USFWS

West Shore Lake Pontchartrain

Methodology and Assumptions for Determining Environmental Benefits

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Table of Contents

WETLAND VALUE ASSESSMENT MODEL

The Wetland Value Assessment (WVA) model was developed under the Coastal Wetlands Planning, Protection, and Restoration program to determine benefits of proposed coastal wetland restoration projects. The WVA Swamp Community Model for Civil Works Version 2.0 (Swamp WVA) and the WVA Bottomland Hardwoods Community Model for Civil Works Version 1.2 (BLH WVA) models were used to assess direct and indirect impacts for WSLP project features proposed for construction. These models are approved for regional use on USACE Civil Works projects. Further information on this model may be obtained from the U.S. Army Corps of Engineers, New Orleans District, Regional Planning and Environmental Division South (Point of Contact: Patrick Smith, Phone: 504-862-1583).

The WVAs are similar to the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project and future with-project conditions. Instead of the species-based approach of HEP, each WVA model utilizes an assemblage of variables considered important to the suitability of that habitat type for supporting a diversity of fish and wildlife species. As with HEP, the WVA allows a numeric comparison of each future condition and provides a quantitative estimate of project-related impacts to fish and wildlife resources.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of mathematical models developed specifically for each wetland type. Each model consists of: 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI). The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources.

HSI values are determined for each target year (TY). Target years, determined by the model user, represent significant changes in habitat quality or quantity that are expected during the 50-year project life, under future with-project (FWP) and future without-project (FWOP) conditions. In this study, target years of 0, 1, 5, 10, 40 and 50 are evaluated for the FWP and FWOP.

The product of an HSI value and the acreage of available habitat for a given target year is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

The change (increase or decrease) in AAHUs between FWP and FWOP scenarios provide a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type. In determining future with-project conditions, all project-related direct (construction) impacts were assumed to occur in Target Year 1.

The Swamp WVA consists of seven variables:
1) stand structure;
2) stand maturity;
3) hydrology;
4) mean high salinity during the growing season;
5) size of contiguous forested area;
6) suitability and traversability of surrounding land use; and
7) disturbance.

The BLH WVA consists of seven variables:
1) tree species composition;
2) stand maturity;
3) understory/midstory;
4) hydrology;
5) size of contiguous forested area;
6) suitability and traversability of surrounding land uses; and
7) disturbance.

Changes in each variable are predicted for future without-project and future with-project scenarios over a 50-year project life.

For determining impacts for the WSLP levee system project (Project), the WVA methodology was selected as the most appropriate evaluation tool. Described below are the assumptions used to determine those swamp and BLH baseline, FWOP, and FWP projections for the proposed Project area.

General Assumptions

- Period of analysis is from 2020 (TY0) to 2070 (TY50).
- TY0 is baseline.
- Five different impact areas were considered Direct Levee footprint, Direct Access road footprints, Indirect Interior High, Indirect Interior Low, and Exterior impact areas.
- The latest (2018) USACE Civil Works versions of Swamp (v2.0) and BLH (v1.2) WVAs were used.
- The FWOP conditions from Louisiana Coastal Area (LCA) Convent Blind River assumed no net vertical accretion. We assume the same since the WSLP is adjacent to the LCA Convent Blind River area. From the LCA Convent Blind River Feasibility Study – Page 5-35: “Existing conditions would persist, including no net vertical accretion of soil deposition and continued subsidence over the 50-year period of analysis.”

- TYs for both FWOP and FWP include TY0, TY1, TY5, TY10, TY40 and TY50. TYs 1-10 are used to capture potential near term impacts resulting from Project construction and operation. TY 40 is used to capture changes due to relative sea level rise (RSLR). As seen in modeling for other projects (Messina, et al 2019 and ERDC 2016) impacts from RSLR are predicted to become discernable by 2060 or TY40.
- The WSLP levee system could create a financial incentive to develop in protected areas, including wetlands. Recent significant changes in the Federal flood insurance program (stemming from passage of the Biggert-Waters Flood Insurance Reform Act) will likely have the effect of establishing dramatically lower flood insurance rates in areas within 100-year or 1% levee systems relative to those without. This could create a significant financial incentive for development in protected areas, particularly as lower lying and less protected communities migrate to safer locations (as occurred after Hurricane Katrina, particularly in St. Bernard Parish). Though induced development may occur this evaluation does not assume it would. It is assumed that if post Project development does occur in wetlands, those impacts would be mitigated for by the developer or owner.

Assessing Current Habitat Type and Health of the Project Area

The WSLP Environmental team asked ERDC to utilize remote sensing techniques to identify and assess the current condition of bottomland hardwood (BLH) and swamp habitats within the WSLP levee system project area (Salstus and Suir, 2019). This effort provided baseline knowledge of the location and quality of these habitats for use in the environmental assessments of this project.

Two Geographic Information Systems (GIS) products generated in the ERDC GIS/RS Report that were used for WVA analysis:

1. Habitat Differentiation Raster: Habitats were distinguished using a variety of data sources including satellite imagery, LIDAR data, WVA field data, the National Land Cover Dataset (NLCD), and the USFWS National Wetland Inventory and a Maximum Likelihood Classification method. These data were used to determine the amount and spatial extent of habitat types for WVA variables and acreages. Swamp habitats were located mostly in interior regions interspersed with water while BLH habitat was primarily confined to the areas between swamp habitats and developed areas. This corroborated with field observations.
2. NDVI Classification: The Normalized Difference Vegetation Index (NDVI), a primary measure of condition, function, recovery, and sustainability with well-established correlations to photosynthetic activity, aboveground biomass, and leaf area, was used as a measure of primary productivity and plant vigor. The NDVI was calculated using WV3 satellite imagery collected in April 2019. These data were used to estimate the spatial extent of habitat types of different floristic qualities related to vegetation type and health. The analysis revealed that BLH habitat represented the highest mean NDVI values, followed closely by swamp and other vegetation habitats.

The project area was separated into three geographically distinct areas for evaluation based on the NDVI – East, Central, and West (Figure 1). The WVAs were split accordingly into these three sections: West, Central, and East and again separated by Direct (Direct Levee and Access

Footprints), Indirect Interior (area between the levee alignment and the developed area), and Indirect Exterior (area outside of and adjacent to the levee system) areas (Figure 2). The HET used the ERDC GIS/RS Habitat Raster data for each area to determine all impact area acres for evaluation (Table 3). Table 1 is a list of all the WVAs based on area (West, Central, and East) and impact zone (Direct and Indirect). Table 2 indicates which plots were used in each location's impacts assessment (WVAs). Table 3 shows the acres used in each WVA based on the ERDC GIS/RS outputs applied to the project area.

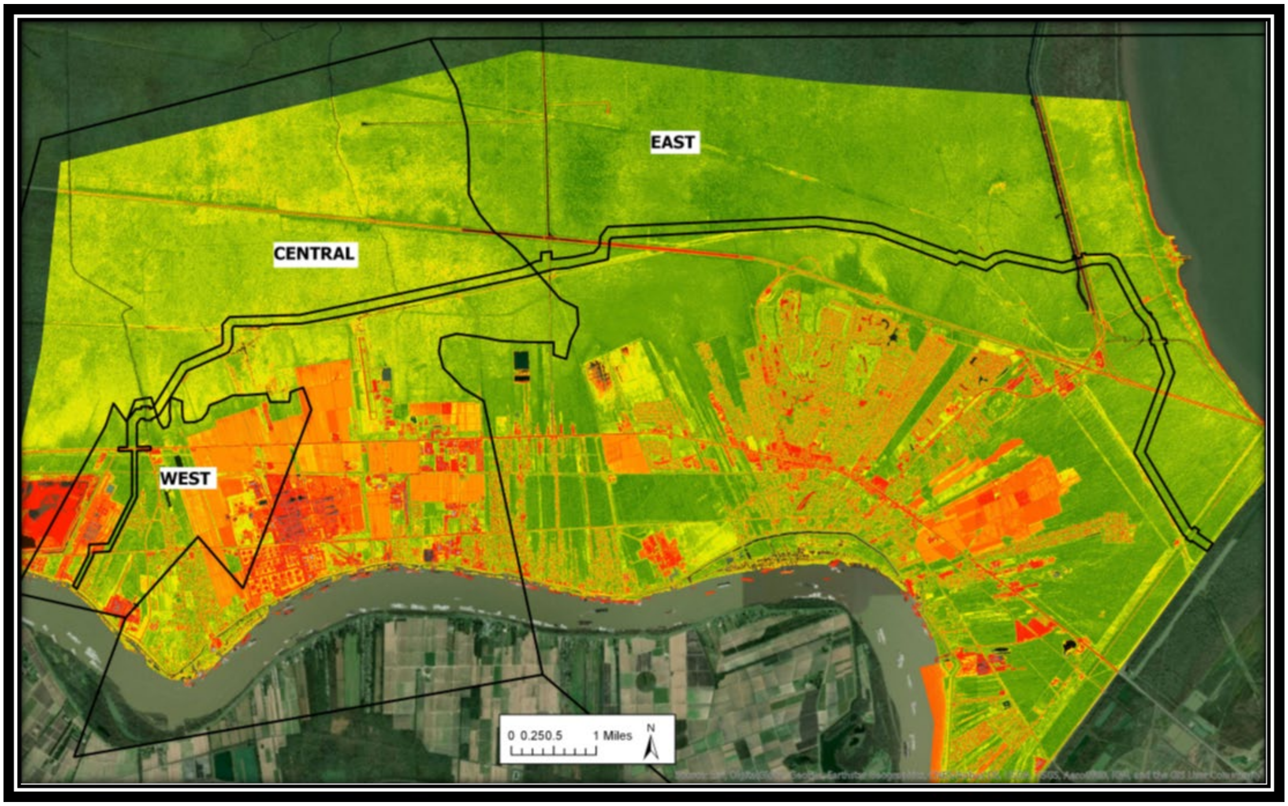

Figure 1. ERDC GIS/RS NDVI raster data with east, west, and central areas (Saltus and Suir, 2019).

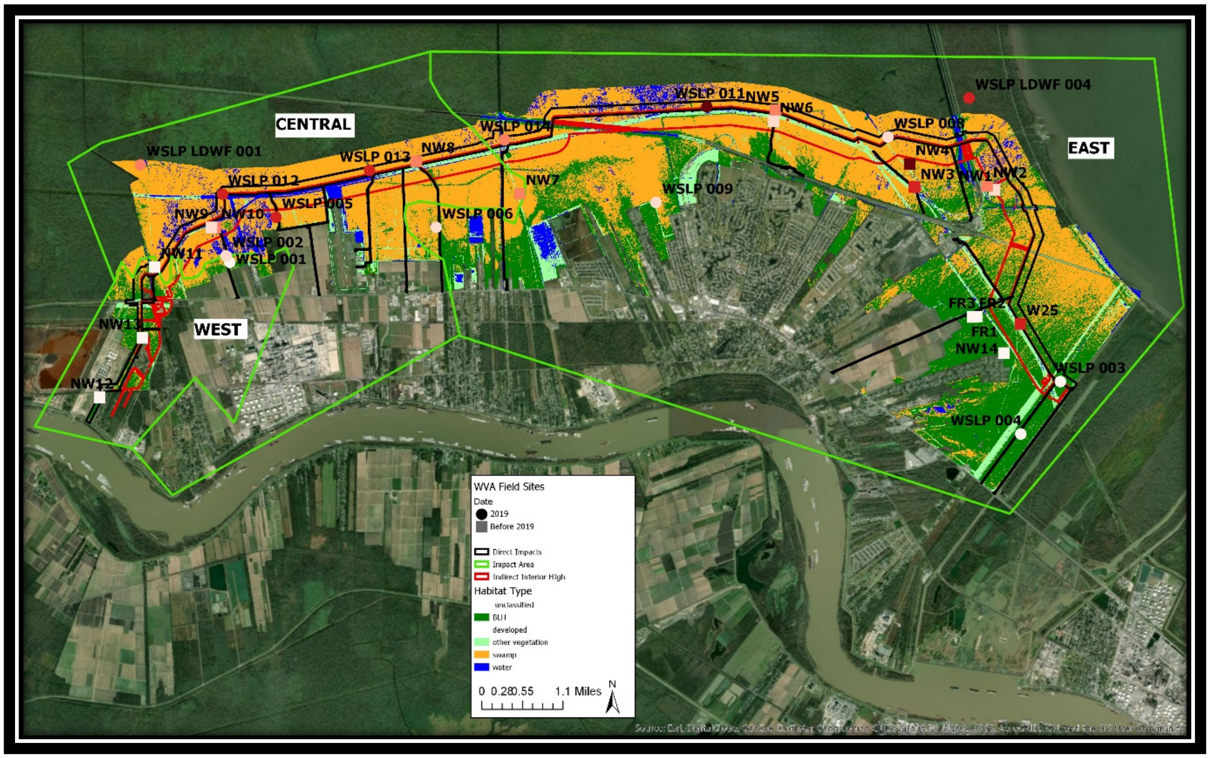

Figure 2. The 3 floristic quality sections: East, Central, and West are within the green polygons. Habitat types (swamp, BLH, etc) are shown for impact areas (Direct and Indirect) only. The Direct Levee and Access Road impact areas are shown in black. The Indirect Exterior impact area is from the north side of Direct Levee to the Exterior (mostly north) edge of habitat type. The Interior Indirect High impact area is shown in red. The Interior Indirect Low impact area is the remaining area between the red (Indirect High) and the developed area to the south. Wetland Value Assessment Plots from the Feasibility Study are shown as squares and from summer 2019 are shown as circles.

Table 1. List of each Wetland Value Assessment (WVA).

SWAMP		BOTTOMLAND HARDWOOD (BLH)
East Direct Levee Footprint		East Direct Levee Footprint
East Direct Access Footprint		East Direct Access Footprint
East Indirect Interior High		East Indirect Interior High
East Indirect Interior Low		East Indirect Interior Low
East Indirect Exterior		East Indirect Exterior
Central Direct Levee Footprint		Central Direct Levee Footprint
Central Direct Access Footprint		Central Direct Access Footprint
Central Indirect Interior High		Central Indirect Interior High
Central Indirect Interior Low		Central Indirect Interior Low
Central Indirect Exterior		Central Indirect Exterior
West Direct Levee Footprint		West Direct Levee Footprint
West Direct Access Footprint		West Direct Access Footprint
West Indirect Interior High		West Indirect Interior High
West Indirect Interior Low		West Indirect Interior Low
West Indirect Exterior		West Indirect Exterior

Table 2. Data from listed plots are used for baseline information in the Wetland Value Assessments.

Central	**Swamp Field Sites**						
Direct	WSLP 012	WSLP 013	NW8				
Indirect Inside High	NW9	NW10					
Indirect Exterior	WSLP LDWF 001						
East	**Swamp Field Sites**						
Direct	WSLP 008	WSLP 011	WSLP 014	W25	NW5		
Indirect Inside High	NW6						
Indirect Inside Low	WSLP 006	FR2	NW14	NW2	NW3	NW4	NW7
Indirect Exterior	WSLP LDWF 004	WSLP 015					
Central	**BLH Field Sites**						
Indirect Inside High	NW15						
Indirect Inside Low	WSLP 005						
East	**BLH Field Sites**						
Direct	WSLP 003						
Indirect Inside Low	WSLP 004	WSLP 009	FR1	FR3	NW17		

Table 3. Acres for all impact areas evaluated.

Eastern-All		
Area	Swamp	BLH
Direct Levee	676.5	149.3
Direct Access	31.6	8.9
Indirect High	1023.4	359.5
Indirect Low	3157.3	3311.5
Indirect Exterior	2102.0	539.6

Eastern-LDWF		
Area	Swamp	BLH
Direct Levee	130.1	1.5
Direct Access	0.0	0.0
Indirect High	5.5	0.0
Indirect Low	0.0	0.0
Indirect Exterior	449.3	2.4

Central-All		
Area	Swamp	BLH
Direct Levee	364.2	1.6
Direct Access	20.4	5.0
Indirect High	600.4	23.8
Indirect Low	1348.2	87.8
Indirect Exterior	1270.9	23.0

Central-LDWF		
Area	Swamp	BLH
Direct Levee	35.0	0.4
Direct Access	0.0	0.0
Indirect High	0.0	0.0
Indirect Low	0.0	0.0
Indirect Exterior	353.4	2.6

Western-All		
Area	Swamp	BLH
Direct Levee	47.1	66.6
Direct Access	2.4	1.3
Indirect High	98.4	125.0
Indirect Low	90.0	90.7
Indirect Exterior	82.6	103.7

Western-LDWF		
Area	Swamp	BLH
Direct Levee	4.9	0.1
Direct Access	0.0	0.0
Indirect High	0.0	0.0
Indirect Low	0.0	0.0
Indirect Exterior	4.9	0.3

Data Collected from Site Visits and CRMS Stations

Baseline data were collected from several field sites in March 2011, July and Dec 2013, and May, June, August and October 2019 for swamp and BLH habitat quality. In addition to field sites, data from Louisiana's Coastwide Reference Monitoring System (CRMS) stations CRMS0059 (Reserve) and CRMS5373 (Hope), such as hydrology and salinity, were also used (CPRA 2020). One tenth acre (37.2 ft radius) size plots were used for field sites. Parameters such as diameter at breast height (DBH), stand structure, and hydrology were taken at each field site. Sites were either directly on the proposed levee alignment or interior and exterior to the alignment (indirect). A total of 29 plots (14 BLH and 15 Swamp sites) representing habitat throughout the project area were used to develop baseline data. However, with each iteration of the WSLP more sites are taken, given large area and the difficulty accessing many of the remote sites we obtained as many plots as feasible. Ideally, many more plots would be preferred. See Figure 2 and Table 2 for plot locations and which areas they were used in the WVA.

The plots were labeled by health and/or stress level during site visits. These categories included: BLH Healthy, BLH Medium Stress, BLH Very Stressed, Swamp Healthy, Swamp Low Stress, Swamp Medium Stress, and Swamp Very Stressed. The naming convention used on the field notes and notes in the ingrowth spreadsheets included the following:

- H= healthy, LS=low stressed, MS= moderately stressed, VS=very stressed,
- BLH= bottomland hardwood, Sw=swamp
- Main= DBH measurements from the main trunk of any trees within a plot.
- Branched= DBH measurement from any branch other than main trunk.
- Stressed Topped = Trees that were topped and stressed; note that any tree indicated as topped was assumed to be stressed.
- Stump growth = any tree growth observed on a downed tree or stump.

In-growth spreadsheets

Ingrowth spreadsheets were used to predict tree growth for individual trees from plots. This spreadsheet grows individual tree DBH and field site basal area over time. All swamp plots were separated into cypress and other tree species groups while BLH plots maintained a single in-growth spreadsheet for each plot.

Outputs from each plot's in-growth spreadsheets including tree composition (BLH V1), stand structure (swamp V1), stand maturity (swamp and BLH V2), and understory/midstory (VLH V3) for each plot were developed individually then combined in the appropriate WVAs by area. See sections on Variables 1, 2, and 3 below.

A growth factor for cypress was used to project tree growth of typical cypress swamp. The growth factor is based on a regression (Y=-0.512X-0.1, R^2=1) based on literature growth rates for specific tree species (Visser and Sasser 1995), and Mr. Bern Wood (Southeastern Louisiana University - working with Dr. Gary Shaffer) during a February 2010 verbal communication with the USFWS (Angela Trahan, personal communication). Data from Mr. Bern Wood were collected from Maurepas Swamp Wildlife Management Area, a Wildlife Management Area in the Project Area and vicinity, study sites.

<u>Assumptions applied to all plots:</u>

- Initial and future relative sea level rise (RSLR) growth rates are presented in Table 4. Initial growth rates were based on dominant trees and site conditions of each plot. See V2 section for details on future growth rates.
- In-growth spreadsheets without mortality were used for plots designated as healthy or low stressed, while in-growth spreadsheets with mortality were used for medium or high stress sites.

<u>Assumptions applied to 2019 Plots for In-growth Spreadsheets:</u>

- Plots with several small trees to be grown in were entered as 0.1 or 0.5 inch DBH depending on field notes and/or measurements.
- Trees that were listed as less than 1 inch DBH were entered as 0.9 inch DBH.

- Each plot had notes on the condition of individual trees. Growth rates and life spans were adjusted based on field observations. Separate in-growth spreadsheets were used for each condition-plot combination and is referred to as a subplot:
    - Main sub-plots include the main (or only) trunk of all healthy looking trees. Growth rates were based on stand structure and habitat quality of the plot and vicinity. Main plots were grown for 50 years.
    - Stressed trees were grown in for 10 years then removed. This subplot growth rate was discounted 25% from the main subplot growth rate. (Equation used = Growth rate*1.25 if growth factor is negative, or GR * 0.75 if growth factor is positive)
    - Stressed and topped trees were grown in for 5 years then removed. This subplot growth rate was discounted 50% from the main subplot growth rate. (Equation used = Growth rate * 1.5 if growth factor is negative, GR*0.5 if growth factor is positive)
    - Branched trees were grown in for 10 years at the same growth rate as the main subplot, then removed. Note the largest branch or trunk was included in the Main sub-plot. It was assumed that the main trunk would out compete branched trees.
    - Growth on downed trees or stumps were grown in for 10 years then removed. This subplot growth rate was discounted 25% from the main subplot growth rate. (Equation used = Growth rate*1.25 if growth factor is negative, or GR * 0.75 if growth factor is positive)
- All main tree subplots were entered into the most recent in-growth spreadsheets which allows for growth with or without mortality. Branched, stressed, topped, or stump growth tree subplots were left in an older version of the ingrowth spreadsheet and allowed to die out as described above.
- Average DBH and basal area of each subplot was calculated and combined for each target year, and then averaged (by DBH and basal area) or summed (number of trees) by plot.

<u>Assumptions applied to 2013 Plots for In-growth Spreadsheets:</u>

- The 2013 plots were evaluated to determine if the site was considered healthy, low stressed, medium stressed, or very stressed based on recollection, review of data sheets and notes by 2013 field participants, and comparison to ERDC GIS/RS raster data.
- The 2013 data were put into the new in-growth spreadsheets and updated by using the sixth year (2013 to 2019) as TY1.

RSLR Assumptions

- Baseline inundations were determined using water depth estimates from the field and nearby CRMS stations. If no field data were available, St. John the Baptist Parish LIDAR data were used primarily for BLH.
- In accordance with the USACE EC-1165-2-212, RSLR was determined using the Lake Pontchartrain at West End USGS Gauge (gage number 85625) to determine base and

future subsidence and sea level rise (SLR) levels and RSLR. 2070 Intermediate SLR was determined to be 0.85 feet NAVD88 and RSLR was determined to be 2.32 feet, North American Vertical Datum of 1988 (NAVD 88).

- Intermediate RSLR was assumed to be 2.32 feet. Future projections used 2.32 as a basis to rerun long term tidal simulations to compare FWP and FWOP.
- HEC-RAS 2D modeling (both with and without an intermediate RSLR) indicated there were minor project-induced hydrology changes (Figures 3 and 4).
- Intermediate RSLR rates were added to existing water depths and then incorporated into the regression to obtain a change in growth rates for trees at each site applied at TY40.
- Intermediate RSLR growth rates were calculated by using a correlation to the increased inundation due to SLR.
- In order to incorporate intermediate RSLR into the growth factor regression, the Service developed a simple spreadsheet in which the calculations are guided by the following assumptions:
  - 1) there is a direct/ linear correlation between water depth and tree growth suppression (y = -0.5125x - 0.1)
  - 2) the maximum growth reduction factor is -2.15 (a more significant reduction factor would signify extreme tree stress and would equate to short-term tree death
  - 3) the maximum growth reduction factor occurs at a total of 4 feet of inundation, beyond which extreme tree stress and death would occur in less than 10 years (based on personal observations)
    - Plots with a RSLR growth rate determined to be less than -2.4 based on the correlated calculations, were capped at a minimum of -2.4 growth rate.
    - A growth rate less than -2.4 produced errors and grew trees in reverse (shrinking rather than growing in DBH).
  - 4) the minimum growth reduction factor (-0.1) occurs in areas where there are optimum hydrologic conditions (i.e., sufficient soil moisture, but no inundation)
  - Example of stressed growth rates in the in growth spreadsheet - a growth rate of -1.69 for cypress are applied to cypress swamps considered to be highly degraded/stressed and likely to convert to marsh in 20-30 years.
  - Growth rates were assumed to slow severely as water levels increase with RSLR. Intermediate RSLR was used that predicted a 2.32 foot increase.
- A RSLR growth rate was applied at TY40 to all swamp and BLH sites predicted to become permanently inundated due to intermediate RSLR (Table 4).
- This RSLR regression growth correction factor was initially developed for swamp but was also applied to BLH habitats. If BLH became permanently flooded it was assumed the worst growth factor was applied to those sites. BLH sites that were predicted to remain dry (elevations at or above water levels for 50 years) maintained the same growth rate through TY50.
- The majority of initial swamp growth rates were either -0.1 or -0.3 depending on the dominant species. All the TY40-TY50 growth rates for swamp were from -1.5 to -2.4 (Table 4).

Table 4. Swamp and BLH growth factors used in the In-growth Spreadsheets. Existing water depth based on field observation, Future total water depth based on existing water depth plus USACE Intermediate Relative Sea Level Rise (The North American Vertical Datum of 1988 or NAVD88). Growth factors based on stand composition and habitat quality. Future tree growth factors based on the future water depths.

SWAMP					
Plot Name	Existing Water Depth (feet)	Sea Level Rise (feet)	Future Total Water Depth (feet)	Initial Growth factor	Future (RSLR) Growth Factor (max -2.4)
FR2 cy	-2.5	2.32	-0.2	-0.10	-0.10
FR2 oth				-0.30	-0.30
NW1 cy	0.5	2.32	2.8	-0.10	-1.5
NW1 oth				1.10	
NW10 cy	1.5	2.32	3.8	-0.10	-2.1
NW10 oth				0.10	
NW14 cy	-2.5	2.32	-0.2	-0.10	0.0
NW14 oth				0.40	
NW2 cy	1.5	2.32	3.8	-0.10	-2.1
NW2 oth				-0.30	
NW3 cy	2.5	2.32	4.8	-0.10	-2.4
NW3 oth				0.30	
NW4 cy	3.5	2.32	5.8	-0.10	-2.4
NW4 oth				0.30	
NW5 cy	1.5	2.32	3.8	-0.10	-2.1
NW5 oth				0.30	
NW6 cy	0.5	2.32	2.8	-0.10	-1.5
NW6 oth				0.30	
NW7 cy	1.5	2.32	3.8	-0.10	-2.1
NW7 oth				0.30	
NW8 cy	1.5	2.32	3.8	-0.10	-2.1
NW8 oth				0.30	
NW9 cy	0.5	2.32	2.8	-0.10	-1.5
NW9 oth				-0.30	
W25 cy	2.5	2.32	4.8	-0.10	-2.4
W25 oth				0.30	
WSLP 006 cy	0.5	2.32	2.8	-0.10	-1.5
WSLP 006 oth				-0.30	
WSLP 008 cy	0.5	2.32	2.8	-0.10	-1.5
WSLP 008 oth				0.30	
WSLP 011 cy	3.5	2.32	5.8	-1.29	-2.4
WSLP 011 oth				-0.30	
WSLP 012 cy	2.5	2.32	4.8	-0.10	-2.4
WSLP 012 oth				-0.30	
WSLP 013 cy	2.5	2.32	4.8	-0.10	-2.4
WSLP 013 oth				0.30	
WSLP 014 cy	1.5	2.32	3.8	-0.10	-2.1
WSLP 014 oth				-0.30	
WSLP 015 cy	0.5	2.32	2.8	-0.10	-1.5
WSLP 015 oth				-0.30	
WSLP LDWF 001 cy	1.5	2.32	3.8	-0.10	-2.1
WSLP LDWF 001 oth				-0.30	
WSLP LDWF 004 cy	2.5	2.32	4.8	-0.10	-2.4
WSLP LDWF 004 oth	2.5	2.32	4.8	0.30	-2.4

Bottomland Hardwood					
Plot Name	Existing Water Depth (feet)	Sea Level Rise (feet)	Future Total Water Depth (feet)	Initial Growth factor	Future (RSLR) Growth Factor (max -2.4)
FR1	-2.1	2.32	0.2	-0.20	-0.6
FR3	-1.8	2.32	0.5	1.10	-0.4
NW11	-1.4	2.32	0.9	0.30	-0.6
NW12	-5.2	2.32	-2.9	1.10	1.1
NW13	-3.0	2.32	-0.7	-0.60	-0.6
NW15				0.10	0.1
NW16				0.10	0.1
NW17				0.10	0.1
WSLP 001	-1.7	2.32	0.6	0.30	-0.4
WSLP 002	0.5	2.32	2.8	-0.60	-1.5
WSLP 003	-2.5	2.32	-0.2	-0.30	-0.3
WSLP 004	-2.5	2.32	-0.2	-0.30	-0.3
WSLP 005 blh	2.5	2.32	4.8	-0.30	-2.4
WSLP 009 blh	0.5	2.32	2.8	-0.30	-1.5

WESTLAND VALUE ASSESSMENT

The WVA spreadsheet for Direct Levee and Access Footprint impacts FWP variables were left blank.

General Swamp V1 and V2 and BLH V1, V2, and V3

Site plots were used to determine these variables for all impact areas (Table 2). In the field, diameter at breast height (DBH) and other characteristics of the stand (species composition, canopy closure, mast productions, general stand health, etc…) were taken. These data were used to determine average DBH and basal area (BA), tree growth, and stand composition components for each area. In some cases a representative plot was not available. For these cases other impact area plots were used as a surrogate. Where representative plots were available, WVAs used information from plots within their impact area.

<u>Swamp</u>

- The same data for Direct Levee Footprint areas (from their respective location - west, central or east) were used for Direct Access Footprint areas.
- There were no swamp plots in the west. The HET used plots from the Central Area for the western swamp, based on proximity and CRMS data.
- There were no swamp plots available in the Central Indirect Interior Low. In this case Central Indirect Interior High was used, because of proximity and similarity of habitats condition.

<u>BLH</u>

- The Central area did not have many BLH impact area plots or acres of impact. The HET used the same central BLH plots (Inside Low) for all central impact areas.
- In the East and West Indirect areas, Indirect Interior Low was used the V1, V2, and V3 for Indirect Interior High.
- For the Exterior Impact Areas, the HET use the closest in proximity (direct in these cases) impact area information for the first three variables.

V1: Swamp V1 (Stand Structure) and BLH V1 (tree association)

<u>Swamp Variable (V) 1 – Stand Structure</u>

Stand structure (V1) data were collected from field site visits (2011, 2013, and 2019).

<u>Swamp FWOP</u>

Some areas have been hydrologically impacted by railroad tracks, roads, and berms created from logging and oil and gas activities. Many of these areas have few drainage outlets. The project area and vicinity was last logged in 1956. The height of logging was the 1920-1930s. Existing stands are currently around 70 years old. Even though regeneration has been observed and there are existing hydrologic restrictions we cannot assume much improvement into the future with an estimated 2.32 foot increase for intermediate RSLR. Therefore, the future conditions are expected to be lower than optimal at TY 50. Without the project (FWOP) we assume stand structure will drop by one class value starting in TY40 unless it is already at the lowest class value (class 1).

Swamp FWP

A V1 class reduction was applied to all Direct FWOP and Indirect FWOP/FWP scenarios at TY40 to represent RSLR impacts to project area hydrology.

HEC-RAS 2D modeling (both with and without an intermediate RSLR) indicated there were minor project-induced hydrology changes (figures 3 and 4, Agnew 2019). To minimize hydrology impacts to enclosed wetlands, the project includes features such as interior drainage canals, water control structures within the levee system and pumping stations. Proposed pumping stations would only operate during the threat of tropical storm events when floodgates are closed. Canals and drainage structures would be used to reduce impacts to hydrology and allow for connectivity between protected and unprotected areas.

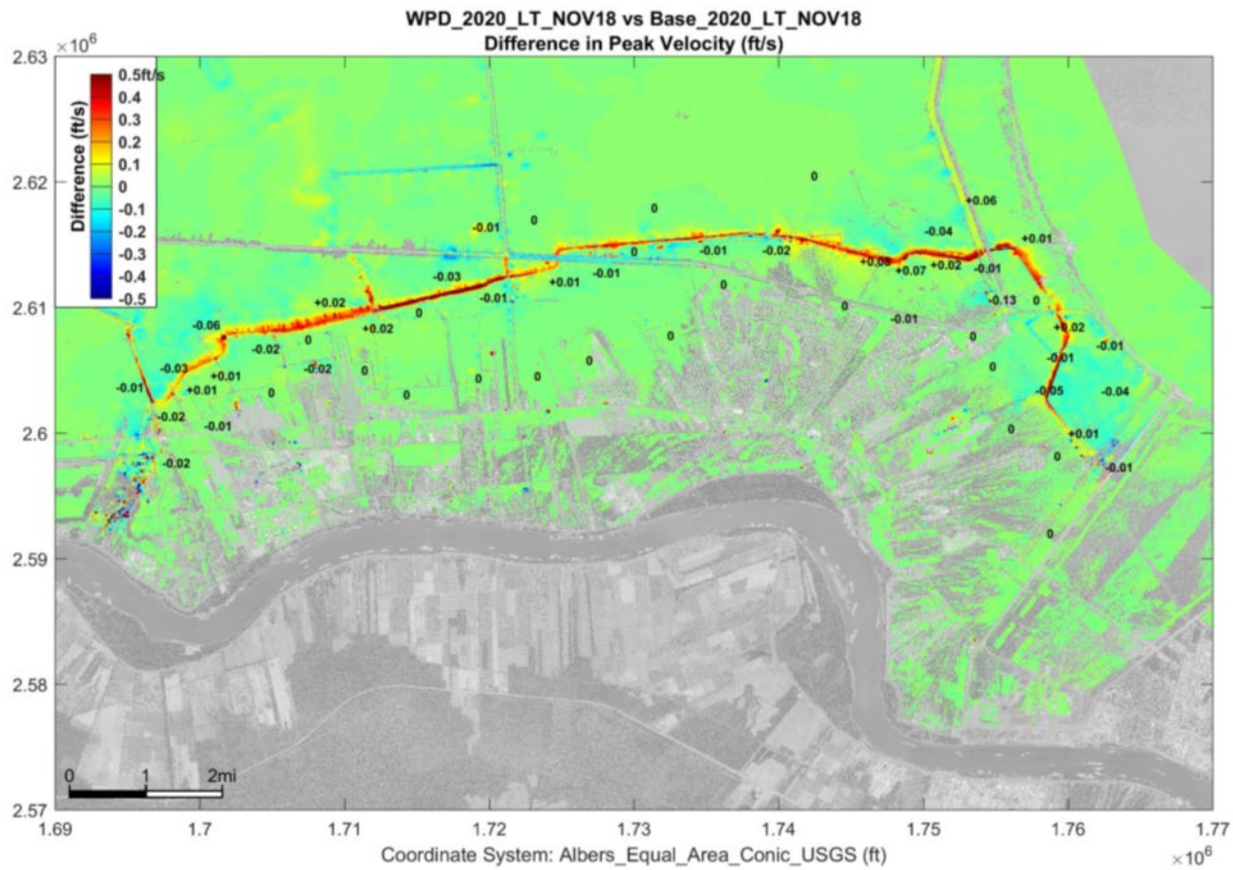

Figure 3. Maximum water velocity difference between West Shore Lake Pontchartrain with and without project for simulation set B1 (B1 is a simulation from November 1, 2018 to November 30, 2018 of observed tidal time-series for Average water surface elevation 0.55foot). Blues and yellows indicate areas of change due to the project while orange to dark indicate the levee alignment (Agnew, 2019).

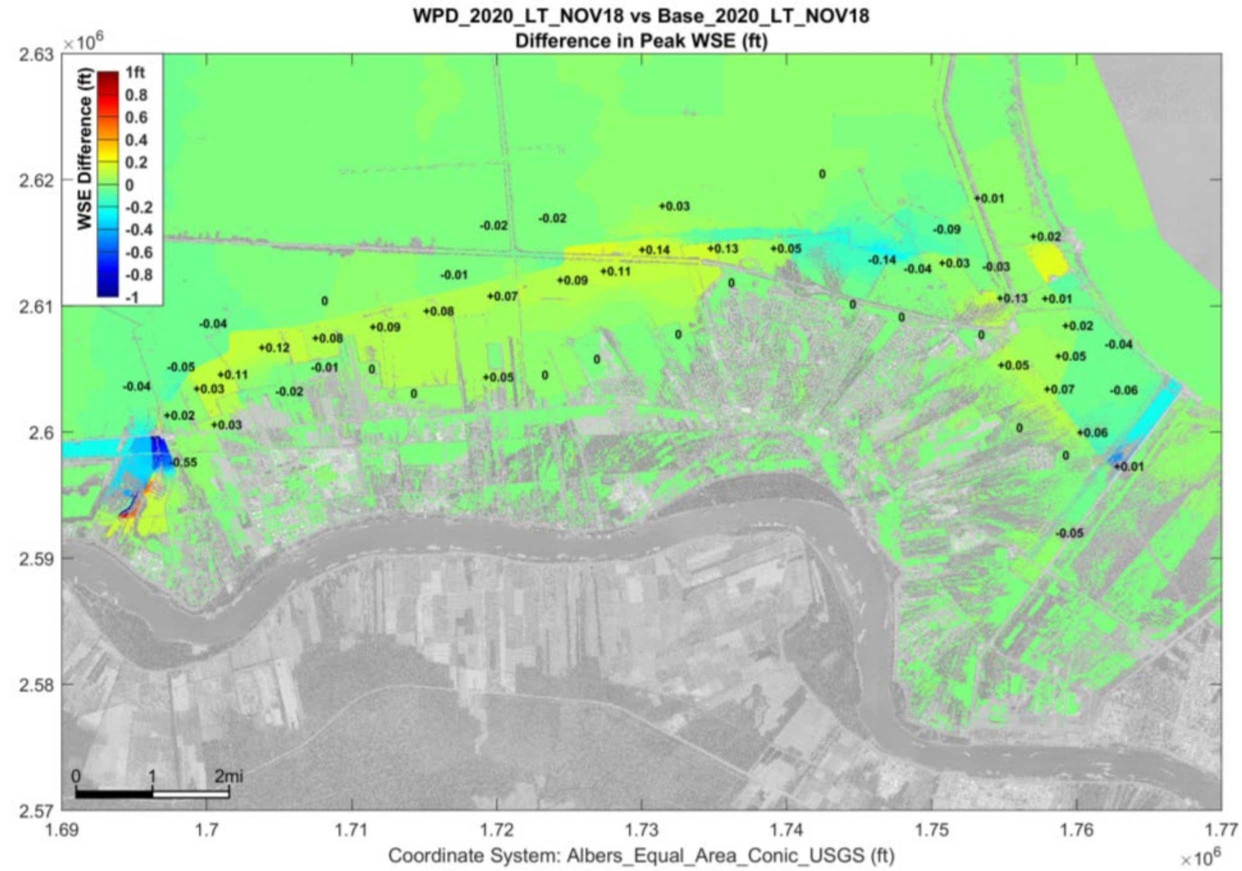

Figure 4. Maximum water surface elevation difference between West Shore Lake Pontchartrain with and without project for simulation set B1 (B1 is a simulation from November 1, 2018 to November 30, 2018 of observed tidal time-series for Average water surface elevation 0.55foot). Blues and yellows indicate areas of change due to the project while orange to dark indicate the levee alignment (Agnew, 2019).

Despite inclusion of project features to avoid hydrology impacts, the HEC-RAS modeling revealed that a slight increase in inundation occurred in some locations near the levee alignment (in the Indirect Exterior and Indirect Interior High areas). Increased water depth can reduce the transfer of oxygen to roots. Depth increases indicate a with-project reduction in water exchange which might lead to water quality deterioration. The combined effects of these changes to water movement might stress previously healthy swamps and result in a reduction in forest diversity and productivity (Krauss et. al. 2009). The reduction in forest diversity and productivity can be seen through a reduction of soft mast production and by limiting the development of stand structure (overstory, midstory, and understory) which are important for provide resting, foraging, breeding, nesting, and nursery habitat.

A Digital Elevation Model (DEM) created from LIDAR data was used to generate initial elevation conditions for the HEC-RAS hydrologic model. LIDAR data does not typically provide accurate estimates of ground elevations in turbid flooded wetlands, especially those with floating aquatic vegetation which is very common in the project area. Additionally, minor typography/bathymetry features which can effect hydrology, are sometimes not captured in LIDAR based DEMs. Thus the HET is concerned that the HEC-RAS hydrologic model may not accurately reflect restrictions in hydrologic surface-flow post-construction. Based on the DEM issues and associated modeling inaccuracies, and the HETs knowledge and experience associated with swamp habitats and the project area, the HET agreed that additional indirect impacts to Swamp habitats beyond what was indicated in the HEC-RAS 2D models are likely.

Portions of the Project Area swamps are presently severely inundated and stressed, though the Indirect High impact swamp areas were found on average to be fairly healthy. Areas containing swamp habitat with a stand structure (V1) with a Class 4 to Class 6 (Table 5), are susceptible to elevated stress levels due to restrictions in hydrologic surface-flow post-construction. Even though in FWP all Indirect Exterior and Indirect High impact swamp areas may experience changes in water movement, only the healthier Indirect High impact swamp areas were evaluated to have additional impacts beyond that indicated by hydrologic modeling results. This delayed response to the with-project hydrology changes was for Indirect High FWP starting at TY10 by dropping V1 one class level (Table 7). Indirect Exterior on average was already stressed thus not likely to add significant additional stress with the project. Indirect low was considered to be too far removed to have hydrologic impacts with the project.

See table 5 for reference to classes and Tables 6 and 7 for each impact area's class.

Table 5. Wetland Value Assessment Swamp Model Variable 1 – Stand Structure.

	Overstory		Scrub-shrub/ Midstory Cover		Herbaceous Cover
Class 1.	<33%				
Class 2.	≥33%<50%	and	<33%	and	<33%
Class 3.	≥33%<50%	and	≥33%	or	≥33%
			OR		
	≥50%<75%	and	<33%	and	<33%
Class 4.	≥50%<75%	and	≥33%	or	≥33%
			OR		
	≥75%	and	<33%	and	<33%
Class 5.	≥33%<50%	and	≥33%	and	≥33%
Class 6.	≥50%	and	≥33%	and	≥33%
			OR		
	≥75%	and	≥33%	or	≥33%

Table 6. V1 Stand Structure for Direct Levee and Access Footprint Swamp Impacts.

East and West Direct Levee and Access Footprints		
	FWOP Class	FWP Class
TY0	1	1
TY1	1	none
TY5	1	none
TY10	1	none
TY40	1	none
TY50	1	none

Central Direct Levee and Access Footprints		
	FWOP Class	FWP Class
TY0	3	3
TY1	3	none
TY5	3	none
TY10	3	none
TY40	2	none
TY50	2	none

Table 7. V1 Stand Structure for Indirect Swamp Impacts.

East and West Indirect High Inside		
	FWOP Class	FWP Class
TY0	6	6
TY1	6	6
TY5	6	6
TY10	6	5
TY40	5	4
TY50	5	4

Central Indirect High Inside		
	FWOP Class	FWP Class
TY0	4	4
TY1	4	4
TY5	4	4
TY10	4	3
TY40	3	2
TY50	3	2

East and West Indirect Low Inside		
	FWOP Class	FWP Class
TY0	6	6
TY1	6	6
TY5	6	6
TY10	6	6
TY40	5	5
TY50	5	5

Central Indirect Low Inside		
	FWOP Class	FWP Class
TY0	4	4
TY1	4	4
TY5	4	4
TY10	4	4
TY40	3	3
TY50	3	3

East Indirect Exterior		
	FWOP Class	FWP Class
TY0	2	2
TY1	2	2
TY5	2	2
TY10	2	2
TY40	1	1
TY50	1	1

Central and West Indirect Exterior		
	FWOP Class	FWP Class
TY0	3	3
TY1	3	3
TY5	3	3
TY10	3	3
TY40	2	2
TY50	2	2

BLH Variable V1 Tree Species Association

Wildlife species that utilize bottomland hardwoods depend heavily on mast, other edible seeds, and tree buds as primary sources of food. The basic assumptions for this variable are: 1) more production of mast (hard and/or soft) and other edible seeds is better than less production, and 2) because of its availability during late fall and winter and its high energy content, hard mast is more critical than soft mast, other edible seeds, and buds. Table 8 shows the class values based on tree species.

BLH Tree Species Association (V1) data were collected during field site visits for baseline estimates. Projections for each site were processed through the WVA Site-Ingrowth spreadsheets (see In-growth spreadsheet section). BLH Class remains the same for the project life FWOP and FWP (Table 9).

Table 8. BLH Variable V1 Tree Species Association Class descriptions.

Class 1:	Less than 25% of overstory canopy consists of mast or other edible-seed producing trees or more than 50% of soft mast present but no hard mast.
Class 2:	25% to 50% of overstory canopy consists of mast or other edible-seed producing trees, but hard mast producers constitute less than 10% of the canopy
Class 3:	25% to 50% of overstory canopy consists of mast or other edible-seed producing trees, and hard mast producers constitute more than 10% of the canopy.
Class 4:	Greater than 50% of overstory canopy consists of mast or other edible-seed producing trees, but hard mast producers constitute less than 20% of the canopy.
Class 5:	Greater than 50% of overstory canopy consists of mast or other edible-seed producing trees, and hard mast producers constitute more than 20% of the canopy.

Table 9. BLH Variable V1 Tree Species Association

	EAST	*CENTRAL*	*WEST*
Direct Levee and Access footprints	*Class 4*	*Class 5*	*Class 4*
Indirect High Inside	*Class 5*	*Class 5*	*Class 4*
Indirect Low Inside	*Class 5*	*Class 5*	*Class 4*
Indirect Exterior	*Class 5*	*Class 5*	*Class 4*

V2/V3: Swamp and BLH V2 (Stand Maturity) and BLH V3 (Understory/Midstory)

Swamp V2 - Stand Maturity

Stand maturity (V2) data was collected from all site visits for baseline estimates. Projections for each site was processed through the WVA Site-Ingrowth spreadsheets (Tables 10 and 11). See In-growth spreadsheets section for information on V2 assumptions.

Table 10. V1 and V2 Summary Tables for Central Swamp.

	CENTRAL DIRECT LEVEE FOOTPRINT SWAMP									
			Plots	WSLP 012	WSLP 013	NW8				
	AVERAGE	TOTAL	HEALTHY							
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	18.0	592.2	18.8	666.7	18.9	758.2	16.6	20.4	23.7	1419.2
# Cy Trees	28.0		29.0		32.0		12.0		39.0	
Other	9.9	338.1	9.9	426.2	10.3	531.3	15.2	1390.3	15.6	1452.4
# O Trees	51.0		65.0		76.0		96.0		96.0	
	% Overstory	56.7								
	% Midstory	9.0								
	% Ground	24.0								

	CENTRAL INDIRECT INSIDE HIGH SWAMP									
				Plots	NW9	NW10				
	AVERAGE	TOTAL	LOW STRESS							
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	22.5	297.2	23.9	333.0	25.4	370.8	33.7	640.1	34.9	681.8
# Cy Trees	10.0		10.0		10.0		10.0		10.0	
Other	12.7	188.8	13.2	225.2	13.9	267.3	15.2	777.5	15.6	999.4
# O Trees	18.0		20.0		22.0		52.0		70.0	
	% Overstory	59.5								
	% Midstory	42.5								
	% Ground	10.0								

	CENTRAL INDIRECT Exterior SWAMP									
				Plots	WSLP LDWF 001					
	AVERAGE	TOTAL	MED STRESSED							
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	20.3	179.0	21.4	196.9	22.8	220.6	28.6	399.2	29.3	416.6
# Cy Trees	7.0		7.0		7.0		8.0		8.0	
Other	10.4	250.9	10.7	300.9	10.3	392.0	14.4	1263.2	14.7	1315.1
# O Trees	34.0		39.0		54.0		98.0		98.0	
	% Overstory	65.0								
	% Midstory	3.0								
	% Ground	6.0								

Table 11. V1 and V2 Summary Tables for East and West Swamp.

	EAST DIRECT LEVEE FOOTPRINT SWAMP									
		Plots	WSLP 008	WSLP 011	WSLP 014	W25	NW5			
	AVERAGE	TOTAL	HEALTHY							
	TY 1.0	91.0	TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	17.9	234.8	19.2	259.1	20.5	286.4	16.2	553.0	18.5	595.4
# Cy Trees	10.9		10.7		10.5		23.9		23.5	
Other	9.2	274.8	9.6	363.2	9.8	435.8	13.9	1764.5	14.4	1600.6
# O Trees	52.9		64.1		72.6		152.2		130.4	
	% Overstory	32.6								
	% Midstory	37.0								
	% Ground	48.0								
	EAST INSIDE INDIRECT HIGH SWAMP									
				Plots	NW6					
	AVERAGE	TOTAL	LOW STRESS							
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	29.7	97.0	31.1	106.3	32.5	115.8	40.6	180.4	41.9	192.0
# Cy Trees	2.0		2.0		2.0		2.0		2.0	
Other	13.8	105.8	13.1	133.4	14.5	158.8	17.3	578.6	18.6	658.4
# O Trees	8.0		11.0		11.0		31.0		31.0	
	% Overstory	73.0								
	% Midstory	40.0								
	% Ground	100.0								
	EAST INSIDE INDIRECT LOW SWAMP									
	Plots	WSLP 006	FR2	NW14	NW2	NW3	NW4	NW7		
	AVERAGE	TOTAL	MED STRESSED							
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	16.4	418.6	15.0	490.5	14.7	574.5	19.1	1288.5	20.3	1433.2
# Cy Trees	23.0		30.0		36.0		53.0		53.0	
Other	12.6	668.3	12.9	820.9	12.0	1013.6	16.9	3164.8	18.1	3553.7
# O Trees	64.0		74.0		97.0		175.0		175.0	
	% Overstory	71.1								
	% Midstory	40.4								
	% Ground	36.2								
	EAST INDIRECT EXTERIOR SWAMP									
	Plots	WSLP LDWF 004	WSLP 015	CRMS5373						
	AVERAGE	TOTAL								
	TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
	DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
Cypress	32.8	431.2	33.3	474.7	34.6	526.9	38.3	954.9	24.4	821.1
# Cy Trees	35.0		36.0		36.0		42.0		21.0	
Other	24.0	484.8	25.2	557.5	26.1	640.5	27.7	1556.2	13.0	807.8
# O Trees	128.0		130.0		135.0		191.0		78.0	
	% Overstory	33.8								
	% Midstory	32.5								
	% Ground	16.9								

BLH Variables V2 - Stand Maturity and V3 - Understory/Midstory

Table 12. V1, V2, and V3 Summary Tables for BLH

EAST DIRECT LEVEE and ACCESS Footprint BLH									
			WSLP 003						10
AVERAGE	TOTAL	HEALTHY							
TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
13.1	190.4	13.0	214.6	12.3	254.2	12.4	882.6	14.7	1185.1
14.0		16.0		21.0		86.0		86.0	
% Overstory	80.0		Hard-mast	0.0					
% Midstory	35.0		Soft-mast	95.0					
% Ground	80.0		Non-mast	5.0					
			Class	4.0					
EAST INDIRECT INSIDE Low BLH									
			WSLP 004	WSLP 009 bl	FR1	FR3	NW16	NW17	
AVERAGE	TOTAL	HEALTHY							
TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
12.7	616.9	12.7	731.4	9.1	881.1	15.4	2727.1	17.9	3525.4
54.9		63.5		105.0		173.9		172.7	
% Overstory	69.2		Hard-mast	27.5					
% Midstory	44.0		Soft-mast	72.5					
% Ground	45.5		Non-mast	0.0					
			Class	5.0					
CENTRAL INDIRECT INSIDE LOW BLH									
									10
AVERAGE	TOTAL	HEALTHY							
TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
16.2	230.1	15.7	274.5	10.8	318.8	21.0	761.4	24.0	956.6
14.0		17.0		27.0		27.0		27.0	
% Overstory	61.7		Hard-mast	30.0					
% Midstory	10.0		Soft-mast	70.0					
% Ground	40.0		Non-mast	0.0					
			Class	5.0					

WEST DIRECT LEVEE and ACCESS Footprint BLH									
			NW11	NW12	NW13				
AVERAGE	TOTAL	HEALTHY							
TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
14.9	323.0	14.1	397.3	8.8	479.6	19.8	1379.3	22.5	1737.6
24.0		30.0		55.0		55.0		55.0	
% Overstory	72.0		Hard-mast	8.3					
% Midstory	72.7		Soft-mast	90.0					
% Ground	51.7		Non-mast	1.7					
			Class	4.0					

WEST INDIRECT INSIDE LOW BLH									
			WSLP 001	WSLP 002					
AVERAGE	TOTAL	HEALTHY							
TY 1.0		TY 5.0		TY 10.0		TY 40.0		TY 50.0	
DBH	BA	DBH	BA	DBH	BA	DBH	BA	DBH	BA
9.0	65.2	9.2	80.1	8.6	111.8	12.8	1184.2	15.2	1599.6
13.8		16.0		24.7		127.0		124.0	
% Overstory	40.0		Hard-mast	5.0					
% Midstory	47.5		Soft-mast	94.0					
% Ground	60.0		Non-mast	1.0					
			Class	4.0					

V3/V4: Swamp V3 (Water regime) and BLH V4 Hydrology

The same information is used to calculate the SIs for Swamp V3 and BLH V4. These variables are somewhat interchangeably referred to as water regime or hydrology as they consider the flooding duration and amount of water flow or exchange in forested wetlands using eight categories (Table 15). For swamp the optimal water regime is assumed to be seasonal flooding with abundant and consistent riverine/tidal input and water flow-through (SI=1.0; Table 13). The optimal water regime for BLH is assumed to be temporary flooding with abundant and consistent riverine input and water flow-through (SI = 1.0; Table 14).

Table 13. Wetland Value Assessment Swamp Model Variable 3 – Water Regime.

		Flow/Exchange			
		High	Moderate	Low	None
Flooding Duration	Permanent	0.65	0.45	0.30	0.10
	Semi-Permanent	0.75	0.65	0.45	0.25
	Seasonal	1.00	0.85	0.70	0.50
	Temporary	0.9	0.75	0.65	0.40

Table 14. Wetland Value Assessment Bottomland Hardwood Model Variable 4 – Hydrology.

		Flow/Exchange			
		High	Moderate	Low	None
Flooding Duration	Temporary	1.00	0.85	0.70	0.50
	Seasonal	0.85	0.75	0.65	0.40
	Semi-Permanent	0.75	0.65	0.45	0.25
	Permanent/Dewatered	0.65	0.45	0.30	0.10

Each WVA subgroups was adjusted for water regime for baseline and future projections based on the data described in the proceeding section.

<u>Data for determining Water Regime and Hydrology</u>

The HET used ERDC RS/GIS data (Saltus and Suir, 2019), WVA field observations, and H&H model results (Agnew, 2019), and CRMS data from 2007 or 2012 to 2019 (CPRA, 2020) to estimate values for these variables. Table 15 shows the percent inundation for the period of analysis for each CRMS station used. CRMS0059 (Reserve) was inundated the entire period of analysis (2012-2019), while CRMS5373 (Hope) was inundated approximately 96% of the period of analysis (2007-2019). These are the two closest CRMS station but only CRMS0059 is within the project area. Both stations are located along waterways which would likely have more water flux than interior swamps. Based on field observation, there were some dry or low water level areas as well as completely inundated areas within the Project Area.

Table 15. CRMS0059 (Reserve) and CRMS 5373 (Hope) mean growing season salinity and inundation.

CRMS0059			
Year	Mean Salinity	Mean growing season salinity	Inundation
2012	0.33	0.26	1.00
2013	0.31	0.28	1.00
2014	0.18	0.14	1.00
2015	0.20	0.21	1.00
2016	0.11	0.09	1.00
2017	0.10	0.08	1.00
2018	0.12	0.12	1.00
2019	0.10	0.10	1.00

CRMS 5373			
Year	Mean Salinity	Mean growing season salinity	Inundation
2007	0.48	0.43	0.99
2008	0.30	0.30	0.87
2009	0.43	0.51	0.87
2010	0.26	0.26	0.98
2011	0.54	0.56	0.97
2012	0.26	0.20	0.97
2013	0.23	0.22	0.99
2014	0.19	0.16	0.96
2015	0.16	0.18	0.96
2016	0.14	0.13	0.98
2017	0.15	0.13	0.98
2018	0.16	0.17	0.95
2019	0.13	0.12	N/A

Swamp flood duration

Coastwide Reference Monitoring System (CRMS) CRMS0059 and CRMS5373 station data indicated flooded all or most of the time at the station sites. Based on U.S. Army Engineer Research and Development Center's (ERDC) Remotely Sensed Habitat Assessment and Geographic Information Systems (GIS) data (ERDC RS/GIS data), WVA field observations, hydrologic model results, and CRMS data from 2007 or 2012 to 2019, the level of inundation was determined to vary from dry to deep (3 feet or deeper).

Each plot was categorized into the following water levels: dry, low water (< 1 foot inundated), wet (1-2 feet inundated), moderate water (2-3 feet inundated), and deep (> 3 feet inundated) based on field site visits, CRMS data (Table 15), and ERDC RS/GIS data. Older data (e.g., field site data from 2011 and 2013) were reviewed and categorized based on notes and recollection. Floating aquatic vegetation was observed during field site visits.

WVA field site inundation levels were averaged to estimate sub-area flood duration values. For instance, sub-area central Indirect Interior High had two field sites: one with low water (valued at 1) and one that was wet (valued at 2). These two plots were combined and weighted (Table 16) for a final value of 1.5 which was assigned a semi-permanent duration on the Swamp V3 (Table 13). Most swamp plots were estimated to have semi-permanent to permanent flood durations (Table 18).

Average water levels were increased by 2.32 feet for each plot and recategorized by the same group ranges at TY40. For example, the addition of 2.32 feet increased the central Indirect Interior High plots to moderate water (value of 3) and deep water (value of 3) with a final weighted average of 3, or permanently flooded. This method corroborated our assumption that all swamp would become permanently flooded in the future. Future projections were applied to both FWOP and FWP.

There were no swamp plots in the western area. Central swamp hydrology information and assumptions were applied to the western swamp WVAs. This was based on the field and CRMS Station data, and geographic proximity.

Hydrologic impacts were captured in the WVA for two impact areas (Indirect Exterior and Indirect High) in the WVAs Swamp V3 Water Regime and Bottomland Hardwood V4 Hydrology variables. These variables consider the flooding duration and amount of water flow/exchange. Although the hydrologic modeling results indicated a slight with-project increase in inundation, the HET chose not to apply WVA impacts due to increased inundation.

Swamp flow/exchange

Field observations, CRMS data, LIDAR data (but see section xyz), aerial imagery, and knowledge of previous anthropogenic alterations, and H&H modeling indicate much of the area has highly restricted flow. The HET assumed that near the levee alignment (Indirect Exterior and Indirect High) there would be a reduction in water flow/exchange.

Flow/exchange were assumed to not change for all FWOP TYs and scenarios. Indirect Interior High and Indirect Exterior flow and exchange were decreased one level at TY1 to account for changes in hydrology in the vicinity of the levee system alignment (ex. Moderate to Low flow/exchange). With RSLR all areas will have Low flow/exchange in FWP (TY40/50) because there will be openings but the efficiency will be reduced due to high RSLR (0.3 HSI).

The HET assumed the flow/exchange variable was between moderate and low flows for much of the project area swamps based on these data. Indirect Interior High flow/exchange was assumed to be lower than Direct and Indirect Exterior areas because of an existing pipeline ROW that likely acts as a hydrologic barrier. Indirect Interior Low is decreased further because it is mostly higher ground with more development and canals, and is less influenced by tidal exchange (Figures 3 and 4).

Some of the areas were determined to be between values seen on Tables 13 and 14, a weighted SI value was given to represent these instances (Table 17). Sometimes the weighted plot values were between flow/exchange categories.

<u>BLH flow/exchange and flood duration</u>

BLH sites were mostly dry except in the central area where they were more inundated. Most BLH habitats may receive some standing water, but the water table is likely below the ground for much of the year. Water inputs come predominantly from rainfall and there was very limited water exchange from riverine and/or tidal inputs. Healthy BLH is typically in higher elevation and drain well.

Based on field observations, aerial imagery, CRMS data, and H&H modeling, BLH was given a low or moderate flow exchange and either temporary or seasonal flood duration (based on weighting above), except for the Central sites which were assumed to be permanently flooded (Table 18).

As in swamp, the 2.32 foot RSLR projection was added to existing ground elevation estimates, derived from LIDAR and field data. FWOP TY50 flood duration were increased, but the flow/exchanged were assumed to remain the same (Table 18). Flow/exchange for all subareas are assumed to decrease to low, except Direct impacts and Indirect Interior Low areas, for FWP TY1. Flow/exchange in the BLH east Indirect Low is hydrologically isolated by bayous, pipeline corridors, and canals. Therefore, BLH east was assumed to have minor project-related flow impacts and was reduced from moderate to 50/50% moderate/low to show a slight impact but not fully (Table 18).

Table 16. Weighted average of field plot water levels to determine flooding of each subarea for the West Shore Lake Pontchartrain Project.

	U	V			
	Value	**# Plots**		**Swamp**	**BLH**
3	1	x	Dry and Low Wet <0.5ft	Seasonal/Temp	Temp/Seasonal
4	2	y	Wet (1.5ft)	Semi-perm	Semi-perm
5	3	z	Mod Wet & Deep >2.5	Perm	Perm
6	Total	0			
	Weighted Avg	=((U3*V3)+(U4*V4)+(U5*V5))/V6			

Table 17. Suitability Index weighted between values from the Swamp V3 Water Regime or Bottomland Hardwood (BLH) V4 Hydrology values from the Swamp and BLH,

respectively, Wetland Value Assessment. Used in the West Shore Lake Pontchartrain Project.

Swamp		
50% Moderate 50% low	Temp	0.7
50% Moderate 50% low	Seasonal	0.775
50% Moderate 50% low	Semi perm	0.55
50% Moderate 50% low	Perm	0.375
75% Moderate 25% low	Semi-perm	0.6
75% Moderate 25% low	Permanent	0.425
BLH		
50% Moderate 50% low	Temp	0.775
50% Moderate 50% low	Seasonal	0.7
50% Moderate 50% low	Semi perm	0.55
50% Moderate 50% low	Perm	0.375

Table 18. Swamp V3 Water Regime and Bottomland Hardwood V4 Hydrology values used for baseline conditions and future projections for the subareas of the West Shore Lake Pontchartrain project.

		FWOP TY1		FWOP TY50		FWP TY1		FWP TY50	
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
EAST									
Ind- Exterior	Swamp	Moderate	Semi-Perm	Moderate	Perm	low	Semi-Perm	low	Perm
Direct	Swamp	Moderate	Semi-Perm	Moderate	Perm	0	Semi-Perm	0	0
Ind - High	Swamp	50 Mod/50 low	Temp	50 Mod/50 low	Perm	low	Temp	low	Perm
Ind - Low	Swamp	low	Semi-Perm	low	Perm	low	Semi-Perm	low	Perm
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
Ind- Exterior	BLH	Moderate	Seasonal	Moderate	Semi-Perm	low	Seasonal	low	Semi-Perm
Direct	BLH	Moderate	Seasonal	Moderate	Seasonal	0	0	0	0
Ind - High	BLH	Moderate	Seasonal	Moderate	Perm	low	Seasonal	low	Perm
Ind - Low	BLH	Moderate	Seasonal	Moderate	semi-perm	50 Mod/50 low	Seasonal	50 Mod/50 low	semi-perm
CENTRAL									
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
Ind- Exterior	Swamp	75% Moderate 25% low	Semi-perm	75% Moderate 25% low	Perm	low	Semi-perm	low	Perm
Direct	Swamp	75% Moderate 25% low	Permanent	75% Moderate 25% low	Perm	0	0	0	0
Ind - High	Swamp	50/50 Moderate Low	Semi-perm	50/50 Moderate Low	Perm	low	Semi-perm	low	Perm
Ind - Low	Swamp	50/50 Moderate Low	Permanent	50/50 Moderate Low	Perm	50/50 Moderate Low	Permanent	50/50 Moderate Low	Perm
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
Ind- Exterior	BLH	75% Moderate 25% low	Permanent	75% Moderate 25% low	Permanent	low	Permanent	low	Permanent
Direct	BLH	75% Moderate 25% low	Permanent	75% Moderate 25% low	Permanent	0	0	0	0
Ind - High	BLH	50/50 Moderate Low	Permanent	50/50 Moderate Low	Permanent	low	Permanent	low	Permanent
Ind - Low	BLH	50/50 Moderate Low	Permanent	50/50 Moderate Low	Permanent	50/50 Moderate Low	Permanent	50/50 Moderate Low	Permanent
WEST									
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
Ind- Exterior	Swamp	75% Moderate 25% low	Semi-perm	75% Moderate 25% low	Perm	low	Semi-perm	low	Perm
Direct	Swamp	75% Moderate 25% low	Permanent	75% Moderate 25% low	Perm	0	0	0	0
Ind - High	Swamp	50/50 Moderate Low	Semi-perm	50/50 Moderate Low	Perm	low	Semi-perm	low	Perm
Ind - Low	Swamp	50/50 Moderate Low	Permanent	50/50 Moderate Low	Perm	50/50 Moderate Low	Permanent	50/50 Moderate Low	Perm
Area	Habitat	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration	Flow/Exchange	Flood Duration
Ind- Exterior	BLH	Low	Temp	Low	Semi-perm	low	Temp	low	Semi-perm
Direct	BLH	Low	Temp	Low	Semi-perm	0	0	0	0
Ind - High	BLH	Low	Temp	Low	Semi-perm	low	Temp	low	Semi-perm
Ind - Low	BLH	Low	Temp	Low	Semi-perm	low	Temp	low	Semi-perm

Note: In addition to the potential impact to water exchange, the Service is concerned about reduced future water exchange due to Relative Sea Level Rise (RSLR) requiring increased structure closures.

As stated in the 2016 WSLP EIS "Hydrologic connectivity would be maintained to the extent practicable through water control structures except during closure for hurricanes or tropical storms. When the system is closed, pumps would operate on average for 1.7 storms per year, which equates to a closure of structures on average 8.5 days per year. This expected rate of closure would be the same regardless of the actual rate of RSLR as closure of the system is tied to tropical storm events and the elevation trigger would be adjusted as sea level rises. The risk reduction system is only authorized to address storm surge caused by hurricane and tropical storm events. It is not authorized to mitigate for or reduce impacts caused by higher day-to-day water levels brought about by increases in sea level rise. Rainfall events and high tides could still cause significant flooding of the swamps within the levee-enclosed area. All drainage features through the levee system were sized to match the existing gravity drainage system, and would mimic the existing drainage patterns when the system is not closed. Any operational changes implemented to address changing SLR conditions or for any other non-project-related purpose would be considered a separate project purpose requiring separate authorization, new NEPA documentation, and/or permit approvals."

The project is not authorized to close the system more often due to higher day-to-day flooding impacts caused by RSLR. Because WSLP is authorized this way, impact analysis to the WSLP project area forested wetlands were evaluated assuming structures would not be closed more often than allowed by the stated triggers. However, if the sponsor/operator sees a higher level of sea level rise and starts to see increased soil saturation/flooding in developed areas due to RSLR, they may want to change the operations to close the structures more frequently, such as at high tides. A change in operations would be considered a separate project purpose and authorization, and would require a new NEPA documentation and a permit approval for this operation change. With a change from the authorized operation, there may be an increase in frequency and duration of gate closures due to area-wide stage increases caused by RSLR thereby leading to potential substantial negative impacts to wetlands enclosed by the levee system not estimated for the current WVAs. If a change in operation due to RSLR is realized, at present, it is unknown how water levels within the system would be managed so there is a potential for substantial additional and unaccounted for indirect impacts to forested wetlands and fish and wildlife resources. Additional impacts would need to be evaluated and mitigated for if changes in structure operations changes occur.

If the proposed levee and/or operation of structures increases flood frequency and water depth the bald cypress swamp will become stressed which could result in a reduction in diversity and productivity (Krauss et. al. 2009). Increased water depth can also reduce the transfer of oxygen to roots. Over time, a stressed swamp could convert to marsh and/or open water. Reduced water exchange in the enclosed wetlands would lead to further water quality deterioration in the Lake Pontchartrain Basin by eliminating or reducing the filtering capacity of those wetlands. The potential wetland habitat impact to the largest remaining continuous forested wetlands in Louisiana would result in the reduction of resident fish and wildlife, reduced important wintering habitat for waterfowl and other migratory birds that use the Central and Mississippi Flyways, and reduced nursery habitat and detritus input important to the maintenance of estuarine-dependent fish and shellfish production.

V4: SWAMP V4 – Salinity

Baseline salinity estimates were based on nearby CRMS station salinities of recent years (2010-2019) to represent salinities after the Mississippi River Gulf Outlet (MRGO) was closed in 2009, the Inner Harbor Navigation Canal-Lake Borgne Surge Barrier (surge barrier) was closed in 2010, and the Seabrook floodgate complex was completed in 2012. Since these closures, salinities have been reduced in the Pontchartrain basin and the project area.

For swamp the WVA standard is to use the mean high growing season salinity, which is from March 1 through October 31. Data from CRMS0059 sites H01 and H02 at Reserve Relief Canal had a 0.16 parts per thousand (ppt) mean growing season salinity for all years/sites from 2012-

2019. CRMS5373 Hope Canal data had a mean growing season salinity of 0.21 ppt from 2010 – 2019 (Table 13, CPRA 2020). Though there are higher salinities in 2011 at CRMS5373 (Hope), salinity did not exceed 0.81 ppt from 2010-2019, and salinities were mostly between 0.08-0.28 ppt (crms0059) and 0.12-0.26 ppt (crms5373, excluding 2011). See figures 2 and 5.

The HET used 0.2 ppt as the baseline salinity for swamp.

Future salinity

In the future, saltwater increases are expected due to continued land loss associated with RSLR. Modeling results from the Delta Management and Mid-Barataria Sediment Diversion projects were reviewed (Messina, et al 2019 and ERDC 2016) to better understand salinity dynamics in the project area and vicinity. Results indicated that salinities in Lake Pontchartrain would not increase by more than 0.5 ppt over the next 50 years. Since the project area is further inland than Lake Pontchartrain, it was assumed salinities within the project area would not increase by more than 0.5 ppt. This expected slight change in salinity is not likely to impact plant health.

The East area is closest to Lake Pontchartrain and was assumed to have the greater increase in salinity (an increase of 0.5ppt) while the areas further away (Central and West) were not likely to increase as much. The HET used 0.5ppt in the West and Central areas and 0.7ppt in the East for TY40 and TY50.

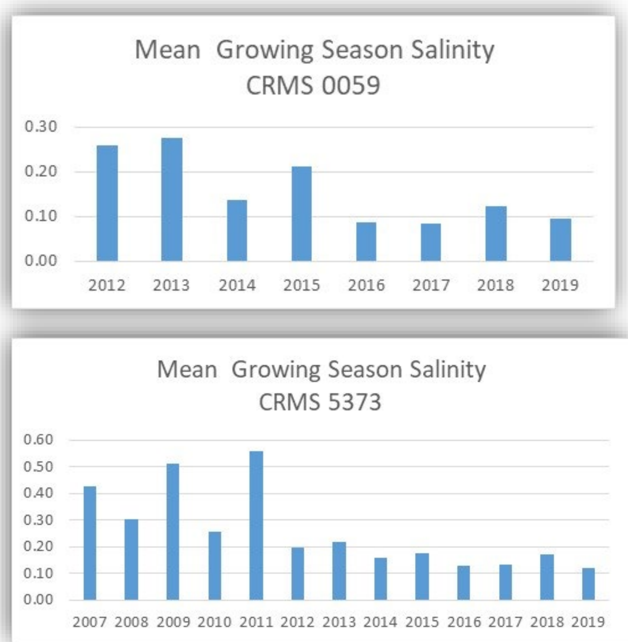

Figure 5. Mean growing season salinities for CRMS0059 (2012-2019) and CRMS5373 (2007-2019)

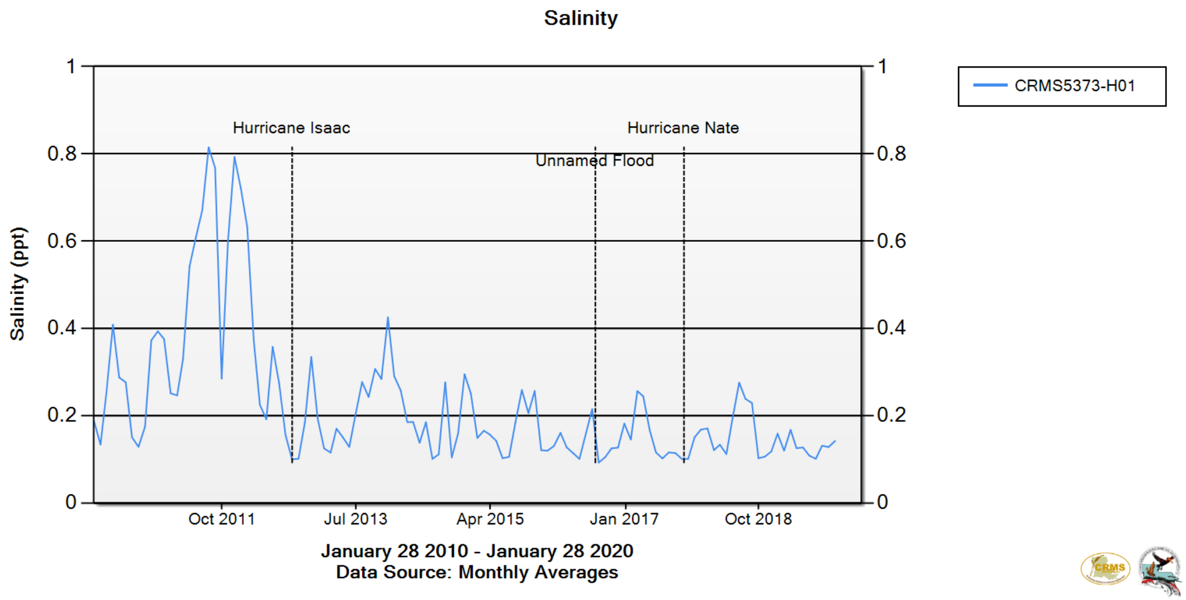

Figure 6. Monthly Average Salinity 2010-2019 for CRMS5373 (Hope).

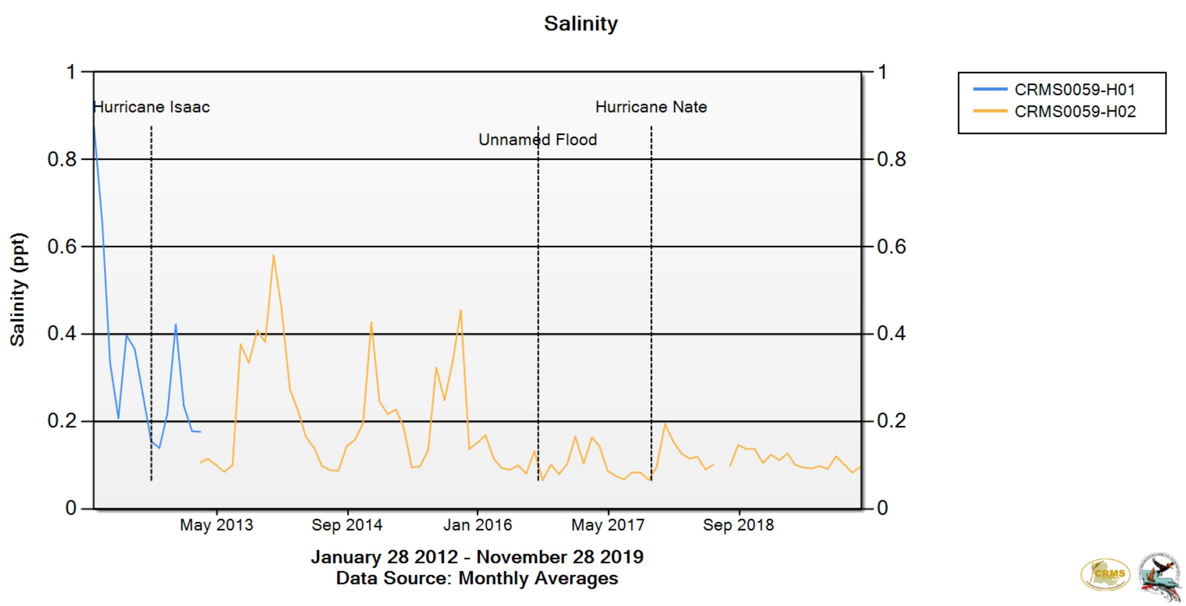

Figure 7. Monthly Average Salinity for CRMS0059 (Reserve).

V5: Size of Contiguous Forested Area

Although edge and diversity, which are dominant features of small forested tracts, are important for certain wildlife species, it is important to understand four concepts: 1) species which thrive in edge habitat are highly mobile and presently occur in substantial numbers, 2) because of forest fragmentation and ongoing timber harvesting by man, edge and diversity are quite available, 3) most species found in "edge" habitat are "generalists" in habitat use and are quite capable of existing in larger tracts, and 4) those species in greatest need of conservation are "specialists" in habitat use and require large forested tracts. Therefore, the basic assumption for this variable is that larger forested tracts are less common and offer higher quality habitat than smaller tracts. For this model, tracts greater than 500 acres in size are considered large enough to warrant being considered optimal. See Table 19.

Table 19. Size of Contiguous Forested Area.

Class 1.	0 to 5 acres
Class 2.	5.1 to 20 acres
Class 3.	20.1 to 100 acres
Class 4.	100.1 to 500 acres
Class 5.	> 500 acres

Note: Corridors less than 75 feet wide do not constitute a break in the forested area contiguity**.**

For this variable, Swamp and BLH were considered together as a large contiguous forest. The ERDC GIS/RS data, 2016 National Land Cover Database (NLCD) data, FWI, and available imagery were used to determine sizes of contiguous forested areas for each area evaluated. A weighted average was calculated for each impact area to determine their HSI for baseline, FWOP, and TY1-TY10 FWP (Table 20). The levee footprint changed to non-forested habitat for all FWP scenarios (Table 20). Access roads were considered to be too small to fit criteria since they were all a maximum of 40 feet wide.

Table 20. Habitat Suitability Index for baseline, and future projections of Size of Contiguous Forest Area.

FWOP (TY0, TY1, and TY50) and FWP (TY0) V5 HSI Table			FWP V5 HSI Table (TY1, TY50)		
	Impact area	HSI		Impact area	HSI
Area E	Footprint	0.99	Area E	Footprint	0.00
	Access Roads	0.99		Access Roads	0.00
	Indirect High	0.98		Indirect High	0.89
	Indirect Low	0.98		Indirect Low	0.97
	Indirect Out	0.98		Indirect Out	0.97
Area C	Footprint	1.00	Area C	Footprint	0.00
	Access Roads	0.99		Access Roads	0.00
	Indirect High	0.96		Indirect High	0.95
	Indirect Low	0.98		Indirect Low	0.98
	Indirect Out	1.00		Indirect Out	1.00
Area W	Footprint	0.94	Area W	Footprint	0.00
	Access Roads	0.92		Access Roads	0.00
	Indirect High	0.91		Indirect High	0.86
	Indirect Low	0.90		Indirect Low	0.88
	Indirect Out	0.87		Indirect Out	0.81

V6: Suitability and Traversability of Surrounding Land Uses

The 2016 National Land Cover Dataset (NLCD) was used to categorize surrounding land uses. Based on a 0.5 mile buffer of the levee alignment, access footprints, and all Indirect areas, Table 21 through Table 26 shows the percent of each land use seen in the buffer and calculates a weighted average of land use that is used for the Suitability Index (SI) for baseline, FWOP, and FWP conditions. Similar to V5, all Indirect impact FWP scenarios included the levee footprint as non-habitat.

In the FWOP it is expected that active agriculture and pasture hayfield areas will become more inundated because of RSLR (Table 18). As there is uncertainty regarding insurability of flood prone areas under the National Flood Insurance Program, future development of these areas is unlikely without the proposed levee system. With the levee alignment, it was assumed most of those areas would experience inundation relief and could be developed. This assumption is based on the Corps economics analysis that projects growth to occur in existing agricultural lands. Note this assumption applies to V6 (Land Use) and V7 (Disturbance) but are not the assumptions used to determine mitigation acreages.

Table 21. V6 - Suitability and Traversability of Surrounding Land Use for Direct East.

V6 East Direct Levee Footprint			
	FWOP TY0, TY1, TY50; FWP TY0		
Land use	**NLCD attributes**	**Acres**	**%**
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	7253.0	94.4
Abandoned ag	None	0.0	0.0
Pasture hayfields	Hay/pasture	0.0	0.0
Active ag	Cultivate Crops, Openwater	102.1	1.3
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	329.6	4.3
Total		7684.6	100.0

V6 East Direct Access Raod Footprint			
	FWOP TY0, TY1, TY50; FWP TY0		
Land use	**NLCD attributes**	**Acres**	**%**
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	7386.6	73.1
Abandoned ag	None	0.0	0.0
Pasture hayfields	Hay/pasture	219.1	2.2
Active ag	Cultivate Crops, Openwater	1002.1	9.9
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	1490.3	14.8
Total		10098.1	100.0

Table 22. V6 - Suitability and Traversability of Surrounding Land Use for Indirect East.

V6 East Indirect Inside High											
	FWOP TY0, TY1, TY50; FWP TY0			subtract levee		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%			Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	3613.0	91.9		754.8	2858.2	72.7			2858.2	72.7
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	26.7	0.7			808.6	20.6			0.0	0.0
Active ag	Cultivate Crops, Openwater	187.3	4.8		2.2	185.0	4.7			12.5	0.3
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	106.3	2.7		24.9	81.4	2.1			1062.6	27.0
Total		3933.3	100.0	Total	781.9	3933.3	100.0			3933.3	100.0

V6 East Indirect Inside Low											
	FWOP TY0, TY1, TY50; FWP TY0			subtract levee		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%			Acres	%			Acres	%
Bottomland hardwood	wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	6194.1	46.3		840.2	5353.9	40.0			5353.9	40.0
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	696.1	5.2			1565.2	11.7			0.0	0.0
Active ag	Cultivate Crops, Openwater	1309.5	9.8		2.7	1306.8	9.8			115.6	0.9
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	5174.7	38.7		26.2	5148.4	38.5			7904.8	59.1
Total		13374.4	100.0	Total	869.1	13374.4	100.0			13374.4	100.0

V6 East Indirect Exterior											
	FWOP TY0, TY1, TY50; FWP TY0			subtract levee		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%			Acres	%			Acres	%
Bottomland hardwood	wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	6867.1	85.3		859.6	6007.6	74.6			6007.6	74.6
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	1.1	0.0			889.4	11.1			0.0	0.0
Active ag	Cultivate Crops, Openwater	902.7	11.2		2.7	900.0	11.2			902.0	11.2
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	277.5	3.4		26.0	251.5	3.1			1138.9	14.2
Total		8048.5	100.0	Total	888.2	8048.5	100.0			8048.5	100.0

Table 23. V6 - Suitability and Traversability of Surrounding Land Use for Direct Central.

V6 Central Direct Levee Footprint			
		FWOP TY0, TY1, TY50; FWP TY0	
Land use	**NLCD attributes**	**Acres**	**%**
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	3921.0	97.1
Abandoned ag	None	0.0	0.0
Pasture hayfields	Hay/pasture	4.2	0.1
Active ag	Cultivate Crops, Openwater	15.6	0.4
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	96.7	2.4
Total		4037.6	100.0

V6 Central Direct Access Roads Footprint			
		FWOP TY0, TY1, TY50; FWP TY0	
Land use	**NLCD attributes**	**Acres**	**%**
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	4327.4	72.1
Abandoned ag	None	0	0
Pasture hayfields	Hay/pasture	231.2906336	3.9
Active ag	Cultivate Crops, Openwater	816.1890628	13.6
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	627.2	10.4
Total			6002.0

Table 24. V6 - Suitability and Traversability of Surrounding Land Use for Indirect Central.

V6 Central Indirect Inside High

		FWOP TY0, TY1, TY50; FWP TY0		subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	3613.0	91.9		477.3	3135.8	79.7			3135.8	79.7
Abandoned ag	None	0	0			0.0	0			0.0	0.0
Pasture hayfields	Hay/pasture	26.6874	0.7			510.0	13.0			0.0	0.0
Active ag	Cultivate Crops, Openwater	187.256	4.8			187.3	4.8			56.0	1.4
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	106.3	2.7		6.0	100.3	2.6			741.5	18.9
Total		3933.3	100	Total	483.3	3933.3	100.0			3933.3	100.0

V6 Central Indirect Inside Low

		FWOP TY0, TY1, TY50; FWP TY0		subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	3201.8	60.6		437.2	2764.6	52.3			2764.6	52.3
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	242.6	4.6			680.1	12.9			0.0	0.0
Active ag	Cultivate Crops, Openwater	1010.3	19.1			1010.3	19.1			231.0	4.4
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	829.1	15.7		0.2	828.9	15.7			2288.3	43.3
Total		5283.9	100.0	Total	437.5	5283.9	100.0			5283.9	100.0

V6 Central Indirect Exterior

		FWOP TY0, TY1, TY50; FWP TY0		subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	4490.6	97.2		404.5	4086.1	88.5			4086.1	88.5
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	4.0	0.1			416.3	9.0			0.0	0.0
Active ag	Cultivate Crops, Openwater	11.8	0.3			11.8	0.3			11.1	0.2
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	112.5	2.4		7.8	104.7	2.3			521.7	11.3
Total		4618.9	100.0	Total	412.3	4618.9	100.0			4618.9	100.0

Table 25. V6 - Suitability and Traversability of Surrounding Land Use for Direct West.

V6 West Direct Levee Footprint			
FWOP TY0, TY1, TY50; FWP TY0			
Land use	NLCD attributes	Acres	%
Bottomland hardwood	wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	7253.0	94.4
Abandoned ag	None	0.0	0.0
Pasture hayfields	Hay/pasture	0.0	0.0
Active ag	Cultivate Crops, Openwater	102.1	1.3
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	329.6	4.3
Total		7684.6	100.0

V6 West Direct Access Raod Footprint			
FWOP TY0, TY1, TY50; FWP TY0			
Land use	NLCD attributes	Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	1600.1	59.9
Abandoned ag	None	0.0	0.0
Pasture hayfields	Hay/pasture	431.4	16.1
Active ag	Cultivate Crops, Openwater	79.6	3.0
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	561.5	21.0
Total		2672.7	100.0

Table 26. V6 - Suitability and Traversability of Surrounding Land Use for Indirect West.

V6 West Indirect Inside High											
	FWOP TY0, TY1, TY50; FWP TY0			subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	1321.0	57.4		141.0	1180.0	51.3			1180.0	51.3
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	107.0	4.7		0.2	284.7	12.4			0.0	0.0
Active ag	Cultivate Crops, Openwater	236.4	10.3		9.6	226.8	9.9			66.7	2.9
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	635.6	27.6		27.1	608.5	26.5			1053.3	45.8
Total		2300.0	100.0	Total	177.9	2300.0	100.0			2300.0	100.0

V6 Westl Indirect Inside Low											
	FWOP TY0, TY1, TY50; FWP TY0			subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	1,415.3	44.7		151.2	1,264.1	40.0			1,264.1	40.0
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	145.7	4.6		0.2	319.1	10.1			0.0	0.0
Active ag	Cultivate Crops, Openwater	880.5	27.8		0.9	879.6	27.8			61.8	2.0
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	722.3	22.8		21.3	701.0	22.2			1,837.9	58.1
Total		3,163.8	100.0	Total	173.7	3,163.8	100.0			3,163.8	100.0

V6 West Indirect Exterior											
	FWOP TY0, TY1, TY50; FWP TY0			subtract		FWP TY1				FWP TY50	
Land use	NLCD attributes	Acres	%	levee		Acres	%			Acres	%
Bottomland hardwood	Emergent herbaceous wetlands, Evergreen forest, herbaceous, mixed forest, woody wetlands	1389.7	73.1		147.7	1242.1	65.3			1242.1	65.3
Abandoned ag	None	0.0	0.0			0.0	0.0			0.0	0.0
Pasture hayfields	Hay/pasture	29.4	1.5		0.2	199.0	10.5			0.0	0.0
Active ag	Cultivate Crops, Openwater	44.3	2.3		0.9	43.4	2.3			38.7	2.0
Development	Barrren Land, Developed (high, medium, low intensity) developed open space	437.5	23.0		21.1	416.3	21.9			620.0	32.6
Total		1900.8	100.0	Total	169.9	1900.8	100.0			1900.8	100.0

V7: Disturbance

The effect of disturbance is a factor of the distance to, and the type of, disturbance. The ERDC GIS/RS data, 2016 National Land Cover Database (NLCD) data, FWI, and available imagery were used to classify the disturbance type such as highways, industrial areas, waterways, agriculture, homes, etc. See Table 27.

Similar to V5, Swamp and BLH were considered together as a large contiguous forest for V7. Each impact area was buffered and distance to disturbances were calculated with a weighted average to determine the resulting HSI (Table 28). Also similar to V5, the levee footprint was applied to the FWP condition to determine the HSI. Similar to V6, all ag land was assumed to become developed by TY40.

For Baseline (TY0), FWOP and FWP TY1, and FWOP TY50 the HET used the HSIs in Table 28. The HET assumed that FWOP TY40 and TY50 are similar to existing conditions for development projections, because of RSLR impacts. An assumption that agricultural land would become developed at FWP TY40 was applied here for reasons described in the V6 variable section (Table 28). This assumption is based on the Corps economics analysis that projects growth to occur in existing agricultural lands. Note this assumption applies to V6 (Land Use) and V7 (Disturbance) but are not the assumptions used to determine mitigation acreages.

Table 27. Variable V7 Disturbance of the Wetland Value Assessment Swamp and Bottomland Hardwood Model.

Variable V_7 Disturbance

The effect of disturbance is a factor of the distance to, and the type of, disturbance, hence both are incorporated in the SI formula.

Note: Linear and/or large project sites may be exposed to various types of disturbances at various distances. The SI for this variable should be weighted to account for those variances.

Distance Classes	**Type Classes**
Class 1. 0 to 50 ft.	**Class 1.** Constant/Major. (Major highways, industrial, commercial, major navigation.)
Class 2. 50.1 to 500 ft.	**Class 2.** Frequent/Moderate. (Residential development, moderately used roads, waterways commonly used by small to mid-sized boats).
Class 3. > 500 ft.	**Class 3.** Seasonal/Intermittent. (Agriculture, aquaculture.)
	Class 4. Insignificant. (Lightly Used roads and waterways, individual homes, levees, rights of way).

Suitability Indices for Distance/Type Class

		Type Class			
		1	2	3	4
Distance Class	1	.01	.26	.41	1
	2	.26	.50	.65	1
	3	1	1	1	1

Table 28. Variable V7 Disturbance Habitat Suitability Index (HSI) for the Wetland Value Assessment Swamp and Bottomland Hardwood Model for the West Shore Lake Pontchartrain Levee Project

Variable V7 Disturbance

FWOP (TY0, TY1, and TY50) and FWP (TY0) V7 HSI Table		
Area E	Levee Footprint	0.86
	Access Roads	0.79
	Indirect High	0.82
	Indirect Low	0.77
	Indirect Exterior	0.80
Area C	Levee Footprint	0.97
	Access Roads	0.88
	Indirect High	0.93
	Indirect Low	0.84
	Indirect Exterior	0.98
Area W	Levee Footprint	0.33
	Access Roads	0.82
	Indirect High	0.56
	Indirect Low	0.66
	Indirect Exterior	0.47

FWP (TY50) V7 HSI Table		
Area E	Levee Footprin	0.00
	Access Roads	0.00
	Indirect High	0.77
	Indirect Low	0.74
	Indirect Exteric	0.80
Area C	Levee Footprin	0.00
	Access Roads	0.00
	Indirect High	0.93
	Indirect Low	0.84
	Indirect Exteric	0.98
Area W	Levee Footprin	0.00
	Access Roads	0.00
	Indirect High	0.56
	Indirect Low	0.63
	Indirect Exteric	0.47

FWP (TY1) V7 HSI Table		
Area E	Levee Footprint	0.00
	Access Roads	0.00
	Indirect High	0.82
	Indirect Low	0.77
	Indirect Exterior	0.80
Area C	Levee Footprint	0.00
	Access Roads	0.00
	Indirect High	0.93
	Indirect Low	0.84
	Indirect Exterior	0.98
Area W	Levee Footprint	0.00
	Access Roads	0.00
	Indirect High	0.56
	Indirect Low	0.66
	Indirect Exterior	0.47

RESULTS

See Table 29 and 30 for a summary of resulting Annual Average Habitat Unit (AAHUs) and acres impacted for all Direct (Levee and Access Footprints) and Indirect (Exterior and Inside High and Low) swamp and bottomland hardwood (BLH) for the West Shore Lake Pontchartrain Project levee system. See Table 29 and 30 for the impacts specific to the Louisiana Department of Wildlife and Fisheries lands. Direct impacts for the entire levee system alignment and access roads is 1,142 acres of swamp and 233 acres of BLH resulting in -602 AAHUs for swamp and -163 AAHUs for BLH. Indirect impacts include 9,773 acres of swamp and 4,665 acres of BLH resulting in -549 AAHUs for swamp and -125 AAHUs for BLH based on the USACE Intermediate RSLR projections.

Table 29. Summary of all Direct and Indirect Annual Average Habitat Units (AAHUs) and acres impacted for swamp in the West Shore Lake Pontchartrain Project and the subset of Louisiana Department of Wildlife and Fisheries lands.

SWAMP	Acres	AAHUS
East Direct Levee Footprint	677	-331.07
East Direct Access Footprint	23	-11.09
East Indirect Interior High	1,016	-82.00
East Indirect Interior Low	3,142	-22.27
East Indirect Exterior	2,102	-103.29
Central Direct Levee Footprint	364	-219.78
Central Direct Access Footprint	24	-14.08
Central Indirect Interior High	594	-62.92
Central Indirect Interior Low	1,330	-9.56
Central Indirect Exterior	1,301	-61.29
West Direct Levee Footprint	47	-20.28
West Direct Access Footprint	3	-1.32
West Indirect Interior High	97	-7.58
West Indirect Interior Low	89	-0.90
West Indirect Exterior	83	-3.89

SWAMP	Acres	AAHUs
Direct	1,137	-598
Indirect Interior High	1,707	-153
Indirect Interior Low	4,561	-33
Indirect Exterior	3,486	-168
TOTAL	10,892	-951

LDWF	Acres	AAHUS
LDWF East Direct Levee Footprint	261	-128
LDWF East Direct Access Footprint	4	-2
LDWF East Indirect Interior High	203	-16
LDWF East Indirect Interior Low	128	-1
LDWF East Indirect Exterior	968	-48
LDWF Central Direct Levee Footprint	37	-22
LDWF Central Indirect Interior High	20	-2
LDWF Central Indirect Exterior	432	-20
LDWF West Direct Levee Footprint	10	-4
LDWF West Direct Access Footprint	1	0
LDWF West Indirect Interior High	17	-1
LDWF West Indirect Exterior	5	0

LDWF SWAMP	Acres	AAHUs
LDWF Direct	312	-156
LDWF Indirect Interior High	241	-20
LDWF Indirect Interior Low	128	-1
LDWF Indirect Exterior	1,405	-68
Total	2,087	-245

Table 30. Summary of all Direct and Indirect Annual Average Habitat Units (AAHUs) and acres impacted for Bottomland Hardwood in the West Shore Lake Pontchartrain Project and the subset of Louisiana Department of Wildlife and Fisheries lands.

BOTTOMLAND HARDWOOD (BLH)	Net Acres	AAHUS		BLH	Acres	AAHUs
East Direct Levee Footprint	149.3	-106.5		Direct	242	-169
East Direct Access Footprint	17.1	-12.1		Indirect Interior High	503	-24
East Indirect Interior High	357.3	-22.5		Indirect Interior Low	3,467	-70
East Indirect Interior Low	3296.9	-68.7		Indirect Exterior	666	-30
East Indirect Exterior	539.6	-28.4		Total	4,877	-293
Central Direct Levee Footprint	1.6	-1.3				
Central Direct Access Footprint	5.2	-3.9				
Central Indirect Interior High	21.9	-0.6				
Central Indirect Interior Low	79.3	-0.6				
Central Indirect Exterior	23.0	-0.9				
West Direct Levee Footprint	66.6	-44.0				
West Direct Access Footprint	2.0	-1.4				
West Indirect Interior High	123.5	-0.8				
West Indirect Interior Low	90.3	-0.7				
West Indirect Exterior	103.7	-0.6				
LDWF	Acres	AAHUS		LDWF BLH	Acres	AAHUs
LDWF East Direct Levee Footprint	92.6	-66.05				
LDWF East Direct Access Footprint	1.7	-1.20		LDWF Direct	101	-72
LDWF East Indirect Interior High	177.4	-11.18		LDWF Indirect Interior High	199	-11
LDWF East Indirect Interior Low	100.1	-2.09		LDWF Indirect Interior Low	100	-2
LDWF East Indirect Exterior	206.9	-10.9		LDWF Indirect Exterior	212.9	-11.1
				Total	613	-96
LDWF Central Direct Levee Footpri	0.5	-0.37				
LDWF Central Indirect Interior High	0.1	0.0				
LDWF Central Indirect Exterior	5.8	-0.2				
LDWF West Direct Levee Footprint	5.4	-3.54				
LDWF West Direct Access Footprint	0.8	-0.5				
LDWF West Indirect Interior High	21.9	-0.1				
LDWF West Indirect Exterior	0.2	0.0				

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