



Environmental Services, Inc.

**MITIGATION PLAN FOR
BESSIE HEIGHTS DRAINAGE PROJECT
ORANGE COUNTY, TEXAS**

PREPARED FOR:

**ORANGE COUNTY DRAINAGE DISTRICT
BEAUMONT, TEXAS**

PREPARED BY:

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1.0 MITIGATION PLAN OVERVIEW

1.1 Mitigation Objectives

The proposed mitigation plan create new marsh form subsided and eroded areas and will help to stabilize eroding shorelines of the Bessie Heights Marsh. The plan for BU disposal by Orange County Drainage District (OCDD) for this project will provide the dredged materials to raise the floor elevation of subsided open water areas to suitable marsh contours (approximately +1.2 MSL). Prior to BU disposal, reference elevations of adjacent marsh will be acquired and used to determine the final elevation of the BU materials. The planting of marsh vegetation proposed herein will significantly aid stabilization of erosive edges and hasten marsh development and maturation with a resultant increase in the functional values of the entire area.

1.2 Site Selection

The 5-acre planting area is located in a portion of the Bessie Heights Marsh identified by Texas Parks and Wildlife Department that is in need of stabilization and marsh bilding (see Figure 1). This site was selected due to its proximity to the project site (within 1/2 mile) to facilitate the beneficial use disposal of dredged materials and due to its direct benefit to the Bessie Heights Marsh.

1.3 Site Protection

The mitigation area is currently owned by Texas Parks and Wildlife Department. The mitigation area will be protected as a part of the Nelda Stark Unit of the Lower Neches Wildlife Management Area.

1.4 Baseline Information

The mitigation site is currently considered open tidal water that has resulted by subsidence and wind erosion. The historical marshes that previously existed in this area were predominantly situated above the mean high tide line but were subject to periodic high tides and flood events. Representative vegetation within the historical marsh areas included common reed (*Phragmites australis*), cattail (*Typha latifolia*), saltmeadow cordgrass (*Spartina patens*), salt marsh bulrush (*Scirpus robustus.*), smooth cordgrass (*Spartina alterniflora*), bulltongue (*Sagittaria lancifolia*), saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), giant bulrush (*Schenoplectis californicus*), and southern blue flag iris (*Iris virginica*), with stands of bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aqautica*).

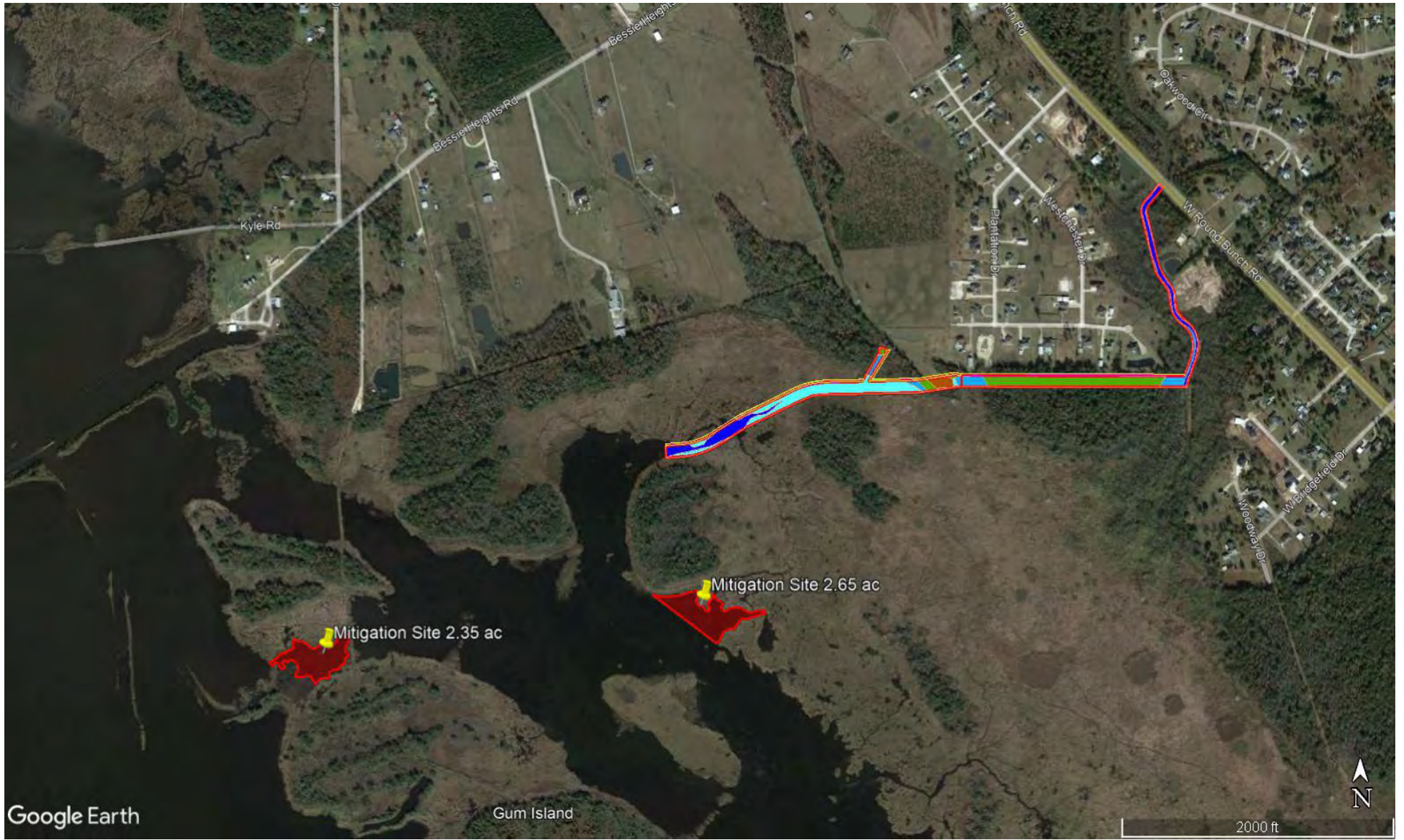


FIGURE 1
MITIGATION LOCATION
BESSIE HEIGHTS DRAINAGE IMPROVEMENTS PROJECT
ORANGE COUNTY, TEXAS

1.5 Mitigation Acreage

The 5-acre mitigation parcel is part of a several hundred-acres of the Nelda Stark Unit of the Lower Neches Wildlife Management Area. The Permittee will place dredged materials in approximately 5 acres of open water and degraded marsh in this area. The Permittee proposes to restore 5 acres of tidal marsh by planting suitable marsh species on the BU dredged materials.

1.6 Sufficiency of Proposed Mitigation

Impacts from the proposed project will include 3.01 acres of herbaceous wetland and 1.31 acres of forested wetland. The herbaceous and forested wetlands have direct connectivity to the Neches River through a series of marsh canals and open water areas but are also highly infested with invasive species.

The proposed mitigation will create 5 acres of high-quality herbaceous/forested wetland directly connected to the Neches River. Additionally, the 5 acres of created herbaceous/forested wetland will also contribute to the stabilization of the adjacent marshes.

Project impacts and the proposed mitigation plan have been modeled with the Riverine herbaceous and forested iHGMS. While this portion of the Bessie Heights Marsh is subject to weak lunar tides, the wetlands are far greater influenced by riverine hydrology and wind driven water levels. The results of the modeling are provided in Appendix A. The proposed mitigation plan meets or exceeds the project impacts after 1 full growing season (Year 2).

1.7 Mitigation Work Plan

The Permittee will plant suitable herbaceous marsh plants and wetland tree/shrub species as described below on BU dredged material placed as part of this project. The goal of the restoration will be the establishment of approximately 5 acres of intertidal herbaceous/forested vegetation. As the nature of the dredged material will be clay and silt, settlement and dewatering time should be 3 months or less via decant and evaporation prior to vegetative establishment activities discussed below.

The proposed mitigation plan for the stated impacts will be accomplished by establishing marsh vegetation on approximately 5 acres within the Nelda Stark Unit of the Lower Neches Wildlife Management Area. Emergent marsh plants, including saltmeadow cordgrass, salt marsh bulrush (*Scirpus robustus*), bulltongue (*Sagittaria lancifolia*), saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), giant bulrush (*Schenoplectis californicus*), and

southern blue flag iris (*Iris virginica*), will be planted in the 5-acre mitigation site (see Figures 2 and 3). Wetland tree and shrub species such as bald cypress (*Taxodium distichum*), red maple (*Acer rubrum*), water hickory (*Carya aquatica*), waxmyrtle (*Morella cerifera*), and buttonbush (*Cephalanthus occidentalis*) will also be planted on approximately 10% of the mitigation area for diversity. This planting zone will provide enhanced stabilization of the adjacent marsh.

Species selection will be based on tested salinity and resultant elevation of the placed dredged material at time of planting. Generally, freshly deposited dredged material is of higher salinity than the ultimately intended plant community. Additionally, the exact placement of the plantings cannot be predicted until the constructed contours of the marsh floor are determined at the time of planting. Initial planting has best success if plant species are selected to match the salinity and elevation of the new dredged material rather than the intended future marsh community. The initial growth of the more salt-tolerant species helps to stabilize the dredged material as well as begin adding organic material and stabilizing nutrient cycles to aid in the natural transition to a less saline plant community as salts leach from the dredged materials. Planting is intended to take place in the first fall (September or October) or spring (March-April) following placement of the BU materials. Specific timing will depend on permit issuance and completion of the project dredging and BU disposal. It is estimated that planting will take approximately 1 week during that time period.

Saltmeadow cordgrass, salt marsh bulrush, bulltongue, black rush, giant bulrush, seashore paspalum (*Paspalum vaginatum*), and southern blue flag iris (*Iris virginica*) will be among the herbaceous species planted. These plant species were selected for their salinity tolerances, wildlife food and/or cover benefits, presence in the adjacent marshes, and ease of transplantation. Plants will be transplanted from local sources as bare-root individual stems, or 2-inch or larger plugs. Plants will be selected and installed according to established sediment elevations. A transplant permit from the Texas Parks and Wildlife Department will be obtained prior to the transplanting.

Herbaceous species will be planted over approximately 5 acres of the restored marsh area. Approximately 2,000 to 3,000 herbaceous plants or sprigs will be installed on the restored marsh floor on approximate 5- to 10-foot centers. Approximately 50-60 trees and shrubs will be planted in clumps throughout the mitigation area.

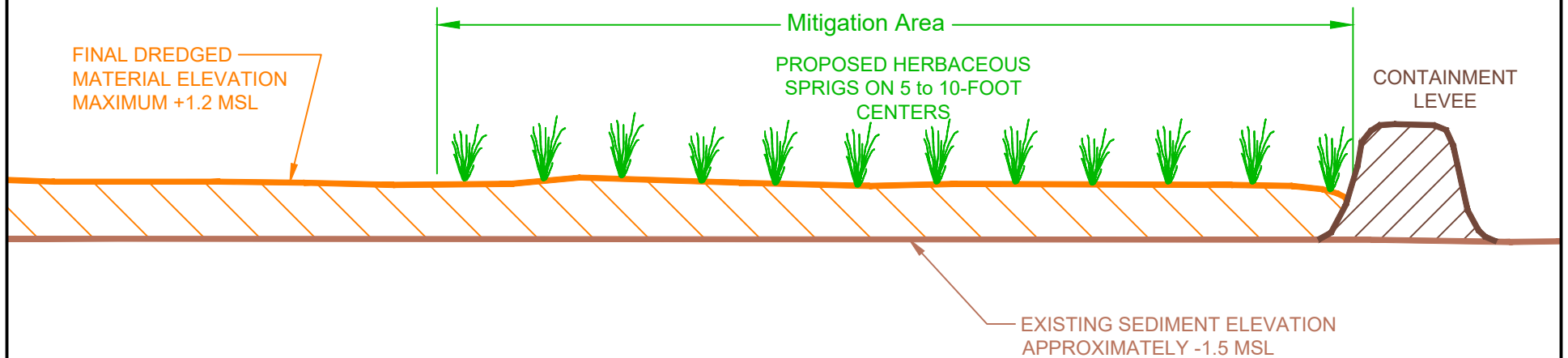
Due to the expected consistency of the dredged materials at the time of BU placement, it is unlikely that formation of specific tide channels will be feasible during the placement activities. Over several years, it is expected that tide channels and ponds will naturally develop in the low areas of the BU marsh floor by erosion due to tidal influxes and drainage of rainwater. The formation of tide channels may be enhanced by cutting small portals in the containment levees that correspond with adjacent low areas in the BU marsh floor. This will allow for enhanced tidal exchange and channel cutting in these areas.



FIGURE 2
MITIGATION CLOSEUP
BESSIE HEIGHTS DRAINAGE IMPROVEMENTS PROJECT
ORANGE COUNTY, TEXAS

A

A'



NOTE:

DREDGED MATERIAL WILL BE HYDRAULICALLY DISCHARGED IN THE MITIGATION AREA TO ACHIEVE AN UNDULATING SURFACE WITH A MAXIMUM FINAL ELEVATION OF +1.2' MSL. LOW AREAS IN THE MATERIAL DISPOSAL WILL DEVELOP SHALLOW OPEN WATER AND TIDAL CHANNELS WILL DEVELOP AS THE AREA IS EXPOSED TO PERIODIC HIGH WATER CONDITIONS.

NOTE:
HORIZONTAL / VERTICAL - NOT TO SCALE



FIGURE 3

Typical Planting Plan
Mitigation Area
Bessie Heights Drainage Project
Orange County, Texas

1.8 Maintenance Plan

Due to the presence of Chinese tallow, cattails, alligatorweed, giant salvinia, and common reed in adjacent areas, the restored marsh will be closely monitored. Invading non-desirable species will be treated with careful annual herbicide application during the annual site inspections. Although not currently present in numbers that represent a problem, the following species are also deemed to be potential nuisance species within the mitigation site: black willow (*Salix nigra*), salt cedar (*Tamarix ramosissima*), and deep-rooted sedge (*Cyperus enterianus*). If annual monitoring determines that their populations represent a discernable percentage of the total vegetative cover, these species will also be controlled with herbicide application.

Other than invasive species control, no other significant maintenance requirements are expected. Annual site inspections will be made by the Permittee or a designated representative who will note any maintenance issues that may be required.

1.9 Ecological Performance Standards

A transplant survival survey of the planted mitigation area will be performed within 60 calendar days following the conclusion of the initial planting effort. If at least 75% survival of transplants is not achieved within 60 calendar days of planting, a second planting effort will be completed within 60 calendar days of completing the initial survival survey. If optimal seasonal requirements for replanting desirable species are not suitable when replanting would be required, the USACE must approve all replanting schedules.

If after one year from the initial planting effort (or subsequent planting efforts) the site does not have at least 50% aerial coverage of desirable species that are not considered invasive or non-native, an additional planting effort will be completed within 60 calendar days of completing the annual survey.

If during the second-year monitoring event evidence of the formation of tide channels and pools is not obvious, small windows will be cut in the containment levees and training levees that correspond with low elevations in the BU floor to allow for additional surface flow in those areas and channel cutting. Channel formation may also be enhanced by running an airboat across the low areas to form linear depressions in the marsh floor.

Written monitoring reports in conformance with Regulatory Guidance Letter No. 08-03 will include, but not be limited to: percent aerial coverage per acre of desirable species, percent aerial coverage per acre of invasive/non-native plant species, hydrology data, soil data, and photos of the mitigation site.

In addition to the initial survey report, monitoring reports will be submitted to the USACE Chief of Compliance Galveston Regulatory Branch bi-annually for the first year following the initial transplanting effort and annually for the next four years. This will be a total of five years.

Success Criteria:

1. Desirable species achieve a minimum aerial coverage of 80% in 5 growing seasons.
2. Invasive/Non-native species will not consist of more than 5 percent of the aerial coverage per acre. Invasive or non-native species are to be considered, but not limited to: Chinese tallow, cattail, giant salvinia, deep-rooted sedge, and black willow.

1.10 Monitoring Requirements

The Permittee will use vegetation sampling procedures approved by the USACE to annually survey and document the percent survival of planted vegetation and the aerial coverage of noxious plant species. The Permittee will survey and document the survival of planted vegetation and the percent aerial coverage of noxious plant species within the mitigation area and report that information to the USACE in the annual report in conformance with Regulatory Guidance Letter No. 08-03. The elevation of the restored marsh floor will be monitored at several random points with sub-meter GPS equipment to determine settlement and resultant elevations.

After five years of monitoring, the applicant will meet with the USACE. The applicant will present a brief summary of the five years of monitoring data. This progress report will allow the USACE to determine if the mitigation site needs to continue with the monitoring plan or if other corrective measures will be required.

- If the mitigation area has been considered successful at this point, the applicant will no longer need to continue to monitor the mitigation area.
- If the mitigation area has been determined to be unsuccessful by USACE personnel at this point, the permittee will have the following options:

1. The applicant will be required to take the necessary corrective measures, as approved by the USACE, to correct the failing components of the mitigation area. The corrective measure plan will be submitted to the USACE within 60 days of the unsuccessful determination of the mitigation area.

a. Once the corrective measures have been approved by the USACE and implemented, the permittee will notify the USACE and the monitoring process will start over. This 5-year cycle will continue until the mitigation area is considered successful.

b. When the mitigation area has been considered successful, monitoring and management activities will shift over to the long-term management and adaptive management measures discussed below.

2. The applicant may choose to cease monitoring of the mitigation area and provide an alternative mitigation plan. This alternative mitigation plan will consist of preservation, enhancement, and/or mitigation banking. The alternative mitigation plan will mitigate the failure of the 25-acre mitigation area. The alternative mitigation plan will be submitted to the USACE within 60 days of the unsuccessful determination of the mitigation area.

1.11 Long-term Management

The Permittee will ensure the success of the mitigation site for 5 years in accordance with the performance standards stated above. Beyond that time, the mitigation site should be a generally self-sustaining preservation area. The Permittee will remain responsible for the mitigation site following demonstration of achieving the stated success criteria. Texas Parks and Wildlife Department will provide continued monitoring and oversight of the mitigation site as needed as part of the Nelda Stark Unit of the Lower Neches Wildlife Management Area.

1.12 Adaptive Management Plan

Other than the possibility of fire or other natural disasters (hurricanes, tornados, extended drought, etc), no significant loss of the marsh habitat or ecological values of the site are expected over time. In the unlikely event of any significant loss of ecological values as may be reported by the Permittee or Texas Parks and Wildlife Department, the Permittee will coordinate with the USACE to determine appropriate reclamation procedures, if any.

1.13 Financial Assurances

The permittee will execute a binding agreement with a mitigation implementation and management company to execute and maintain the authorized mitigation.

2.0 RESPONSIBLE PARTIES AND MITIGATION MONITORING AND REPORTING

The above-named permittee is responsible for the implementation of the proposed mitigation plan. The permittee (or a designated representative) will act as the responsible party to coordinate with the USACE on mitigation plan compliance and site inspections. The permittee will also establish a self-monitoring program that includes monitoring and reporting to

the USACE as described above. The mitigation monitoring and reporting will be continued until written confirmation from the USACE is received that the planted mitigation area has met success criteria (up to 5 years) and is on the way to developing the intended type of functions.

In addition to the annual monitoring reports, the permittee will submit a final written compliance report to the USACE within 30 days of completion of all construction and mitigation work. This report will include: a) a statement that the authorized work and required mitigation was done in accordance with USACE authorization, including all general and specific conditions; b) a summary of all construction and mitigation activities; c) a comparison of the post-construction and pre-construction site condition; d) a detailed description of all impacts to “waters of the US”; e) a map showing the final configuration of mitigation areas and features; f) the species, number, and acreage of the vegetation planted; the final topographic elevations of the project; and a map describing the location of the plantings) a discussion about erosional damage and whether disturbed areas are adequately vegetated; and h) photographs and maps, as appropriate, to illustrate the information presented.

3.0 CONSERVATION STEWARDSHIP

The mitigation area will be protected as part of the Nelda Stark Unit of the Lower Neches Wildlife Management Area

4.0 MITIGATION SCHEDULE

A mitigation agreement between the Permittee and Texas Parks and Wildlife Department will be initiated concurrent with start of site construction activities that result in impacts to waters of the US. Planting is intended to take place in the first fall (September or October) or spring (March-April) following placement of the BU materials. Specific timing will depend on permit issuance and completion of the basin dredging and BU disposal. It is estimated that planting will take approximately 2 weeks during that time period.

APPENDIX A
iHGM ANALYSIS

BESSIE HEIGHTS DRAINAGE - iHGM SUMMARY					
		FCUs			
WAA	Acres	Storage	Biological	Removal	TOTAL
1	3.01	2.30	2.01	2.20	6.51
2	0.67	0.61	0.43	0.61	1.65
3	0.64	0.48	0.36	0.53	1.37
TOTAL	4.32	3.39	2.80	3.34	9.53

Mitigation Site (Year 2)	5	3.94	2.92	3.58	10.44
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HGM Class: RIVERINE

HGM subclass: LOW GRADIENT HERBACEOUS/SCRUB/SHRUB

Project: Bessie Heights Drainage Area(s): WAA1 DP 472

Acres: 3.01

	Site Score	VARIABLES	Score	Criteria			
Temporary Storage and Detention of Surface Water Storage Coefficient (FCI) = $((Vdur * Vfreq) / .5 * (Vtopo + (Vherb + Vmid) / 2) / .5)$ Storage Coefficient (FCI): 0.76 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.30	1.00	Vdur (duration of flooding)	1.00	In average year, at least 80% of site either floods or ponds for at least 14 days			
			0.75	In average year, at least 80% of site either floods or ponds for at least 7 days			
			0.50	In average year, 50 to 79% of site floods or ponds for at least 7 days			
			0.25	In average year, 25 to 50% of site floods or ponds for at least 7 days			
			0.10	In average year, all or portions floods or ponds from 1 - 7 days			
			0.00	The area is not subject to flooding or ponding			
Maintenance of Plant and Animal Communities Maintenance Coefficient (FCI) = $(Vmid + Vherb + Vconnect) / 3$ Maintenance Coefficient (FCI): 0.67 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.01	1.00	Vfreq (frequency of flooding)	1.00	Floods or ponds annually 5 out of 5 years			
			0.75	Floods or ponds 3 of 5 years or 4 of 5 years			
			0.50	Floods or ponds 2 of 5 years			
			0.25	Floods or ponds less than 2 of 5 years			
			0.00	The area is not subject to flooding or ponding			
			Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	0.40	Vtopo (topography)	1.00	> 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features
0.70	15 to 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features						
0.40	< 15% of the site is covered by rises, dips, hummocks, channel sloughs and other topographic features						
0.10	Smooth, flat, or very gently undulating with little or no topographic relief						
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	1.00	Vherb (herbaceous layer)				1.00	Herbaceous cover averages >75
						0.75	Herbaceous cover averages between 50-75%
			0.50	Herbaceous cover averages between 25-50%			
			0.25	Herbaceous cover averages between 1-25%			
			0.10	Herbaceous cover is equal to or <1%			
			Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	0.25	Vmid (midstory)	1.00	Midstory cover averages > 75%
0.75	Midstory cover averages 50 to 75%						
0.50	Midstory cover averages 25 to 50%						
0.25	Midstory cover averages 1 to 25%						
0.10	The site is openland						
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	0.75	Vconnect (connection to other habitat)				1.00	Wetland plus four habitats and/or surrounded by forested
			0.75	Wetland plus two or more habitat type (other than forested) OR three or more habitat types			
			0.50	Wetland plus one other habitat types or two other habitat types			
			0.25	One other habitat types other than urban habitat			
			0.10	Surround by urban (homes, lawn, concrete, etc)			
			Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	0.10	Vwood (woody vegetation)	1.00	> 90% of area is covered by woody vegetation
0.75	67 to 89% of area is covered by woody vegetation						
0.50	34 to 66% of area is covered by woody vegetation						
0.25	11 to 33% of area is covered by woody vegetation						
0.10	1 to 10% of area is covered by woody vegetation						
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	1.00	Vdetritus (detritus)				1.00	> 85% of the area possesses an O or A horizon
			0.50	From 11 to 84% of the area possesses an O or A horizon			
			0.30	< 10% of the area possesses an O or A horizon			
			0.10	Site is plowed			
			Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	1.00	Vredox (redoximorphic processes)	1.00	Redox features represent >20% of the pedon within the top 4" of soil surface (mottles = many)
						0.10	Redox features < 20% (mottles = common or few)
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetritus + Vredox + Vsorp) / 3)) / 5$ Removal Coefficient (FCI): 0.73 Acres: 3.01 Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.20	1.00	Vsorp (sorptive soil properties)				1.00	Site is dominated by clays (clay, clay loam, silty clay loams) or highly organic (value=2/chroma=1; 2/2; 3/1)
						0.50	Site is dominated by loams (silt loams, very fine sandy loams, fine sandy loams, loams) OR non-montmorillonitic clays
						0.10	Site is dominated by sands (sands, loamy fine sands, loamy sands)

HGM Class: RIVERINE

HGM subclass: LOW GRADIENT FORESTED

Project: Bessie Heights Drainage Area(s): WAA2 - DP 473,478, 480 Acres: 0.67

	Site Score	VARIABLES	Score	Criteria		
Temporary Storage and Detention of Surface Water Storage Coefficient (FCI) = $\text{square root}(\text{square root}(\text{Vdur} + \text{Vfrq})) * ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3))$ Storage Coefficient (FCI): 0.90 Acres: 0.67	1.00	Vdur (duration of flooding)	1.00	In average year, at least 80% of site either floods or ponds for at least 14 days		
			0.75	In average year, at least 80% of site either floods or ponds for at least 7 days		
			0.50	In average year, 50 to 79% of site floods or ponds for at least 7 days		
			0.25	In average year, 25 to 49% of site floods or ponds for at least 7 days		
			0.10	In average year, all or portions floods or ponds from 1 - 7 days		
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.605	1.00	Vfrq (frequency of flooding)	1.00	Floods or ponds annually 5 out of 5 years		
			0.75	Floods or ponds 3 of 5 years or 4 of 5 years		
			0.50	Floods or ponds 2 of 5 years		
			0.25	Floods or ponds less than 2 of 5 years		
			0.00	The area is not subject to flooding or ponding		
Maintenance of Plant and Animal Communities Maintenance Coefficient (FCI) = $(\text{Vtree} + \text{Vcwd} + \text{Vrich} + ((\text{Vbasal} + \text{Vdensity})/2) + ((\text{Vmid} + \text{Vherb})/2) + \text{Vconnect})/6$ Maintenance Coefficient (FCI): 0.65 Acres: 0.67	0.70	Vtopo (topography)	1.00	> 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features		
			0.70	15 to 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features		
			0.40	< 15% of the site is covered by rises, dips, hummocks, channel sloughs and other topographic features		
			0.10	Smooth, flat, or very gently undulating with little or no topographic relief		
			Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.433	1.00	Vcwd (coarse woody debris)	1.00
0.50	3 to 7 pieces of cwd > 3" diameter along 100' transect					
0.30	< 3 pieces of cwd > 3" diameter along 100' transect					
0.10	Area is openland (pasture or cropland)					
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.433	0.75	Vveg (vegetation)				1.00
			0.75	67 to 89% of area is covered by woody vegetation		
			0.50	34 to 66% of area is covered by woody vegetation		
			0.25	11 to 33% of area is covered by woody vegetation		
			0.10	1 to 10% of area is covered by woody vegetation		
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.91 Acres: 0.67	0.30	Vtree (tree species)	1.00	At least 60% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 5% of stand)		
			0.80	> 40% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 10% of stand)		
			0.50	> 20% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 15% of stand)		
			0.30	< 20% of stand is oak, hickory or elm		
			0.10	The area is openland		
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.80	Vrich (tree species richness) trees > 5% of stand	1.00	5 or more tree species present		
			0.80	4 tree species present		
			0.60	3 tree species present		
			0.40	1 or 2 species present		
			0.10	The site is openland		
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.40	Vbasal (tree basal area)	1.00	The basal area (DBH) of site averages > 100 sq ft/acre		
			0.80	The basal area of site averages 80 to 100 sq ft/acre		
			0.60	The basal area of the site averages 60 to 79 sq ft/acre		
			0.40	The basal area of the site averages < 60 sq ft/acre		
			0.10	The site is openland		
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.60	Vdensity (tree density)	1.00	The site averages a tree density of 100 to 250 trees/acre		
			0.60	The site averages a tree density of 250 to 500 trees/acre OR 50 to 100 trees/acre		
			0.40	The site averages < 50 trees/acre		
			0.10	The site is openland		
			Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.75	Vmid (midstory)	1.00
0.75	Midstory cover averages 31 to 50%					
0.50	Midstory cover averages 11 to 30%					
0.30	Midstory cover < 10%					
0.10	The site is openland					
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.30	Vherb (herbaceous layer)	1.00	Herbaceous cover averages 5 to 30%		
			0.50	Herbaceous cover averages 31 to 50%		
			0.30	Herbaceous cover < 5% OR > 50%		
			0.10	The site is dominated by tame pasture species or is cropland		
			Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	0.75	Vconnect (connection to other habitat)	1.00
0.75	Wetland plus two or more habitat type (other than forested) OR three or more habitat types					
0.50	Wetland plus one other habitat types or two other habitat types					
0.25	One other habitat types other than urban habitat					
0.10	Surround by urban (homes, lawn, concrete, etc)					
Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	1.00	Vdetritus (detritus)	1.00	> 85% of the area possesses an O or A horizon		
			0.50	From 11 to 84% of the area possesses an O or A horizon		
			0.30	< 10% of the area possesses an O or A horizon		
			0.10	Site is plowed		
			Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.612	1.00	Vredox (redoximorphic processes)	1.00
0.10	Redox features < 20% (mottles = common or few)					
1.00	Vsorp (sorptive soil properties)	1.00				Site is dominated by clays (clay, clay loam, silty clay loams) or highly organic (value=2/chroma=1; 2/2; 3/1)
		0.50				Site is dominated by loams (silt loams, very fine sandy loams, fine sandy loams, loams) OR non-montmorillonitic clays
		0.10				Site is dominated by sands (sands, loamy fine sands, loamy sands)

HGM Class: RIVERINE
HGM subclass: LOW GRADIENT FORESTED
Project: Bessie Heights Drainage Area(s): WAA3 - DP 475 Acres: 0.64

	Site Score	VARIABLES	Score	Criteria
Temporary Storage and Detention of Surface Water Storage Coefficient (FCI) = $\text{square root}(\text{square root}(\text{Vdur} + \text{Vfrq})) * ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3))$ Storage Coefficient (FCI): 0.75 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.480	0.75	Vdur (duration of flooding)	1.00 0.75 0.50 0.25 0.10 0.00	In average year, at least 80% of site either floods or ponds for at least 14 days In average year, at least 80% of site either floods or ponds for at least 7 days In average year, 50 to 79% of site floods or ponds for at least 7 days In average year, 25 to 49% of site floods or ponds for at least 7 days In average year, all or portions floods or ponds from 1 - 7 days The area is not subject to flooding or ponding
	1.00	Vfrq (frequency of flooding)	1.00 0.75 0.50 0.25 0.00	Floods or ponds annually 5 out of 5 years Floods or ponds 3 of 5 years or 4 of 5 years Floods or ponds 2 of 5 years Floods or ponds less than 2 of 5 years The area is not subject to flooding or ponding
Maintenance of Plant and Animal Communities Maintenance Coefficient (FCI) = $(\text{Vtree} + \text{Vcwd} + \text{Vrich} + ((\text{Vbasal} + \text{Vdensity})/2) + ((\text{Vmid} + \text{Vherb})/2) + \text{Vconnect})/6$ Maintenance Coefficient (FCI): 0.56 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.360	0.70	Vtopo (topography)	1.00 0.70 0.40 0.10	> 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features 15 to 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features < 15% of the site is covered by rises, dips, hummocks, channel sloughs and other topographic features Smooth, flat, or very gently undulating with little or no topographic relief
	0.50	Vcwd (coarse woody debris)	1.00 0.50 0.30 0.10	> 7 pieces of cwd > 3" diameter along 100' transect 3 to 7 pieces of cwd > 3" diameter along 100' transect < 3 pieces of cwd > 3" diameter along 100' transect Area is openland (pasture or cropland)
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	0.75	Vveg (vegetation)	1.00 0.75 0.50 0.25 0.10	> 90% of area is covered by woody vegetation 67 to 89% of area is covered by woody vegetation 34 to 66% of area is covered by woody vegetation 11 to 33% of area is covered by woody vegetation 1 to 10% of area is covered by woody vegetation
	0.30	Vtree (tree species)	1.00 0.80 0.50 0.30 0.10	At least 60% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 5% of stand) > 40% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 10% of stand) > 20% of stand is oak, hickory or elm (black willow, cottonwood, tallow and sycamore = < 15% of stand) < 20% of stand is oak, hickory or elm The area is openland
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	0.80	Vrich (tree species richness) trees > 5% of stand	1.00 0.80 0.60 0.40 0.10	5 or more tree species present 4 tree species present 3 tree species present 1 or 2 species present The site is openland
	0.40	Vbasal (tree basal area)	1.00 0.80 0.60 0.40 0.10	The basal area (DBH) of site averages > 100 sq ft/acre The basal area of site averages 80 to 100 sq ft/acre The basal area of the site averages 60 to 79 sq ft/acre The basal area of the site averages < 60 sq ft/acre The site is openland
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	0.60	Vdensity (tree density)	1.00 0.60 0.40 0.10	The site averages a tree density of 100 to 250 trees/acre The site averages a tree density of 250 to 500 trees/acre OR 50 to 100 trees/acre The site averages < 50 trees/acre The site is openland
	0.75	Vmid (midstory)	1.00 0.75 0.50 0.30 0.10	Midstory cover averages > 50% Midstory cover averages 31 to 50% Midstory cover averages 11 to 30% Midstory cover < 10% The site is openland
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	0.30	Vherb (herbaceous layer)	1.00 0.50 0.30 0.10	Herbaceous cover averages 5 to 30% Herbaceous cover averages 31 to 50% Herbaceous cover < 5% OR > 50% The site is dominated by tame pasture species or is cropland
	0.75	Vconnect (connection to other habitat)	1.00 0.75 0.50 0.25 0.10	Wetland plus four habitats and/or surrounded by forested Wetland plus two or more habitat type (other than forested) OR three or more habitat types Wetland plus one other habitat types or two other habitat types One other habitat types other than urban habitat Surround by urban (homes, lawn, concrete, etc)
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	1.00	Vdetritus (detritus)	1.00 0.50 0.30 0.10	> 85% of the area possesses an O or A horizon From 11 to 84% of the area possesses an O or A horizon < 10% of the area possesses an O or A horizon Site is plowed
	1.00	Vredox (redoximorphic processes)	1.00 0.10	Redox features represent >20% of the pedon within the top 4" of soil surface (mottles = many) Redox features < 20% (mottles = common or few)
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $(\text{Vveg} + \text{Vfrq} + \text{Vdur} + ((\text{Vtopo} + \text{Vcwd} + \text{Vveg})/3) + ((\text{Vdetritus} + \text{Vredox} + \text{Vsorp})/3))/5$ Removal Coefficient (FCI): 0.83 Acres: 0.64 Functional Unit (FCU) = Coefficient (FCI) * Acres: 0.531	1.00	Vsorp (sorptive soil properties)	1.00 0.50 0.10	Site is dominated by clays (clay, clay loam, silty clay loams) or highly organic (value=2/chroma=1; 2/2; 3/1) Site is dominated by loams (silt loams, very fine sandy loams, fine sandy loams, loams) OR non-montmorillonitic clays Site is dominated by sands (sands, loamy fine sands, loamy sands)

HGM Class: RIVERINE

HGM subclass: LOW GRADIENT HERBACEOUS/SCRUB/SHRUB

Project: Bessie Heights Drainage Area(s): Mitigation Sites 1, 2, 3 (Year 1) Acre(s): 5

	Site Score	VARIABLES	Score	Criteria	
Temporary Storage and Detention of Surface Water Storage Coefficient (FCI) = $((Vdur * Vfreq) / 5 * (Vtopo + (Vherb + Vmid) / 2) / .5)$ Storage Coefficient (FCI): 0.79 Acres: 5	1.00	Vdur (duration of flooding)	1.00	In average year, at least 80% of site either floods or ponds for at least 14 days	
			0.75	In average year, at least 80% of site either floods or ponds for at least 7 days	
			0.50	In average year, 50 to 79% of site floods or ponds for at least 7 days	
			0.25	In average year, 25 to 50% of site floods or ponds for at least 7 days	
			0.10	In average year, all or portions floods or ponds from 1 - 7 days	
			0.00	The area is not subject to flooding or ponding	
Functional Unit (FCU) = Coefficient (FCI) * Acres: 3.94	1.00	Vfreq (frequency of flooding)	1.00	Floods or ponds annually 5 out of 5 years	
			0.75	Floods or ponds 3 of 5 years or 4 of 5 years	
			0.50	Floods or ponds 2 of 5 years	
			0.25	Floods or ponds less than 2 of 5 years	
			0.00	The area is not subject to flooding or ponding	
Maintenance of Plant and Animal Communities Maintenance Coefficient (FCI) = $(Vmid + Vherb + Vconnect) / 3$ Maintenance Coefficient (FCI): 0.58 Acres: 5	0.70	Vtopo (topography)	1.00	> 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features	
			0.70	15 to 30% of the site is represented by rises, dips, hummocks, channel sloughs and other topographic features	
	Maintenance Coefficient (FCI): 0.58 Acres: 5	0.75	Vherb (herbaceous layer)	1.00	Herbaceous cover averages >75
				0.75	Herbaceous cover averages between 50-75%
				0.50	Herbaceous cover averages between 25-50%
				0.25	Herbaceous cover averages between 1-25%
Functional Unit (FCU) = Coefficient (FCI) * Acres: 2.92	0.25	Vmid (midstory)	1.00	Midstory cover averages > 75%	
			0.75	Midstory cover averages 50 to 75%	
			0.50	Midstory cover averages 25 to 50%	
			0.25	Midstory cover averages 1 to 25%	
			0.10	The site is openland	
Removal and Sequestration of Elements and Compounds Removal Coefficient (FCI) = $((Vwood + Vfreq + Vdur) / 3 + ((Vtopo + Vherb + Vmid) / 3) + ((Vdetrivirus + Vredox + Vsorpt) / 3)) / 5$ Removal Coefficient (FCI): 0.72 Acres: 5	0.75	Vconnect (connection to other habitat)	1.00	Wetland plus four habitats and/or surrounded by forested	
			0.75	Wetland plus two or more habitat type (other than forested) OR three or more habitat types	
	Removal Coefficient (FCI): 0.72 Acres: 5	0.25	Vwood (woody vegetation)	1.00	> 90% of area is covered by woody vegetation
				0.75	67 to 89% of area is covered by woody vegetation
				0.50	34 to 66% of area is covered by woody vegetation
				0.25	11 to 33% of area is covered by woody vegetation
0.10				1 to 10% of area is covered by woody vegetation	
Functional Unit (FCU) = Coefficient (FCI) * Acres: 3.58	0.30	Vdetrivirus (detrivirus)	1.00	> 85% of the area possesses an O or A horizon	
			0.50	From 11 to 84% of the area possesses an O or A horizon	
			0.30	< 10% of the area possesses and O or A horizon	
			0.10	Site is plowed	
			1.00	Redox features represent >20% of the pedon within the top 4" of soil surface (mottles = many)	
Functional Unit (FCU) = Coefficient (FCI) * Acres: 3.58	1.00	Vredox (redoximorphic processes)	1.00	Redox features represent >20% of the pedon within the top 4" of soil surface (mottles = many)	
			0.10	Redox features < 20% (mottles = common or few)	
			1.00	Site is dominated by clays (clay, clay loam, silty clay loams) or highly organic (value=2/chroma=1; 2/2; 3/1)	
Functional Unit (FCU) = Coefficient (FCI) * Acres: 3.58	1.00	Vsorp (sorptive soil properties)	0.50	Site is dominated by loams (silt loams, very fine sandy loams, fine sandy loams, loams) OR non-montmorillonitic clays	
			0.10	Site is dominated by sands (sands, loamy fine sands, loamy sands)	
			0.10	Site is dominated by sands (sands, loamy fine sands, loamy sands)	