

## INTERIM HYDROGEOMORPHIC FUNCTIONAL ASSESSMENT

A functional assessment is conducted to evaluate the current functional capacity of a given wetland system and then predict potential changes to that wetland's functions that may result from proposed project activities. The applicable USACE regulatory district engineer can then use the functional assessment results to determine compensatory mitigation that may be required of the project through the permitting process.

The functional assessment approach is based on combining wetland variables that are typically structural measures or indicators that are associated with one or more ecosystem functions. Functions normally fall into one of three major categories:

- (1) physical (e.g., storage of surface water),
- (2) chemical (e.g., removal of elements and compounds), and
- (3) biological (e.g., topography, depth of water, number, and size of trees).

The USACE Galveston Regulatory District utilizes the iHGM approach to estimate the change in wetland function induced by the alteration of the wetland, either positive or negative. Negative effects (i.e., reductions in sustainable levels of function) are normally determined in association with dredge-and-fill permits. Input from the project can also be used to determine the extent of positive effects (i.e., increases in sustainable levels of functioning) associated with compensatory mitigation requirements, which may occur through restoration of previously altered wetlands of the same type.

The Herbaceous Riverine iHGM model is limited to herbaceous wetlands that are located along floodplains and/or floodways located along a riverine system, which share a surface hydrology connection with the waters of the riverine system for at least a portion of the season. The Herbaceous Riverine iHGM model was used for this project to complete an estimate of the potential impacts to herbaceous wetlands within the project area and to see if the proposed mitigation will adequately address the wetland functions that are being impacted.

Arcadis completed the field wetland delineation in August 2019 (see Appendix B of the original PCN submittal package, dated July 9, 2020) following the methods described in the USACE 1987 Wetlands Delineation Manual (1987 Manual) (Environmental Laboratory, 1987) and supplemented by regional technical guidance for delineating wetlands provided in the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plains, Version 2.0 (USACE, 2010). The iHGM functional assessment was completed following the guidelines provided in the USACE Riverine Herbaceous/Shrub iHGM guidance document.

As depicted on **Figure 2**, wetlands and surface ponds were divided into separate wetland assessment areas (WAAs), which includes two PEM wetlands (PEM Wetland 1 and PEM Wetland 2) and two manmade surface ponds (Pond A and Pond B). The iHGM method evaluates wetland sub-index characteristics and applies an estimated value for each. Descriptions of the sub-indices are provided below. Completed iHGM dataforms for each WAA are provided as **Attachment B** and **Table 2** provides a summary of each of the applicable sub-index values.

- Duration of flooding (Vdur) is estimated using hydrology indicators listed in the 1987 Manual and the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Atlantic and Gulf Coastal Region (Version 2.0). Each of the WAAs are located within the 100-year floodplain, indicating that both areas flood semi-regularly.
- Frequency of flooding (Vfreq) uses indicators listed in the 1987 Manual, the Regional Supplement, and FEMA floodplain maps. The WAAs occur within the 100-year floodplain and the geography of the sites suggest that some of these areas are inundated by periodic flooding. Based on field observation, Arcadis believes that all WAAs flood or pond annually at least two out of five times a year.
- Topography (Vtopo) relies on visual estimates collected during the field survey to determine what percent of the project area is composed of heterogeneous topographic features (e.g., dips, hummocks, channel sloughs).
- Woody vegetation (Vwood) estimates the amount of woody cover within the WAA and includes both field survey data and an assessment of aerial imagery.
- Midstory (Vmid) describes the shrub and sapling vegetation layer found between ground level and an upper forest canopy.
- Herbaceous (Vherb) describes the average herbaceous vegetation cover in each WAA.
- Connectivity to other habitat types (Vconnect) was assessed using aerial field data and imagery of the project area.
- Detritus (Vdetritus) refers to the presence of either an O or A soil horizon associated with each WAA. Frequent flooding within the WAA can saturate soils and decrease the rate at which organic carbon is naturally decomposed and cycled. This creates an accumulation of organic matter and can form an O or A horizon.
- Redoximorphic process (Vredox) is based on the extent to which pedons within each WAA exhibit redoximorphic features as an indication of oxidation and reduction conditions. Periodic

flooding of soils can cause cyclical anaerobic and aerobic conditions, which allows the reduction and translocation of iron and manganese within the upper portions of the soil.

- Sorptive soil properties (Vsorpt) are determined using field survey data paired with the Natural Resources Conservation Service (NRCS) Soil Survey.

**Table 2. Estimated Sub-index Values for Each WAA within the Project Area.**

WAA/Feature ID	Vdur	Vfreq	Vtopo	Vwood	Vmid	Vherb	Vconnect	Vdetritus	Vredox	Vsorpt
PEM Wetland - 1	0.25	0.75	0.10	0.10	0.10	1.00	1.00	1.00	1.00	0.50
PEM Wetland - 2	0.25	0.75	0.10	0.10	0.10	1.00	1.00	1.00	1.00	0.75
Pond A	0.75	1.00	0.10	0.10	0.10	1.00	1.00	1.00	1.00	0.75
Pond B	0.75	1.00	0.10	0.10	0.10	1.00	1.00	1.00	1.00	0.75

Based on the sub-index values in **Table 2**, Arcadis calculated the Functional Capacity Index (FCI) and the Functional Capacity Unit (FCU) corresponding to each WAA for the project. These calculated indices are provided in **Table 3**.

**Table 3. Existing WAA Acreage, Functional Capacity Index (FCI) Values, and Functional Capacity Unit (FCU) Values for the Project Area.**

WAA/Feature ID	Acreage	Temporary Storage and Detention of Storage Water (Physical)		Maintain Plant and Animal Communities (Biological)		Removal and Sequestration of Elements and Compounds (Chemical)	
		FCI	FCU	FCI	FCU	FCI	FCU
PEM Wetland - 1	0.34	0.01	0.005	0.53	0.18	0.50	0.17
PEM Wetland - 2	0.26	0.01	0.003	0.62	0.16	0.5	0.13
Pond A	0.58	0.16	0.09	0.62	0.36	0.65	0.37
Pond B	2.96	0.16	0.09	0.62	0.36	0.65	0.37
<b>Total</b>	<b>4.14</b>		<b>0.188</b>		<b>1.06</b>		<b>1.04</b>

## MITIGATION

The project has been designed to minimize impacts to Waters of the U.S. to the extent practicable. EMPCo evaluated multiple roadway alignment options, but selected the current alignment based on a complex network of existing pipelines/utilities, roadbed design criteria, and operational site security considerations. Thus, following additional impact avoidance planning measures and permitting considerations, the current alignment was selected as the most viable option.

The project will not adversely impact Clear Creek or the HCFCD canal. However, the project will result in a net loss of the two surface water ponds, which are considered proposed Waters of the U.S. Based on aerial imagery, the surface ponds were constructed sometime prior to 1969 and have historically been used for surface water/stormwater management. No hazardous materials have been placed in the ponds and no records of hazardous waste pit permitting or placement of hazardous waste materials have been identified by EMPCo or Arcadis. Both ponds are hydrologically connected to Clear Creek via Ditch 1. Pond A typically holds a shallow amount of surface water runoff year-round, but Pond B is much larger than Pond A and typically only contains water after rain events with sufficient surface runoff. Approximately 0.3 acre of Pond A and 0.43 acre of Pond B will be permanently impacted by the proposed roadway construction.

Arcadis reviewed the online Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS) to determine the availability of wetland mitigation banks that service the project area based on the 8 and 12-unit Hydrologic Unit Code (HUC). The project site is located in HUC-12040204 and there are currently no available mitigation banks within this HUC. However, the project site is located in the secondary service area (12-digit HUC) of the Lower Brazos River Mitigation Bank (8-unit HUC-102040205).

Arcadis contacted the Lower Brazos River Mitigation Bank to verify project area applicability and wetland credit availability. Based on that conversation, in-kind credits are available and the mitigation credit ratio for projects in the bank's secondary service area is 1.5:1. Therefore, approximately 1.12 acre-credits would be required for the permanent loss of approximately 0.73 acres of open water and 0.018 acre of PEM wetlands, if required by USACE, at a cost of approximately \$168,300. EMPCo will continue to coordinate with USACE and Lower Brazos River Mitigation Bank (as applicable) throughout the Section 404 permitting process to determine whether mitigation is required, verify the appropriate mitigation credit ratio, and satisfy the mitigation requirement.

## ***Riverine Herbaceous/Shrub HGM Interim (FCI formulas)***

Temporary Storage & Detention of Storage Water:

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\}/2\}]^{1/2}$$

Maintain Plant and Animal Community:

$$\{V_{mid} + V_{herb} + V_{connect}\}/3$$

Removal & Sequestration of Elements & Compounds:

$$[[V_{wood} + V_{freq} + V_{dur} + [\{V_{topo} + V_{herb} + V_{mid}\}/3] + [\{V_{detritus} + V_{redox} + V_{sorpt}\}/3]]/5$$

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$V_{freq}$

$V_{topo}$

$V_{wood}$

$V_{mid}$

$V_{herb}$

$V_{connect}$

$V_{detritus}$

$V_{redox}$

$V_{sorpt}$

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## ***Riverine Herbaceous/Shrub HGM Interim***

The techniques used to determine which functional capacity index (FCI) will be used for each variable are typically based on standard techniques described in detail in the 1987 Corps Wetland Delineation Manual, the NRCS 3<sup>rd</sup> Edition to the National Food Security Act Manual (NFSAM) and/or the “A Regional Guidebook for Application of Hydrogeomorphic Assessments to Riverine Low Gradient Wetlands (Ainslie et al. 1997). These sources will hereafter be referred to as the 87 WDM, NFSAM, and the Kentucky Riverine Guidebook, respectively.

Documentation should be made for each variable as to which method, indicator, plot size was used for each variable. The number of sample plots is related to the variability of the site. Significantly different timber age classes or species types should be sampled separately. One or two sample plots might be sufficient in a small uniform site, whereas, numerous sample plots would be required for a large diverse site. The following is a general definition and guidance on the methodology for each variable.

**V<sub>dur</sub>: Duration of Flooding:** Indicators as described in the Wetland Hydrology Section of the 87 WDM (paragraphs 46-49) will be utilized to estimate duration of flooding. NOTE: unlike the criteria for hydrology for wetland delineation, growing season is not a factor in the variable. Those indicators associated with saturation should not be used.

**V<sub>freq</sub>: Frequency of Flooding:** Indicators as described in the Wetland Hydrology Section of the 87 WDM (paragraphs 46-49) will be utilized to estimate frequency of flooding. Utilization of the county soil survey is a particularly good tool. NOTE: unlike the criteria for hydrology for wetland delineation, growing season is not a factor in the variable.

**V<sub>topo</sub>: Topography:** To determine percent for these criteria, visual estimate will be conducted. Those areas with significant topographic features will be shown on a reference map, briefly described (i.e. ridge/slough, mounds, undulations, channels/burn, etc.) and measured to determine acreage. Percent of site containing topographic features can then be determined.

**V<sub>wood</sub>: Woody vegetation:** Percentage of the WAA that is covered by woody vegetation will be determined by the use of recent aerial photography. Field verification is needed to ensure land use changes have not occurred. Size and density of woody vegetation impedes water flow. For example; a few large trees in a pasture would NOT constitute “covered with woody vegetations” nor would 1 year old seedlings. It should also be noted that an area clear cut with stumps, sprouts and shrubs removed would NOT constitute “woody vegetation” and the functions should be assessed using a herbaceous model.

**V<sub>mid</sub>: Midstory (Shrubs/saplings/woody vines):** The midstory layer is the layer of botanical species located between the herbaceous and forest/tree canopy. This would include shrubs, saplings, smaller trees, small trees, and large woody vines. A measure is taken at each plot and/or a visual estimate is performed at each sample location(s).

**V<sub>herb</sub> : Herbaceous layer:** Herbaceous layers are made at each data location/plot as is described in the 87 WDM. It is recommended that 2-5 sub plots be taken at each location to account for vegetative variability.

**V<sub>detritus</sub>: Detritus:** This variable is a measure of the percentage of areas with detritus at the soil surface. Plowed areas or areas “washed” by high velocity flood water should not be considered as areas having detritus. Determination of an A (with organic) or O horizon should be determined for the entire site by on site field information. For this variable, the A (with organic) must have a Munsell value of 4 or less. Refer to the Kentucky Riverine Model for additional details regarding this variable.

**V<sub>redox</sub>: Redoximorphic process:** This variable is an indicator of periodic aerobic and anaerobic process within the top 10-12 inches of the soil surface. Redox features should be documented for each sample plot/location and any other soil investigation conducted on the site. At least 50% of the must meet this criteria to be a 1 in the sub index.

**V<sub>sorpt</sub>: Sorptive Soil Properties:** This variable is a general indicator of the potential that the soil has in regards to it’s absorptive properties. This information can be obtained by the use of the county soil survey in conjunction with the field data.

**V<sub>connect</sub>: Connectivity to other habitat types:** This variable concentration on the geo-location of the WAA in relationship to other habitat type within 600 feet from the perimeter of the WAA.

## *Variables for HGM (Interim) Herbaceous/Shrub Riverine*

$V_{dur}$ : The % of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway

Criteria	Variable Sub index
In an average year at 80% of the WAA either floods and/or ponds for at least 14 consecutive days	1.00
In an average year at 80% of the WAA either floods and/or ponds for at least 7 consecutive days	0.75
In an average year at 50-79% of the WAA either floods and/or ponds for at least 7 consecutive days	0.50
In an average year at 25-50% of the WAA either floods and/or ponds for at least 7 consecutive days	0.25
In an average year all or portions of the WAA either floods and/or ponds for at least 1-7 consecutive days	0.10
The area is NOT subject to flooding	0.00

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 $V_{freq}$ : The frequency that the WAA is flooded and/or ponded by nearby waterway .

Criteria	Variable Sub index
Floods or pond annually 5 out of 5 years (floodway)	1.00
Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped w/n 100 yr floodplain)	0.75
Floods or ponds 2 out of 5 years (100- year floodplain)	0.50
Floods or ponds less than 2 out of 5 years (100-500 yr floodplain grey w/out elevations)	0.25
The area is not subject to flooding or ponding (500 yr floodplain)	0.00

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 $V_{topo}$ : The roughness associated with the WAA

Criteria	Variable Sub Index
Greater than 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	1.00
15 - 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.70
Less than 15% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.40
Smooth, flat, or very gentle undulating with little or no topographic features	0.10

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 $V_{wood}$ : Percentage of the WAA that is covered by woody vegetation

Criteria	Variable Sun Index
Greater than 90% of the WAA is covered with woody vegetation	1.00
67 to 90 % of the WAA is covered with woody vegetation	0.75
34 to 66% of the WAA is covered with woody vegetation	0.50
11 to 33% of the WAA is covered with woody vegetation	0.25
0-10% if the WAA is covered with woody vegetation	0.10

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V<sub>mid</sub>: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA

Criteria	Variable Sub Index
Midstory coverage of the WAA is more than 75%	1.00
Midstory coverage of the WAA is between 50-75 %	0.75
Midstory coverage of the WAA is between 25-50%	0.50
Midstory coverage of the WAA is between 1-25%	0.25
Midstory coverage of the WAA is equal to or less than 1%	0.10

V<sub>herb</sub>: The average/mean coverage of the WAA by the herbaceous layer

Criteria	Variable Sub Index
Herbaceous cover in the WAA averages greater than 75%	1.00
Herbaceous cover in the WAA averages between 50-75%	0.75
Herbaceous cover in the WAA averages between 25-50%	0.50
Herbaceous cover in the WAA average is between 1-25%	0.25
Herbaceous cover in the WAA is equal to or less than 1% (barren soil or all shrub)	0.10

V<sub>connect</sub>: the number of habitat types within a 600' of the parameter of the WAA  
(Habitat to be counted has to be at a minimum 5% of the size of the WAA)

Habitat Types:

Forested	Shrub/Sapling
Herbaceous/Prairie/Abandoned Ag field	Active Agricultural Field
Open water	Wetland
Mudflat	Lawn

Criteria:	Variable Sub Index
Wetland plus four habitats and/or surrounded by forested	1.00
Wetland plus two or more habitat type (other than forested) OR three or more habitat types	0.75
Wetland plus one other habitat types or two other habitat types	0.50
One other habitat types other than urban habitat	0.25
Surround by urban (homes, lawn, concrete, etc.)	0.10

V<sub>detritus</sub>: The amount of the detritus on the WAA  
(A horizon has to have a value of 4 or less)

Criteria	Variable Sub Index
Greater than 85% of the area possesses an O or A horizon	1.00
From 11-84% of the area possesses an O or A horizon	0.50
Less than 10% of the area possesses an O or A horizon	0.30
Site is plowed	0.10

V<sub>redox</sub>: The amount of the WAA that exhibits redox features an indication of the chemical exchange

Criteria	Variable Sub Index
Redox concentrations represent at least 20% of the pedon within the top 4 inches of the soil surface, or feature masked due to parent material but conditions are conducive to redoximorphic processes. (many mottles)	1.0
Redox features less than 20%	0.1

V<sub>sort</sub>: The absorptive properties of the soils in the WAA

Criteria	Variable Sub Index
The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1)	1.00
WAA is dominated by loamy (silt loams, very fine sandy loams, loam) or non-montmorillonitic clays	0.50
The WAA is dominated by sandy soils (sands, loamy fine sands, loamy sands)	0.10

## *Riverine Herb/Shrub HGM (Interim) Worksheet*

WAA # PEM Wetland-1

Variable	Subindex
V <sub>dur</sub>	0.25
V <sub>freq</sub>	0.75
V <sub>topo</sub>	0.10
V <sub>wood</sub>	0.10
V <sub>mid</sub>	0.10
V <sub>herb</sub>	1.00
V <sub>detritus</sub>	1.00
V <sub>redox</sub>	1.00
V <sub>sorpt</sub>	1.00
V <sub>connect</sub>	0.50

The 87 Wetland Delineation Manual and AGCP Regional Supplement were used to determine variable subindex values. Wetland data form WET-1 was referenced for on-site data along with Google Earth aerial imagery, FEMA floodplain, and NRCS Soil Survey data.

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

WAA #

Variable	Subindex
V <sub>dur</sub>	
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V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

***Riverine Herb/Shrub (Interim HGM) Worksheet  
Functional Capacity Index (FCI)***

**Temporary Storage & Dentention of Storage Water:**

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\} / 2\}^{1/2}]^{1/2}$$

$$[\{0.25 \times 0.75\}^{1/2} \times \{0.10 + \{1.00 + 0.10 / 2\} / 2\}^{1/2}]^{1/2} = FCI \ 0.015$$

$$[\{ \_ \times \_ \}^{1/2} \times \{ \_ + \{ \_ + \_ / 2 \} / 2 \}^{1/2}]^{1/2} = FCI$$

**Maintain Plant and Animal Communities:**

$$\{V_{mid} + V_{herb} + V_{connect}\} / 3$$

$$\{0.10 + 1.00 + 0.50\} / 3 = FCI \ 0.53$$

$$\{ \_ + \_ + \_ \} / 3 = FCI$$

**Removal & Sequestrian of Elements & Compounds:**

$$[[V_{wood} + V_{freq} + V_{dur} + [\{V_{topo} + V_{herb} + V_{mid}\} / 3] + [\{V_{detritus} + V_{redox} + V_{sorp}\} / 3]] / 5$$

$$[[0.10 + 0.75 + 0.25 + [\{0.10 + 1.00 + 0.10\} / 3] + [\{1.00 + 1.00 + 1.00\} / 3]] / 5 = FCI \ 0.5$$

$$[[ \_ + \_ + \_ + [\{ \_ + \_ + \_ \} / 3] + [\{ \_ + \_ + \_ \} / 3]] / 5 = FCI$$

Functional Capacity Units (FCU); FCI x wetland acres per WAA...

WAA #	Pre-project FCUs	Post Project FCUs
Temp Storage of Water	0.0051	0.00501
Maintain Plant & Animal	0.1802	0.17702
Removal of Elements	0.17	0.167

## ***Riverine Herbaceous/Shrub HGM Interim (FCI formulas)***

Temporary Storage & Detention of Storage Water:

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In an average year at 25-50% of the WAA either floods and/or ponds for at least 7 consecutive days	0.25
In an average year all or portions of the WAA either floods and/or ponds for at least 1-7 consecutive days	0.10
The area is NOT subject to flooding	0.00

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 $V_{freq}$ : The frequency that the WAA is flooded and/or ponded by nearby waterway .

Criteria	Variable Sub index
Floods or pond annually 5 out of 5 years (floodway)	1.00
Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped w/n 100 yr floodplain)	0.75
Floods or ponds 2 out of 5 years (100- year floodplain)	0.50
Floods or ponds less than 2 out of 5 years (100-500 yr floodplain grey w/out elevations)	0.25
The area is not subject to flooding or ponding (500 yr floodplain)	0.00

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 $V_{topo}$ : The roughness associated with the WAA

Criteria	Variable Sub Index
Greater than 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	1.00
15 - 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.70
Less than 15% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.40
Smooth, flat, or very gentle undulating with little or no topographic features	0.10

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 $V_{wood}$ : Percentage of the WAA that is covered by woody vegetation

Criteria	Variable Sun Index
Greater than 90% of the WAA is covered with woody vegetation	1.00
67 to 90 % of the WAA is covered with woody vegetation	0.75
34 to 66% of the WAA is covered with woody vegetation	0.50
11 to 33% of the WAA is covered with woody vegetation	0.25
0-10% if the WAA is covered with woody vegetation	0.10

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V<sub>mid</sub>: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA

Criteria	Variable Sub Index
Midstory coverage of the WAA is more than 75%	1.00
Midstory coverage of the WAA is between 50-75 %	0.75
Midstory coverage of the WAA is between 25-50%	0.50
Midstory coverage of the WAA is between 1-25%	0.25
Midstory coverage of the WAA is equal to or less than 1%	0.10

V<sub>herb</sub>: The average/mean coverage of the WAA by the herbaceous layer

Criteria	Variable Sub Index
Herbaceous cover in the WAA averages greater than 75%	1.00
Herbaceous cover in the WAA averages between 50-75%	0.75
Herbaceous cover in the WAA averages between 25-50%	0.50
Herbaceous cover in the WAA average is between 1-25%	0.25
Herbaceous cover in the WAA is equal to or less than 1% (barren soil or all shrub)	0.10

V<sub>connect</sub>: the number of habitat types within a 600' of the parameter of the WAA  
(Habitat to be counted has to be at a minimum 5% of the size of the WAA)

Habitat Types:

Forested	Shrub/Sapling
Herbaceous/Prairie/Abandoned Ag field	Active Agricultural Field
Open water	Wetland
Mudflat	Lawn

Criteria:	Variable Sub Index
Wetland plus four habitats and/or surrounded by forested	1.00
Wetland plus two or more habitat type (other than forested) OR three or more habitat types	0.75
Wetland plus one other habitat types or two other habitat types	0.50
One other habitat types other than urban habitat	0.25
Surround by urban (homes, lawn, concrete, etc.)	0.10

V<sub>detritus</sub>: The amount of the detritus on the WAA  
(A horizon has to have a value of 4 or less)

Criteria	Variable Sub Index
Greater than 85% of the area possesses an O or A horizon	1.00
From 11-84% of the area possesses an O or A horizon	0.50
Less than 10% of the area possesses an O or A horizon	0.30
Site is plowed	0.10

V<sub>redox</sub>: The amount of the WAA that exhibits redox features an indication of the chemical exchange

Criteria	Variable Sub Index
Redox concentrations represent at least 20% of the pedon within the top 4 inches of the soil surface, or feature masked due to parent material but conditions are conducive to redoximorphic processes. (many mottles)	1.0
Redox features less than 20%	0.1

V<sub>sorpt</sub>: The absorptive properties of the soils in the WAA

Criteria	Variable Sub Index
The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1)	1.00
WAA is dominated by loamy (silt loams, very fine sandy loams, loam) or non-montmorillonitic clays	0.50
The WAA is dominated by sandy soils (sands, loamy fine sands, loamy sands)	0.10

## *Riverine Herb/Shrub HGM (Interim) Worksheet*

WAA # PEM Wetland-2

Variable	Subindex
V <sub>dur</sub>	0.25
V <sub>freq</sub>	0.75
V <sub>topo</sub>	0.10
V <sub>wood</sub>	0.10
V <sub>mid</sub>	0.10
V <sub>herb</sub>	1.00
V <sub>detritus</sub>	1.00
V <sub>redox</sub>	1.00
V <sub>sorpt</sub>	1.00
V <sub>connect</sub>	0.75

The 87 Wetland Delineation Manual and AGCP Regional Supplement were used to determine variable subindex values. Wetland data form WET-2 was referenced for on-site data along with Google Earth aerial imagery, FEMA floodplain, and NRCS Soil Survey data.

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

***Riverine Herb/Shrub (Interim HGM) Worksheet  
Functional Capacity Index (FCI)***

**Temporary Storage & Dentention of Storage Water:**

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\} / 2\}^{1/2}]^{1/2}$$

$$[\{0.25 \times 0.75\}^{1/2} \times \{0.10 + \{1.00 + 0.10 / 2\} / 2\}^{1/2}]^{1/2} = FCI \quad 0.015$$

$$[\{ \_ \times \_ \}^{1/2} \times \{ \_ + \{ \_ + \_ / 2 \} / 2 \}^{1/2}]^{1/2} = FCI$$

-----  
**Maintain Plant and Animal Communities:**

$$\{V_{mid} + V_{herb} + V_{connect}\} / 3$$

$$\{0.10 + 1.00 + 0.75\} / 3 = FCI \quad 0.62$$

$$\{ \_ + \_ + \_ \} / 3 = FCI$$

-----  
**Removal & Sequestrian of Elements & Compounds:**

$$[[V_{wood} + V_{freq} + V_{dur} + \{V_{topo} + V_{herb} + V_{mid}\} / 3] + [\{V_{detritus} + V_{redox} + V_{sorp}\} / 3]] / 5$$

$$[[0.10 + 0.75 + 0.25 + \{0.10 + 1.00 + 0.10\} / 3] + [\{1.00 + 1.00 + 1.00\} / 3]] / 5 = FCI \quad 0.5$$

$$[[ \_ + \_ + \_ + \{ \_ + \_ + \_ \} / 3] + [\{ \_ + \_ + \_ \} / 3]] / 5 = FCI$$

-----

Functional Capacity Units (FCU); FCI x wetland acres per WAA...

WAA #	Pre-project FCUs	Post Project FCUs
Temp Storage of Water	0.0039	0.00372
Maintain Plant & Animal	0.1612	0.15376
Removal of Elements	0.13	0.124

## ***Riverine Herbaceous/Shrub HGM Interim (FCI formulas)***

Temporary Storage & Detention of Storage Water:

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\}/2\}]^{1/2}$$

Maintain Plant and Animal Community:

$$\{V_{mid} + V_{herb} + V_{connect}\}/3$$

Removal & Sequestration of Elements & Compounds:

$$[[V_{wood} + V_{freq} + V_{dur} + [\{V_{topo} + V_{herb} + V_{mid}\}/3] + [\{V_{detritus} + V_{redox} + V_{sorpt}\}/3]]/5$$

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$V_{dur}$

$V_{freq}$

$V_{topo}$

$V_{wood}$

$V_{mid}$

$V_{herb}$

$V_{connect}$

$V_{detritus}$

$V_{redox}$

$V_{sorpt}$

\* The Riverine model is designed to be used to produce an assessment of the potential function of wetlands that share a surface hydrologic connection (at least periodically during anticipated high flows) with a riverine system {i.e. it is limited to wetlands located in the floodplain and/or floodway}. This model is to be used for a rapid non-controversial estimate of the potential impacts to herbaceous riparian wetlands and to see if the proposed mitigation will adequately address the wetland functions that are being impacted.

## ***Riverine Herbaceous/Shrub HGM Interim***

The techniques used to determine which functional capacity index (FCI) will be used for each variable are typically based on standard techniques described in detail in the 1987 Corps Wetland Delineation Manual, the NRCS 3<sup>rd</sup> Edition to the National Food Security Act Manual (NFSAM) and/or the “A Regional Guidebook for Application of Hydrogeomorphic Assessments to Riverine Low Gradient Wetlands (Ainslie et al. 1997). These sources will hereafter be referred to as the 87 WDM, NFSAM, and the Kentucky Riverine Guidebook, respectively.

Documentation should be made for each variable as to which method, indicator, plot size was used for each variable. The number of sample plots is related to the variability of the site. Significantly different timber age classes or species types should be sampled separately. One or two sample plots might be sufficient in a small uniform site, whereas, numerous sample plots would be required for a large diverse site. The following is a general definition and guidance on the methodology for each variable.

**V<sub>dur</sub>: Duration of Flooding:** Indicators as described in the Wetland Hydrology Section of the 87 WDM (paragraphs 46-49) will be utilized to estimate duration of flooding. NOTE: unlike the criteria for hydrology for wetland delineation, growing season is not a factor in the variable. Those indicators associated with saturation should not be used.

**V<sub>freq</sub>: Frequency of Flooding:** Indicators as described in the Wetland Hydrology Section of the 87 WDM (paragraphs 46-49) will be utilized to estimate frequency of flooding. Utilization of the county soil survey is a particularly good tool. NOTE: unlike the criteria for hydrology for wetland delineation, growing season is not a factor in the variable.

**V<sub>topo</sub>: Topography:** To determine percent for these criteria, visual estimate will be conducted. Those areas with significant topographic features will be shown on a reference map, briefly described (i.e. ridge/slough, mounds, undulations, channels/burn, etc.) and measured to determine acreage. Percent of site containing topographic features can then be determined.

**V<sub>wood</sub>: Woody vegetation:** Percentage of the WAA that is covered by woody vegetation will be determined by the use of recent aerial photography. Field verification is needed to ensure land use changes have not occurred. Size and density of woody vegetation impedes water flow. For example; a few large trees in a pasture would NOT constitute “covered with woody vegetations” nor would 1 year old seedlings. It should also be noted that an area clear cut with stumps, sprouts and shrubs removed would NOT constitute “woody vegetation” and the functions should be assessed using a herbaceous model.

**V<sub>mid</sub>: Midstory (Shrubs/saplings/woody vines):** The midstory layer is the layer of botanical species located between the herbaceous and forest/tree canopy. This would include shrubs, saplings, smaller trees, small trees, and large woody vines. A measure is taken at each plot and/or a visual estimate is performed at each sample location(s).

**V<sub>herb</sub> : Herbaceous layer:** Herbaceous layers are made at each data location/plot as is described in the 87 WDM. It is recommended that 2-5 sub plots be taken at each location to account for vegetative variability.

**V<sub>detritus</sub>: Detritus:** This variable is a measure of the percentage of areas with detritus at the soil surface. Plowed areas or areas “washed” by high velocity flood water should not be considered as areas having detritus. Determination of an A (with organic) or O horizon should be determined for the entire site by on site field information. For this variable, the A (with organic) must have a Munsell value of 4 or less. Refer to the Kentucky Riverine Model for additional details regarding this variable.

**V<sub>redox</sub>: Redoximorphic process:** This variable is an indicator of periodic aerobic and anaerobic process within the top 10-12 inches of the soil surface. Redox features should be document for each sample plot/location and any other soil investigation conducted on the site. At least 50% of the must meet this criteria to be a 1 in the sub index.

**V<sub>sorpt</sub>: Sorptive Soil Properties:** This variable is a general indicator of the potential that the soil has in regards to it’s absorptive properties. This information can be obtained by the use of the county soil survey in conjunction with the field data.

**V<sub>connect</sub>: Connectivity to other habitat types:** This variable concentration on the geo-location of the WAA in relationship to other habitat type within 600 feet from the perimeter of the WAA.

## *Variables for HGM (Interim) Herbaceous/Shrub Riverine*

$V_{dur}$ : The % of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway

Criteria	Variable Sub index
In an average year at 80% of the WAA either floods and/or ponds for at least 14 consecutive days	1.00
In an average year at 80% of the WAA either floods and/or ponds for at least 7 consecutive days	0.75
In an average year at 50-79% of the WAA either floods and/or ponds for at least 7 consecutive days	0.50
In an average year at 25-50% of the WAA either floods and/or ponds for at least 7 consecutive days	0.25
In an average year all or portions of the WAA either floods and/or ponds for at least 1-7 consecutive days	0.10
The area is NOT subject to flooding	0.00

-----  
 $V_{freq}$ : The frequency that the WAA is flooded and/or ponded by nearby waterway .

Criteria	Variable Sub index
Floods or pond annually 5 out of 5 years (floodway)	1.00
Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped w/n 100 yr floodplain)	0.75
Floods or ponds 2 out of 5 years (100- year floodplain)	0.50
Floods or ponds less than 2 out of 5 years (100-500 yr floodplain grey w/out elevations)	0.25
The area is not subject to flooding or ponding (500 yr floodplain)	0.00

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 $V_{topo}$ : The roughness associated with the WAA

Criteria	Variable Sub Index
Greater than 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	1.00
15 - 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.70
Less than 15% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.40
Smooth, flat, or very gentle undulating with little or no topographic features	0.10

-----  
 $V_{wood}$ : Percentage of the WAA that is covered by woody vegetation

Criteria	Variable Sun Index
Greater than 90% of the WAA is covered with woody vegetation	1.00
67 to 90 % of the WAA is covered with woody vegetation	0.75
34 to 66% of the WAA is covered with woody vegetation	0.50
11 to 33% of the WAA is covered with woody vegetation	0.25
0-10% if the WAA is covered with woody vegetation	0.10

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V<sub>mid</sub>: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA

Criteria	Variable Sub Index
Midstory coverage of the WAA is more than 75%	1.00
Midstory coverage of the WAA is between 50-75 %	0.75
Midstory coverage of the WAA is between 25-50%	0.50
Midstory coverage of the WAA is between 1-25%	0.25
Midstory coverage of the WAA is equal to or less than 1%	0.10

V<sub>herb</sub>: The average/mean coverage of the WAA by the herbaceous layer

Criteria	Variable Sub Index
Herbaceous cover in the WAA averages greater than 75%	1.00
Herbaceous cover in the WAA averages between 50-75%	0.75
Herbaceous cover in the WAA averages between 25-50%	0.50
Herbaceous cover in the WAA average is between 1-25%	0.25
Herbaceous cover in the WAA is equal to or less than 1% (barren soil or all shrub)	0.10

V<sub>connect</sub>: the number of habitat types within a 600' of the parameter of the WAA  
(Habitat to be counted has to be at a minimum 5% of the size of the WAA)

#### Habitat Types:

Forested	Shrub/Sapling
Herbaceous/Prairie/Abandoned Ag field	Active Agricultural Field
Open water	Wetland
Mudflat	Lawn

Criteria:	Variable Sub Index
Wetland plus four habitats and/or surrounded by forested	1.00
Wetland plus two or more habitat type (other than forested) OR three or more habitat types	0.75
Wetland plus one other habitat types or two other habitat types	0.50
One other habitat types other than urban habitat	0.25
Surround by urban (homes, lawn, concrete, etc.)	0.10

V<sub>detritus</sub>: The amount of the detritus on the WAA  
(A horizon has to have a value of 4 or less)

Criteria	Variable Sub Index
Greater than 85% of the area possesses an O or A horizon	1.00
From 11-84% of the area possesses an O or A horizon	0.50
Less than 10% of the area possesses an O or A horizon	0.30
Site is plowed	0.10

V<sub>redox</sub>: The amount of the WAA that exhibits redox features an indication of the chemical exchange

Criteria	Variable Sub Index
Redox concentrations represent at least 20% of the pedon within the top 4 inches of the soil surface, or feature masked due to parent material but conditions are conducive to redoximorphic processes. (many mottles)	1.0
Redox features less than 20%	0.1

V<sub>sort</sub>: The absorptive properties of the soils in the WAA

Criteria	Variable Sub Index
The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1)	1.00
WAA is dominated by loamy (silt loams, very fine sandy loams, loam) or non-montmorillonitic clays	0.50
The WAA is dominated by sandy soils (sands, loamy fine sands, loamy sands)	0.10

## *Riverine Herb/Shrub HGM (Interim) Worksheet*

WAA # Pond A

Variable	Subindex
V <sub>dur</sub>	0.75
V <sub>freq</sub>	1.00
V <sub>topo</sub>	0.10
V <sub>wood</sub>	0.10
V <sub>mid</sub>	0.10
V <sub>herb</sub>	1.00
V <sub>detritus</sub>	1.00
V <sub>redox</sub>	1.00
V <sub>sorpt</sub>	1.00
V <sub>connect</sub>	0.75

The 87 USACE Wetland Delineation Manual and AGCP Regional Supplement were used to assist in determining variable subindex values. Site visit photos, google earth imagery, FEMA floodplain mapper, and NRCS Soil Surveys were also utilized to determine variable subindex values.

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

***Riverine Herb/Shrub (Interim HGM) Worksheet  
Functional Capacity Index (FCI)***

**Temporary Storage & Dentention of Storage Water:**

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\} / 2\}^{1/2}]^{1/2}$$

$$[\{0.75 \times 1.00\}^{1/2} \times \{0.10 + \{1.00 + 0.10 / 2\} / 2\}^{1/2}]^{1/2} = FCI \quad 0.16$$

$$[\{ \_ \times \_ \}^{1/2} \times \{ \_ + \{ \_ + \_ / 2 \} / 2 \}^{1/2}]^{1/2} = FCI$$

**Maintain Plant and Animal Communities:**

$$\{V_{mid} + V_{herb} + V_{connect}\} / 3$$

$$\{0.10 + 1.00 + 0.75\} / 3 = FCI \quad 0.62$$

$$\{ \_ + \_ + \_ \} / 3 = FCI$$

**Removal & Sequestrian of Elements & Compounds:**

$$[[V_{wood} + V_{freq} + V_{dur} + \{V_{topo} + V_{herb} + V_{mid}\} / 3] + \{V_{detritus} + V_{redox} + V_{sorp}\} / 3] / 5$$

$$[[0.10 + 1.00 + 0.75 + \{0.10 + 1.00 + 0.10\} / 3] + \{1.00 + 1.00 + 1.00\} / 3] / 5 = FCI \quad 0.65$$

$$[[ \_ + \_ + \_ + \{ \_ + \_ + \_ \} / 3] + \{ \_ + \_ + \_ \} / 3] / 5 = FCI$$

Functional Capacity Units (FCU); FCI x wetland acres per WAA...

WAA #	Pre-project FCUs	Post Project FCUs
Temp Storage of Water	0.0928	0.088
Maintain Plant & Animal	0.3596	0.341
Removal of Elements	0.377	0.3575

## ***Riverine Herbaceous/Shrub HGM Interim (FCI formulas)***

Temporary Storage & Detention of Storage Water:

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\}/2\}]^{1/2}$$

Maintain Plant and Animal Community:

$$\{V_{mid} + V_{herb} + V_{connect}\}/3$$

Removal & Sequestration of Elements & Compounds:

$$[[V_{wood} + V_{freq} + V_{dur} + [\{V_{topo} + V_{herb} + V_{mid}\}/3] + [\{V_{detritus} + V_{redox} + V_{sorpt}\}/3]]/5$$

---

$V_{dur}$

$V_{freq}$

$V_{topo}$

$V_{wood}$

$V_{mid}$

$V_{herb}$

$V_{connect}$

$V_{detritus}$

$V_{redox}$

$V_{sorpt}$

\* The Riverine model is designed to be used to produce an assessment of the potential function of wetlands that share a surface hydrologic connection (at least periodically during anticipated high flows) with a riverine system {i.e. it is limited to wetlands located in the floodplain and/or floodway}. This model is to be used for a rapid non-controversial estimate of the potential impacts to herbaceous riparian wetlands and to see if the proposed mitigation will adequately address the wetland functions that are being impacted.

## ***Riverine Herbaceous/Shrub HGM Interim***

The techniques used to determine which functional capacity index (FCI) will be used for each variable are typically based on standard techniques described in detail in the 1987 Corps Wetland Delineation Manual, the NRCS 3<sup>rd</sup> Edition to the National Food Security Act Manual (NFSAM) and/or the “A Regional Guidebook for Application of Hydrogeomorphic Assessments to Riverine Low Gradient Wetlands (Ainslie et al. 1997). These sources will hereafter be referred to as the 87 WDM, NFSAM, and the Kentucky Riverine Guidebook, respectively.

Documentation should be made for each variable as to which method, indicator, plot size was used for each variable. The number of sample plots is related to the variability of the site. Significantly different timber age classes or species types should be sampled separately. One or two sample plots might be sufficient in a small uniform site, whereas, numerous sample plots would be required for a large diverse site. The following is a general definition and guidance on the methodology for each variable.

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**V<sub>freq</sub>: Frequency of Flooding:** Indicators as described in the Wetland Hydrology Section of the 87 WDM (paragraphs 46-49) will be utilized to estimate frequency of flooding. Utilization of the county soil survey is a particularly good tool. NOTE: unlike the criteria for hydrology for wetland delineation, growing season is not a factor in the variable.

**V<sub>topo</sub>: Topography:** To determine percent for these criteria, visual estimate will be conducted. Those areas with significant topographic features will be shown on a reference map, briefly described (i.e. ridge/slough, mounds, undulations, channels/burn, etc.) and measured to determine acreage. Percent of site containing topographic features can then be determined.

**V<sub>wood</sub>: Woody vegetation:** Percentage of the WAA that is covered by woody vegetation will be determined by the use of recent aerial photography. Field verification is needed to ensure land use changes have not occurred. Size and density of woody vegetation impedes water flow. For example; a few large trees in a pasture would NOT constitute “covered with woody vegetations” nor would 1 year old seedlings. It should also be noted that an area clear cut with stumps, sprouts and shrubs removed would NOT constitute “woody vegetation” and the functions should be assessed using a herbaceous model.

**V<sub>mid</sub>: Midstory (Shrubs/saplings/woody vines):** The midstory layer is the layer of botanical species located between the herbaceous and forest/tree canopy. This would include shrubs, saplings, smaller trees, small trees, and large woody vines. A measure is taken at each plot and/or a visual estimate is performed at each sample location(s).

**V<sub>herb</sub> : Herbaceous layer:** Herbaceous layers are made at each data location/plot as is described in the 87 WDM. It is recommended that 2-5 sub plots be taken at each location to account for vegetative variability.

**V<sub>detritus</sub>: Detritus:** This variable is a measure of the percentage of areas with detritus at the soil surface. Plowed areas or areas “washed” by high velocity flood water should not be considered as areas having detritus. Determination of an A (with organic) or O horizon should be determined for the entire site by on site field information. For this variable, the A (with organic) must have a Munsell value of 4 or less. Refer to the Kentucky Riverine Model for additional details regarding this variable.

**V<sub>redox</sub>: Redoximorphic process:** This variable is an indicator of periodic aerobic and anaerobic process within the top 10-12 inches of the soil surface. Redox features should be document for each sample plot/location and any other soil investigation conducted on the site. At least 50% of the must meet this criteria to be a 1 in the sub index.

**V<sub>sorpt</sub>: Sorptive Soil Properties:** This variable is a general indicator of the potential that the soil has in regards to it’s absorptive properties. This information can be obtained by the use of the county soil survey in conjunction with the field data.

**V<sub>connect</sub>: Connectivity to other habitat types:** This variable concentration on the geo-location of the WAA in relationship to other habitat type within 600 feet from the perimeter of the WAA.

## *Variables for HGM (Interim) Herbaceous/Shrub Riverine*

$V_{dur}$ : The % of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway

Criteria	Variable Sub index
In an average year at 80% of the WAA either floods and/or ponds for at least 14 consecutive days	1.00
In an average year at 80% of the WAA either floods and/or ponds for at least 7 consecutive days	0.75
In an average year at 50-79% of the WAA either floods and/or ponds for at least 7 consecutive days	0.50
In an average year at 25-50% of the WAA either floods and/or ponds for at least 7 consecutive days	0.25
In an average year all or portions of the WAA either floods and/or ponds for at least 1-7 consecutive days	0.10
The area is NOT subject to flooding	0.00

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 $V_{freq}$ : The frequency that the WAA is flooded and/or ponded by nearby waterway .

Criteria	Variable Sub index
Floods or pond annually 5 out of 5 years (floodway)	1.00
Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped w/n 100 yr floodplain)	0.75
Floods or ponds 2 out of 5 years (100- year floodplain)	0.50
Floods or ponds less than 2 out of 5 years (100-500 yr floodplain grey w/out elevations)	0.25
The area is not subject to flooding or ponding (500 yr floodplain)	0.00

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 $V_{topo}$ : The roughness associated with the WAA

Criteria	Variable Sub Index
Greater than 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	1.00
15 - 30% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.70
Less than 15% of the WAA is represented by dips, hummocks, channel sloughs and/or other topographic features	0.40
Smooth, flat, or very gentle undulating with little or no topographic features	0.10

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 $V_{wood}$ : Percentage of the WAA that is covered by woody vegetation

Criteria	Variable Sun Index
Greater than 90% of the WAA is covered with woody vegetation	1.00
67 to 90 % of the WAA is covered with woody vegetation	0.75
34 to 66% of the WAA is covered with woody vegetation	0.50
11 to 33% of the WAA is covered with woody vegetation	0.25
0-10% if the WAA is covered with woody vegetation	0.10

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V<sub>mid</sub>: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA

Criteria	Variable Sub Index
Midstory coverage of the WAA is more than 75%	1.00
Midstory coverage of the WAA is between 50-75 %	0.75
Midstory coverage of the WAA is between 25-50%	0.50
Midstory coverage of the WAA is between 1-25%	0.25
Midstory coverage of the WAA is equal to or less than 1%	0.10

V<sub>herb</sub>: The average/mean coverage of the WAA by the herbaceous layer

Criteria	Variable Sub Index
Herbaceous cover in the WAA averages greater than 75%	1.00
Herbaceous cover in the WAA averages between 50-75%	0.75
Herbaceous cover in the WAA averages between 25-50%	0.50
Herbaceous cover in the WAA average is between 1-25%	0.25
Herbaceous cover in the WAA is equal to or less than 1% (barren soil or all shrub)	0.10

V<sub>connect</sub>: the number of habitat types within a 600' of the parameter of the WAA  
(Habitat to be counted has to be at a minimum 5% of the size of the WAA)

Habitat Types:

Forested	Shrub/Sapling
Herbaceous/Prairie/Abandoned Ag field	Active Agricultural Field
Open water	Wetland
Mudflat	Lawn

Criteria:	Variable Sub Index
Wetland plus four habitats and/or surrounded by forested	1.00
Wetland plus two or more habitat type (other than forested) OR three or more habitat types	0.75
Wetland plus one other habitat types or two other habitat types	0.50
One other habitat types other than urban habitat	0.25
Surround by urban (homes, lawn, concrete, etc.)	0.10

V<sub>detritus</sub>: The amount of the detritus on the WAA  
(A horizon has to have a value of 4 or less)

Criteria	Variable Sub Index
Greater than 85% of the area possesses an O or A horizon	1.00
From 11-84% of the area possesses an O or A horizon	0.50
Less than 10% of the area possesses an O or A horizon	0.30
Site is plowed	0.10

V<sub>redox</sub>: The amount of the WAA that exhibits redox features an indication of the chemical exchange

Criteria	Variable Sub Index
Redox concentrations represent at least 20% of the pedon within the top 4 inches of the soil surface, or feature masked due to parent material but conditions are conducive to redoximorphic processes. (many mottles)	1.0
Redox features less than 20%	0.1

V<sub>sort</sub>: The absorptive properties of the soils in the WAA

Criteria	Variable Sub Index
The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1)	1.00
WAA is dominated by loamy (silt loams, very fine sandy loams, loam) or non-montmorillonitic clays	0.50
The WAA is dominated by sandy soils (sands, loamy fine sands, loamy sands)	0.10

## *Riverine Herb/Shrub HGM (Interim) Worksheet*

WAA # Pond B

Variable	Subindex
V <sub>dur</sub>	0.75
V <sub>freq</sub>	1.00
V <sub>topo</sub>	0.10
V <sub>wood</sub>	0.10
V <sub>mid</sub>	0.10
V <sub>herb</sub>	1.00
V <sub>detritus</sub>	1.00
V <sub>redox</sub>	1.00
V <sub>sorpt</sub>	1.00
V <sub>connect</sub>	0.75

The 87 USACE Wetland Delineation Manual and AGCP Regional Supplement were used to assist in determining variable subindex values. Site visit photos, google earth imagery, FEMA floodplain mapper, and NRCS Soil Surveys were also utilized to determine variable subindex values.

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

WAA #

Variable	Subindex
V <sub>dur</sub>	
V <sub>freq</sub>	
V <sub>topo</sub>	
V <sub>wood</sub>	
V <sub>mid</sub>	
V <sub>herb</sub>	
V <sub>detritus</sub>	
V <sub>redox</sub>	
V <sub>sorpt</sub>	
V <sub>connect</sub>	

***Riverine Herb/Shrub (Interim HGM) Worksheet  
Functional Capacity Index (FCI)***

**Temporary Storage & Dentention of Storage Water:**

$$[\{V_{dur} \times V_{freq}\}^{1/2} \times \{V_{topo} + \{V_{herb} + V_{mid}/2\} / 2\}^{1/2}]^{1/2}$$

$$[\{0.75 \times 1.00\}^{1/2} \times \{0.10 + \{1.00 + 0.10 / 2\} / 2\}^{1/2}]^{1/2} = FCI \quad 0.16$$

$$[\{ \_ \times \_ \}^{1/2} \times \{ \_ + \{ \_ + \_ / 2 \} / 2 \}^{1/2}]^{1/2} = FCI$$

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**Maintain Plant and Animal Communities:**

$$\{V_{mid} + V_{herb} + V_{connect}\} / 3$$

$$\{0.10 + 1.00 + 0.75\} / 3 = FCI \quad 0.62$$

$$\{ \_ + \_ + \_ \} / 3 = FCI$$

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**Removal & Sequestrian of Elements & Compounds:**

$$[[V_{wood} + V_{freq} + V_{dur} + \{V_{topo} + V_{herb} + V_{mid}\} / 3] + [\{V_{detritus} + V_{redox} + V_{sorp}\} / 3]] / 5$$

$$[[0.10 + 1.00 + 0.75 + \{0.10 + 1.00 + 0.10\} / 3] + [\{1.00 + 1.00 + 1.00\} / 3]] / 5 = FCI \quad 0.65$$

$$[[ \_ + \_ + \_ + \{ \_ + \_ + \_ \} / 3] + [\{ \_ + \_ + \_ \} / 3]] / 5 = FCI$$

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Functional Capacity Units (FCU); FCI x wetland acres per WAA...

WAA #	Pre-project FCUs	Post Project FCUs
Temp Storage of Water	0.0928	0.088
Maintain Plant & Animal	0.3596	0.341
Removal of Elements	0.377	0.3575