 7 acres of LGRB are subjected direct clearing. Of the losses resulting from indirect hydrologic changes, more than half of those are from changes in frequency severe enough that a fundamental shift from a river connected subclass to an unconnected subclass occurs. Hence, of the 7344 acres of naturally vegetated LGRB existing in the New Madrid Floodway currently, 2216 acres are cut off from the river sufficiently to be outside the 5-year floodplain, and therefore to qualify as Flats (Table 11). All functions associated with these areas as LGRB wetlands are lost, and though they still exist on the landscape as Flats, they no longer perform the functions of Detain Floodwater or Export Organic Compounds to the aquatic ecosystem in a measureable way.

Table 12a illustrates the functional losses due to wholesale conversion of wetland acres to a subclass unconnected to the river, or due to direct clearing. The 2216 acres converted from LGRB to flats results in a loss of 1950 FCUs in the Detain Floodwater function and 1884 FCUs in the Export Organic Carbon function that are in no way offset by the fact that some gains occurred in the Flats subclass. Even in the functions that both LGRB and Flat wetlands perform, the fact that the indices are calibrated only within each subclass means that the FCUs cannot be added or subtracted across subclasses (e.g., Detain Precipitation), or that they represent fundamentally different conditions (i.e., the plants and habitat provided by different subclasses are different, and therefore cannot fully substitute for each other). As a result, although these acres are still considered to be jurisdictional wetlands and still occur within the landscape of the project area, they are treated as though they were cleared, because from a functional standpoint, they are no longer provided the same functions that they were before the project.

Those wetland areas not subject to a full scale removal from the 5-year floodplain and the resultant subclass shift are still subject to an incremental decrease in function, summarized in Table 12b. For instance, the 5121 acres of forested LGRB remaining after the Flats are removed are subject to decreases in FCIs ranging from 0.01 to 0.27, and the resulting losses of FCUs when multiplied by the acreages are provided in Table 12b. The largest of these impacts are the loss of 1280 FCUs for the Detain Floodwater function, and a loss of 1383 FCUs in the Export Carbon function (Table 12b)

Tables 11a and 11b: Authorized Project With Avoid and Minimize Measures Management Scenario 1 Conditions – New Madrid Floodway:

HGM Assessment of Potential Wetlands: Alternative 3.1 Conditions By Basin below the 5-year floodplain: FCIs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	214	92	7	5121	1163	2216	191	109	416	179	119	51
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.15	NA	0.00	0.63	0.79	NA	0.44	NA	0.36	NA	0.12	NA
Detain Precipitation	0.54	0.35	0.00	0.96	0.58	0.79	NA	NA	0.93	0.71	NA	NA
Cycle Nutrients	0.24	0.19	0.00	0.84	0.85	0.88	0.58	0.76	0.72	0.67	0.42	0.53
Export Organic Carbon	0.11	NA	0.00	0.58	0.76	0.00	0.49	NA	0.43	NA	0.24	NA
Maintain Plant Communities	0.00	0.00	0.00	0.86	0.81	0.93	0.47	0.86	0.71	0.68	0.12	0.39
Provide Habitat for Fish and Wildlife	0.00	0.00	0.00	0.73	0.62	0.71	0.48	0.61	0.25	0.24	0.13	0.09

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Alternative 3.1 Conditions By Basin below the 5-year floodplain: FCUs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP2 : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	214	92	7	5121	1163	2216	191	109	416	179	119	51
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	32	NA	0	3226	919	NA	84	NA	150	NA	14	NA
Detain Precipitation	116	32	0	4916	675	1751	NA	NA	385	127	NA	NA
Cycle Nutrients	51	18	0	4302	989	1950	111	83	300	120	50	27
Export Organic Carbon	24	NA	0	2970	884	0	94	NA	179	NA	29	NA
Maintain Plant Communities	0	0	0	4404	942	2061	90	94	295	122	14	20
Provide Habitat for Fish and Wildlife	0	0	0	3738	721	1573	92	67	104	43	16	5

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 12a and 12b: Gains and Losses Associated with the Authorized Project With Avoid and Minimize Measures Management Scenario 1 as compared with No Action Alternative – New Madrid Floodway.

HGM Assessment of Potential Wetlands: Gains and Losses between No Action Alternative and Alternative 3.1 Conditions By Basins below the 5-year floodplain: FCUs

Losses due to wholesale conversion to non-river connected Subclass, or due to direct clearing

Basin	New Madrid										
Vegetation Class	Ag Fields		Forested Area					WRP			
HGM Subclass	LGRB	Flat	LGRB		Flat	CD	UCD	LGRB	Flat	CD	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	-92	92	0	-2216	2216	-109	109	-179	179	-51	51
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-23	NA	0	-1950	NA	-58	NA	-107	NA	-11	NA
Detain Precipitation	-50	32	0	-2150	1751	NA	NA	-166	127	NA	NA
Cycle Nutrients	-22	18	0	-1884	1950	-66	83	-129	120	-22	27
Export Organic Carbon	-17	NA	0	-1884	NA	-62	NA	-129	NA	-21	NA
Maintain Plant Communities	0	0	0	-2061	2061	-73	94	-136	122	-8	20
Provide Habitat for Fish and Wildlife	0	0	0	-1706	1573	-62	67	-47	43	-8	5

Losses due to incremental decreases in function within remaining river-connected subclasses

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area			WRP	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD
Impacts	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	214	5121	1163	191	416	119
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-21	-1280	-35	-17	-99	-11
Detain Precipitation	0	-51	0	NA	0	NA
Cycle Nutrients	0	-51	0	-6	0	0
Export Organic Carbon	-17	-1383	-35	-15	-121	-20
Maintain Plant Communities	0	-358	-35	-38	-20	-5
Provide Habitat for Fish and Wildlife	0	-205	-12	-17	-6	-2

Table 12c. Summary of FCU losses for the Avoid and Minimize Alternative (3.1) in New Madrid Floodway.

	Losses in FCUs		
Function	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-3487	-35	-97
Detain Precipitation	-2423	0	0
Cycle Nutrients	-2092	0	-94
Export Organic Carbon	-3558	-35	-118
Maintain Plant Communities	-2582	-35	-124
Provide Habitat for Fish and Wildlife	-1970	-12	-89

Total losses of FCUs for this alternative are summarized by subclass in Table 12c. The largest impacts are to the Detain Floodwater and Export Organic Carbon functions for both LGRB and LGRO wetlands. It should be noted that this mitigation debt is summarized in FCUs. The acreage required will depend on the rate of functional gain realized by the mitigation scenarios, which are subject to post-project hydrology.

3.2. Management Scenario 2 New Madrid Floodway

Details of the Management Scenario 2 for the Authorized Project With Avoid and Minimize Measures Alternative within the New Madrid Floodway may be found in the Alternatives Section of the EIS. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the Authorized Project are identified in Tables 13 and 14 below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after the Authorized Project With Avoid and Minimize Measures Management Scenario 2 is implemented in New Madrid Floodway are documented in Tables 13a and 13b. The vast majority of impacts are associated with indirect hydrologic changes. Total changes of FCIs and FCUs comparing the Authorized Project With Avoid and Minimize Measures Management Scenario 2 (Alternative 3.2), with the No Action alternative (Alternative 1.2) are shown in Tables 14a and 14b.

Changes in FCIs and FCUs associated with the Authorized Project With Avoid and Minimize Measures Management Scenario 2 within the New Madrid Floodway are shown in Tables 14a and 14b, and summarized by subclass in Table 14c. The vast majority of impacts are associated with indirect hydrologic changes; only 7 acres of LGRB are subjected direct clearing. Of the losses resulting from indirect hydrologic changes, the majority of those are from changes in frequency severe enough that a fundamental shift from a river connected subclass to an unconnected subclass occurs. Hence, of the 7344 acres of naturally vegetated LGRB existing in the New Madrid Floodway currently, 3253 acres are cut off from the river sufficiently to be outside the 5-year floodplain, and therefore to qualify as Flats (Table 13). All functions associated with these areas as LGRB wetlands

are lost, and though they still exist on the landscape as Flats, they no longer perform the functions of Detain Floodwater or Export Organic Compounds to the aquatic ecosystem in a measureable way.

Table 14a illustrates the functional losses due to wholesale conversion of wetland acres to a subclass unconnected to the river, or due to direct clearing. The 3253 acres converted from LGRB to flats results in a loss of 2863 FCUs in the Detain Floodwater function and 2765 FCUs in the Export Organic Carbon function that are in no way offset by the fact that some gains occurred in the Flats subclass. Even in the functions that both LGRB and Flat wetlands perform, the fact that the indices are calibrated only within each subclass means that the FCUs cannot be added or subtracted across subclasses (e.g., Detain Precipitation), or that they represent fundamentally different conditions (i.e., the plants and habitat provided by different subclasses are different, and therefore cannot fully substitute for each other). As a result, although these acres are still considered to be jurisdictional wetlands and still occur within the landscape of the project area, they are treated as though they were cleared, because from a functional standpoint, they are no longer provided the same functions that they were before the project.

Those wetland areas not subject to a full scale removal from the 5-year floodplain and the resultant subclass shift are still subject to an incremental decrease in function, summarized in Table 14b. For instance, the 4084 acres of forested LGRB remaining after the Flats are removed are subject to decreases in FCIs ranging from 0.01 to 0.26, and the resulting losses of FCUs when multiplied by the acreages are provided in Table 14b. The largest of these impacts are the loss of 1062 FCUs for the Export Organic Carbon function, and a loss of 939 FCUs in the Detain Floodwater function (Table 14b)

Total losses of FCUs for this alternative are summarized by subclass in Table 14c. The largest impacts are to the Detain Floodwater (a loss of 4046 FCUs) and Export Organic Carbon (4102 FCUs) functions for LGRB wetlands. The Maintain Plant Communities function for LGRO (a loss of 70 FCUs) and CD wetlands (a loss of 138 FCUs), LGRO wetlands, products of changes to flood duration seen in this alternative. Although the gains of Flat and UCD are reported, they are not meant to be seen as offsetting the losses. It should also be noted that this mitigation debt is summarized in FCUs. The acreage required will depend on the rate of functional gain realized by the mitigation scenarios, which are subject to post-project hydrology.

Tables 13a and 13b: Authorized Project With Avoid and Minimize Measures Management Scenario 2 Conditions – New Madrid Floodway:

HGM Assessment of Potential Wetlands: Alternative 3.2 Conditions By Basin below the 5-year floodplain: FCIs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	171	135	7	4084	1163	3253	191	109	333	262	95	75
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.20	NA	0.00	0.65	0.79	NA	0.44	NA	0.48	NA	0.17	NA
Detain Precipitation	0.54	0.35	0.00	0.96	0.58	0.81	NA	NA	0.93	0.71	NA	NA
Cycle Nutrients	0.24	0.19	0.00	0.82	0.85	0.85	0.58	0.76	0.72	0.67	0.42	0.53
Export Organic Carbon	0.15	NA	0.00	0.59	0.76	NA	0.49	NA	0.58	NA	0.33	NA
Maintain Plant Communities	0.00	0.00	0.00	0.85	0.78	0.91	0.41	0.86	0.71	0.68	0.12	0.39
Provide Habitat for Fish and Wildlife	0.00	0.00	0.00	0.71	0.60	0.73	0.47	0.61	0.25	0.24	0.13	0.09

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Alternative 3.2 Conditions By Basin below the 5-year floodplain: FCUs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	171	135	7	4084	1163	3253	191	109	333	262	95	75
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	34	NA	0	2655	919	NA	84	NA	160	NA	16	NA
Detain Precipitation	92	47	0	3921	675	2635	NA	NA	310	186	NA	NA
Cycle Nutrients	41	26	0	3349	989	2765	111	83	240	176	40	40
Export Organic Carbon	26	NA	0	2410	884	NA	94	NA	193	NA	31	NA
Maintain Plant Communities	0	0	0	3471	907	2960	78	94	236	178	11	29
Provide Habitat for Fish and Wildlife	0	0	0	2900	698	2375	90	66	83	63	12	7

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 14a and 14b: Gains and Losses Associated with the Authorized Project With Avoid and Minimize Measures Management Scenario 2 as compared with No Action Alternative – New Madrid Floodway.

HGM Assessment of Potential Wetlands: Gains and Losses between No Action Alternative and Alternative 3.2 Conditions By Basins below the 5-year floodplain: FCUs

Losses due to wholesale conversion to non-river connected Subclass, or due to direct clearing

Basin	New Madrid										
Vegetation Class	Ag Fields		Forested Area					WRP			
HGM Subclass	LGRB	Flat	LGRB		Flat	CD	UCD	LGRB	Flat	CD	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	-135	135	7	-3253	3253	-109	109	-262	262	-75	75
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-34	NA	-6	-2863	NA	-58	NA	-157	NA	-16	NA
Detain Precipitation	-73	47	-7	-3155	2635	NA	NA	-242	186	NA	NA
Cycle Nutrients	-32	26	-6	-2765	2765	-66	83	-189	176	-32	40
Export Organic Carbon	-26	NA	-6	-2765	NA	-62	NA	-189	NA	-30	NA
Maintain Plant Communities	0	0	-7	-3025	2960	-73	94	-199	178	-12	29
Provide Habitat for Fish and Wildlife	0	0	-5	-2505	2375	-62	67	-69	63	-11	7

Losses due to incremental decreases in function within remaining river-connected subclasses

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area			WRP	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD
Impacts	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	171	4084	1163	191	333	95
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-9	-939	-35	-17	-39	-4
Detain Precipitation	0	-41	0	NA	-2	NA
Cycle Nutrients	0	-123	0	-6	-1	0
Export Organic Carbon	-7	-1062	-35	-15	-47	-7
Maintain Plant Communities	0	-327	-70	-50	-16	-4
Provide Habitat for Fish and Wildlife	0	-245	-35	-19	-5	-2

Table 14c. Summary of FCU losses for the Avoid and Minimize Alternative (3.2) in New Madrid Floodway.

	Losses in FCUs			Gains in FCUs	
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**
Detain Floodwater	-4046	-35	-95	NA	NA
Detain Precipitation	-3520	0	0	2868	NA
Cycle Nutrients	-3116	0	-104	2966	123
Export Organic Carbon	-4102	-35	-115	NA	NA
Maintain Plant Communities	-3574	-70	-138	3138	123
Provide Habitat for Fish and Wildlife	-2830	-35	-94	2438	73

4.1. Limited Management Scenario New Madrid Floodway

Details of the Alternative 4.1 within the New Madrid Floodway may be found in the Alternatives Section of the EIS. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the alternative are identified in Tables 15 and 16, below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after Alternative 4.1 is implemented in New Madrid Floodway are documented in Tables 15a and 15b. The vast majority of impacts are associated with indirect hydrologic changes.

Total changes of FCIs and FCUs comparing Alternative 4.1 with the No Action alternative (Alternative 1.2) are shown in Tables 16a and 16b, and summarized by subclass in Table 16c. The vast majority of impacts are associated with indirect hydrologic changes; only 7 acres of LGRB are subjected direct clearing. Of the losses resulting from indirect hydrologic changes, the majority of those are from changes in frequency severe enough that a fundamental shift from a river connected subclass to an unconnected subclass occurs. Hence, of the 7344 acres of naturally vegetated LGRB existing in the New Madrid Floodway currently, 2150 acres are cut off from the river sufficiently to be outside the 5-year floodplain, and therefore to qualify as Flats (Table 15). All functions associated with these areas as LGRB wetlands are lost, and though they still exist on the landscape as Flats, they no longer perform the functions of Detain Floodwater or Export Organic Compounds to the aquatic ecosystem in a measureable way.

Table 16a illustrates the functional losses due to wholesale conversion of wetland acres to a subclass unconnected to the river, or due to direct clearing. The 2150 acres converted from LGRB to flats results in a loss of 1892 FCUs in the Detain Floodwater function and 1828 FCUs in the Export Organic Carbon function that are in no way offset by the fact that some gains occurred in the Flats subclass. Even in the functions that both LGRB and Flat wetlands perform, the fact that the indices are calibrated only within each subclass means that the FCUs cannot be added or subtracted across

Tables 15a and 15b: Alternative 4.1 Conditions – New Madrid Floodway:

HGM Assessment of Potential Wetlands: Alternative 4.1 Conditions By Basin below the 5-year floodplain: FCIs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	217	89	7	5187	1163	2150	191	109	422	173	121	49
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.15	NA	0.00	0.72	0.66	NA	0.41	NA	0.48	NA	0.17	NA
Detain Precipitation	0.54	0.35	0.00	0.96	0.58	0.78	NA	NA	0.93	0.71	NA	NA
Cycle Nutrients	0.24	0.19	0.00	0.84	0.85	0.87	0.58	0.76	0.72	0.67	0.42	0.53
Export Organic Carbon	0.11	NA	0.00	0.67	0.64	NA	0.46	NA	0.58	NA	0.32	NA
Maintain Plant Communities	0.00	0.00	0.00	0.92	0.84	0.91	0.53	0.86	0.76	0.68	0.16	0.39
Provide Habitat for Fish and Wildlife	0.00	0.00	0.00	0.77	0.62	0.70	0.49	0.61	0.26	0.24	0.14	0.09

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Alternative 4.1 Conditions By Basin below the 5-year floodplain: FCUs

Basin	New Madrid											
Vegetation Class	Ag Fields		Forested Areas						WRP2 : 765 ac			
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	217	89	7	5187	1163	2150	191	109	422	173	121	49
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	33	NA	0	3735	768	NA	78	NA	203	NA	21	NA
Detain Precipitation	117	31	0	4980	675	1677	NA	NA	393	123	NA	NA
Cycle Nutrients	52	17	0	4357	989	1871	111	83	304	116	51	26
Export Organic Carbon	24	NA	0	3475	744	NA	88	NA	245	NA	39	NA
Maintain Plant Communities	0	0	0	4772	977	1957	101	94	321	118	19	19
Provide Habitat for Fish and Wildlife	0	0	0	3994	721	1505	94	67	110	42	17	4

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 16a and 16b: Gains and Losses Associated with Alternative 4.1 as compared with No Action Alternative – New Madrid Floodway.

HGM Assessment of Potential Wetlands: Gains and Losses between No Action Alternative and Alternative 4.1 Conditions By Basins below the 5-year floodplain: FCUs

Losses due to wholesale conversion to non-river connected Subclass, or due to direct clearing

Basin	New Madrid										
Vegetation Class	Ag Fields		Forested Area					WRP			
HGM Subclass	LGRB	Flat	LGRB		Flat	CD	UCD	LGRB	Flat	CD	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	-89	89	7	-2150	2150	-109	109	-173	173	-49	49
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-22	NA	-6	-1892	NA	-58	NA	-103	NA	-10	NA
Detain Precipitation	-48	31	-7	-2086	1677	NA	NA	-160	123	NA	NA
Cycle Nutrients	-21	17	-6	-1828	1871	-66	83	-125	116	-21	26
Export Organic Carbon	-17	NA	-6	-1828	NA	-62	NA	-125	NA	-20	NA
Maintain Plant Communities	0	0	-7	-2000	1957	-73	94	-131	118	-8	19
Provide Habitat for Fish and Wildlife	0	0	-5	-1656	1505	-62	67	-46	42	-7	4

Losses due to incremental decreases in function within remaining river-connected subclasses

Basin	New Madrid					
Vegetation Class	Ag Fields	Forested Area			WRP	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD
Impacts	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	214	5121	1163	191	416	119
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-21	-819	-186	-23	-49	-5
Detain Precipitation	0	-51	0	NA	2	NA
Cycle Nutrients	0	-51	0	-6	-1	0
Export Organic Carbon	-17	-922	-174	-21	-59	-10
Maintain Plant Communities	0	-51	0	-27	0	0
Provide Habitat for Fish and Wildlife	0	0	-12	-15	-2	-1

Table 16c. Summary of FCU losses for Alternative 4.1 in New Madrid Floodway.

	Losses in FCUs			Gains in FCUs	
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**
Detain Floodwater	-2914	-186	-96	NA	NA
Detain Precipitation	-2350	0	NA	1831	NA
Cycle Nutrients	-2032	0	-93	2003	109
Export Organic Carbon	-2973	-174	-113	NA	NA
Maintain Plant Communities	-2188	0	-108	2074	113
Provide Habitat for Fish and Wildlife	-1709	-12	-86	1547	71

subclasses (e.g., Detain Precipitation), or that they represent fundamentally different conditions (i.e., the plants and habitat provided by different subclasses are different, and therefore cannot fully substitute for each other). As a result, although these acres are still considered to be jurisdictional wetlands and still occur within the landscape of the project area, they are treated as though they were cleared, because from a functional standpoint, they are no longer provided the same functions that they were before the project.

Those wetland areas not subject to a full scale removal from the 5-year floodplain and the resultant subclass shift are still subject to an incremental decrease in function, summarized in Table 16b. For instance, the 5121 acres of forested LGRB remaining after the Flats are removed are subject to decreases in FCIs ranging from 0.01 to 0.18, and the resulting losses of FCUs when multiplied by the acreages are provided in Table 16b. The largest of these impacts are the loss of 922 FCUs for the Export Organic Carbon function, and a loss of 819 FCUs in the Detain Floodwater function (Table 16b).

Total losses of FCUs for this alternative are summarized by subclass in Table 16c. The largest impacts are to the Detain Floodwater (a loss of 2914 FCUs) and Export Organic Carbon (2973 FCUs) functions for LGRB wetlands. Although the gains of Flat and UCD are reported, they are not meant to be seen as offsetting the losses of river-connected subclass. It should also be noted that this mitigation debt is summarized in FCUs. The acreage required will depend on the rate of functional gain realized by the mitigation scenarios, which are subject to post-project hydrology.

4.2. Limited Management with Reforestation Scenario New Madrid Floodway

Details of the Alternative 4.2 within the New Madrid Floodway may be found in the Alternatives Section of the EIS. It is identical to Alternative 4.1, except that it also calls for the reforestation of 13,340 acres of current agricultural lands to wet forests. Using the assumptions and data sources identified in the Methods, the conditions and impacts associated with the alternative are identified in Tables 17 and 18, below. Acreages for all Direct Impacts, as well as hydrology variables for all indirect impacts, were supplied by Memphis District.

The conditions forecast after Alternative 4.2 is implemented in New Madrid Floodway are documented in Tables 17a and 17b. The vast majority of impacts are associated with indirect hydrologic changes.

Total changes of FCIs and FCUs comparing Alternative 4.2 with the No Action alternative (Alternative 1.2) are shown in Tables 18a and 18b, and summarized by subclass in Table 18c. These impacts are identical to those in Alternative 4.1, with the exception of the last two columns, the Newly Restored Forest. Annualized FCIs were calculated for these areas over the 50-year life of the project. The ratio of LGRB to CD wetlands was based on the typical ratio used in WRP restorations, but it was assumed that these areas would be allowed to mature fully, unlike CD in WRP which are typically arrested at an herbaceous stage.
As a result of the 13,340 acres of restoration, this alternative actually results in gains for most subclasses of river-connected wetlands, as summarized in Table 18c. The restoration of 12,820 acres of forested LGRB results in a gain of function ranging from 6154 FCUs for the Detain Floodwater function to 11,923 FCUs for the Detain Precipitation function (Table 17b, Table 18b). The function Detain Floodwater was the one least influenced by the restoration, and even that function shows a gain in FCUs (35) for LGRB wetlands for this alternative. Other functions have much larger surpluses for the LGRB subclass, from 2021 FCUs for the Export Organic Carbon function, to 7555 FCUs for the Maintain Plant Communities function. Likewise, CD wetlands experienced no functional losses for this alternative. Only LGRO wetlands were subject to functional losses, since it was assumed that the restoration would all be existing agricultural land, which is assumed to be appropriate for LGRB and CD restoration. Those losses were focused on the Detain Floodwater function, with a loss of 186 FCUs, and Export Organic Carbon, with a loss of 174 FCUs.

It should be noted that this mitigation debt is summarized in FCUs. The acreage required will depend on the rate of functional gain realized by the mitigation scenarios, which are subject to post-project hydrology.

Tables 17a and 17b: Alternative 4.2 Conditions – New Madrid Floodway:

HGM Assessment of Potential Wetlands: Alternative 4.2 Conditions By Basin below the 5-year floodplain: FCIs

Basin	New Madrid													
Vegetation Class	Ag Fields		Forested Areas						WRP[2] : 765 ac				Newly Restored Forest	
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD	LGRB	CD[3]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	217	89	7	5187	1163	2150	191	109	422	173	121	49	12820	1900
Function	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**	**FCI**
Detain Floodwater	0.15	NA	0.00	0.72	0.66	NA	0.41	NA	0.48	NA	0.17	NA	0.48	0.17
Detain Precipitation	0.54	0.35	0.00	0.96	0.58	0.78	NA	NA	0.93	0.71	NA	NA	0.93	NA
Cycle Nutrients	0.24	0.19	0.00	0.84	0.85	0.87	0.58	0.76	0.72	0.67	0.42	0.53	0.72	0.42
Export Organic Carbon	0.11	NA	0.00	0.67	0.64	NA	0.46	NA	0.58	NA	0.32	NA	0.58	0.32
Maintain Plant Communities	0.00	0.00	0.00	0.92	0.84	0.91	0.53	0.86	0.76	0.68	0.16	0.39	0.76	0.16
Provide Habitat for Fish and Wildlife	0.00	0.00	0.00	0.77	0.62	0.70	0.49	0.61	0.26	0.24	0.14	0.09	0.59	0.14

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

HGM Assessment of Potential Wetlands: Alternative 4.2 Conditions By Basin below the 5-year floodplain: FCUs

Basin	New Madrid													
Vegetation Class	Ag Fields		Forested Areas						WRP2 : 765 ac				Newly Restored Forest	
HGM Subclass	LGRB	Flat	LGRB		LGRO	Flat	CD	UCD	LGRB	Flat	CD[3]	UCD	LGRB	CD[3]
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage[1]	217	89	7	5187	1163	2150	191	109	422	173	121	49	12820	1900
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCI**	**FCI**
Detain Floodwater	33	NA	0	3735	768	NA	78	NA	203	NA	21	NA	6154	323
Detain Precipitation	117	31	0	4980	675	1677	NA	NA	393	123	NA	NA	11923	NA
Cycle Nutrients	52	17	0	4357	989	1871	111	83	304	116	51	26	9230	798
Export Organic Carbon	24	NA	0	3475	744	NA	88	NA	245	NA	39	NA	7436	608
Maintain Plant Communities	0	0	0	4772	977	1957	101	94	321	118	19	19	9743	304
Provide Habitat for Fish and Wildlife	0	0	0	3994	721	1505	94	67	110	42	17	4	7564	266

1 Forested acreage were provided by Memphis District. Agricultural Acreage from NRCS, and assigned to basins by Memphis District. Vegetation Class acreages were subdivided into HGM subclasses based in GIS and field sample data.

2 WRP FCI are annualized over a 50-year life of project, based on projections in Klimas et al. 2011. Only the WRP acreage within the 5-year floodplain is assessed.

3 Forest WRP is assumed to be LGRB, herbaceous WRP is assumed to be CD; both are assumed to be restored from PC agricultural lands.

Tables 18a and 18b: Gains and Losses Associated with Alternative 4.2 as compared with No Action Alternative – New Madrid Floodway.

HGM Assessment of Potential Wetlands: Gains and Losses between No Action Alternative and Alternative 4.2 Conditions By Basins below the 5-year floodplain: FCUs
Losses due to wholesale conversion to non-river connected Subclass, or due to direct clearing

Basin	New Madrid										
Vegetation Class	Ag Fields		Forested Area					WRP			
HGM Subclass	LGRB	Flat	LGRB		Flat	CD	UCD	LGRB	Flat	CD	UCD
Impacts	Indirect Hydro	Indirect Hydro	Direct Clearing	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	-89	89	7	-2150	2150	-109	109	-173	173	-49	49
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**
Detain Floodwater	-22	NA	-6	-1892	NA	-58	NA	-103	NA	-10	NA
Detain Precipitation	-48	31	-7	-2086	1677	NA	NA	-160	123	NA	NA
Cycle Nutrients	-21	17	-6	-1828	1871	-66	83	-125	116	-21	26
Export Organic Carbon	-17	NA	-6	-1828	NA	-62	NA	-125	NA	-20	NA
Maintain Plant Communities	0	0	-7	-2000	1957	-73	94	-131	118	-8	19
Provide Habitat for Fish and Wildlife	0	0	-5	-1656	1505	-62	67	-46	42	-7	4

Losses and gains due to incremental decreases or increases in function within remaining river-connected subclasses (increases only in restoration areas)

Basin	New Madrid							
Vegetation Class	Ag Fields	Forested Area			WRP		Newly Restored Forest	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD	LGRB	CD
Impacts	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro	Indirect Hydro
Acreage	214	5121	1163	191	416	119	12820	1900
Function	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCU**	**FCI**	**FCI**
Detain Floodwater	-21	-819	-186	-23	-49	-5	2949	228
Detain Precipitation	0	-51	0	NA	2	NA	5000	NA
Cycle Nutrients	0	-51	0	-6	-1	0	6154	589
Export Organic Carbon	-17	-922	-174	-21	-59	-10	5000	513
Maintain Plant Communities	0	-51	0	-27	0	0	9743	304
Provide Habitat for Fish and Wildlife	0	0	-12	-15	-2	-1	7564	266

Table 18c. Summary of FCU gains and losses for Alternative 4.2 in New Madrid Floodway.

	Losses/Gains in FCUs			Gains in FCUs	
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**
Detain Floodwater	35	-186	132	NA	NA
Detain Precipitation	2650	0	0	1831	NA
Cycle Nutrients	4122	0	496	2003	109
Export Organic Carbon	2027	-174	400	NA	NA
Maintain Plant Communities	7555	0	196	2074	113
Provide Habitat for Fish and Wildlife	5855	-12	180	1547	71

1 Negative mitigation debt indicates a surplus based on forest restoration that is part of the project.

Mitigation Scenarios

Annualized FCIs were calculated for potential mitigation. For each alternative, the post-project hydrology was used for the FCI projects. Hence, there are different tables for annualized functional gain for each alternative, within each basin. In addition, for each alternative, two Tract Size scenarios were used for Low Gradient Riverine Backwater wetland mitigation, one reflecting mitigation accomplished in large 500 ha (1200 ac) tracts connected to similarly sized blocks of existing habitat, and another reflecting mitigation accomplished in smaller (~500 ac), more isolated tracts. In all cases, it is assumed that wetland mitigation will be planted in the first year of the project, will be allowed to grow to forest, and will not be arrested at an herbaceous stage. As with the WRP projections, FCIs were annualized using the following year intervals: 0, 1, 5, 15, 25, and 50. It is assumed that any planting mortality is immediately rectified, and does not affect the projections for vegetation variables. These two Tract Size scenarios only differ in results for the Provide Wildlife Habitat function, but because this function has the lowest functional gain, it may well be a determining factor in mitigation requirements. The difference in the two scenarios show a clear advantage of linking mitigation to existing blocks of forested wetland.

Low Gradient Overbank wetlands occur in narrow strips along riparian corridors. While it is possible that they can occur in large tracts consisting of both Low Gradient Riverine Overbank and Backwater wetlands, given the condition of the basin, it seems more likely that mitigation of this subclass would occur in smaller, relatively unconnected tracts. It is assumed that LGRO mitigation will occur in 100 ha (250 acre) tracts that are approximately 10 percent connected, reflecting that they are likely filling gaps in a riparian corridor, but not linked or near large blocks of forest. Results for all mitigation projections are shown in Table 7. These are to help guide the siting and amount of mitigation in a general sense. Once actual mitigation locations are identified, the projections can be rerun with actual tract size, core and connectivity amounts, which will lead to more accurate calculations of mitigation debt.

Mitigation Annualized FCIs are offered for each alternative. In addition, the acreage required for mitigating a single lost FCU is also tabularized for each alternative. Then, a summary table offers the impacts associated with each alternative for each function, and these FCUs are multiplied through by

the acres required to mitigate a single FCU, resulting in an estimate of required acreage based on all the assumptions used in this analysis. In each case, the acreage required assumes that the basin is subject to the post-project hydrology.

The mitigation proposal includes creation of a structure that would restore more natural flooding to Big Oak Tree State Park (BOTSP) and some of its surrounding area. For each alternative, an additional table indicates how this structure would change the mitigation debt. At the time of this initial analysis, final design of the structure had yet to be finalized, and therefore certain assumptions were made. It is assumed that the design will optimize the hydrologic gain within the park itself. So first, the impacts associated with the BOTSP are removed from the mitigation debt, and second, the BOTSP is assumed to receive an improvement to its flood frequency (V_{FREQ}) and flood duration (V_{DUR}) resulting in a 0.2 increase to the variable subindex of both of these variables. The functional gains associated with the increased indices for these variables are also calculated.

Finally, some of the farmland around the BOTSP will be subject to improved hydrology, and would accrue mitigation functional lift at a higher rate than the parts of the basin subject to post-project hydrology unaffected by the structure. Where the rest of the basin might be subject to a loss in frequency or duration of flooding, post project, it is assumed that the structure counteracts these projects impacts within a limited area near the park. It is assumed for the purposes of this analysis that these areas would instead be subject to the No Action Annualized FCIs, which are subject to existing hydrology. It is not known how extensive this area would be, so this is reported as a difference in FCIs, not FCUs or acres.

Alternative 1 - No Action

1.1. Existing Conditions

No Annualized FCIs need to be calculated to represent Existing Conditions.

1.2 . Future enrollment of WRP without (w/o) the project

Table 19: Annualized gains per acre of for Forested WRP Subject to Existing Hydrologic Conditions

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.265
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.599
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.693	0.452

Alternative 2 - Authorized Project

2.1. St. John's Bayou Basin Improvements Only

Mitigation associated with the Authorized Project within St Johns Basin would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 20a and 20b.

Tables 20a and 20b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated The Authorized Project in St. Johns Bayou.

Mitigation FCIs below the 5-year floodplain For Authorized Project Within St Johns Basin. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Annualized Functional Capacity Indices**					
Small (500ac) Tracts	0.578	0.925	0.722	0.702	0.749	0.265
Large (1200ac) Tracts	0.578	0.925	0.722	0.702	0.749	0.599
LGRO	**Annualized Functional Capacity Indices**					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.653	0.442
CD	**Annualized Functional Capacity Indices**					
Inclusions in Large (1200ac) Tracts	0.581	NA	0.668	0.629	0.635	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain for Authorized Project Within St Johns Basin. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Acres Needed to Offset 1 Lost FCU**					
Small (500ac) Tracts	1.729	1.081	1.386	1.425	1.335	3.781
Large (1200ac) Tracts	1.729	1.081	1.386	1.425	1.335	1.671
LGRO	**Acres Needed to Offset 1 Lost FCU**					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.530	2.265
CD	**Acres Needed to Offset 1 Lost FCU**					
Inclusions in Large (1200ac) Tracts	1.723	NA	1.498	1.589	1.574	1.663

Using these mitigation functional gains, and the FCU losses associated with the Authorized Project in the St. Johns Basin, mitigation debt can be calculated in acres (Table 21).

Table 21. Functional Losses in FCUs Associated with the Authorized Project within St. Johns Basin, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 20.

Mitigation Required for Authorized Project in St. Johns Basin, Assuming that Mitigation is accomplished in large connected tracts, and post-project hydrology.

	Losses in FCUs			Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Authorized Project Hydrology		
Function	**LGRB**	**LGRO**	**CD[1]**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-116.0	-653.0	0.0	200.6	1026.2	0.0
Detain Precipitation	0.0	-505.0	NA	0.0	559.8	NA
Cycle Nutrients	0.0	-565.0	0.0	0.0	908.1	0.0
Export Organic Carbon	-116.0	-525.0	0.0	165.3	854.9	0.0
Maintain Plant Communities	-49.0	-580.0	0.0	65.4	887.7	0.0
Provide Habitat for Fish and Wildlife	0.0	-337.0	0.0	0.0	763.3	0.0

1 No connected depressions were located or sampled within St. Johns Basin.

Table 21 shows the losses associated with the Authorized Project in St. Johns Basin summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 20. It is assumed that mitigation is taking place within the 5-year floodplain, subject to the post-project hydrology. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functional losses will be more than fully offset. For both the LGRB and LGRO subclasses, the largest acreage requirements are associated with the Detain Floodwater Function, 200.6 acres for LGRB wetlands, and 1026.2 acres for LGRO wetlands.

2.2. New Madrid Floodway Levee Closure Only

Mitigation associated with the Authorized Project within the New Madrid Floodway would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 22a and 22b.

Tables 22a and 22b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated with the Authorized Project in the New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain For Authorized Project Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Annualized Functional Capacity Indices**					
Small (500ac) Tracts	0.477	0.925	0.722	0.577	0.682	0.246
Large (1200ac) Tracts	0.477	0.925	0.722	0.577	0.682	0.555
LGRO	**Annualized Functional Capacity Indices**					
Small (250ac) Tracts	0.507	0.902	0.622	0.489	0.601	0.422
CD	**Annualized Functional Capacity Indices**					
Inclusions in Large (1200ac) Tracts	0.481	NA	0.668	0.518	0.410	0.530

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain for Authorized Project Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Acres Needed to Offset 1 Lost FCU**					
Small (500ac) Tracts	2.098	1.081	1.386	1.735	1.466	4.065
Large (1200ac) Tracts	2.098	1.081	1.386	1.735	1.466	1.803
LGRO	**Acres Needed to Offset 1 Lost FCU**					
Small (250ac) Tracts	1.972	1.109	1.607	2.046	1.664	2.372
CD	**Acres Needed to Offset 1 Lost FCU**					
Inclusions in Large (1200ac) Tracts	2.078	NA	1.498	1.930	2.437	1.889

Using these mitigation functional gains, and the FCU losses associated with the Authorized Project in the New Madrid Floodway, mitigation debt can be calculated in acres (Table 23).

Table 23. Functional Losses in FCUs Associated with the Authorized Project within the New Madrid Floodway, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 22.

Mitigation Required for Authrized Project New Madrid Floodway, Assuming that Mitigation is accomplished in large connected tracts around Big Oak State Park

	Losses in FCUs			Gains in FCUs		Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Authorized Project Hydrology		
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-6449	-186	-179	NA	NA	13531	367	372
Detain Precipitation	-7332	0	NA	5651	NA	7925	0	NA
Cycle Nutrients	-6283	0	-234	5765	258	8706	0	351
Export Organic Carbon	-6312	-174	-223	NA	NA	10949	357	431
Maintain Plant Communities	-6845	-128	-211	6454	266	10038	213	514
Provide Habitat for Fish and Wildlife	-5503	-58	-181	5050	153	9924	138	341

Table 23 shows the losses associated with the Authorized Project in New Madrid Floodway summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 22. It is assumed that mitigation is taking place within the 5-year floodplain, in large (1200 acre) well-connected tracts, but that no structure has been installed to restore flooding. Thus, the mitigation is maturing while subject to the altered hydrology associated with the Authorized Project. This leads to a much smaller functional lift per acre (or Annualized FCI), and larger acreage requirements for mitigation to offset the losses associated with the project. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the most impacted function will be mitigated, and all other functions will be more than fully offset. For both the LGRB and LGRO subclasses, the largest acreage requirements are associated with the Detain Floodwater Function, 13,531 acres for LGRB wetlands, and 367 acres for LGRO wetlands. For CD wetlands, the largest mitigation acreage requirement is associated with the Export Organic Carbon Function, resulting in 431 acres of CD wetlands.

If the structure is built to restore more natural flooding to Big Oak Tree State Park (BOTSP), then the FCUs lost shown in Table 23 would be decreased. Table 24 shows that the impacts associated with the BOTSP are removed from the mitigation debt as No Longer Impacted. In addition, hydrology is planned to be improved beyond existing conditions. This analysis assumes that the design will optimize the hydrologic gain within the park itself. The BOTSP is assumed to receive an improvement to its flood frequency (V_{FREQ}) and flood duration (V_{DUR}) resulting in a 0.2 increase to the variable subindex of both of these variables. The functional gains associated with the increased indices for these variables are also calculated and shown in Table 24. The resulting benefit is 1615.1 LGRB mitigation acres saved, and 83 CD mitigation acres saved.

Table 24. Analysis of Benefits of a Flood Structure Restoring Flood Frequency and Duration to BOTSP, in terms of FCUs no longer impacted, FCUs Gained Due to Hydrologic Improvement beyond Existing Conditions, and Acreages Associated with the FCUs

Subclass	LGRB			CD			Mitigation Acres Saved	
Acres	976			49				
FCUs	No Longer Impacted	Hydrologic Improvement	Total	No Longer Impacted	Hydrologic Improvement	Total	LGRB	CD
Detain Floodwater	810.1	156.2	966.3	33.8	6.86	40.66	-1615.1	-67.7
Detain Precipitation	976	0	976	NA	NA	NA	-1054.9	NA
Cycle Nutrients	868.6	0	868.6	33.3	0	33.3	-1203.5	-49.9
Export Organic Carbon	868.6	175.7	1044.3	34.3	6.86	41.16	-1446.8	-63.4
Maintain Plant Communities	927.2	29.3	956.5	44.1	3.92	48.02	-1300.5	-83.0
Provide Habitat for Fish and Wildlife	732	29.3	761.3	33.3	1.47	34.77	-1296.9	-59.2

In addition, some of the farmland around the BOTSP will be subject to improved hydrology, and would accrue mitigation functional lifts at a higher rate than the portions of the basin subject to post-Authorized Project hydrology. It is assumed for the purposes of this analysis that these areas would instead on average have hydrology similar to existing conditions, and be subject to the No Action Annualized FCIs. It is not known how extensive this area would be, so this benefit is reported FCIs, not FCUs or acres. Tables 25a and 25b show the FCIs that should be used to calculated mitigation acres required when mitigation is accomplished within this hydrologically improved area, rather than elsewhere in the basin. They supplant the FCIs shown in Tables 22a and 22b within this area. Mitigation accomplished outside the area influenced by the Structure would still be subject to FCIs offered in Tables 22a and 22b.

Tables 25a and 25b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass and Function within Areas Around Big Oak Tree State Park Hydrologically Improved by the Structure and Available for Mitigation, New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.265
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.599
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.693	0.452
CD	Annualized Functional Capacity Indices					
Inclusions in Large (1200ac) Tracts	0.601	N/A	0.668	0.649	0.645	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Acres Needed to Offset 1 Lost FCU					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.318	3.781
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.318	1.671
LGRO	Acres Needed to Offset 1 Lost FCU					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.442	2.215
CD	Acres Needed to Offset 1 Lost FCU					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.550	1.663

2.3. Combined 2.1 and 2.2 Projects

If the Authorized Project is completed within both basins, the combined acreage totals given in Tables 21 and 23 will be required. The combined acreages are as follows: 13,732 acres of LGRB wetlands, 1393 acres of LGRO wetlands, and 431 acres of CD wetlands.

These totals could be decreased by at least 1615 LGRB mitigation acres saved, and 83 CD mitigation acres saved if the structure restoring hydrology to BOTSP is built. Additional benefits could be gained, depending on how much mitigation could be accomplished within the improved hydrology zone around BOTSP. The difference in FCIs between Tables 22 and 25 reflect this gain.

Alternative 3 - Authorized Project with Avoid and Minimize Measures

St. Johns Basin

Mitigation associated with the Authorized Project within St Johns Basin would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 26a and 26b.

Tables 26a and 26b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated The Authorized Project in St. Johns Bayou.

Mitigation FCIs below the 5-year floodplain For Authorized Project Within St Johns Basin. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Annualized Functional Capacity Indices**					
Small (500ac) Tracts	0.578	0.925	0.722	0.702	0.749	0.265
Large (1200ac) Tracts	0.578	0.925	0.722	0.702	0.749	0.599
LGRO	**Annualized Functional Capacity Indices**					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.653	0.442
CD	**Annualized Functional Capacity Indices**					
Inclusions in Large (1200ac) Tracts	0.581	NA	0.668	0.629	0.635	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain for Authorized Project Within St Johns Basin. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Acres Needed to Offset 1 Lost FCU**					
Small (500ac) Tracts	1.729	1.081	1.386	1.425	1.335	3.781
Large (1200ac) Tracts	1.729	1.081	1.386	1.425	1.335	1.671
LGRO	**Acres Needed to Offset 1 Lost FCU**					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.530	2.265
CD	**Acres Needed to Offset 1 Lost FCU**					
Inclusions in Large (1200ac) Tracts	1.723	NA	1.498	1.589	1.574	1.663

Using these mitigation functional gains, and the FCU losses associated with the Authorized Project in the St. Johns Basin, mitigation debt can be calculated in acres (Table 27).

Table 27. Functional Losses in FCUs Associated with the Authorized Project with Avoid and Minimize Measures within St. Johns Basin, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 26.

Mitigation Required for Avoid and Minimize Alternative Assuming that Mitigation is accomplished in large connected tracts, and post-project hydrology.

	Losses in FCUs			Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Project Hydrology		
Function	**LGRB**	**LGRO**	**CD[1]**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-116	-397	0	201	623	0
Detain Precipitation	0	-307	NA	0	340	NA
Cycle Nutrients	0	-344	0	0	552	0
Export Organic Carbon	-115	-319	0	164	519	0
Maintain Plant Communities	-50	-374	0	67	573	0
Provide Habitat for Fish and Wildlife	0	-210	0	0	476	0

1 No connected depressions were located or sampled within St. Johns Basin.

Table 27 shows the losses associated with the Authorized Project with Avoid and Minimize Measures in St. Johns Basin summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 26. It is assumed that mitigation is taking place within the 5-year floodplain, subject to the post-project hydrology. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functions will be more than mitigated. For both the LGRB and LGRO subclasses, the largest acreage requirements are associated with the Detain Floodwater Function, 201 acres for LGRB wetlands, and 623 acres of LGRO wetlands.

3.1. New Madrid Floodway Management Scenario 1

Mitigation associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 within the New Madrid Floodway would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 28a and 28b.

Tables 28a and 28b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 in the New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain For Authorized Project With Avoid & Minimize Measures Management Scenario 1 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Annualized Functional Capacity Indices**					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.736	0.246
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.736	0.587
LGRO	**Annualized Functional Capacity Indices**					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.667	0.444
CD	**Annualized Functional Capacity Indices**					
Inclusions in Large (1200ac) Tracts	0.601	NA	0.668	0.649	0.579	0.588

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain For Authorized Project With Avoid & Minimize Measures Management Scenario 1 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Acres Needed to Offset 1 Lost FCU**					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.360	4.065
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.360	1.704
LGRO	**Acres Needed to Offset 1 Lost FCU**					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.500	2.255
CD	**Acres Needed to Offset 1 Lost FCU**					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.729	1.702

Using these mitigation functional gains, and the FCU losses associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 in the New Madrid Floodway, mitigation debt can be calculated in acres (Table 29). Table 25 shows the losses associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 in New Madrid Floodway summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 28.

Table 29. Functional Losses in FCUs Associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 within the New Madrid Floodway, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 28.

Mitigation Required for Alternative 3.1 New Madrid Floodway, Assuming that Mitigation is accomplished in large connected tracts around Big Oak State Park.

	Losses in FCUs			Gains in FCUs		Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Project Hydrology		
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-3487	-35	-97	NA	NA	5828	55	161
Detain Precipitation	-2423	0	0	1910	NA	2619	0	NA
Cycle Nutrients	-2092	0	-94	2088	110	2899	0	141
Export Organic Carbon	-3558	-35	-118	NA	NA	4929	57	182
Maintain Plant Communities	-2582	-35	-124	2183	113	3511	52	215
Provide Habitat for Fish and Wildlife	-1970	-12	-89	1616	71	3356	26	152

It is assumed that mitigation is taking place within the 5-year floodplain, in large (1200 acre) well-connected tracts, but that no structure has been installed to restore flooding. Thus, the mitigation is maturing while subject to the altered hydrology associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1. This leads to a smaller functional lift per acre (or Annualized FCI), and larger acreage requirements for mitigation to offset the losses associated with the project. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functions will be more than mitigated. For the LGRB subclass, the largest acreage requirements are associated with the Detain Floodwater Function: 5828 acres for LGRB wetlands. For the LGRO subclass, the Export Organic Carbon Function required the greatest acreage at 57 acres. For CD wetlands, the largest mitigation acreage requirement is associated with the Maintain Plant Communities Function, resulting in 215 acres of CD wetlands.

If the structure is built to restore more natural flooding to Big Oak Tree State Park (BOTSP), then the FCUs lost shown in Table 29 would be decreased. Table 30 shows that the impacts associated with the BOTSP are removed from the mitigation debt as No Longer Impacted. In addition, hydrology is planned to be improved beyond existing conditions. This analysis assumes that the design will optimize the hydrologic gain within the park itself. The BOTSP is assumed to receive an improvement to its flood frequency (V_{FREQ}) and flood duration (V_{DUR}) resulting in a 0.2 increase to the variable subindex of both of these variables. The functional gains associated with the increased indices for these variables are also calculated and shown in Table 26. The resulting benefit is 1615.1 LGRB mitigation acres saved, and 83 CD mitigation acres saved.

Table 30. Analysis of Benefits of a Flood Structure Restoring Flood Frequency and Duration to BOTSP, in terms of FCUs no longer impacted, FCUs Gained Due to Hydrologic Improvement beyond Existing Conditions, and Acreages Associated with the FCUs

Subclass	LGRB			CD			Mitigation Acres Saved	
Acres	976			49				
FCUs	No Longer Impacted	Hydrologic Improvement	Total	No Longer Impacted	Hydrologic Improvement	Total	LGRB	CD
Detain Floodwater	810.1	156.2	966.3	33.8	6.86	40.66	-1615.1	-67.7
Detain Precipitation	976	0	976	NA	NA	NA	-1054.9	NA
Cycle Nutrients	868.6	0	868.6	33.3	0	33.3	-1203.5	-49.9
Export Organic Carbon	868.6	175.7	1044.3	34.3	6.86	41.16	-1446.8	-63.4
Maintain Plant Communities	927.2	29.3	956.5	44.1	3.92	48.02	-1300.5	-83.0
Provide Habitat for Fish and Wildlife	732	29.3	761.3	33.3	1.47	34.77	-1296.9	-59.2

In addition, some of the farmland around the BOTSP will be subject to improved hydrology, and would accrue mitigation functional lifts at a higher rate than the portions of the basin subject to post-Authorized Project hydrology. It is assumed for the purposes of this analysis that these areas would instead on average have hydrology similar to existing conditions, and be subject to the No Action Annualized FCIs. It is not known how extensive this area would be, so this benefit is reported FCIs, not FCUs or acres. Tables 31a and 31b show the FCIs that should be used to calculated mitigation acres required when mitigation is accomplished within this hydrologically improved area, rather than elsewhere in the basin. They supplant the FCIs shown in Tables 28a and 28b within this area. Mitigation accomplished outside the area influenced by the Structure would still be subject to FCIs offered in Tables 28a and 28b.

Tables 31a and 31b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass and Function within Areas Around Big Oak Tree State Park Hydrologically Improved by the Structure and Available for Mitigation, New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.265
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.599
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.693	0.452
CD	Annualized Functional Capacity Indices					
Inclusions in Large (1200ac) Tracts	0.601	N/A	0.668	0.649	0.645	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Acres Needed to Offset 1 Lost FCU					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.318	3.781
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.318	1.671
LGRO	Acres Needed to Offset 1 Lost FCU					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.442	2.215
CD	Acres Needed to Offset 1 Lost FCU					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.550	1.663

3.2. New Madrid Floodway Management Scenario 2

Mitigation associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2 within the New Madrid Floodway would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 32a and 32b.

Tables 32a and 32b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2 in the New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain For Authorized Project With Avoid & Minimize Measures Management Scenario 2 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Annualized Functional Capacity Indices**					
Small (500ac) Tracts	0.477	0.925	0.722	0.577	0.709	0.249
Large (1200ac) Tracts	0.477	0.925	0.722	0.577	0.709	0.565
LGRO	**Annualized Functional Capacity Indices**					
Small (250ac) Tracts	0.507	0.902	0.622	0.489	0.632	0.430
CD	**Annualized Functional Capacity Indices**					
Inclusions in Large (1200ac) Tracts	0.483	NA	0.668	0.520	0.500	0.552

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain For Authorized Project With Avoid & Minimize Measures Management Scenario 2 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	**Acres Needed to Offset 1 Lost FCU**					
Small (500ac) Tracts	2.098	1.081	1.386	1.735	1.411	4.024
Large (1200ac) Tracts	2.098	1.081	1.386	1.735	1.411	1.770
LGRO	**Acres Needed to Offset 1 Lost FCU**					
Small (250ac) Tracts	1.972	1.109	1.607	2.046	1.583	2.328
CD	**Acres Needed to Offset 1 Lost FCU**					
Inclusions in Large (1200ac) Tracts	2.070	NA	1.498	1.923	1.998	1.813

Using these mitigation functional gains, and the FCU losses associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2 in the New Madrid Floodway, mitigation debt can be calculated in acres (Table 33). Table 33 shows the losses associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2 in New Madrid Floodway summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 32.

Table 33. Functional Losses in FCUs Associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2 within the New Madrid Floodway, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 28.

Mitigation Required for Alternative 3.2 New Madrid Floodway, Assuming that Mitigation is accomplished in large connected tracts around Big Oak State Park.

	Losses in FCUs			Gains in FCUs		Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Project Hydrology		
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-4046	-35	-95	NA	NA	8490	69	196
Detain Precipitation	-3520	0	0	2868	NA	3805	0	NA
Cycle Nutrients	-3116	0	-104	2966	123	4317	0	156
Export Organic Carbon	-4102	-35	-115	NA	NA	7115	71	221
Maintain Plant Communities	-3574	-70	-138	3138	123	5043	110	277
Provide Habitat for Fish and Wildlife	-2830	-35	-94	2438	73	5008	81	171

It is assumed that mitigation is taking place within the 5-year floodplain, in large (1200 acre) well-connected tracts, but that no structure has been installed to restore flooding. Thus, the mitigation is maturing while subject to the altered hydrology associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 2. This leads to a smaller functional lift per acre (or Annualized FCI), and larger acreage requirements for mitigation to offset the losses associated with the project. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functions will be more than mitigated. For the LGRB subclass, the largest acreage requirements are associated with the Detain Floodwater Function: 8490 acres for LGRB wetlands. For the LGRO subclass, the Maintain Plant Communities Function required the greatest acreage at 110 acres. For CD wetlands, the largest mitigation acreage requirement is associated with the Export Organic Carbon Function, resulting in 221 acres of CD wetlands.

If the structure were built to restore more natural flooding to Big Oak Tree State Park (BOTSP), then the FCUs lost shown in Table 29 would be decreased. Table 34 shows that the impacts associated with the BOTSP are removed from the mitigation debt as No Longer Impacted. In addition, hydrology is planned to be improved beyond existing conditions. There are currently few details about how this structure would deliver water to BOTSP. This analysis assumes that the design will optimize the hydrologic gain within the park itself. The BOTSP is assumed to receive an improvement to its flood frequency (V_{FREQ}) and flood duration (V_{DUR}) resulting in a 0.2 increase to the variable subindex of both of these variables. The functional gains associated with the increased indices for these variables are also calculated and shown in Table 30. The resulting benefit is 1615.1 LGRB mitigation acres saved, and 83 CD mitigation acres saved.

Table 34. Analysis of Benefits of a Flood Structure Restoring Flood Frequency and Duration to BOTSP, in terms of FCUs no longer impacted, FCUs Gained Due to Hydrologic Improvement beyond Existing Conditions, and Acreages Associated with the FCUs

Subclass	LGRB			CD			Mitigation Acres Saved	
Acres	976			49				
FCUs	No Longer Impacted	Hydrologic Improvement	Total	No Longer Impacted	Hydrologic Improvement	Total	LGRB	CD
Detain Floodwater	810.1	156.2	966.3	33.8	6.86	40.66	-1615.1	-67.7
Detain Precipitation	976	0	976	NA	NA	NA	-1054.9	NA
Cycle Nutrients	868.6	0	868.6	33.3	0	33.3	-1203.5	-49.9
Export Organic Carbon	868.6	175.7	1044.3	34.3	6.86	41.16	-1446.8	-63.4
Maintain Plant Communities	927.2	29.3	956.5	44.1	3.92	48.02	-1300.5	-83.0
Provide Habitat for Fish and Wildlife	732	29.3	761.3	33.3	1.47	34.77	-1296.9	-59.2

In addition, some of the farmland around the BOTSP will be subject to improved hydrology, and would accrue mitigation functional lifts at a higher rate than the portions of the basin subject to post-Authorized Project hydrology. It is assumed for the purposes of this analysis that these areas would instead on average have hydrology similar to existing conditions, and would be subject to the No Action Annualized FCIs. It is not known how extensive this area would be, so this benefit is reported FCIs, not FCUs or acres. Tables 35a and 35b show the FCIs that should be used to calculated mitigation acres required when mitigation is accomplished within this hydrologically improved area, rather than elsewhere in the basin. They supplant the FCIs shown in Tables 32a and 32b within this area. Mitigation accomplished outside the area influenced by the Structure would still be subject to FCIs offered in Tables 32a and 32b.

Tables 35a and 35b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass and Function within Areas Around Big Oak Tree State Park Hydrologically Improved by the Structure and Available for Mitigation, New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.265
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.599
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.693	0.452
CD	Annualized Functional Capacity Indices					
Inclusions in Large (1200ac) Tracts	0.601	N/A	0.668	0.649	0.645	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Acres Needed to Offset 1 Lost FCU					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.318	3.781
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.318	1.671
LGRO	Acres Needed to Offset 1 Lost FCU					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.442	2.215
CD	Acres Needed to Offset 1 Lost FCU					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.550	1.663

4.1 & 4.2. New Madrid Floodway Limited Management Scenarios

Mitigation associated with the Alternatives 4.1 and 4.2 within the New Madrid Floodway would be subject to annualized FCIs reflecting the post-project hydrology as shown in Tables 36a and 36b. Using these mitigation functional gains, and the FCU losses associated with the Alternatives 4.1 and 4.2 in the New Madrid Floodway, mitigation debt can be calculated in acres (Tables 37 and 38).

Tables 36a and 36b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass, Function and Mitigation Scenario Associated with the Authorized Project with Avoid and Minimize Measures Management Scenario 1 in the New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain For Alternatives 4.1 and 4.2 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.736	0.246
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.736	0.587
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.667	0.444
CD	Annualized Functional Capacity Indices					
Inclusions in Large (1200ac) Tracts	0.601	NA	0.668	0.649	0.579	0.588

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain For Alternatives 4.2 and 4.2 Within New Madrid Floodway. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Acres Needed to Offset 1 Lost FCU					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.360	4.065
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.360	1.704
LGRO	Acres Needed to Offset 1 Lost FCU					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.500	2.255
CD	Acres Needed to Offset 1 Lost FCU					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.729	1.702

Tables 37 and 38 shows the losses associated with Alternatives 4.1 and 4.2 in New Madrid Floodway summarized by subclass. Mitigation requirements for each subclass are then calculated by multiplying the FCUs lost by the Mitigation Acres Needed to Offset 1 FCU, as calculated in Table 36.

Table 37. Functional Losses in FCUs Associated with Alternative 4.1 within the New Madrid Floodway, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 36.

Mitigation Required for Alternative 4.1 New Madrid Floodway, Assuming that Mitigation is accomplished in large connected tracts around Big Oak State Park.

	Losses in FCUs			Gains in FCUs		Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Project Hydrology		
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	-2914	-186	-96	NA	NA	4870	292	160
Detain Precipitation	-2350	0	NA	1831	NA	2539	0	NA
Cycle Nutrients	-2032	0	-93	2003	109	2815	0	140
Export Organic Carbon	-2973	-174	-113	NA	NA	4119	284	174
Maintain Plant Communities	-2188	0	-108	2074	113	2975	0	186
Provide Habitat for Fish and Wildlife	-1709	-12	-86	1547	71	2911	26	146

It is assumed that mitigation is taking place within the 5-year floodplain, in large (1200 acre) well-connected tracts, but that no structure has been installed to restore flooding. Thus, the mitigation is maturing while subject to the altered hydrology associated with the Alternative 4 hydrology. This leads to a smaller functional lift per acre (or Annualized FCI), and larger acreage requirements for mitigation to offset the losses associated with the project. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functions will be more than mitigated. For the LGRB subclass, the largest acreage requirements are associated with the Detain Floodwater Function: 4870 acres for LGRB wetlands. For the LGRO subclass, the Detain Floodwater Function required the greatest acreage at 292 acres. For CD wetlands, the largest mitigation acreage requirement is associated with the Maintain Plant Communities Function, resulting in 186 acres of CD wetlands.

Alternative 4.2 results in identical post-project hydrology, and hence identical mitigation FCIs, but involves extensive forest restoration as part of the project. Thus, the mitigation debt is much lower, and in most cases a surplus of wetland function with respect to a future without project is forecast. Table 38 summarizes these mitigation requirements.

Table 38. Functional Losses in FCUs Associated with Alternative 4.2 within the New Madrid Floodway, and a Calculation of Mitigation Acres Based on Mitigation Annualized FCIs from Table 36.

Mitigation Required for Alternative 4.2 New Madrid Floodway, Assuming that Mitigation is accomplished in large connected tracts around Big Oak State Park.

	Losses/Gains in FCUs			Gains in FCUs		Mitigation for Losses in Acres Using Mitigation Rates for Large Tracts & Post Project Hydrology[1]		
Function	**LGRB**	**LGRO**	**CD**	**Flats**	**UCD**	**LGRB**	**LGRO**	**CD**
Detain Floodwater	35	-186	132	NA	NA	-58	292	-220
Detain Precipitation	2650	0	0	1831	NA	-2865	0	NA
Cycle Nutrients	4122	0	496	2003	109	-5711	0	-742
Export Organic Carbon	2027	-174	400	NA	NA	-2808	284	-616
Maintain Plant Communities	7555	0	196	2074	113	-10272	0	-339
Provide Habitat for Fish and Wildlife	5855	-12	180	1547	71	-9974	26	-306

1 Negative mitigation debt indicates a surplus based on forest restoration that is part of the project.

It is assumed that mitigation is taking place within the 5-year floodplain, in large (1200 acre) well-connected tracts, but that no structure has been installed to restore flooding. Thus, the mitigation is maturing while subject to the altered hydrology associated with the Alternative 4 hydrology. This leads to a smaller functional lift per acre (or Annualized FCI), and larger acreage requirements for mitigation to offset the losses associated with the project. Cells highlighted in yellow indicate the maximum mitigation required for each subclass. If this acreage is mitigated, losses to the maximally impacted function will be mitigated, and all other functions will be more than mitigated. Mitigation is actually only required for the LGRO wetland subclass. The largest acreage requirement is associated with the Detain Floodwater function: 292 acres.

If the structure is built to restore more natural flooding to Big Oak Tree State Park (BOTSP), then the FCUs lost shown in Tables 37 and 38 would be decreased. Table 39 shows that the impacts associated with the BOTSP are removed from the mitigation debt as No Longer Impacted. In addition, hydrology is planned to be improved beyond existing conditions. This analysis assumes that the design will optimize the hydrologic gain within the park itself. The BOTSP is assumed to receive an improvement to its flood frequency (V_{FREQ}) and flood duration (V_{DUR}) resulting in a 0.2 increase to the variable subindex of both of these variables. The functional gains associated with the increased indices for these variables are also calculated and shown in Table 39. The resulting benefit is 1615.1 LGRB mitigation acres saved, and 83 CD mitigation acres saved.

Table 39. Analysis of Benefits of a Flood Structure Restoring Flood Frequency and Duration to BOTSP, in terms of FCUs no longer impacted, FCUs Gained Due to Hydrologic Improvement beyond Existing Conditions, and Acreages Associated with the FCUs

Subclass	LGRB			CD			Mitigation Acres Saved	
Acres	976			49				
FCUs	No Longer Impacted	Hydrologic Improvement	Total	No Longer Impacted	Hydrologic Improvement	Total	LGRB	CD
Detain Floodwater	810.1	156.2	966.3	33.8	6.86	40.66	-1615.1	-67.7
Detain Precipitation	976	0	976	NA	NA	NA	-1054.9	NA
Cycle Nutrients	868.6	0	868.6	33.3	0	33.3	-1203.5	-49.9
Export Organic Carbon	868.6	175.7	1044.3	34.3	6.86	41.16	-1446.8	-63.4
Maintain Plant Communities	927.2	29.3	956.5	44.1	3.92	48.02	-1300.5	-83.0
Provide Habitat for Fish and Wildlife	732	29.3	761.3	33.3	1.47	34.77	-1296.9	-59.2

In addition, some of the farmland around the BOTSP will be subject to improved hydrology, and would accrue mitigation functional lifts at a higher rate than the portions of the basin subject to post-Authorized Project hydrology. It is assumed for the purposes of this analysis that these areas would instead on average have hydrology similar to existing conditions, and be subject to the No Action Annualized FCIs. It is not known how extensive this area would be, so this benefit is reported FCIs, not FCUs or acres. Tables 40a and 40b show the FCIs that should be used to calculated mitigation acres required when mitigation is accomplished within this hydrologically improved area, rather than elsewhere in the basin. They supplant the FCIs shown in Tables 36a and 36b within this area. Mitigation accomplished outside the area influenced by the Structure would still be subject to FCIs offered in Tables 36a and 36b.

Tables 40a and 40b: Annualized FCIs and Acres Needed to offset 1 Lost FCU by Subclass and Function within Areas Around Big Oak Tree State Park Hydrologically Improved by the Structure and Available for Mitigation, New Madrid Floodway.

Mitigation FCIs below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Annualized Functional Capacity Indices					
Small (500ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.265
Large (1200ac) Tracts	0.598	0.925	0.722	0.722	0.759	0.599
LGRO	Annualized Functional Capacity Indices					
Small (250ac) Tracts	0.636	0.902	0.622	0.614	0.693	0.452
CD	Annualized Functional Capacity Indices					
Inclusions in Large (1200ac) Tracts	0.601	N/A	0.668	0.649	0.645	0.602

Mitigation Acres needed to offset 1 lost FCU: below the 5-year floodplain within the area around BOTSP that is subject to hydrologic improvement due to the structure. All restored wetlands are forested.

Mitigation Scenario	Wetland Functions					
	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
LGRB	Acres Needed to Offset 1 Lost FCU					
Small (500ac) Tracts	1.671	1.081	1.386	1.385	1.318	3.781
Large (1200ac) Tracts	1.671	1.081	1.386	1.385	1.318	1.671
LGRO	Acres Needed to Offset 1 Lost FCU					
Small (250ac) Tracts	1.572	1.109	1.607	1.628	1.442	2.215
CD	Acres Needed to Offset 1 Lost FCU					
Inclusions in Large (1200ac) Tracts	1.665	NA	1.498	1.540	1.550	1.663

CONCLUSIONS

Within the St Johns Basin, the Avoid And Minimize Alternative, 3.1, has the fewest impacts to wetlands. Mitigation required within St. Johns basin includes 201 acres of LGRB and 623 acres of LGRO wetlands. Both requirements are driven by losses to the Detain Floodwater function.

Within the New Madrid Floodway, Alternative 4.2 has the fewest impacts to wetlands, and in fact the restoration associated with that alternative creates a surplus of wetland functions for most subclasses. Only 292 acres of LGRO wetlands are estimated to be needed for mitigation under this alternative.

If Alternative 4.2 is deemed unfeasible, Alternative 4.1 is the next least impacting alternative. Estimated mitigation requirements for Alternative 4.1 include 4870 acres of LGRB wetlands, 292 acres of LGRO wetlands, and 186 acres of CD wetlands.

Alternative 3.1, The Authorized Project with Avoid and Minimize Measures with Management Scenario 1 within the New Madrid Floodway had the next fewest impacts to wetlands. For the LGRB subclass, the largest acreage requirements are associated with the Detain Floodwater Function: 5828 acres for LGRB wetlands. For the LGRO subclass, the Export Organic Carbon Function required the greatest acreage at 57 acres. For CD wetlands, the largest mitigation acreage requirement is associated with the Maintain Plant Communities Function, resulting in 215 acres of CD wetlands.

These mitigation acreages may be further reduced by the construction of the structure that would restore improved hydrology to the Big Oak Tree State Park and some portion of the surrounding farmland. At the very least, the improved hydrology to the park itself results in 1615 LGRB mitigation acres saved, and 83 CD mitigation acres saved. Additional reductions could be possible by completing mitigation in the surrounding farmland subject to the improved hydrology, but since the expanse of the area under the influence of the structure is not determined, actual saved acreages cannot be calculated at this point.

Actual mitigation requirements will need to be calculated once the final design of any structure and the final layout of mitigation are determined. However, the estimates in this report serve to illustrate the difference between the alternatives, and the potential advantages of different strategies regarding siting of the mitigation.

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