
Interim Hydrogeomorphic Function Analysis

As part of the permitting process, InControl Technologies conducted an Interim Hydrogeomorphic Function Assessment for wetland habitats within a 75-acre tract. This work is documented in a report included in **Appendix A**. At present, the USACE Galveston District requires the use of their interim hydrogeomorphic model (iHGM) to calculate the functional value of jurisdictional wetlands. Within this framework, major classes of wetland functions (i.e., biological, chemical, physical) are described as indices that can be multiplied by the acreages that will be impacted to determine functional losses by fill, conversion, or temporary impairment by construction activities. Under the 2008 Mitigation Rule, these impacts must be compensated for through equivalent mitigation credits.

In February 2020, a wetland delineation was completed for the wetlands within the property to determine the extent of wetlands within the property. On-site iHGM functional assessment data were collected on February 13, 2020 through February 14, 2020 to determine the sub-index values for the Herbaceous/Shrub and Forested iHGM models.

InControl Technologies delineation identified 1.88 acres of PEM wetlands and 9.55 acres of PFO wetlands within the proposed location of the project (**Figure 4**) that would be considered jurisdictional wetlands. Wetland F is believed to be non-jurisdictional and was not included in the functional assessment. Based on field data, wetlands with similar functional values were selectively grouped into the minimum number of Wetland Assessment Areas (WAAs) for each vegetation class using the iHGM analyses (**Figure 7**).

The mitigation credits required to offset the identified wetlands include 7.097 FCUs for Physical (TSSW), 6.858 FCUs for biological (MPAC) and 7.492 FCUs for Chemical (RSEC).

Table 5. Existing Riverine Forested/Herbaceous Wetland FCI & FCU Values

WAAID	Type	Acreage	TSSW (physical)		MPAC (biological)		RSEC (chemical)	
			FCI	FCU	FCI	FCU	FCI	FCU
WAA1	PEM		0.791	0.791	0.64	0.638	0.81	0.807
WAA2	PEM	5.64	0.742	4.183	0.71	4.019	0.79	4.437
WAA3	PEM	1.71	0.689	1.179	0.61	1.043	0.77	1.311
WAA4	PEM	1.06	0.597	0.633	0.62	0.654	0.56	0.594
WAAS	PEM	.82	0.381	0.313	0.62	0.506	0.42	0.344
Total		11.58		7.097		6.858		7.492

The findings presented in the iHGM report are restricted to and are based upon our professional opinions. These values are subject to alterations in project plans, verification of the wetland delineation, and verification of the iHGM. Only the USACE and the U.S. Environmental Protection Agency have final legal authority to determine the location, extent, and functional value of waters of the U.S. We believe that the information contained in the iHGM report accurately represent conditions at the site and the findings would be consistent with those of the USACE.

Wetland Functional Assessment

The USACE Galveston District requires the use of their interim hydrogeomorphic model (iHGM) to calculate the functional value of jurisdictional wetlands. Within this framework, major classes of wetland functions (i.e., biological, chemical, physical) are described as indices which are multiplied by the acreages that will be impacted to determine functional losses by fill, conversion, or temporary impairment by construction activities. Under the 2008 Mitigation Rule, these impacts must be compensated for through equivalent mitigation credits.

iHGM Model

The iHGM uses multiple variables to evaluate three ecological functions which describe, and measure forested and herbaceous/shrub riverine wetlands in the U.S. Army Corps of Engineers (USACE) Galveston District. These three functional capacity indices (FCI) are used to quantify potential impacts for each wetland assessment area (WAA) associated with a project. For this project, InControl Technologies applied the Riverine Herbaceous-Shrub functional assessment (USACE 2010a). The FCI quantify temporary storage of surface water (TSSW), maintenance of plant and animal communities (MPAC), and removal and sequestration of elements and compounds (RSEC) for each wetland to determine physical, biological, and chemical functions, respectively.

The Riverine Herbaceous-Shrub iHGM functional assessment uses ten (10) variables to evaluate non-forested (herbaceous or scrub-shrub) riverine wetlands. The three indices are expressed by the following function:

$$TSSW = \sqrt[3]{\sqrt{(V_{dur} * V_{freq}) * \left(\frac{V_{topo} + \frac{V_{herb} * V_{mid}}{3}}{3} \right)}}}$$

$$MPAC = \frac{V_{mid} + V_{herb} + V_{connect}}{3}$$

$$RSEC = \frac{V_{wood} + V_{rreq} + V_{dur} + \left(\frac{V_{iopo} + V_{iierb} + V_{wood}}{3} \right) + \left(\frac{V_{detritus} + V_{redox} + V_{soil}}{3} \right)}{5}$$

The variables for the herbaceous scrub-shrub iHGM include:

- Vdur: Duration of flooding and ponding in an average year
- Vfreq: Frequency of flooding and ponding
- Vtopo: Percent containing topographic features
- Vherb: Percent of herbaceous cover
- Vmid: Percent of relative cover between the herbaceous and tree strata
- Vwood: Percent covered by woody vegetation
- Vdetritus: Percent of area with detritus at the soil surface
- Vredox: Abundance of redox features within the top 12 inches of soil

- Vsorpt: Absorptive properties of the soil
- Vconnect: Number of habitat types found within 600 feet

The Riverine Forested iHGM model includes the variables found in the Riverine Herbaceous/Shrub iHGM functional assessment with five additional variables that account for the ecological effects of the tree stratum and associated detritus, forest indices are expressed with the following function:

$$TSSW = \sqrt{\sqrt{(Vdur * Vfreq) * ((Vtopo + Vwd + Vwood) / 3)}}$$

$$MPAC = \frac{[Vtree + Vcwd + Vrich + ((Vbasal + Vdensity) / 2) + ((Vmid + Viierb) / 2) + Vconnect]}{6}$$

$$RSEC = \frac{[Vwood + Vfreq + Vdur + ((Vcwd + Vwood) / 3) + ((V13dox + Vsorpt) / 3) + (Vdetritus / 3)]}{5}$$

The additional variables for the Forested iHGM include:

- Vcwd: Duration of flooding and ponding in an average year
- Vtree: Frequency of flooding and ponding
- Vrich: Percent containing topographic features
- Vbasal: Percent of herbaceous cover
- Vdensity: Percent of relative cover between the herbaceous and tree strata

Therefore, a wetland scoring closer to 1 for each variable will generate a higher FCI score for each ecological function (TSSW, MPAC, and RSEC) than one in which variable values are near 0. Once an FCI has been calculated for each wetland, the corresponding functional capacity units (FCU) can be determined based on the product of the total acreage of a wetland and its corresponding FCI values.

Wetland Functional Assessment Results

InControl Technologies delineation identified 1.88 acres of PEM wetlands and 9.55 acres of PFO wetlands within the proposed location of the project (**Figure 6**) that would be considered jurisdictional wetlands. Wetland F is believed to be non-jurisdictional and was not included in the functional assessment. Based on field data, wetlands with similar functional values were selectively grouped into the minimum number of Wetland Assessment Areas (WAAs) for each vegetation class using the iHGM analyses. **Table 3** shows the sub-index values assigned for each WAA within the project area. The following paragraphs provide general descriptions of the values used to calculate the iHGM values.

- **Duration of flooding (Vdur)** is estimated using hydrology indicators listed in the Corps of Engineers Wetlands Delineation Manual (Manual; USACE 1987) and the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Atlantic and Gulf Coastal Region, Version 2.0 (Regional Supplement; USACE 2010b). The portion of the property containing wetlands is

within the 100-year flood plain and the wetlands are situated in local depressions. Based on field observations, the duration of inundation events in all WAAs occur for at least seven consecutive days, resulting in sub-index values of 0.75 for all wetlands except for WAA 5 which scored 5.0.

- **Frequency of flooding (Vfreq)** uses indicators listed in the Manual (USACE 1987), the Regional Supplement (USACE 2010b), and FEMA floodplain maps. The project areas lying within the 500-year floodplain and the geography of the wetlands are such that much of these areas are inundated by frequent periodic flooding. Based on field observation, InControl Technologies believes that all WAAs flood or pond semi-annually; with WAA1, WAA2 and WAA4 flooding more frequently and scoring 0.75 due to their lower landscape position than WAA3 and WAA5 which scored a 0.5 respectively.
- **Topography (Vtopo)** relies on visual estimates conducted in the field to determine what percent of the WAA is composed of heterogeneous topographic features (e.g., dips, hummocks, channel sloughs). Some topographic features observed within the project area include depressions and hummocks; however, the wetlands generally lacked significant microtopographic features.
- **Woody vegetation (Vwood)** was assessed visual observations. Woody vegetation obviously dominated the PFO wetlands (WAA1, WAA2 and WAA3), with cover greater than 67% in each. Therefore, their scores were 1.0. PEM wetlands within the property contained low densities of woody shrubs and trees resulting in scores of 0.1, indicating that woody vegetation cover in these wetlands were less than 33 percent.
- **Midstory (Vmid)** describes the shrub and sapling vegetation layer found between ground level and an upper forest canopy. The midstory stratum covers ranged widely across the wetlands, with sub-index values ranging from 0.1 to 0.5.
- **Herbaceous (Vherb)** describes the average herbaceous vegetation cover in each WAA. The most common sub-index value was 1.0 within the PEM WAAs, while the PFO WAAs scored at 0.3.
- **Connectivity to other habitat types (Vconnect)** was assessed using aerial imagery extending 600 feet from the project area. The project area included two or more habitat types (other than forested) throughout. Therefore, a sub-index score of 1.0 to 0.75 was assigned.
- **Detritus (Vdetritus)** refers to the presence of either an O or A horizon associated with the WAAs. Frequent flooding within the project area saturates soils, decreasing the rate at which organic carbon is naturally utilized thereby allowing for the accumulation of organic matter. Sub-index value of 1.0 was assigned to all WAAs within the project area.
- **Redoximorphic process (Vredox)** is based on extent to which pedons within the WAA that exhibit redoximorphic features as an indication of alternating oxidizing and reducing conditions. Periodic flooding within saturated soils, causing vacillation between anaerobic and aerobic conditions which allows the reduction and translocation of iron and manganese within the upper portions of the soil. Soils within all wetlands contained redoximorphic concentrations that represent less than 20

percent of the upper portion of the pedon, warranting a sub-index score of 0.1.

- **Sorptive soil properties (V_{sorpt})** are determined using the Natural Resources Conservation Service (NRCS) Soil Survey (U.S. Department of Agriculture [USDA] 2016) and data recorded in the field. According to the USDA Soil Survey, Brazoria Clay, rarely flooded (Ma) and Lake Charles Clay, 0 to 1 percent slopes (Le & La) are present in the project area. Field surveys confirmed that sandy clay soils (sub-index score of 1.0) dominated all WAAs.

The following results are exclusively for the Riverine Forested iHGM model.

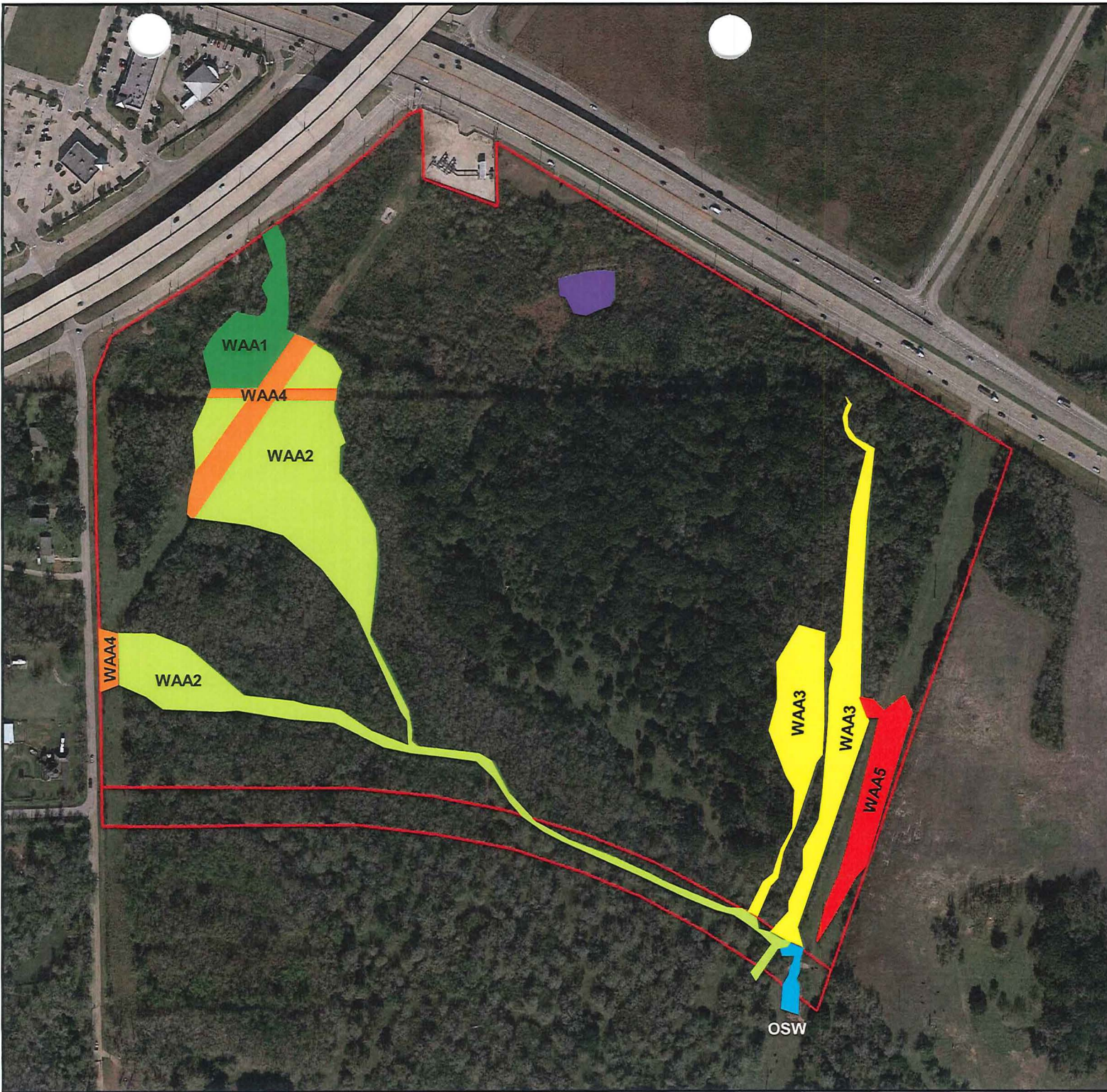
- **Coarse woody debris (V_{cwd})** is measured by a point-intercept method involving a tally of woody debris greater than 3 inches in diameter along a 100-foot-long transect in forested WAAs. Due to land use of the property, this could not be directly measured; therefore, this sub-index score was estimated from adjacent forested wetland areas. Based on this, we estimate that coarse woody debris is three to seven pieces within all forested WAAs which correspond to a score of 0.5.
- **The percentage of trees that are mast producers (V_{tree})** was assessed via summation of the percent cover of mast producing species (e.g., oak, hickory, cypress, maple, and elm) in the WAA. Due to land use of the property, this could not be directly measured; therefore, this sub-index score was estimated from residual materials (stumps and stems left on the ground) and those identified in adjacent forested wetland areas. Forested wetlands in WAA1 and WAA3 was a significant coverage of Chinese tallow; however, WAA2 was dominated by a far more diverse assemblage. Therefore, these wetlands were assigned sub-index values of 0.5, 0.3 and 0.8 respectively.
- **Tree richness (V_{rich})** is a measure of the diversity of species within the WAAs. Common tree species found within PFO WAAs include Chinese tallow and cedar elm and water oak and green Ash. Therefore, these wetlands warrant sub index score 0.6 respectively.
- **Tree basal area (V_{basal})** is the mean basal area per acre of trees in the WAA. The calculated basal area within WAA1, WAA2 and WAA3 is approximately 144, 61 and 146 square feet per acre, corresponding to sub-index scores of 1.0.
- **Tree density (V_{density})** is based on the number of trees per acre that are at least 3 inches in diameter at breast height. Tree density ranged from between 250 and 300 trees per acre, resulting in a sub-index score of 1.0 for both associated WAAs.

These categories are summarized in separate Functional Assessment Variables Scores table included in **Attachment D**. The tables in **Attachment D** summarize the scores for each of the each of the variables detailed above. **Table 4** below summarizes the FCI and FCU scores with totals beneath of the functional credit units that will need to be mitigated with credits from an appropriate mitigation bank.

The mitigation credits required to offset the identified wetlands include 7.097 FCUs for Physical (TSSW), 6.858 FCUs for biological (MPAC) and 7.492 FCUs for Chemical (RSEC).

Table 4. Existing Riverine Forested/Herbaceous Wetland FCI & FCU Values

WAAID	Type	Acreage	TSSW (physical)		MPAC (biological)		RSEC (chemical)	
			FCI	FCU	FCI	FCU	FCI	FCU
WAA1	PEM	1	0.791	0.791	0.64	0.638	0.81	0.807
WAA2	PEM	5.64	0.742	4.183	0.71	4.019	0.79	4.437
WAA3	PEM	1.71	0.689	1.179	0.61	1.043	0.77	1.311
WAA4	PEM	1.06	0.597	0.633	0.62	0.654	0.56	0.594
WAAS	PEM	.82	0.381	0.313	0.62	0.506	0.42	0.344
Total		11.58		7.097		6.858		7.492



LEGE" -

- / Property Boundary
- WAA1
- WAA2
- WAA3
- w AA4
- w AA5
- OSW
- NONJURISDICTIONAL



InControl Technologies

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iHGM Wetland Assessment Areas

CLIENT: NewQuest Properties			PM: MFM
Location: SEC Fort Bend Toll & Hwy 6 Missouri City, TX 77545			CHECKED:
DETAILED: 3/19/2020	DESIGNED: MFM	PROJECT NO: 320-223	FIGURE: 7

Riverine Forested HGM (Interim) Assessment Pre-Impacts

Applicant: _____ MC-~~68~~Sienna _____ WAA ID: _____ **WAA1** _____ WAA Acreage: 1.000

V_{du} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision: <i>In an average year, at least 80% of the WAA either floods and/or ponds for at least 7 consecutive days.</i>	
Subindex: 0.750	
Comments: <i>Nearly half the individuals were triadica sebifera.</i>	

V_{1Q} : Frequency that the WAA is flooded and/or ponded by the nearby waterway.	
Decision: <i>Floods or ponds 2 out of 5 years (100-year floodplain).</i>	
Subindex: 0.500	
Comments:	

V_{10,0} : Roughness associated with the WAA.	
Decision: <i>Greater than 30% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.</i>	
Subindex: 1.000	
Comments:	

V_{cwd} : Coarse Woody Debris within the WAA.	
Decision: <i>Less than 3 pieces of CWD greater than 3" diameter along 100' transect.</i>	
Subindex: 0.300	
Comments:	

V_wo₃ : Percentage of the WAA that is covered by woody vegetation.	
Decision: <i>67-90% of the WAA is covered with woody vegetation.</i>	
Subindex: 1.000	
Comments:	

V₁₀₀ : The percentage of the trees in the WAA that are mast producers.	
Decision: <i>Less than 20% of the stand is oak, hickory, cypress, maple, and/or elm.</i>	
Subindex: 0.300	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ MC-68Sienna _____ WAA ID: _____ WAA1 _____ WAA Acreage: 1.000

V _{rich} : The diversity of the species within the WAA. (To be considered the species must comprise at least 5% of the stand.)	
Decision:	
<i>Four tree species present.</i>	
I Subindex: 0.600	
Comments:	

V _{basal} : The average/mean basal area of the trees in the WAA per acre.	
Decision:	
<i>The average basal area of the WAA is greater than 100 square feet per acre.</i>	
I Subindex: 1.000	
Comments:	

V _{dens} : The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	
Decision:	
<i>The WAA averages a tree density of 100-250 trees per acre.</i>	
I Subindex: 0.600	
Comments:	

V _{mi} : The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	
Decision:	
<i>Midstory coverage of the WAA is less than 10%.</i>	
I Subindex: 0.250	
Comments:	

V _{herb} : The average/mean coverage of the herbaceous layer in the WAA.	
Decision:	
<i>Herbaceous cover in the WAA averages between 5-30%.</i>	
I Subindex: 1.000	
Comments:	

V _{detr} : The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	
Decision:	
<i>Greater than 85% of the area possesses an O or A horizon.</i>	
I Subindex: 1.000	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ MC-SB Sienna _____ WAA ID: WAA1 WAA Acreage: 1.000

V _{redox} : The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	
Decision: <i>Redox features less than 20%.</i>	
	Subindex: 0.100
Comments:	

V ₅₀₀ : The absorptive properties of the soils in the WAA.	
Decision: <i>The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (211, 212, or 3/1).</i>	
	Subindex: 1.000
Comments:	

V _{connect} : Number of habitat types within 600 feet of the perimeter of the WAA.									
<i>Habitat to be counted has to be at a minimum 5% of the size of the WAA</i>									
Habitat Types:	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Forested</td> <td style="width: 50%;">Shrub/Sapling</td> </tr> <tr> <td>Herbaceous/Prairie/Abandoned Ag Field</td> <td>Active Ag Field</td> </tr> <tr> <td>Open Water</td> <td>Wetland</td> </tr> <tr> <td>Mudflat</td> <td>Lawn</td> </tr> </table>	Forested	Shrub/Sapling	Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field	Open Water	Wetland	Mudflat	Lawn
Forested	Shrub/Sapling								
Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field								
Open Water	Wetland								
Mudflat	Lawn								
Decision: <i>Wetland plus four habitats and/or surrounded by forested.</i>									
	Subindex: 1.000								
Comments:									

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	Pre-FCI	Pre-FCU
Temporary Storage & Detention of Storage Water $[(V_{dur} \cdot V_{freq})^{0.5} \cdot ((V_{topo} + V_{cwd} + V_{wood}) / 3)]^{0.5}$	0.79	0.7910
Maintain Plant & Animal Community $(V_{tree} + V_{cwd} + V_{rich} + [(V_{basal} + V_{density}) / 2] + [(V_{mid} + V_{herb}) / 2] + V_{connect}) / 6$	0.64	0.6400
Removal & Sequestration of Elements & Compounds $(V_{wood} + V_{freq} + V_{dur} + [(V_{topo} + V_{cwd} + V_{wood}) / 3] + [(V_{detritus} + V_{redox} + V_{sorp}) / 3]) / 5$	0.81	0.8100

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ MC-68 Sienna _____ WAA ID: _____ WAA2 _____ WAA Acreage: 5.640

V_{dur} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision: <i>In an average year, at least 80% of the WAA either floods and/or ponds for at least 7 consecutive days.</i>	
Subindex: 0.750	
Comments:	

$V_{f,0}$: Frequency that the WAA is flooded and/or ponded by the nearby waterway.	
Decision: <i>Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped within the 100-year floodplain).</i>	
Subindex: 0.750	
Comments:	

$V_{10,0}$: Roughness associated with the WAA.	
Decision: <i>15-30% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.</i>	
Subindex: 0.700	
Comments:	

V_{cwd} : Coarse Woody Debris within the WAA.	
Decision: <i>From 3-7 pieces of CWD greater than 3" diameter along 100' transect.</i>	
Subindex: 0.500	
Comments:	

V_{wo} : Percentage of the WAA that is covered by woody vegetation.	
Decision: <i>67-90% of the WAA is covered with woody vegetation.</i>	
Subindex: 1.000	
Comments:	

$V_{t,0}$: The percentage of the trees in the WAA that are mast producers.	
Decision: <i>67-90% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 10% of the stand.</i>	
Subindex: 0.800	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ MC-68 Sienna _____ WAA ID: _____ WAA2 _____ WAA Acreage: 5.640

V _{div} : The diversity of the species within the WAA. (To be considered the species must comprise at least 5% of the stand.)	
Decision:	
<i>Three tree species present.</i>	
!Subindex: 0.600	
Comments:	

V _{basal} : The average/mean basal area of the trees in the WAA per acre.	
Decision:	
<i>The average basal area of the WAA is between 60-80 square feet per acre.</i>	
!Subindex: 1.000	
Comments:	

V _{density} : The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	
Decision:	
<i>The WAA averages a tree density of 100-250 trees per acre.</i>	
!Subindex: 1.000	
Comments:	

V _{mid} : The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	
Decision:	
<i>Midstory coverage of the WAA is less than 10%.</i>	
!Subindex: 0.250	
Comments:	

V _{herb} : The average/mean coverage of the herbaceous layer in the WAA.	
Decision:	
<i>Herbaceous cover in the WAA averages between 31-50%.</i>	
!Subindex: 0.500	
Comments:	

V _{detritus} : The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	
Decision:	
<i>Greater than 85% of the area possesses an O or A horizon.</i>	
!Subindex: 1.000	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: MC-68 Sienna WAA ID: WAA2 WAA Acreage: 5.640

V _{redox} : The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	
Decision: <i>Redox features less than 20%.</i>	
Subindex: 0.100	
Comments:	

V _{topo} : The absorptive properties of the soils in the WAA.	
Decision: <i>The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (211, 212, or 311).</i>	
Subindex: 1.000	
Comments:	

V _{connect} : Number of habitat types within 600 feet of the perimeter of the WAA.									
<i>Habitat to be counted has to be at a minimum 5% of the size of the WAA</i>									
Habitat Types:	<table border="1"> <tr> <td>Forested</td> <td>Shrub/Sapling</td> </tr> <tr> <td>Herbaceous/Prairie/Abandoned Ag Field</td> <td>Active Ag Field</td> </tr> <tr> <td>Open Water</td> <td>Wetland</td> </tr> <tr> <td>Mudflat</td> <td>Lawn</td> </tr> </table>	Forested	Shrub/Sapling	Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field	Open Water	Wetland	Mudflat	Lawn
Forested	Shrub/Sapling								
Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field								
Open Water	Wetland								
Mudflat	Lawn								
Decision: <i>Wetland plus four habitats and/or surrounded by forested.</i>									
Subindex: 1.000									
Comments:									

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	Pre-FCI	Pre-FCU
Temporary Storage & Detention of Storage Water $[(V_{dur} \cdot V_{freq}) \wedge 0.5 \cdot ((V_{topo} + V_{cwd} + V_{wood}) / 3)] \wedge 0.5$	0.74	4.1849
Maintain Plant & Animal Community $(V_{tree} + V_{cwd} + V_{rich} + [(V_{basal} + V_{density}) / 2] + [(V_{mid} + V_{herb}) / 2] + V_{connect}) / 6$	0.71	4.0190
Removal & Sequestration of Elements & Compounds $(V_{wood} + V_{freq} + V_{dur} + [(V_{topo} + V_{cwd} + V_{wood}) / 3] + [(V_{detritus} + V_{redox} + V_{sorp}) / 3]) / 5$	0.79	4.4370

Riverine Forested HGM (Interim) Assessment Pre-Impacts

Applicant: _____ MC-68 Sienna _____ WAA ID: _____ WAA3 _____ WAA Acreage: 1.710

V _{du} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision:	
<i>In an average year, at/least 80% of the WAA either floods and/or ponds for at/least 7 consecutive days.</i>	
Subindex: 0.750	
Comments:	

V _{ra} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision:	
<i>Floods or ponds 2 out of 5 years (100-year floodplain).</i>	
Subindex: 0.500	
Comments:	

V ₁₀₀₀ : Roughness associated with the WAA.	
Decision:	
<i>Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.</i>	
Subindex: 0.400	
Comments:	

V _{cwd} : Coarse Woody Debris within the WAA.	
Decision:	
<i>From 3-7 pieces of CWD greater than 3" diameter along 100' transect.</i>	
Subindex: 0.500	
Comments:	

V _w : Percentage of the WAA that is covered by woody vegetation.	
Decision:	
<i>0-10% of the WAA is covered with woody vegetation.</i>	
Subindex: 0.750	
Comments:	

V _{1,2} : The percentage of the trees in the WAA that are mast producers.	
Decision:	
<i>5% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 5% of the stand.</i>	
Subindex: 0.500	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ MC-68Sienna _____ WAA ID: WAA3 WAA Acreage: 1.710

V_{div} : The diversity of the species within the WAA. (To be considered the species must comprise at least 5% of the stand.)	
Decision:	
<i>Three tree species present.</i>	
	Subindex: 0.600
Comments:	

V_{basal} : The average/mean basal area of the trees in the WAA per acre.	
Decision:	
<i>The average basal area of the WAA is greater than 100 square feet per acre.</i>	
	Subindex: 1.000
Comments:	

V_{densit} : The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	
Decision:	
<i>The WAA averages a tree density of 100-250 trees per acre.</i>	
	Subindex: 0.600
Comments:	

V_{mid} : The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	
Decision:	
<i>The site is open land (non-forested).</i>	
	Subindex: 0.500
Comments:	

V_{herb} : The average/mean coverage of the herbaceous layer in the WAA.	
Decision:	
<i>Herbaceous cover in the WAA averages between 5-30%.</i>	
	Subindex: 0.500
Comments:	

$V_{detritus}$: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	
Decision:	
<i>Greater than 85% of the area possesses an O or A horizon.</i>	
	Subindex: 1.000
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ **MC-68 Sienna** _____ WAA ID: **WAA3** WAA Acreage: **1.710**

V_{edox}: The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	
Decision: <i>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.</i>	
I Subindex: 0.100	
Comments:	

V_{sorpt}: The absorptive properties of the soils in the WAA.	
Decision: <i>The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (211, 212, or 3/1).</i>	
I Subindex: 1.000	
Comments:	

Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA. <i>Habitat to be counted has to be at a minimum 5% of the size of the WAA</i>									
Habitat Types:	<table border="1"> <tr> <td>Forested</td> <td>Shrub/Sapling</td> </tr> <tr> <td>Herbaceous/Prairie/Abandoned Ag Field</td> <td>Active Ag Field</td> </tr> <tr> <td>Open Water</td> <td>Wetland</td> </tr> <tr> <td>Mudflat</td> <td>Lawn</td> </tr> </table>	Forested	Shrub/Sapling	Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field	Open Water	Wetland	Mudflat	Lawn
Forested	Shrub/Sapling								
Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field								
Open Water	Wetland								
Mudflat	Lawn								
Decision: <i>Wetland plus two or more habitat types (other than forested) OR three or more habitat types.</i>									
I Subindex: 0.750									
Comments:									

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)		Pre-FCI	Pre-FCU
Temporary Storage & Detention of Storage Water $[(V_{dur} \cdot V_{freq}) \wedge 0.5 \cdot ((V_{topo} + V_{cwd} + V_{wood}) / 3)] \wedge 0.5$		I 0.69	I 1.1790
Maintain Plant & Animal Community $(V_{tree} + V_{cwd} + V_{rich} + [(V_{basal} + V_{density}) / 2] + [(V_{mid} + V_{herb}) / 2] + V_{connect}) / 6$		0.61	I 1.0430
Removal & Sequestration of Elements & Compounds $(V_{wood} + V_{freq} + V_{dur} + [(V_{topo} + V_{cwd} + V_{wood}) / 3] + [(V_{detritus} + V_{redox} + V_{sorpt}) / 3]) / 5$		I 0.77	I 1.3110

Riverine Forested HGM (Interim) Assessment Pre-Impacts

Applicant: -----'M_C_-6_8_S_ie_n_n_a-----

WAA ID: WAA4WAA Acreage: 1.060

V_{du} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision: <i>In an average year, at least 80% of the WAA either floods and/or ponds for at least 7 consecutive days.</i>	
Subindex: 0.750	
Comments:	

V_{1Q} : Frequency that the W M is flooded and/or ponded by the nearby waterway.	
Decision: <i>Floods or ponds 3 or 4 out of 5 years (elevation data reveals in floodway and mapped within the 100-year floodplain).</i>	
Subindex: 0.750	
Comments:	

V_{10P} : Roughness associated with the W M.	
Decision: <i>15-30% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.</i>	
Subindex: 0.400	
Comments:	

$V_{cw d}$: Coarse Woody Debris within the W M.	
Decision: <i>Area is open land (pasture or cropland)</i>	
Subindex: 0.000	
Comments:	

V_{wo} : Percentage of the W M that is covered by woody vegetation.	
Decision: <i>0-10% of the WAA is covered with woody vegetation.</i>	
Subindex: 0.100	
Comments:	

V_{tree} : The percentage of the trees in the W M that are mast producers.	
Decision: <i>The area is open land (non-forested).</i>	
Subindex: 0.000	
Comments:	

Interim HGM for MC-68: Forested WAAs

Applicant: _____ MC-68 Senna _____ WAA ID: _____ WAA4 _____ WAA Acreage: _____ 1.060 _____

V _{ch} : The diversity of the species within the WAA. (To be considered the species must comprise at least 5% of the stand.)	
Decision:	
<i>One-two tree species present.</i>	
!Subindex: 0.000	
Comments:	

V _{basal} : The average/mean basal area of the trees in the WAA per acre.	
Decision:	
<i>The average basal area of the WAA is between 60-80 square feet per acre.</i>	
!Subindex: 0.000	
Comments:	

V _{densit} : The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	
Decision:	
<i>The site is open land (non-forested).</i>	
!Subindex: 0.000	
Comments:	

V _{mid} : The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	
Decision:	
<i>The site is open land (non-forested).</i>	
!Subindex: 0.100	
Comments:	

V _{herb} : The average/mean coverage of the herbaceous layer in the WAA.	
Decision:	
<i>Herbaceous cover in the WAA averages between 5-30%.</i>	
!Subindex: 1.000	
Comments:	

V _{detritus} : The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	
Decision:	
<i>Greater than 85% of the area possesses an O or A horizon.</i>	
!Subindex: 1.000	
Comments:	

Interim HGM for MC-68: Forested WAAs

Applicant: _____ ~~MC-68~~ Senna _____ WAA ID: _____ WAA4 _____ WAA Acreage: 1,060

V _{edox} : The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	
Decision: <i>Redox features less than 20%.</i>	
	subindex: 0.100
Comments:	

V _{sm} : The absorptive properties of the soils in the W M .	
Decision: <i>The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (211, 212, or 311).</i>	
	subindex: 1.000
Comments:	

V _{connect} : Number of habitat types within 600 feet of the perimeter of the WAA.									
<i>Habitat to be counted has to be at a minimum 5% of the size of the WAA</i>									
Habitat Types:	<table border="1"> <tr> <td>Forested</td> <td>Shrub/Sapling</td> </tr> <tr> <td>Herbaceous/Prairie/Abandoned Ag Field</td> <td>Active Ag Field</td> </tr> <tr> <td>Open Water</td> <td>Wetland</td> </tr> <tr> <td>Mudflat</td> <td>Lawn</td> </tr> </table>	Forested	Shrub/Sapling	Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field	Open Water	Wetland	Mudflat	Lawn
Forested	Shrub/Sapling								
Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field								
Open Water	Wetland								
Mudflat	Lawn								
Decision: <i>Wetland plus four habitats and/or surrounded by forested.</i>									
	Subindex: 0.750								
Comments:									

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	Pre-FCI	Pre-FCU
Temporary Storage & Detention of Storage Water $[(V_{dur} \cdot V_{freq}) \wedge 0.5 \cdot ((V_{topo} + V_{cwd} + V_{wood}) / 3) \wedge 0.5]$	0.60	0.6330
Maintain Plant & Animal Community $(V_{tree} + V_{cwd} + V_{rich} + [(V_{basal} + V_{density}) / 2] + [(V_{mid} + V_{herb}) / 2] + V_{connect}) / 6]$	0.62	0.6540
Removal & Sequestration of Elements & Compounds $(V_{wood} + V_{freq} + V_{dur} + [(V_{topo} + V_{cwd} + V_{wood}) / 3] + [(V_{detritus} + V_{redox} + V_{sorpt}) / 3]) / 5]$	0.56	0.5940

Riverine Forested HGM (Interim) Assessment Pre-Impacts

Applicant: _____ ~~6-are MC~~ _____ WAA ID: _____ **WAA5** _____ WAA Acreage: **0.820** _____

V_{d,0} : Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	
Decision: <i>In an average year, at least 50-79% of the WAA either floods and/or ponds for at least 7 consecutive days.</i>	
ISubindex: 0.500	
Comments:	

V_{f,0} : Frequency that the WAA is flooded and/or ponded by the nearby waterway.	
Decision: <i>Floods or ponds 2 out of 5 years (100-year floodplain).</i>	
ISubindex: 0.500	
Comments:	

V_{10,0} : Roughness associated with the WAA.	
Decision: <i>Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.</i>	
subindex: 0.400	
Comments:	

V_{cw,d} : Coarse Woody Debris within the WAA.	
Decision: <i>Area is open land (pasture or cropland)</i>	
ISubindex: 0.000	
Comments:	

V_{w,0} : Percentage of the WAA that is covered by woody vegetation.	
Decision: <i>0-10% of the WAA is covered with woody vegetation.</i>	
ISubindex: 0.100	
Comments:	

V_{m,0} : The percentage of the trees in the WAA that are mast producers.	
Decision: <i>The area is open land (non-forested).</i>	
Subindex: 0.100	
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ ~~8-acre~~MC _____ WAA ID: _____ **WAA5** _____ WAA Acreage: 0.820

V _{rich} : The diversity of the species within the WAA. (To be considered the species must comprise at least 5% of the stand.)	
Decision:	
<i>The area is open land (non-forested).</i>	
	Subindex: 0.000
Comments:	

V _{basal} : The average/mean basal area of the trees in the WAA per acre.	
Decision:	
<i>The site is open land (non-forested).</i>	
	Subindex: 0.000
Comments:	

V _{densit} : The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	
Decision:	
<i>The site is open land (non-forested).</i>	
	Subindex: 0.000
Comments:	

V _{mid} : The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	
Decision:	
<i>The site is open land (non-forested).</i>	
	Subindex: 0.100
Comments:	

V _{herb} : The average/mean coverage of the herbaceous layer in the WAA.	
Decision:	
<i>Herbaceous cover in the WAA averages between 5-30%.</i>	
	Subindex: 1.000
Comments:	

V _{detr} : The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	
Decision:	
<i>Greater than 85% of the area possesses an O or A horizon.</i>	
	Subindex: 1.000
Comments:	

Interim HGM for MC-68 Sienna: Forested WAAs

Applicant: _____ 8-acre MC _____ WAA ID: _____ WAAS _____ WAA Acreage: 0.820

V _{redox} : The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	
Decision: <i>Redox features less than 20%.</i>	
	I Subindex: 0.100
Comments:	

V _{mont} : The absorptive properties of the soils in the WAA.	
Decision: <i>The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (211, 212, or 311).</i>	
	I Subindex: 1.000
Comments:	

V _{connect} : Number of habitat types within 600 feet of the perimeter of the WAA.																	
<i>Habitat to be counted has to be at a minimum 5% of the size of the WAA</i>																	
Habitat Types:	<table border="1"> <tr> <td>Forested</td> <td>Shrub/Sapling</td> <td>x</td> <td>x</td> </tr> <tr> <td>Herbaceous/Prairie/Abandoned Ag Field</td> <td>Active Ag Field</td> <td></td> <td></td> </tr> <tr> <td>Open Water</td> <td>Wetland</td> <td></td> <td></td> </tr> <tr> <td>Mudflat</td> <td>Lawn</td> <td></td> <td></td> </tr> </table>	Forested	Shrub/Sapling	x	x	Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field			Open Water	Wetland			Mudflat	Lawn		
Forested	Shrub/Sapling	x	x														
Herbaceous/Prairie/Abandoned Ag Field	Active Ag Field																
Open Water	Wetland																
Mudflat	Lawn																
Decision: <i>Wetland plus one other habitat type or two other habitat types.</i>																	
	I Subindex: 0.500																
Comments:																	

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)		Pre-FCI	Pre-FCU
Temporary Storage & Detention of Storage Water $[(V_{dur} \cdot V_{freq}) \wedge 0.5 \cdot ((V_{topo} + V_{cwd} + V_{wood}) / 3)] \wedge 0.5$		0.38	0.3130
Maintain Plant & Animal Community $(V_{tree} + V_{cwd} + V_{rich} + [(V_{basal} + V_{density}) / 2] + [(V_{mid} + V_{herb}) / 2] + V_{connect}) / 16$		0.62	0.5060
Removal & Sequestration of Elements & Compounds $(V_{wood} + V_{freq} + V_{dur} + [(V_{topo} + V_{cwd} + V_{wood}) / 3] + [(V_{detritus} + V_{redox} + V_{sorpt}) / 3]) / 5$		0.42	0.3444

Table 4 Functional Assessment Variable Scores

WAAID	Wetland ID(s)	Title	Acreage	Vdur	Vtreq	V t r p o	Vcwd	Vwood	Vtree	Vrich	Vbasal	Vdensity	Vmid	Vherb>	Vconnect	Vdetritus	Vredox	Vsorpt
WAA1	Wet A	PFO	1.00	0.75	0.5	1	0.3	0.75	0.3	0.6	1.0	1.0	0.25	1	1.0	1.0	0.1	1.0
WAA2	WetA	PFO	5.64	.075	0.75	0.7	0.5	0.75	0.8	0.8	1.0	1.0	0.25	0.5	1.0	1.0	0.1	1.0
WAA3	WetC&D	PFO	1.71	0.75	0.5	0.4	0.5	0.75	0.5	0.6	1.0	1.0	0.5	0.5	0.75	1.0	0.1	1.0
WAA4	WetB	PEM	1.06	0.75	0.5	0.4	--	0.1	--	--	--	--	0.1	1	0.75	1.0	0.1	1.0
WAAS	WetE	PEM	0.82	0.5	0.4	0.1	--	0	--	--	--	--	0.1	1.0	0.75	1.0	0.1	1.0