Sabine Pass to Galveston Bay, Texas
Coastal Storm Risk Management and Ecosystem Restoration
Final Integrated Feasibility Report and
Environmental Impact Study

Appendix Q

WETLANDS VALUE ASSESSMENT
COASTAL MARSH MODEL SENSITIVITY ANALYSIS

May 2017

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1 OVERVIEW

In conjunction with the U.S. Army Corps of Engineers Headquarters' (HQUSACE) single-use approval of the Wetland Value Assessment's (WVA) Coastal Marsh Community Model, the U.S. Army Corps of Engineers, Galveston District (CESWG) was directed to conduct sensitivity analyses of the model's evaluation of marsh impacts and mitigation for the Sabine Pass to Galveston Bay, Texas (S2G), Coastal Storm Risk Management (CSRM) and Ecosystem Restoration (ER) Feasibility Study. The HQUSACE Model Certification Panel reviewed the WVA marsh model in accordance with EC 1105-2-412 and determined that the model and its accompanying documentation were sufficient to approve the marsh model Version 1.0 for use on the S2G Feasibility Study. However, based on the recommendations of an independent external peer review of the WVA Community Index models (Battelle, 2010), a sensitivity analysis was required to evaluate several unresolved issues with the form of marsh model suitability indices (SI) for Variables (V) 1, 2, and 3 and the aggregation method used to combine marsh and open water habitat units. Galveston District was directed to use a WVA spreadsheet prepared by the Engineering Research and Development Center's (ERDC) Environmental Lab (USACE, 2013) to conduct the sensitivity analyses, and to have the analyses reviewed as part of the overall Agency Technical Review process. ERDC's WVA spreadsheet contains Version 1.0, as well as two updated versions (2.0 and 2.0B) that have incorporated comments made by Battelle (2010).

1.1   WVA SUMMARY

Version 1.0 of the WVA marsh model, developed by the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Environmental Workgroup (USFWS, 2010), was applied to evaluate ecosystem impacts and mitigation in support of alternative comparisons for the Orange County element of the S2G Feasibility Study. WVA outputs were entered into the IWR Planning Suite to select best buy plans from the final array of alternatives for each affected marsh type.

The WVA model suite uses a quantitative habitat-based assessment methodology originally developed for wetland restoration and planning projects in coastal Louisiana and east Texas. It directly applies the Habitat Evaluation Procedures (HEP), which was developed by the U.S. Fish and Wildlife Service to evaluate project impacts on fish and wildlife resources and benefits of ecosystem restoration projects. The WVA methodology employs a community approach that assumes that optimal conditions for all fish and wildlife within a specific type of coastal wetland habitat can be characterized by a group of significant variables, and that existing or future conditions can be compared to that optimum, providing an index of habitat quality like that provided by the HEP methodology. Using this methodology, several habitat-specific community models have been developed by the EnvWG, and three were selected for use in this study: the Coastal Marsh Model, the Swamp Community Model, and the Bottomland Hardwood Model. As

the variables in question are part of the coastal marsh model, the sensitivity analysis applies only to the marsh model of the WVA suite. There are four variations of the marsh models, for application to fresh, intermediate, brackish, and saline marsh. No saline marsh was in the S2G affected area, and therefore, the sensitivity analyses presented here do not cover that wetland type.

1.2   CERTIFICATION REVIEW COMMENTS

Battelle's reviewers of the WVA Model Suite suggested an alternative treatment for the SIs for three marsh model variables (V1 - percent of wetland area covered by emergent vegetation, V2 - percent of open water area covered by submerged aquatic vegetation, and V3 - marsh edge and interspersion). For these variables, the reviewers commented that policy decisions appear to supersede what is known about the ecology and hydrology of the relationships. Some reviewers also questioned the overall aggregation method used to combine net marsh and open water habitat suitability index (HSI) components (Battelle, 2010). They commented that spreadsheet formulas for the marsh models incorrectly combined open water and emergent marsh average annual habitat units (AAHUs) by taking the weighted average of the net benefits for marsh and open water.

1.3   ERDC'S WVA SPREADSHEET

ERDC's WVA Spreadsheet was developed to be utilized for all of the community models in the WVA Model Suite. Spreadsheet pages include input and output, landloss, and calculation pages for each of the models included in the WVA suite. The model type to be applied is selected on the input page, along with the total number of simulation years. An example of the input page is presented in Figure 1-1 (note: target years have been truncated to allow a readable presentation). A landloss spreadsheet can be linked to the model spreadsheet on the landloss page, making data input for emergent marsh and open water acres easier and reducing the risk of data input errors. The input page is linked to the calculation pages, which present all of the formulas that are applied to calculate AAHUs, and they are locked to prevent unintended changes to formulas and other errors. The capability to handle risk and uncertainty was incorporated by the use of a Monte Carlo simulation and the ability to input data using either a low to high range or standard deviation, and it also allows the user to select between linear and stepwise transitions between target years. WVA modeling for the S2G study utilized ranges and linear transitions, as the former were more easily determined by the resource agency workgroup, and the latter better represented the changes between the selected target years. For the Monte Carlo simulations, 100 iterations of the statistics of outputs were performed.

Simulation Date	6/6/2016	**Model Type:**	Marsh - Brackish ▼
Model User	Jan S		
Simulation Name	B-1 Direct Int RSLR	**Uncertainty:**	Range (Low to High) ▼
Project:	S2G B-1Direct Impacts Old River Cove	**Transitions:**	Linear ▼
Condition: Future Without Project		**Acreage Entry:**	Land Loss ▼

Simulation Years: 61
Monte Carlo Iterations: 100

Condition: Future Without Project

			Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Project Area (acres)		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Emergent Marsh (acres)		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Open Water (acres)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V1	% Emergent	Low	94	94	94	93	93	93	93	92	92	92	92	91	91	91	91	91	90	90	90	90	89
		High	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	99	99	99	99	99
V2	% Aquatic	Low	10	10	10	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	8	8
		High	20	20	20	20	20	20	20	21	21	21	21	21	21	21	21	21	21	21	21	22	22
V3	Interspersion																						
	Class 1		35	35	35	35	35	35	35	34	34	34	34	34	34	34	34	34	34	34	34	33	33
	Class 2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 3		65	65	65	65	65	65	65	66	66	66	66	66	66	66	66	66	66	66	66	67	67
	Class 4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V4	% Open Water <= 1.5ft	Low	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
		High	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
V5	Salinity (ppt)		10	10	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11
V6	Access Value		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Condition: Future With Project

			Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Project Area (acres)		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Emergent Marsh (acres)		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Open Water (acres)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V1	% Emergent	Low	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		High	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V2	% Aquatic	Low	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		High	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V3	Interspersion																						
	Class 1		35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 3		65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Class 5		0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
V4	% Open Water <= 1.5ft	Low	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		High	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V5	Salinity (ppt)		10	10	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11
V6	Access Value		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1-1. Example of ERDC Spreadsheet Model Input Page

A sensitivity analysis was incorporated into the fresh/intermediate, brackish and saline marsh pages of the spreadsheet which calculates and presents the outputs for Versions 1.0, 2.0 and 2.0B of the marsh models. Version 2.0 applies the SI curves suggested by reviewers for V1 and V2, and the weighted arithmetic mean Total Net AAHU calculation which is also used in Version 1.0. Version 2.0B applies the same suitability index (SI) curves for V1 and V2 but changes the aggregation method to that suggested by Battelle reviewers, which adds the net HSI marsh and open water AAHUs. All three versions incorporate the change to V3 which reduces the value of carpet marsh. Inasmuch as the change to V3 has already been incorporated into the most recent CWPPRA Marsh Model Version 1.0, a sensitivity analysis of this variable was not conducted.

Output for all three versions are shown in a table of output statistics that appear at the bottom of both the input and output pages. The original output tables for all S2G marsh impacts and mitigation measures are presented in Attachments 1 and 2, respectively. All outputs present the mean of the Monte Carlo simulation with the calculated standard deviation as well as a 95% confidence interval. Incorporating these statistics allows the user to visualize the amount of uncertainty of each simulation.

2 COMPARISON OF WVA MODEL VERSIONS

2.1 VERSION 1.0

2.1.1 V1 – Percent Emergent Marsh

The EnvWG assigned an SI of 1.0 to areas with 100 percent marsh cover of all marsh types, and an SI of 0 for areas with no marsh cover. This was based on the well–established concept that "persistent emergent vegetation plays an important role in coastal wetlands by providing foraging, resting, and breeding habitat for a variety of fish and wildlife species; and by providing a source of detritus and energy for lower trophic organisms that form the basis of the food chain (USFWS, 2010)." The model was developed for application in Coastal Louisiana and the western extent of the Chenier Plain in the east Texas coastal zone, which is losing marsh faster than any other place in the US (USACE, 2004). In this unique disappearing landscape, 100 percent emergent marsh cover was considered optimum by the EnvWG. The suitability graph is shown in Figure 2-1.
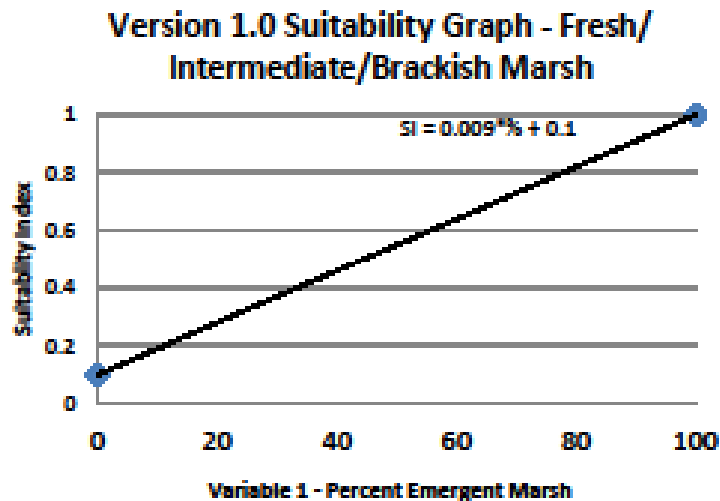

Figure 2-1. Variable 1 (Version 1.0) Marsh Suitability Graph

2.1.2 V2 – Percent Submerged Aquatic Vegetation

"Fresh and intermediate marshes often support diverse communities of floating-leaved and submerged aquatic plants that provide important food and cover to a wide variety of fish and wildlife species. A fresh/intermediate open water area with no aquatics is assumed to have low suitability (SI=0.1). Optimal conditions (SI=1.0) are assumed to occur when 100 percent of the open water is dominated by aquatic vegetation (USFWS, 2010)."

"Brackish marshes also have the potential to support aquatic plants that serve as important sources of food and cover for several species of fish and wildlife. Although brackish marshes generally do not support the amounts and kinds of aquatic plants that occur in fresh/intermediate marshes, certain species, such as widgeon-grass, and coontail and milfoil in lower salinity brackish marshes, can occur abundantly under certain conditions. Those species, particularly widgeon-grass, provide important food and cover for many species of fish and wildlife. Therefore, the V_2 Suitability Index graph in the brackish marsh model is identical to that in the fresh/intermediate model (USFWS, 2010)." The suitability graph for fresh/intermediate and brackish marsh is shown in Figure 2-2.
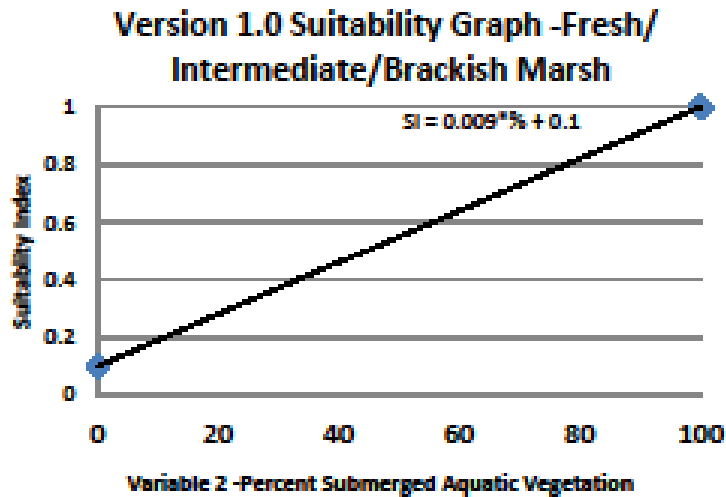

Figure 2-2. Variable 2 (Version 1.0) Marsh Suitability Graph

2.1.3 V3 – Marsh Edge and Interspersion

"This variable takes into account the relative juxtaposition of marsh and open water for a given marsh:open water ratio and is measured by comparing the project area to sample illustrations … depicting different degrees of interspersion. … A relatively high degree of interspersion in the form of tidal channels and small ponds (Class 1) is assumed to be optimal (SI=1.0); tidal channels and small ponds offer interspersion, yet are not indicative of active marsh deterioration. Numerous small marsh ponds (Class 2) offer a high degree of interspersion, but can be indicative of the onset of marsh break-up and deterioration, and are therefore assigned a lower SI of 0.6. Large ponds (Class 3) and open water areas with little surrounding marsh (Class 4) offer lower interspersion values and usually indicate advanced stages of marsh loss. Therefore, Classes 3 and 4 are assigned SIs of 0.4 and 0.2, respectively. Also grouped within Class 3 are areas of "carpet" marsh which contain no or relatively insignificant tidal channels, creeks, trenasses, ponds, or other features of interspersion but may still provide habitat for aquatic organisms during tidal flooding. Class 5 is

6

characterized by very small marsh islands (i.e., less than 5% emergent marsh) or areas made up entirely of open water. Habitat of this type provides little to no marsh edge and its function as nursery habitat for marine organisms or foraging habitat for avian predators has been significantly reduced. Although habitats represented by this classification are predominantly unvegetated open water areas, they still provide habitat for many fish and shellfish species and provide loafing areas for waterfowl and other waterbirds. Class 5 is assigned an SI of 0.1. Also grouped within Class 5 are areas characterized as solid land with no interspersion features and little to no vegetation. Newly created marsh with no ponds, creeks, or other tidal features would fall within this class (EnvWG, 2010)." The suitability graph is shown in Figure 2-3.
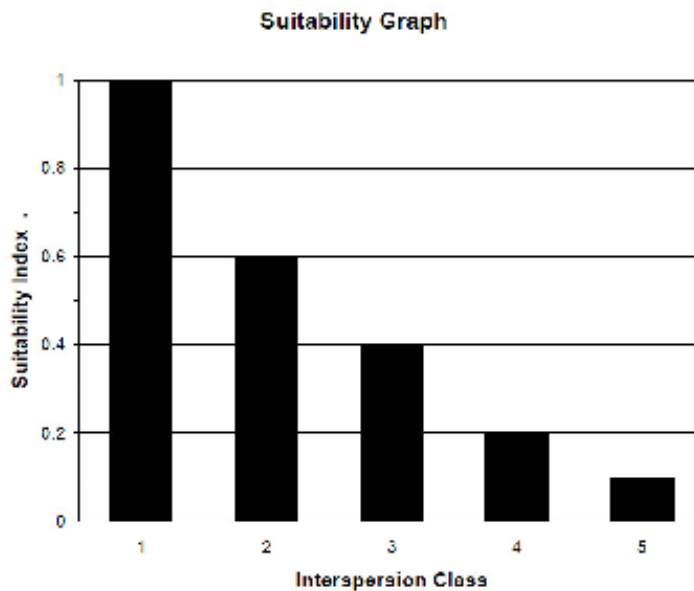
Figure 2-3. Variable 3 (Version 1) All Marsh Suitability Graph

2.1.4　　　Aggregation of Total Benefits

In the Version 1.0 aggregation method, weighted arithmetic means for emergent marsh and open water are added to calculate the Total Benefits in AAHUs. WVA emergent marsh models employ a split model format to account for the value of both marsh and open-water habitats. Two HSI formulas are calculated for each marsh type—one for emergent marsh habitat and one for open-water habitat. The HSI formula for emergent marsh contains only those variables that are important for evaluating its habitat quality (V_1, V_3, V_5, and V_6). The HSI formula for open-water habitat contains only those variables important to that habitat component (V_2, V_3, V_4, V_5, and V_6). The HSI formulae for fresh/intermediate and brackish marsh, respectively, are shown below.

Fresh/Intermediate Marsh HSI

$$Emergent\ Marsh\ HSI = \frac{(3.5 \text{ x } (SIV_1{}^5 \text{ x } SIV_6{}^1)^{(1/6)}) + \underline{(SIV_3 + SIV_5)}}{4.5}$$

$$Open\ Water\ HSI = \frac{(3.5 \text{ x } (SIV_2{}^3 \text{ x } SIV_6{}^1)^{(1/4)}) + \underline{(SIV_3 + SIV_4 + SIV_5)}}{4.5}$$

Brackish Marsh HSI

$$Emergent\ Marsh\ HSI = \frac{(3.5 \text{ x } (SIV_1{}^5 \text{ x } SIV_6{}^{1.5})^{(1/6.5)}) + \underline{(SIV_3 + SIV_5)}}{4.5}$$

$$Open\ Water\ HSI = \frac{(3.5 \text{ x } (SIV_2{}^3 \text{ x } SIV_6{}^2)^{(1/5)}) + \underline{(SIV_3 + SIV_4 + SIV_5)}}{4.5}$$

Since the marsh models are split into emergent marsh and open-water components, an HSI is calculated for both. Net AAHUs, determined for both components, must be combined to determine total net benefits. In the weighted formulas for determining net AAHUs for each marsh type (below), AAHUs for emergent marsh are weighted higher than open-water AAHUs to reflect the EnvWG emphasis on marsh restoration/protection over open-water habitat.

Fresh/Intermediate Marsh Net AAHUs $=$ $\dfrac{\textit{2.1 (Emergent Marsh AAHUs) + Open-water AAHUs}}{\textit{3.1}}$

Brackish Marsh Net AAHUs $=$ $\dfrac{\textit{2.6 (Emergent Marsh AAHUs) + Open-water AAHUs}}{\textit{3.6}}$

2.2   VERSION 2.0

2.2.1   V1 – Percent Emergent Marsh

While the EnvWG recognized that assigning 100 percent emergent marsh coverage an optimal SI of 1.0 is not supported by generally accepted ecological science, they believed it to be necessary because of the extreme marsh loss rates in the area. The reviewers felt that the inclusion of policy goals for the construction of marsh vegetation cover variables is not appropriate. One-hundred percent emergent vegetation coverage in marshes is not optimal for foraging and breeding by fish and wildlife, and it is not realistic since tidal wetlands must have tidal creeks to survive. Therefore, Version 2.0 applies the SI curves suggested by reviewers. The same curve was applied for fresh and intermediate marsh, and a slightly different curve for brackish marsh; saline marsh was not evaluated for this study and

is not covered by this sensitivity analysis. The suitability graphs for fresh/intermediate and brackish marsh are shown in Figures 2-4 and 2-5, respectively.

Version 2.0 Suitability Graph - Fresh/Intermediate Marsh

$SI = 0.02 * \%$

$SI = -0.0133 * \% + 1.9333$

Suitability Index

Variable 1 - Percent Emergent Marsh
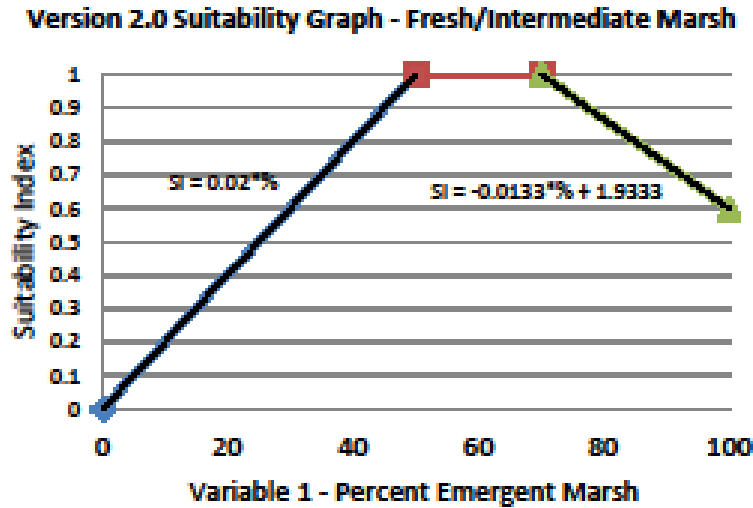
Figure 2-4. Variable 1 (Version 2.0) Fresh/Intermediate Marsh Suitability Graph

Version 2.0 Suitability Graph - Brackish Marsh

$SI = 0.018 * \% + 0.1$

$SI = -0.0167 * \% + 2.1667$

Suitability Index

Variable 1 - Percent Emergent Marsh
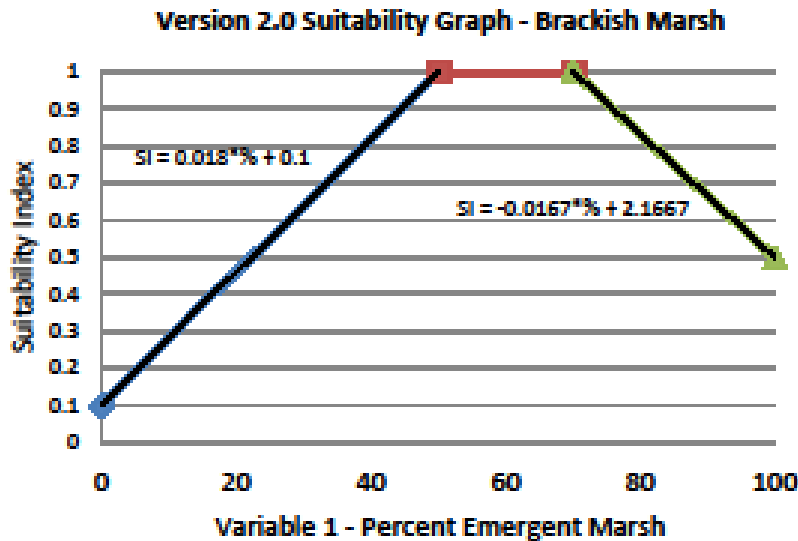
Figure 2-5. Variable 1 (Version 2.0) Brackish Marsh Suitability Graph

2.2.2   V2 – Percent Submerged Aquatic Vegetation

The reviewers commented that the SI curve for V2 is designed similarly to V1 and is not reasonable at the high end. Setting the SI value to 1.0 at 100 percent SAV cover severely limits the model. A 100 percent SAV cover is not likely to occur naturally, and thus the model can never generate an SI of 1.0, and optimum habitat conditions could never be reflected. Reviewers suggested that

an optimal cover of 70 or 80 percent would make more biological sense. The suitability graphs for fresh/intermediate and brackish marsh are shown in Figures 2-6 and 2-7, respectively.

**Version 2.0 Suitability Graph - Fresh/Intermediate Marsh**

$SI = 0.018 * \% + 0.1$

$SI = -0.0317 * \% + 3.2167$

Suitability Index

Variable 2 - Percent Submerged Aquatic Vegetation
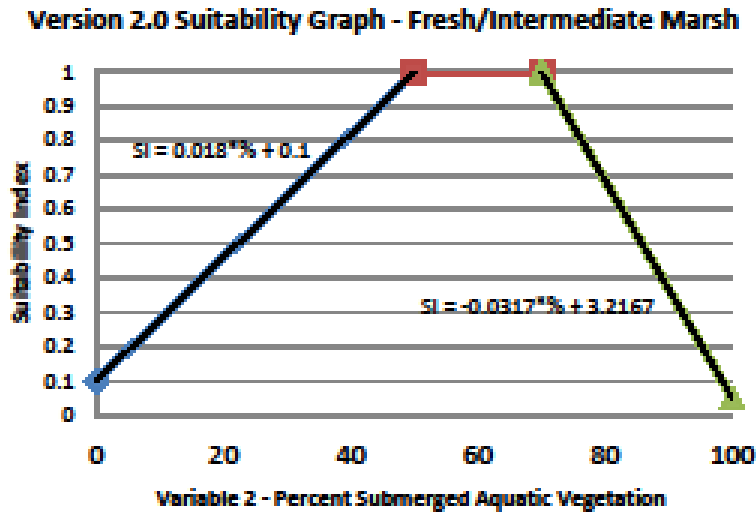
Figure 2-6. Variable 2 (Version 2.0) Fresh/Intermediate Marsh Suitability Graph

Version 2.0 Suitability Graph - Brackish Marsh

$SI = 0.014 * \% + 0.3$

$SI = -0.01 * \% + 1.7$

Suitability Index

Variable 2 - Percent Submerged Aquatic Vegetation
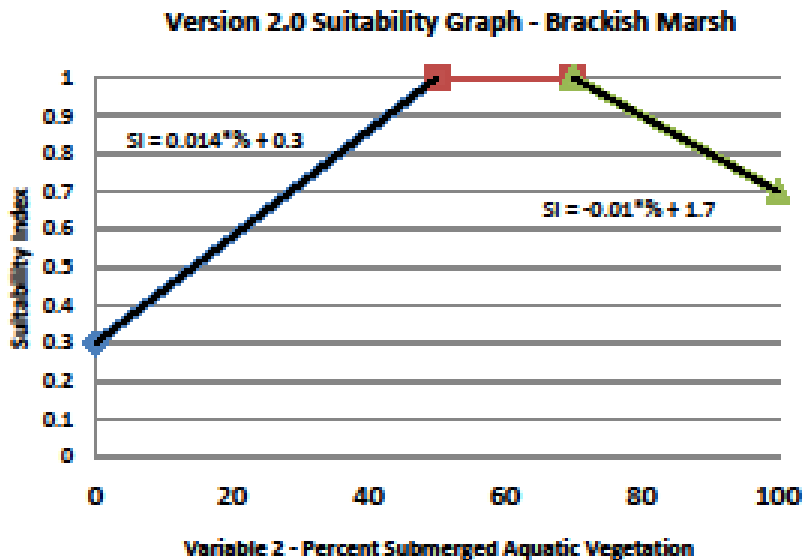
Figure 2-7. Variable 2 (Version 2.0) Brackish Marsh Suitability Graph

2.2.3   V3 – Marsh Edge and Interspersion

Battelle reviewed an earlier iteration of the Version 1.0 marsh model (USFWS, 2008), and that version ranked areas exhibiting a high degree of marsh cover (also called carpet marsh) as optimal, assigning them an SI 1.0. This was done to avoid conflicts with the premises underlying the SI

graph for V1 in Version 1.0. The rankings for this variable were modified in the Version 1.0 (USFWS, 2010) model which was utilized for the S2G WVA modeling, and is described in Section 2.1.3. Carpet marsh is ranked as Class 3 in this most recent version.

2.2.4 Aggregation of Total Benefits

WVA Version 2.0 utilizes the Version 1.0 aggregation method described in Section 2.1.4.

2.3 VERSION 2.0B

2.3.1 V1 (Percent Emergent Marsh) and V2 (Percent Submerged Aquatic Vegetation

WVA Version 2.0B utilizes the Version 2.0 SIs for both V1 and V2.

2.3.2 V3 – Marsh Edge and Interspersion

WVA Version 2.0B utilizes the Version 1.0 SI for V3.

2.3.3 Aggregation of Total Benefits

In Version 2.0B, the net marsh and open water AAHUs are calculated by simple addition. The reviewers believed that averaging the emergent marsh and open water values in any form is incorrect, because it results in model output of fewer AAHUs than are being evaluated. The reviewers stated that "It is inappropriate to carry out the weighting when calculating benefits measured by AAHUs. Weighting would more appropriately be applied at the HSI level, not the AAHU level (Battelle, 2010).

3 SENSITIVITY ANALYSIS AND RESULTS

3.1   METHODOLOGY

The sensitivity of the WVA model outputs for impacts and mitigation measures to the suggested SI changes in V1 and V2 has been assessed. AAHUs of direct and indirect impacts associated with construction and operation of the proposed Orange levee system, and compensation provided by each mitigation measure in the final array of mitigation measures, were calculated using the ERDC WVA spreadsheet. This spreadsheet referenced the data input cells of the Version 1.0 model using the Version 2.0/2.0B model equations, and all model results are contained in the same Excel workbook. The results for impacts and mitigation are provided in Attachments 1 and 2, respectively.

The magnitude of change was quantified in terms of the percent change of the total AAHUs, as well as to the emergent marsh and open water habitats. The effects of the new model outputs on the selection of Best Buy mitigation plans are also assessed. Tables 3-1 and 3-2 summarize the results of the application of the new SIs in terms of percent change of net AAHUs to relative to Version 1.0 model runs. Percentage differences are calculated using the following equation.

$$Percent\ AAHU\ change = \frac{AAHU_{Version\ 2.0\ or\ 2.0B} - AAHU_{Version\ 1.0}}{AAHU_{Version\ 2.0\ or\ 2.0B}} \times 100$$

3.2   RESULTS OF THE ANALYSIS

WVA Versions 2.0 and 2.0B generally resulted in higher AAHU impacts than Version 1.0. The overall percentage change in mean AAHU impact output for Version 2.0 was a 16.3 percent increase, and the percent change for Version 2.0B was a 50.9 percent increase. For mitigation, the overall percentage change in mean AAHU output for Version 2.0 was a 59 percent increase in required compensation, and the percent change for Version 2.0B was a 119.9 percent increase. Some of the percentage changes for the mitigation measures shown in Table 3-2 are extremely large (i.e. -3319 percent), and this was the result of making the percentage comparisons to very small numbers; thus percentage changes were very large.

Care must be taken when evaluating the percentage changes, especially when reviewing the Version 2.0B results for mitigation. Version 2.0B actually yielded negative results (i.e. impacts versus benefits) for some of the mitigation measures; the reason for this will be discussed below. This results in positive percentage changes for mitigation measures 27, 28, and 31, which mean that the negative values are increasing under Version 2.0B.

Table 3-1. Percent Change in Marsh Impacts Between Versions 2.0/2.0B and Version 1.0

	Version 2.0 Percent Change			Version 2.0B Percent Change		
	Emergent Marsh	Open Water	Total Net Benefits	Emergent Marsh	Open Water	Total Net Benefits
Fresh Marsh						
F-1 Direct Impacts Bessie Heights	-35.0%	16.3%	-35.0%	-35.0%	16.3%	8.7%
F-2 Direct Impacts Old River Cove	-34.1%	29.0%	-32.2%	-34.1%	29.0%	13.3%
F-3 Direct Impacts Chemical Row	-38.1%	22.1%	-37.9%	-38.1%	22.1%	6.9%
F-4 Direct Impacts Adams Bayou	18.7%	27.8%	19.9%	28.8%	27.8%	52.7%
F Indirect-2 Cow Bayou Fisheries Access	34.2%	33.8%	34.1%	34.2%	33.8%	64.5%
F Indirect-3-Adams Bayou Fisheries Access	34.3%	26.4%	29.3%	34.3%	26.4%	71.9%
Net Change			21.2%			62.0%
Intermediate Marsh						
I-1 Direct Impacts Old River Cove	-31.3%	16.9%	-30.7%	-31.3%	16.9%	12.7%
I-2 Direct Impacts Cow Bayou	-31.5%	14.5%	-31.4%	-31.5%	14.5%	11.3%
I-3 Direct Impacts Adams Bayou	-36.8%	25.4%	-36.7%	-36.8%	25.4%	7.6%
I Indirect-1 and 2 Thru TY30 Hydrologic Impacts	5.9%	24.2%	7.7%	5.9%	24.2%	43.6%
I Indirect-3-Cow Bayou Fisheries Access	33.3%	33.6%	33.4%	33.3%	33.6%	64.1%
I Indirect-4-Adams Bayou Fisheries Access	28.8%	33.8%	29.8%	28.8%	33.8%	60.6%
Net Change			9.4%			46.1%
Brackish Marsh						
B-1 Direct Impacts Old River Cove	-30.0%	28.6%	-28.9%	-30.0%	28.6%	4.2%
B-2 Direct Impacts Cow Bayou	19.9%	28.2%	20.7%	19.9%	28.2%	50.4%
B-3 Direct Impacts Adams Bayou	-41.1%	29.0%	-41.0%	-41.1%	29.0%	-8.9%
B Indirect-I 1 and2 Switch Brackish TY31 - Hydrologic Impacts	6.5%	25.6%	7.9%	6.5%	25.6%	39.5%
B Indirect-2 Cow Bayou-Hydrologic Impacts	14.2%	16.1%	14.4%	14.2%	16.1%	47.2%
B Indirect-3 Persistent Marsh- Hydrologic Impacts	-0.1%	16.1%	1.1%	-0.1%	16.1%	35.3%
B Indirect-3 Marsh Migration-Hydrologic Impacts	24.8%	-0.4%	24.6%	24.8%	-0.4%	42.1%
B Indirect-4 Cow Bayou Fisheries Impacts	30.3%	35.0%	31.1%	30.3%	35.0%	63.3%
B Indirect-5 Adams Bayou Fishery Access Impacts	11.9%	34.3%	14.1%	11.9%	34.3%	46.8%
B Indirect-S-2 Switch TY31-Hydrologic Impacts	-10.7%	1.5%	-10.7%	-10.7%	1.5%	15.1%
Net Change			15.8%			46.8%
Overall Totals						
Total Net Mean		-171.1			-291.4	
Lower 95% Confidence Interval		-172.5			-294.1	
Upper 95% Confidence Interval		-169.7			-288.7	
Standard Deviation		1.4			2.7	
Total Percent Net Change From Version 1.0 Total Net Mean (-143.1)		16.3%			50.9%	

3.2.1 Sensitivity of the Impacts Analysis

As would be expected, total net outputs are greatly influenced by the existing percentage of marsh cover (V1) (USFWS, 2010). The relative contribution of V1 to the overall HSI equation for fresh/

Table 3-2. Percent Change in Marsh Mitigation Between Version 2.0/2.0B and Version 1.0

	Version 2.0 Percent Change			Version 2.0B Percent Change		
	Emergent Marsh	Open Water	Total Net Benefits	Emergent Marsh	Open Water	Total Net Benefits
Fresh Marsh						
Mit 42 Scale 1	-32.6%	12.2%	-45.9%	-32.6%	12.2%	-46.9%
Mit 42 Scale 2	2.5%	12.7%	0.2%	2.5%	12.7%	11.2%
Mit 52	-225.2%	13.4%	-368.0%	-225.2%	13.4%	-826.5%
Net Change						
Intermediate Marsh						
Mit 31	-135.0%	21.6%	-298.6%	-135.0%	21.6%	1909.1%
Mit 32	22.4%	536.6%	26.3%	22.4%	536.6%	50.5%
Mit 143	21.1%	29.1%	20.0%	21.1%	29.1%	36.1%
Net Change						
Brackish Marsh						
Mit 27	-84.1%	24.2%	-161.1%	-84.1%	24.2%	360.9%
Mit 28	-322.2%	23.8%	-3319.3%	-322.2%	23.8%	228.8%
Mit 29	-19.6%	40.5%	-29.8%	-19.6%	40.5%	-74.8%
Net Change						
Overall Totals						
Total Net Mean		237.6			171.8	
Lower 95% Confidence Interval		236.3			169.4	
Upper 95% Confidence Interval		238.8			174.2	
Standard Deviation		1.2			2.4	
Total Percent Net Change From Version 1.0 Total Net Mean (377.84)		-59.0%			-119.9%	

intermediate and brackish marsh are 43.9 percent and 43.2 percent, respectively. V2 has a lower contribution, providing 18.8 percent and 13.0 percent of the total net output for the fresh/intermediate and brackish marsh HSI models, respectively.

In Version 2.0 of the model, the V1 SI for fresh/intermediate marsh drops from 1.0 at 70 percent cover to 0.6 at 100 percent marsh cover; for brackish marsh, the SI drops from 1.0 at 70 percent cover to 0.5 at 100 percent marsh cover. In the S2G impact areas, generally there were two degrees of marsh cover – either around 100 percent cover or within a range of 50 to 75 percent cover. For 100 percent marsh cover, Version 2.0 results in lower impacts because total marsh cover percentages between 70-100 percent are not ranked as highly as in Version 1.0. The decrease in impacts is about -30 to -40 percent. For those areas with marsh cover in the 50-75 percent range,

impacts are higher for Version 2.0 because this percentage of marsh cover receives an SI at or near 1.0, while in Version 1.0, the SIs for this degree of cover ranges from 0.5 to 0.7.

The Version 2.0 changes to the V2 SI also resulted in increasing impacts, but to a much lesser overall degree than for V1. Almost all of the impact areas exhibited SAV cover between 0-50 percent. Version 2.0 results in slightly higher impacts for this range (SI between 0.1 - 1.0) than Version 1.0, with SIs between 0.1 and 0.6.

Version 2.0B results in higher impacts overall with impacts increasing for 100 percent marsh cover by 7 to 40 percent. For areas with 50-75 percent marsh cover, impacts increased from 44 to 63 percent. This is due solely to the different aggregation method, which adds net marsh and net open water AAHUs rather than using the weighted average method that is applied in Versions 1.0 and 2.0. Using simple addition results in higher net impacts, and it also gives equal weighting to marsh and open water habitat. The appropriateness of an equal weighting is questionable. Although neither marsh nor open water could be ecological viable without the other in this estuarine environment, marsh has greater relative value because it provides nutrients and cover for aquatic species that would not be available in a 100 percent open water environment. In other words, it takes less open water than marsh cover to make a marsh system valuable to all aquatic and terrestrial species. The WVA models were developed specifically for the coastal regions of Louisiana and East Texas where rates of marsh loss are extremely high (USFWS, 2010). The marshes in this region are comprised of organic soils, which erode more easily when marsh vegetation is lost due to relative sea level rise or salinity intrusion, and convert readily to open water. In this area, giving marsh a greater weight than water in determining net AAHUs appears to be more appropriate.

The new models would have had no effect on selection of the Tentatively Selected Plan (TSP). The screening of alternatives for inclusion in the TSP used estimates of mitigation costs included in the preliminary cost/benefit analysis, but these costs were small when compared to overall construction costs and, therefore, they did not affect plan selection. The mitigation estimates were based on the cost per acre of similar mitigation measures developed for previous studies in this area. A detailed mitigation plan was not developed for the TSP because the final feasibility design was developed after release of the TSP report. Final impacts and mitigation were developed using the WVA model and the IWR Planning Suite (Version 2.0) during the final feasibility phase.

3.2.2 Sensitivity of the Mitigation Plan

Selection of the final mitigation plan would be highly sensitive to the WVA model version applied. Compensation (e.g. benefits) provided by the mitigation measures was highly dependent upon the resulting percentage cover of emergent marsh and the amount of existing marsh within the area prior to restoration. When marsh restoration results in total emergent marsh between 50 and about

75 percent, Versions 2.0 and 2.0B yield higher net benefits that Version 1.0. For Versions 2.0 and 2.0B only, when the total restored area of emergent marsh exceeds about 75 percent, the net benefits are generally lower than Versions 1.0.

Three mitigation measures (27, 28 and 31) actually yielded negative AAHUs under Version 2.0B. The aggregation method used for Version 2.0B, which gives equal weight to net marsh and open water HSIs, quantifies the restoration as a reduction in the overall quality of the marsh below that of the existing condition. These areas include substantial percentages of existing, though degraded, marsh. Figure 3-1 shows the existing conditions at mitigation measures 28 and 29. The proposed restoration effort would nourish existing, breaking and subsiding marsh and create new marsh in 65 percent of the existing open water. Sinuous channels and small, shallow ponds would be created in 35 percent of the existing open water. This results in a total marsh percentage, after restoration, of about 85 percent. Under Version 2.0B, the resulting restoration effort would be considered an impact and result in negative AAHUs, with total net benefits being reduced by 75 percent when compared to Version 1.0.

Marsh restoration in areas with little or no existing marsh such as I-32 (a mitigation measure not selected for the Mitigation Plan using Version 1.0, and shown in Figure 3-2) result in a total percentage of emergent marsh within the optimum range (between 50 and 70 percent), and benefits that are higher than those produced under Version 1.0. Versions 2.0 and 2.0B produce increases in benefits of about 25 percent and 50 percent, respectively.   Use of Version 2.0 would make it difficult to identify cost effective measures for nourishing areas within existing, degraded marsh, and Version 2.0B would make it impossible to produce net benefits.

As noted above, impacts generally increased under both new versions. In most cases, the compensation provided by the mitigation measures also decreased, and the cost effectiveness ranking of mitigation measures changed. This would result in different mitigation plans and additional mitigation under either of the new versions. Mitigation compensation (AAHUs), determined using WVA Versions 2.0 and 2.0B, was compared to average annual costs using the IWR Planning Suite. The cost effectiveness/incremental cost analysis identified new Best Buy plans identified in Table 3-3.

Using Version 2.0, the mitigation target (e.g. total impacts) increased from -145.0 to -171 AAHUs, All of the fresh marsh mitigation areas combined would provide 37.9 AAHUs, which is roughly equal to the -38.4 AAHUs of fresh marsh impacts calculated in this version. The Best Buy plan selected for intermediate marsh changed to measure 143, which provides well more than the needed compensation. However, all of the brackish marsh mitigation areas combined would provide 49.4 AAHUs of compensation, well short of the -114.5 AAHUs of impacts calculated under Version 2.0.
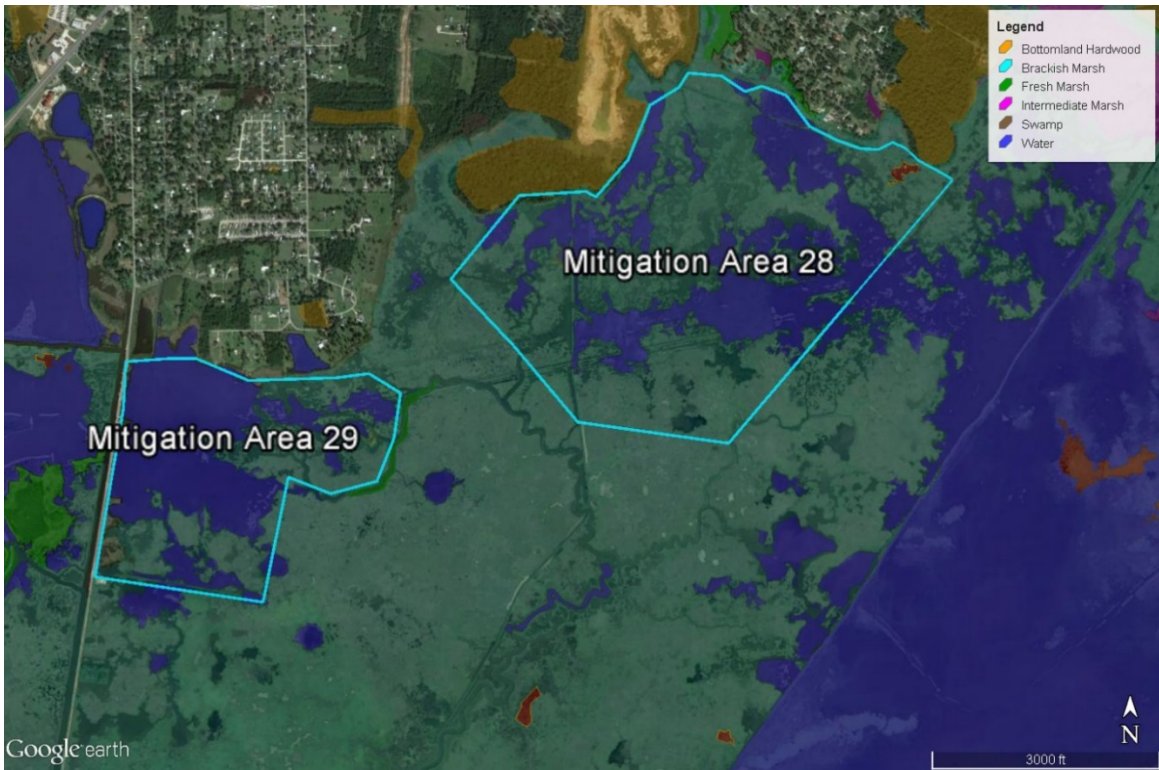
Figure 3-1. Brackish Marsh Mitigation Measures 28 and 29
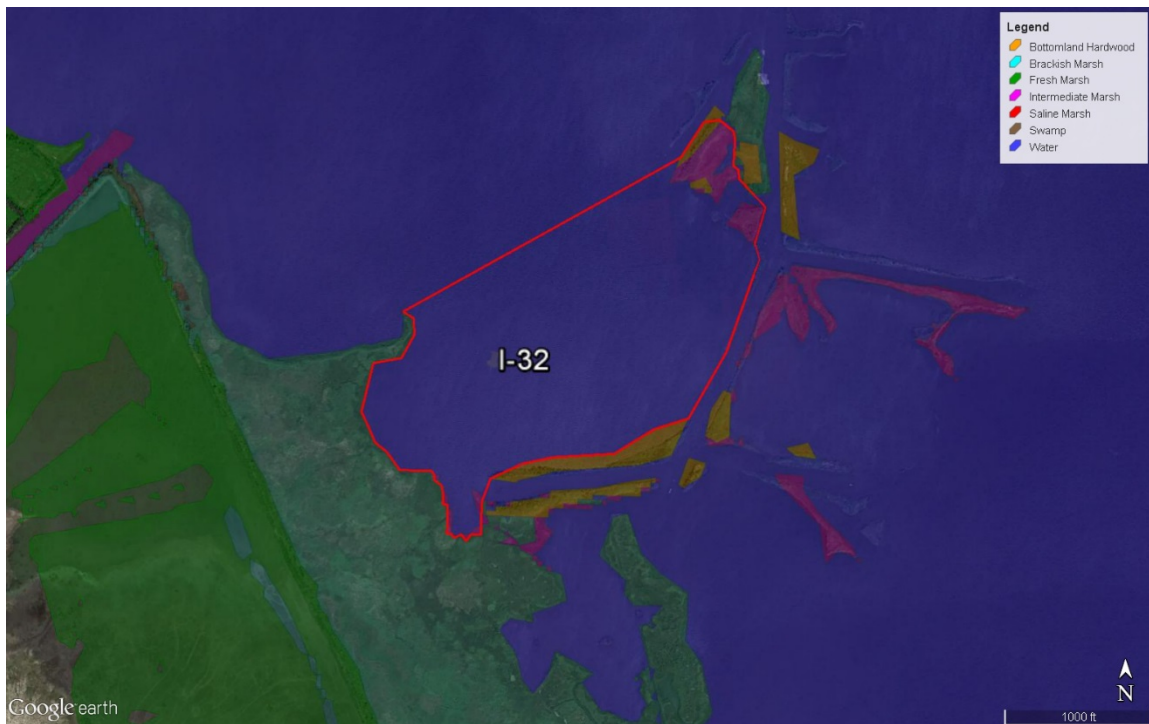
Figure 3-2. Marsh Mitigation Alternative I-32

Table 3-3. Comparison of Mitigation Between WVA Versions 2.0/2.0B and Version 1.0

Marsh Type	WVA Version 1.0				WVA Version 2.0				WVA Version 2.0B			
	Mitigation Target	Best Buy (BB) Plan Measure(s)	Mitigation Compensation (AAHUs)	Average Annual Cost ($1,000)	Mitigation Target	BB Plan Measure(s)	Mitigation Compensation (AAHUs)	Average Annual Cost ($1,000)	Mitigation Target	BB Plan Measure(s)	Mitigation Compensation (AAHUs)	Average Annual Cost ($1,000)
Fresh	-30.2	F52	33.4	$ 82.9	-38.4	F42(2)+F52	37.9	$ 355.6	-79.6	F42(2)+F52	37.9	$ 711.2
Intrmd	-18.2	I31	60.4	$ 243.1	-18.3	I143	94.5	567.6	-30.7	I143	118.3	567.6
Brackish	-96.6	B28 & B29	100.4	$ 310.1	-114.5	B27+B28+B29	49.4	683.7	-181.1	B29	24.0	920.0
Totals	-145.0		194.2	$ 636.1	-171.2		181.8	$ 1,606.9	-291.4		180.2	$ 2,198.8

Red numbers indicate that the compensation is lower than the mitigation target for the specific marsh type.

It is estimated that the average annual cost of the mitigation plan would be about $1,600, or a 150 percent increase over Version 1.0.

Using Version 2.0B, the mitigation target (e.g. total impacts) increased from -145.0 to -291.4 AAHUs. All of the fresh marsh mitigation areas combined would provide 37.9 AAHUs, which is 41.7 AAHUs less than the amount needed to fully compensate for impacts to fresh marsh. New mitigation areas would need to be identified for brackish marsh as well, as Mitigation Areas 27 and 28 yield negative AAHUs under Version 2.0B, and Mitigation Area 29 provides only 24.0 AAHUs of compensation, well below the brackish marsh mitigation target of 181 AAHUs. Mitigation Area 29 has less existing marsh than the others, and therefore scores better under Version 2.0B. It is estimated that the average annual cost of the mitigation plan would be about $2,200, or about a 250 percent increase over Version 1.0. The magnitude of the mitigation plan cost increase under Version 2.0B increases the possibility that the selection of the Recommended Plan could be different than that chosen using Version 1.0.

3.3   CONCLUSION

In conclusion, use of WVA Versions 2.0 and 2.0B in this case study generally resulted in higher impacts and greater mitigation than Version 1.0, and could significantly affect plan selection if applied to future studies. Version 2.0 results in higher impacts for those areas with marsh cover in the 50-75 percent range. In this case study, impacts ranged from 1 to 41 percent higher than Version 1.0, with a total net percentage increase of about 16 percent.

Version 2.0B increases impacts in areas with existing emergent marsh less than or equal to about 50 percent. Since available mitigation sites in this study area generally contain well more than 50 percent emergent marsh, impacts ranged from 7 to 72 percent, with a total net percentage increase of about 51 percent.

The total net percent changes in compensation provided by mitigation areas under Versions 2.0 and 2.0B   were generally lower than Version 1.0. Percentage changes varied widely, and were

greatly affected by the amount of existing marsh within the proposed mitigation areas.   For Version 2.0, the percentage change in total net AAHUS ranged from +26 to -3,319 percent, with the majority ranging from -46 to -368 percent, and a total net percentage of -59 percent. For Version 2.0B, the percentage change in total net AAHUs ranged from +1,909 to -826 AAHUs, with the majority ranging from +360 to -47 AAHUs, and a total net percentage of about -120 percent. Large positive percent changes were often the result of a large change toward negative AAHUs.

These results are affected primarily by changes made to V1 in both versions, and the aggregation method used in Version 2.0B. Under Version 2.0B, many of the proposed mitigation areas would result in negative AAHUs because of the presence of a significant percentage of existing, degraded marsh. This would make it very difficult to identify cost effective mitigation measures that would nourish degrading marsh and restore new marsh in the same general area.

4 REFERENCES

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ATTACHMENT 1
WVA MARSH IMPACTS SENSITIVITY RESULTS

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Fresh Marsh

DIRECT IMPACTS

S2G F-1 Revised Impacts Bessie Heights 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.02	0.00	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.00	0.02	0.02
B. Future Without Project Emergent Marsh AAHUs=	1.26	0.00	1.26	1.26	1.26	0.00	1.26	1.26	1.70	0.00	1.70	1.70
Net Change (FWP - FWOP)=	-1.24	0.00	-1.24	-1.24	-1.24	0.00	-1.24	-1.24	-1.67	0.00	-1.67	-1.67
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-1.24	0.00	-1.24	-1.24	-1.24	0.00	-1.24	-1.24	-1.67	0.00	-1.67	-1.67
B. Open Water Habitat Net AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Benefits=	-0.84	0.00	-0.84	-0.84	-1.24	0.00	-1.24	-1.24	-1.13	0.00	-1.13	-1.13

S2G F-2 Recommended Plan Impacts Old River Cove 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.08	0.00	0.08	0.08	0.08	0.00	0.08	0.08	0.11	0.00	0.11	0.11
B. Future Without Project Emergent Marsh AAHUs=	5.48	0.02	5.47	5.48	5.48	0.02	5.47	5.48	7.34	0.01	7.34	7.35
Net Change (FWP - FWOP)=	-5.40	0.02	-5.40	-5.40	-5.40	0.02	-5.40	-5.40	-7.24	0.01	-7.24	-7.24
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.36	0.00	0.35	0.36	0.36	0.00	0.35	0.36	0.25	0.00	0.25	0.25
Net Change (FWP - FWOP)=	-0.35	0.00	-0.35	-0.35	-0.35	0.00	-0.35	-0.35	-0.25	0.00	-0.25	-0.25
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-5.40	0.02	-5.40	-5.40	-5.40	0.02	-5.40	-5.40	-7.24	0.01	-7.24	-7.24
B. Open Water Habitat Net AAHUs=	-0.35	0.00	-0.35	-0.35	-0.35	0.00	-0.35	-0.35	-0.25	0.00	-0.25	-0.25
Net Benefits=	-3.77	0.01	-3.77	-3.77	-5.75	0.02	-5.76	-5.75	-4.98	0.01	-4.99	-4.98

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Fresh Marsh

S2G F-3 Recommended Plan Impacts Chemical Row 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01
B. Future Without Project Emergent Marsh AAHUs=	0.39	0.00	0.39	0.39	0.39	0.00	0.39	0.39	0.54	0.00	0.54	0.54
Net Change (FWP - FWOP)=	-0.38	0.00	-0.38	-0.38	-0.38	0.00	-0.38	-0.38	-0.53	0.00	-0.53	-0.53
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-0.38	0.00	-0.38	-0.38	-0.38	0.00	-0.38	-0.38	-0.53	0.00	-0.53	-0.53
B. Open Water Habitat Net AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Benefits=	-0.26	0.00	-0.26	-0.26	-0.39	0.00	-0.39	-0.38	-0.36	0.00	-0.36	-0.36

S2G F-4 Recommended Plan Impacts Adams Bayou 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.11	0.00	0.11	0.11	0.11	0.00	0.11	0.11	0.09	0.00	0.09	0.09
B. Future Without Project Emergent Marsh AAHUs=	7.93	0.02	7.93	7.93	7.93	0.02	7.93	7.93	6.44	0.01	6.44	6.45
Net Change (FWP - FWOP)=	-7.82	0.02	-7.82	-7.81	-7.82	0.02	-7.82	-7.81	-6.35	0.01	-6.36	-6.35
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.04	0.00	0.04	0.04	0.04	0.00	0.04	0.04	0.03	0.00	0.03	0.03
B. Future Without Project Open Water AAHUs=	2.57	0.03	2.56	2.57	2.57	0.03	2.56	2.57	1.85	0.02	1.85	1.86
Net Change (FWP - FWOP)=	-2.53	0.03	-2.54	-2.52	-2.53	0.03	-2.54	-2.52	-1.83	0.02	-1.83	-1.82
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-7.82	0.02	-7.82	-7.81	-7.82	0.02	-7.82	-7.81	-6.35	0.01	-6.36	-6.35
B. Open Water Habitat Net AAHUs=	-2.53	0.03	-2.54	-2.52	-2.53	0.03	-2.54	-2.52	-1.83	0.02	-1.83	-1.82
Net Benefits=	-6.11	0.01	-6.11	-6.11	-10.35	0.03	-10.35	-10.34	-4.89	0.01	-4.89	-4.89

Sabine Pass to Galveston Bay Feasibility Study
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INDIRECT IMPACTS

S2G F Indirect-2 Cow Bayou Fisheries Access	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	381.86	0.39	381.78	381.94	381.86	0.39	381.78	381.94	291.05	1.75	290.71	291.40
B. Future Without Project Emergent Marsh AAHUs=	394.04	0.37	393.97	394.11	394.04	0.37	393.97	394.11	299.07	1.73	298.73	299.41
Net Change (FWP - FWOP)=	-12.18	0.42	-12.26	-12.10	-12.18	0.42	-12.26	-12.10	-8.02	2.38	-8.48	-7.55
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	170.72	2.75	170.18	171.26	170.72	2.75	170.18	171.26	125.61	1.58	125.30	125.92
B. Future Without Project Open Water AAHUs=	178.54	2.56	178.04	179.04	178.54	2.56	178.04	179.04	130.78	1.48	130.49	131.07
Net Change (FWP - FWOP)=	-7.82	3.90	-8.58	-7.06	-7.82	3.90	-8.58	-7.06	-5.18	2.25	-5.62	-4.74
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-12.18	0.42	-12.26	-12.10	-12.18	0.42	-12.26	-12.10	-8.02	2.38	-8.48	-7.55
B. Open Water Habitat Net AAHUs=	-7.82	3.90	-8.58	-7.06	-7.82	3.90	-8.58	-7.06	-5.18	2.25	-5.62	-4.74
Net Benefits=	-10.77	1.26	-11.02	-10.53	-20.00	3.88	-20.76	-19.24	-7.10	1.78	-7.45	-6.75

S2G F Indirect-3-Adams Bayou Fisheries Access	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	50.53	0.09	50.51	50.55	50.53	0.09	50.51	50.55	37.27	0.23	37.22	37.31
B. Future Without Project Emergent Marsh AAHUs=	59.30	0.10	59.28	59.32	59.30	0.10	59.28	59.32	43.02	0.25	42.97	43.07
Net Change (FWP - FWOP)=	-8.77	0.12	-8.79	-8.74	-8.77	0.12	-8.79	-8.74	-5.76	0.31	-5.82	-5.69
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.82	0.05	0.81	0.83	0.82	0.05	0.81	0.83	0.63	0.03	0.62	0.63
B. Future Without Project Open Water AAHUs=	33.88	0.52	33.78	33.99	33.88	0.52	33.78	33.99	24.94	0.30	24.89	25.00
Net Change (FWP - FWOP)=	-33.06	0.52	-33.17	-32.96	-33.06	0.52	-33.17	-32.96	-24.32	0.30	-24.38	-24.26
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-8.77	0.12	-8.79	-8.74	-8.77	0.12	-8.79	-8.74	-5.76	0.31	-5.82	-5.69
B. Open Water Habitat Net AAHUs=	-33.06	0.52	-33.17	-32.96	-33.06	0.52	-33.17	-32.96	-24.32	0.30	-24.38	-24.26
Net Benefits=	-16.60	0.20	-16.64	-16.56	-41.83	0.55	-41.94	-41.72	-11.74	0.25	-11.79	-11.69

IMPACT SUMMARY

Direct Impact Subtotals	-10.98		-10.99	-10.98	-17.73		-17.74	-17.71	-11.37		-11.37	-11.36
Indirect Impact Subtotals	-27.38		-27.66	-27.09	-61.83		-62.70	-60.96	-18.84		-19.24	-18.45
Totals	**-38.36**		**-38.65**	**-38.07**	**-79.55**		**-80.43**	**-78.67**	**-30.21**		**-30.61**	**-29.81**

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Intermediate Marsh

DIRECT IMPACTS

S2G I-1 Recommended Plan Impacts Old River Cove 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Emergent Marsh AAHUs=	0.20	0.00	0.20	0.20	0.20	0.00	0.20	0.20	0.26	0.00	0.26	0.26
Net Change (FWP - FWOP)=	-0.20	0.00	-0.20	-0.20	-0.20	0.00	-0.20	-0.20	-0.26	0.00	-0.26	-0.26
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)=	-0.01	0.00	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-0.20	0.00	-0.20	-0.20	-0.20	0.00	-0.20	-0.20	-0.26	0.00	-0.26	-0.26
B. Open Water Habitat Net AAHUs=	-0.01	0.00	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00
Net Benefits=	-0.13	0.00	-0.13	-0.13	-0.20	0.00	-0.20	-0.20	-0.18	0.00	-0.18	-0.18

S2G I-2 Recommended Plan Impacts Cow Bayou 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.05	0.00	0.05	0.05	0.05	0.00	0.05	0.05	0.06	0.00	0.06	0.06
B. Future Without Project Emergent Marsh AAHUs=	3.32	0.01	3.32	3.32	3.32	0.01	3.32	3.32	4.37	0.01	4.37	4.37
Net Change (FWP - FWOP)=	-3.27	0.01	-3.28	-3.27	-3.27	0.01	-3.28	-3.27	-4.30	0.01	-4.31	-4.30
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.02	0.00	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.00	0.02	0.02
Net Change (FWP - FWOP)=	-0.02	0.00	-0.02	-0.02	-0.02	0.00	-0.02	-0.02	-0.02	0.00	-0.02	-0.02
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-3.27	0.01	-3.28	-3.27	-3.27	0.01	-3.28	-3.27	-4.30	0.01	-4.31	-4.30
B. Open Water Habitat Net AAHUs=	-0.02	0.00	-0.02	-0.02	-0.02	0.00	-0.02	-0.02	-0.02	0.00	-0.02	-0.02
Net Benefits=	-2.22	0.01	-2.23	-2.22	-3.29	0.01	-3.30	-3.29	-2.92	0.01	-2.92	-2.92

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Intermediate Marsh

S2G I-3 Recommended Plan Impacts Adams Bayou 2016	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.00	0.02	0.02
B. Future Without Project Emergent Marsh AAHUs=	0.95	0.00	0.95	0.95	0.95	0.00	0.95	0.95	1.30	0.00	1.30	1.30
Net Change (FWP - FWOP)=	-0.94	0.00	-0.94	-0.94	-0.94	0.00	-0.94	-0.94	-1.29	0.00	-1.29	-1.29
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-0.94	0.00	-0.94	-0.94	-0.94	0.00	-0.94	-0.94	-1.29	0.00	-1.29	-1.29
B. Open Water Habitat Net AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Benefits=	-0.64	0.00	-0.64	-0.64	-0.94	0.00	-0.94	-0.94	-0.87	0.00	-0.87	-0.87

INDIRECT IMPACTS

S2G I Indirect-1 and 2 Thru TY30 Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.37	0.00	0.36	0.37	0.37	0.00	0.36	0.37	0.34	0.00	0.34	0.34
B. Future Without Project Emergent Marsh AAHUs=	12.68	0.15	12.65	12.71	12.68	0.15	12.65	12.71	11.92	0.11	11.90	11.94
Net Change (FWP - FWOP)=	-12.31	0.15	-12.34	-12.28	-12.31	0.15	-12.34	-12.28	-11.58	0.11	-11.61	-11.56
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.08	0.00	0.08	0.08	0.08	0.00	0.08	0.08	0.06	0.00	0.06	0.06
B. Future Without Project Open Water AAHUs=	2.91	0.06	2.90	2.92	2.91	0.06	2.90	2.92	2.20	0.03	2.20	2.21
Net Change (FWP - FWOP)=	-2.83	0.06	-2.84	-2.82	-2.83	0.06	-2.84	-2.82	-2.14	0.03	-2.15	-2.14
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-12.31	0.15	-12.34	-12.28	-12.31	0.15	-12.34	-12.28	-11.58	0.11	-11.61	-11.56
B. Open Water Habitat Net AAHUs=	-2.83	0.06	-2.84	-2.82	-2.83	0.06	-2.84	-2.82	-2.14	0.03	-2.15	-2.14
Net Benefits=	-9.25	0.11	-9.27	-9.23	-15.14	0.16	-15.17	-15.11	-8.54	0.08	-8.55	-8.52

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Intermediate Marsh

S2G I Indirect-3-Cow Bayou Fisheries Access	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	159.39	0.16	159.36	159.42	159.39	0.16	159.36	159.42	123.23	0.70	123.09	123.37
B. Future Without Project Emergent Marsh AAHUs=	165.09	0.15	165.06	165.12	165.09	0.15	165.06	165.12	127.03	0.69	126.89	127.17
Net Change (FWP - FWOP)=	-5.70	0.17	-5.73	-5.67	-5.70	0.17	-5.73	-5.67	-3.80	0.95	-3.99	-3.61
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	70.82	1.09	70.61	71.03	70.82	1.09	70.61	71.03	52.92	0.63	52.79	53.04
B. Future Without Project Open Water AAHUs=	74.48	1.03	74.28	74.68	74.48	1.03	74.28	74.68	55.35	0.59	55.23	55.46
Net Change (FWP - FWOP)=	-3.66	1.55	-3.96	-3.35	-3.66	1.55	-3.96	-3.35	-2.43	0.89	-2.60	-2.25
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-5.70	0.17	-5.73	-5.67	-5.70	0.17	-5.73	-5.67	-3.80	0.95	-3.99	-3.61
B. Open Water Habitat Net AAHUs=	-3.66	1.55	-3.96	-3.35	-3.66	1.55	-3.96	-3.35	-2.43	0.89	-2.60	-2.25
Net Benefits=	-5.04	0.50	-5.14	-4.94	-9.36	1.54	-9.66	-9.05	-3.36	0.71	-3.50	-3.22

S2G I Indirect-4-Adams Bayou Fisheries Access	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	33.04	0.10	33.02	33.06	33.04	0.10	33.02	33.06	26.91	0.16	26.88	26.94
B. Future Without Project Emergent Marsh AAHUs=	34.24	0.11	34.22	34.26	34.24	0.11	34.22	34.26	27.76	0.15	27.73	27.79
Net Change (FWP - FWOP)=	-1.20	0.11	-1.22	-1.18	-1.20	0.11	-1.22	-1.18	-0.85	0.20	-0.89	-0.81
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	11.41	0.18	11.37	11.44	11.41	0.18	11.37	11.44	8.51	0.10	8.49	8.53
B. Future Without Project Open Water AAHUs=	12.00	0.16	11.96	12.03	12.00	0.16	11.96	12.03	8.90	0.09	8.88	8.92
Net Change (FWP - FWOP)=	-0.59	0.25	-0.64	-0.54	-0.59	0.25	-0.64	-0.54	-0.39	0.15	-0.42	-0.36
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-1.20	0.11	-1.22	-1.18	-1.20	0.11	-1.22	-1.18	-0.85	0.20	-0.89	-0.81
B. Open Water Habitat Net AAHUs=	-0.59	0.25	-0.64	-0.54	-0.59	0.25	-0.64	-0.54	-0.39	0.15	-0.42	-0.36
Net Benefits=	-1.00	0.11	-1.02	-0.98	-1.79	0.28	-1.84	-1.73	-0.70	0.14	-0.73	-0.68

Direct Impact Subtotals	-1.41		-1.41	-1.41	-2.09		-2.09	-2.09	-1.92		-1.92	-1.92
Indirect Impact Subtotals	-15.30		-15.44	-15.16	-26.29		-26.67	-25.90	-12.60		-12.78	-12.42
Totals	**-16.71**		**-16.85**	**-16.57**	**-28.37**		**-28.76**	**-27.98**	**-14.52**		**-14.70**	**-14.34**

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Brackish Marsh

DIRECT IMPACTS

S2G B-1 Direct Impacts Old River Cove	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.06	0.00	0.06	0.06	0.06	0.00	0.06	0.06	0.08	0.00	0.08	0.08
B. Future Without Project Emergent Marsh AAHUs=	4.01	0.03	4.00	4.01	4.01	0.03	4.00	4.01	5.21	0.02	5.21	5.21
Net Change (FWP - FWOP)=	-3.95	0.03	-3.96	-3.94	-3.95	0.03	-3.96	-3.94	-5.13	0.01	-5.14	-5.13
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.27	0.00	0.26	0.27	0.27	0.00	0.26	0.27	0.19	0.00	0.19	0.19
Net Change (FWP - FWOP)=	-0.26	0.00	-0.26	-0.26	-0.26	0.00	-0.26	-0.26	-0.19	0.00	-0.19	-0.19
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-3.95	0.03	-3.96	-3.94	-3.95	0.03	-3.96	-3.94	-5.13	0.01	-5.14	-5.13
B. Open Water Habitat Net AAHUs=	-0.26	0.00	-0.26	-0.26	-0.26	0.00	-0.26	-0.26	-0.19	0.00	-0.19	-0.19
Net Benefits=	-3.13	0.02	-3.14	-3.13	-4.21	0.03	-4.22	-4.21	-4.04	0.01	-4.04	-4.03

S2G B-2 Direct Impacts Cow Bayou	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.60	0.00	0.60	0.60	0.60	0.00	0.60	0.60	0.48	0.00	0.48	0.48
B. Future Without Project Emergent Marsh AAHUs=	43.77	0.02	43.76	43.77	43.77	0.02	43.76	43.77	35.06	0.12	35.03	35.08
Net Change (FWP - FWOP)=	-43.17	0.02	-43.17	-43.16	-43.17	0.02	-43.17	-43.16	-34.57	0.12	-34.59	-34.55
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.22	0.01	0.22	0.22	0.22	0.01	0.22	0.22	0.16	0.01	0.16	0.16
B. Future Without Project Open Water AAHUs=	16.44	0.10	16.42	16.46	16.44	0.10	16.42	16.46	11.81	0.09	11.79	11.83
Net Change (FWP - FWOP)=	-16.22	0.10	-16.24	-16.20	-16.22	0.10	-16.24	-16.20	-11.65	0.09	-11.67	-11.63
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-43.17	0.02	-43.17	-43.16	-43.17	0.02	-43.17	-43.16	-34.57	0.12	-34.59	-34.55
B. Open Water Habitat Net AAHUs=	-16.22	0.10	-16.24	-16.20	-16.22	0.10	-16.24	-16.20	-11.65	0.09	-11.67	-11.63
Net Benefits=	-37.18	0.03	-37.18	-37.17	-59.39	0.11	-59.41	-59.37	-29.48	0.09	-29.50	-29.46

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Brackish Marsh

S2G B-3 Direct Impacts Adams Bayou	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Emergent Marsh AAHUs=	0.14	0.02	0.14	0.15	0.14	0.02	0.14	0.15	0.20	0.02	0.20	0.21
Net Change (FWP - FWOP)=	-0.14	0.02	-0.15	-0.14	-0.14	0.02	-0.15	-0.14	-0.20	0.02	-0.20	-0.20
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Net Change (FWP - FWOP)=	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-0.14	0.02	-0.15	-0.14	-0.14	0.02	-0.15	-0.14	-0.20	0.02	-0.20	-0.20
B. Open Water Habitat Net AAHUs=	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Net Benefits=	-0.11	0.02	-0.11	-0.11	-0.14	0.03	-0.15	-0.14	-0.16	0.02	-0.16	-0.15

INDIRECT IMPACTS

S2G B Indirect-I 1 and2 Switch Brackish TY31 - Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Emergent Marsh AAHUs=	6.53	0.10	6.51	6.55	6.53	0.10	6.51	6.55	6.10	0.06	6.09	6.12
Net Change (FWP - FWOP)=	-6.53	0.10	-6.55	-6.51	-6.53	0.10	-6.55	-6.51	-6.10	0.06	-6.12	-6.09
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	1.81	0.03	1.80	1.81	1.81	0.03	1.80	1.81	1.35	0.02	1.34	1.35
Net Change (FWP - FWOP)=	-1.81	0.03	-1.81	-1.80	-1.81	0.03	-1.81	-1.80	-1.35	0.02	-1.35	-1.34
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-6.53	0.10	-6.55	-6.51	-6.53	0.10	-6.55	-6.51	-6.10	0.06	-6.12	-6.09
B. Open Water Habitat Net AAHUs=	-1.81	0.03	-1.81	-1.80	-1.81	0.03	-1.81	-1.80	-1.35	0.02	-1.35	-1.34
Net Benefits=	-5.48	0.08	-5.49	-5.46	-8.34	0.10	-8.36	-8.32	-5.05	0.05	-5.06	-5.04

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Brackish Marsh

S2G B Indirect-2 Cow Bayou-Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.24	0.01	0.24	0.24	0.24	0.01	0.24	0.24	0.21	0.01	0.21	0.21
B. Future Without Project Emergent Marsh AAHUs=	16.88	0.09	16.87	16.90	16.88	0.09	16.87	16.90	14.49	0.07	14.47	14.50
Net Change (FWP - FWOP)=	-16.64	0.09	-16.66	-16.63	-16.64	0.09	-16.66	-16.63	-14.28	0.07	-14.30	-14.27
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.10	0.01	0.09	0.10	0.10	0.01	0.09	0.10	0.08	0.01	0.08	0.08
B. Future Without Project Open Water AAHUs=	6.91	0.02	6.91	6.92	6.91	0.02	6.91	6.92	5.80	0.04	5.79	5.81
Net Change (FWP - FWOP)=	-6.82	0.01	-6.82	-6.81	-6.82	0.01	-6.82	-6.81	-5.72	0.04	-5.73	-5.71
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-16.64	0.09	-16.66	-16.63	-16.64	0.09	-16.66	-16.63	-14.28	0.07	-14.30	-14.27
B. Open Water Habitat Net AAHUs=	-6.82	0.01	-6.82	-6.81	-6.82	0.01	-6.82	-6.81	-5.72	0.04	-5.73	-5.71
Net Benefits=	-14.46	0.07	-14.47	-14.45	-23.46	0.09	-23.48	-23.44	-12.38	0.06	-12.39	-12.37

S2G B Indirect-3 Persistent Marsh- Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.17	0.00	0.17	0.17	0.17	0.00	0.17	0.17	0.17	0.00	0.17	0.17
B. Future Without Project Emergent Marsh AAHUs=	11.77	0.13	11.74	11.79	11.77	0.13	11.74	11.79	11.79	0.07	11.77	11.80
Net Change (FWP - FWOP)=	-11.60	0.13	-11.63	-11.58	-11.60	0.13	-11.63	-11.58	-11.62	0.07	-11.63	-11.60
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.05	0.00	0.05	0.05	0.05	0.00	0.05	0.05	0.04	0.00	0.04	0.04
B. Future Without Project Open Water AAHUs=	3.35	0.01	3.35	3.35	3.35	0.01	3.35	3.35	2.81	0.02	2.81	2.82
Net Change (FWP - FWOP)=	-3.31	0.01	-3.31	-3.30	-3.31	0.01	-3.31	-3.30	-2.78	0.02	-2.78	-2.77
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-11.60	0.13	-11.63	-11.58	-11.60	0.13	-11.63	-11.58	-11.62	0.07	-11.63	-11.60
B. Open Water Habitat Net AAHUs=	-3.31	0.01	-3.31	-3.30	-3.31	0.01	-3.31	-3.30	-2.78	0.02	-2.78	-2.77
Net Benefits=	-9.76	0.10	-9.78	-9.74	-14.91	0.13	-14.93	-14.88	-9.65	0.06	-9.66	-9.64

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Brackish Marsh

S2G B Indirect-3 Marsh Migration-Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Emergent Marsh AAHUs=	12.67	0.16	12.64	12.70	12.67	0.16	12.64	12.70	9.53	0.12	9.51	9.56
Net Change (FWP - FWOP)=	-12.67	0.16	-12.70	-12.64	-12.67	0.16	-12.70	-12.64	-9.53	0.12	-9.56	-9.51
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.21	0.00	0.21	0.21	0.21	0.00	0.21	0.21	0.21	0.00	0.21	0.21
Net Change (FWP - FWOP)=	-0.21	0.00	-0.21	-0.21	-0.21	0.00	-0.21	-0.21	-0.21	0.00	-0.21	-0.21
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-12.67	0.16	-12.70	-12.64	-12.67	0.16	-12.70	-12.64	-9.53	0.12	-9.56	-9.51
B. Open Water Habitat Net AAHUs=	-0.21	0.00	-0.21	-0.21	-0.21	0.00	-0.21	-0.21	-0.21	0.00	-0.21	-0.21
Net Benefits=	-9.90	0.12	-9.92	-9.88	-12.88	0.16	-12.91	-12.85	-7.46	0.10	-7.48	-7.44

S2G B Indirect-4 Cow Bayou Fisheries Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	164.54	0.18	164.51	164.58	164.54	0.18	164.51	164.58	129.21	0.70	129.07	129.35
B. Future Without Project Emergent Marsh AAHUs=	174.07	0.16	174.04	174.10	174.07	0.16	174.04	174.10	135.85	0.67	135.72	135.99
Net Change (FWP - FWOP)=	-9.53	0.21	-9.57	-9.49	-9.53	0.21	-9.57	-9.49	-6.64	0.89	-6.82	-6.47
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	75.56	0.99	75.36	75.75	75.56	0.99	75.36	75.75	55.64	0.85	55.47	55.81
B. Future Without Project Open Water AAHUs=	83.07	0.99	82.88	83.27	83.07	0.99	82.88	83.27	60.53	0.85	60.36	60.70
Net Change (FWP - FWOP)=	-7.52	1.42	-7.80	-7.24	-7.52	1.42	-7.80	-7.24	-4.89	1.22	-5.13	-4.65
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-9.53	0.21	-9.57	-9.49	-9.53	0.21	-9.57	-9.49	-6.64	0.89	-6.82	-6.47
B. Open Water Habitat Net AAHUs=	-7.52	1.42	-7.80	-7.24	-7.52	1.42	-7.80	-7.24	-4.89	1.22	-5.13	-4.65
Net Benefits=	-9.08	0.35	-9.15	-9.01	-17.05	1.43	-17.33	-16.77	-6.25	0.78	-6.41	-6.10

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Impacts Sensitivity Analysis
Brackish Marsh

S2G B Indirect-5 Adams Bayou Fishery Access Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	499.17	3.69	498.44	499.89	499.17	3.69	498.44	499.89	478.19	2.14	477.77	478.61
B. Future Without Project Emergent Marsh AAHUs=	527.83	3.72	527.10	528.56	527.83	3.72	527.10	528.56	503.45	2.17	503.03	503.88
Net Change (FWP - FWOP)=	-28.67	5.00	-29.65	-27.69	-28.67	5.00	-29.65	-27.69	-25.27	2.93	-25.84	-24.69
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	118.10	1.10	117.88	118.31	118.10	1.10	117.88	118.31	88.39	0.94	88.21	88.58
B. Future Without Project Open Water AAHUs=	129.49	1.10	129.28	129.71	129.49	1.10	129.28	129.71	95.88	0.94	95.70	96.07
Net Change (FWP - FWOP)=	-11.40	1.61	-11.71	-11.08	-11.40	1.61	-11.71	-11.08	-7.49	1.38	-7.76	-7.22
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-28.67	5.00	-29.65	-27.69	-28.67	5.00	-29.65	-27.69	-25.27	2.93	-25.84	-24.69
B. Open Water Habitat Net AAHUs=	-11.40	1.61	-11.71	-11.08	-11.40	1.61	-11.71	-11.08	-7.49	1.38	-7.76	-7.22
Net Benefits=	-24.83	3.90	-25.59	-24.06	-40.06	5.24	-41.09	-39.04	-21.32	2.31	-21.77	-20.86

S2G B Indirect-S-2 Switch TY31-Hydrologic Impacts	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
B. Future Without Project Emergent Marsh AAHUs=	0.67	0.03	0.66	0.67	0.67	0.03	0.66	0.67	0.74	0.02	0.74	0.74
Net Change (FWP - FWOP)=	-0.67	0.02	-0.67	-0.66	-0.67	0.02	-0.67	-0.66	-0.74	0.01	-0.74	-0.74
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
B. Future Without Project Open Water AAHUs=	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02
Net Change (FWP - FWOP)=	-0.01	0.01	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	-0.67	0.02	-0.67	-0.66	-0.67	0.02	-0.67	-0.66	-0.74	0.01	-0.74	-0.74
B. Open Water Habitat Net AAHUs=	-0.01	0.01	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
Net Benefits=	-0.52	0.02	-0.53	-0.52	-0.68	0.03	-0.69	-0.68	-0.58	0.01	-0.58	-0.58

IMPACT SUMMARY

Direct Impact Subtotals	-40.42		-40.43	-40.41	-63.75		-63.78	-63.71	-33.67		-33.69	-33.65
Indirect Impact Subtotals	-74.03		-74.94	-73.12	-117.37		-118.78	-115.97	-62.69		-63.34	-62.03
Totals	**-114.45**		**-115.37**	**-113.53**	**-181.12**		**-182.56**	**-179.68**	**-96.35**		**-97.04**	**-95.67**

ATTACHMENT 2
WVA MARSH MITIGATION SENSITIVITY RESULTS

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Mitigation Sensitivity Analysis

Fresh Marsh Mitigation Areas

Mit 42 Scale 1	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	47.96	0.24	47.91	48.01	47.96	0.24	47.91	48.01	45.21	0.16	45.18	45.25
B. Future Without Project Emergent Marsh AAHUs=	28.78	0.19	28.75	28.82	28.78	0.19	28.75	28.82	19.79	0.10	19.77	19.81
Net Change (FWP - FWOP)=	19.17	0.32	19.11	19.24	19.17	0.32	19.11	19.24	25.42	0.19	25.39	25.46
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	8.47	0.06	8.46	8.48	8.47	0.06	8.46	8.48	7.24	0.04	7.23	7.25
B. Future Without Project Open Water AAHUs=	17.70	0.10	17.68	17.72	17.70	0.10	17.68	17.72	15.34	0.06	15.33	15.36
Net Change (FWP - FWOP)=	-9.23	0.12	-9.26	-9.21	-9.23	0.12	-9.26	-9.21	-8.10	0.07	-8.12	-8.09
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	19.17	0.32	19.11	19.24	19.17	0.32	19.11	19.24	25.42	0.19	25.39	25.46
B. Open Water Habitat Net AAHUs=	-9.23	0.12	-9.26	-9.21	-9.23	0.12	-9.26	-9.21	-8.10	0.07	-8.12	-8.09
Net Benefits=	10.01	0.22	9.97	10.05	9.94	0.34	9.87	10.01	14.61	0.13	14.58	14.63

Mit 42 Scale 2	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	85.63	0.41	85.55	85.70	85.63	0.41	85.55	85.70	75.87	0.29	75.81	75.93
B. Future Without Project Emergent Marsh AAHUs=	30.82	0.09	30.81	30.84	30.82	0.09	30.81	30.84	22.41	0.05	22.40	22.42
Net Change (FWP - FWOP)=	54.80	0.42	54.72	54.88	54.80	0.42	54.72	54.88	53.46	0.29	53.40	53.52
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	19.22	0.14	19.19	19.25	19.22	0.14	19.19	19.25	16.42	0.08	16.40	16.43
B. Future Without Project Open Water AAHUs=	39.74	0.23	39.70	39.79	39.74	0.23	39.70	39.79	34.33	0.13	34.31	34.36
Net Change (FWP - FWOP)=	-20.52	0.28	-20.58	-20.47	-20.52	0.28	-20.58	-20.47	-17.92	0.16	-17.95	-17.89
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	54.80	0.42	54.72	54.88	54.80	0.42	54.72	54.88	53.46	0.29	53.40	53.52
B. Open Water Habitat Net AAHUs=	-20.52	0.28	-20.58	-20.47	-20.52	0.28	-20.58	-20.47	-17.92	0.16	-17.95	-17.89
Net Benefits=	30.50	0.30	30.45	30.56	34.28	0.51	34.18	34.38	30.43	0.21	30.39	30.47

Sabine Pass to Galveston Bay Feasibility Study
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Mit 52	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	148.94	0.77	148.79	149.09	148.94	0.77	148.79	149.09	161.43	0.51	161.33	161.53
B. Future Without Project Emergent Marsh AAHUs=	132.12	0.21	132.08	132.17	132.12	0.21	132.08	132.17	106.74	0.40	106.66	106.81
Net Change (FWP - FWOP)=	16.82	0.78	16.66	16.97	16.82	0.78	16.66	16.97	54.70	0.60	54.58	54.81
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	13.95	0.12	13.92	13.97	13.95	0.12	13.92	13.97	11.96	0.07	11.95	11.97
B. Future Without Project Open Water AAHUs=	27.16	0.20	27.12	27.20	27.16	0.20	27.12	27.20	23.41	0.13	23.39	23.44
Net Change (FWP - FWOP)=	-13.22	0.23	-13.26	-13.17	-13.22	0.23	-13.26	-13.17	-11.45	0.14	-11.48	-11.42
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	16.82	0.78	16.66	16.97	16.82	0.78	16.66	16.97	54.70	0.60	54.58	54.81
B. Open Water Habitat Net AAHUs=	-13.22	0.23	-13.26	-13.17	-13.22	0.23	-13.26	-13.17	-11.45	0.14	-11.48	-11.42
Net Benefits=	7.13	0.53	7.03	7.23	3.60	0.79	3.45	3.75	33.36	0.41	33.28	33.44

Intermediate Marsh

Mit 31	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	251.42	1.33	251.16	251.68	251.42	1.33	251.16	251.68	258.86	0.88	258.69	259.03
B. Future Without Project Emergent Marsh AAHUs=	205.67	0.01	205.67	205.67	205.67	0.01	205.67	205.67	151.36	0.66	151.23	151.49
Net Change (FWP - FWOP)=	45.75	1.33	45.49	46.01	45.75	1.33	45.49	46.01	107.50	1.07	107.29	107.71
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	42.94	0.67	42.81	43.08	42.94	0.67	42.81	43.08	33.39	0.38	33.31	33.46
B. Future Without Project Open Water AAHUs=	92.03	1.30	91.78	92.29	92.03	1.30	91.78	92.29	71.87	0.74	71.73	72.01
Net Change (FWP - FWOP)=	-49.09	1.50	-49.38	-48.79	-49.09	1.50	-49.38	-48.79	-38.48	0.85	-38.65	-38.32
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	45.75	1.33	45.49	46.01	45.75	1.33	45.49	46.01	107.50	1.07	107.29	107.71
B. Open Water Habitat Net AAHUs=	-49.09	1.50	-49.38	-48.79	-49.09	1.50	-49.38	-48.79	-38.48	0.85	-38.65	-38.32
Net Benefits=	15.16	1.02	14.96	15.36	-3.34	2.00	-3.73	-2.95	60.41	0.77	60.26	60.56

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Mitigation Sensitivity Analysis

Mit 32		Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	46.04	0.04	46.04	46.05	46.04	0.04	46.04	46.05	36.12	0.17	36.08	36.15
B. Future Without Project Emergent Marsh AAHUs=	0.89	0.02	0.89	0.89	0.89	0.02	0.89	0.89	1.07	0.01	1.07	1.07
Net Change (FWP - FWOP)=	45.15	0.05	45.14	45.16	45.15	0.05	45.14	45.16	35.05	0.17	35.01	35.08
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	22.13	0.36	22.06	22.20	22.13	0.36	22.06	22.20	17.16	0.21	17.12	17.20
B. Future Without Project Open Water AAHUs=	21.41	0.15	21.38	21.44	21.41	0.15	21.38	21.44	20.31	0.08	20.29	20.32
Net Change (FWP - FWOP)=	0.72	0.40	0.64	0.80	0.72	0.40	0.64	0.80	-3.15	0.23	-3.20	-3.11
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	45.15	0.05	45.14	45.16	45.15	0.05	45.14	45.16	35.05	0.17	35.01	35.08
B. Open Water Habitat Net AAHUs=	0.72	0.40	0.64	0.80	0.72	0.40	0.64	0.80	-3.15	0.23	-3.20	-3.11
Net Benefits=	30.82	0.13	30.80	30.85	45.88	0.40	45.80	45.96	22.72	0.14	22.70	22.75

Mit 143		Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	165.87	0.31	165.81	165.93	165.87	0.31	165.81	165.93	132.44	0.62	132.32	132.56
B. Future Without Project Emergent Marsh AAHUs=	7.08	0.05	7.07	7.08	7.08	0.05	7.07	7.08	7.20	0.03	7.19	7.20
Net Change (FWP - FWOP)=	158.80	0.31	158.74	158.86	158.80	0.31	158.74	158.86	125.24	0.61	125.12	125.36
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	80.77	2.09	80.36	81.18	80.77	2.09	80.36	81.18	61.08	1.25	60.84	61.33
B. Future Without Project Open Water AAHUs=	121.24	3.40	120.57	121.90	121.24	3.40	120.57	121.90	89.75	1.93	89.38	90.13
Net Change (FWP - FWOP)=	-40.47	4.14	-41.28	-39.66	-40.47	4.14	-41.28	-39.66	-28.67	2.39	-29.14	-28.20
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	158.80	0.31	158.74	158.86	158.80	0.31	158.74	158.86	125.24	0.61	125.12	125.36
B. Open Water Habitat Net AAHUs=	-40.47	4.14	-41.28	-39.66	-40.47	4.14	-41.28	-39.66	-28.67	2.39	-29.14	-28.20
Net Benefits=	94.52	1.37	94.25	94.79	118.33	4.18	117.51	119.15	75.59	0.89	75.42	75.77

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Mitigation Sensitivity Analysis

Brackish Marsh

Mit 27			Version 2.0				Version 2.0B				Version 1.0	
Marsh	**Mean**	**SD**	**95% C.I.**		**Mean**	**SD**	**95% C.I.**		**Mean**	**SD**	**95% C.I.**	
NET CHANGE IN AAHUs DUE TO PROJECT			**Lower**	**Upper**			**Lower**	**Upper**			**Lower**	**Upper**
A. Future With Project Emergent Marsh AAHUs=	142.55	0.87	142.38	142.72	142.55	0.87	142.38	142.72	139.66	0.47	139.57	139.76
B. Future Without Project Emergent Marsh AAHUs=	108.64	0.19	108.60	108.68	108.64	0.19	108.60	108.68	77.24	0.35	77.17	77.30
Net Change (FWP - FWOP)=	33.91	0.91	33.74	34.09	33.91	0.91	33.74	34.09	62.43	0.57	62.32	62.54
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	44.77	0.20	44.73	44.81	44.77	0.20	44.73	44.81	35.49	0.38	35.41	35.56
B. Future Without Project Open Water AAHUs=	94.11	0.51	94.01	94.21	94.11	0.51	94.01	94.21	72.88	0.75	72.74	73.03
Net Change (FWP - FWOP)=	-49.34	0.58	-49.45	-49.23	-49.34	0.58	-49.45	-49.23	-37.39	0.86	-37.56	-37.23
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	33.91	0.91	33.74	34.09	33.91	0.91	33.74	34.09	62.43	0.57	62.32	62.54
B. Open Water Habitat Net AAHUs=	-49.34	0.58	-49.45	-49.23	-49.34	0.58	-49.45	-49.23	-37.39	0.86	-37.56	-37.23
Net Benefits=	15.41	0.74	15.27	15.56	-15.43	1.16	-15.65	-15.20	40.24	0.47	40.15	40.34

Mit 28			Version 2.0				Version 2.0B				Version 1.0	
Marsh	**Mean**	**SD**	**95% C.I.**		**Mean**	**SD**	**95% C.I.**		**Mean**	**SD**	**95% C.I.**	
NET CHANGE IN AAHUs DUE TO PROJECT			**Lower**	**Upper**			**Lower**	**Upper**			**Lower**	**Upper**
A. Future With Project Emergent Marsh AAHUs=	264.97	1.72	264.64	265.31	264.97	1.72	264.64	265.31	281.12	0.89	280.94	281.29
B. Future Without Project Emergent Marsh AAHUs=	243.71	0.09	243.69	243.73	243.71	0.09	243.69	243.73	191.34	0.74	191.19	191.48
Net Change (FWP - FWOP)=	21.26	1.72	20.93	21.60	21.26	1.72	20.93	21.60	89.78	1.13	89.56	90.00
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	61.48	0.30	61.43	61.54	61.48	0.30	61.43	61.54	48.47	0.52	48.37	48.57
B. Future Without Project Open Water AAHUs=	128.20	0.70	128.06	128.34	128.20	0.70	128.06	128.34	99.28	1.02	99.08	99.48
Net Change (FWP - FWOP)=	-66.72	0.80	-66.87	-66.56	-66.72	0.80	-66.87	-66.56	-50.81	1.18	-51.04	-50.58
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	21.26	1.72	20.93	21.60	21.26	1.72	20.93	21.60	89.78	1.13	89.56	90.00
B. Open Water Habitat Net AAHUs=	-66.72	0.80	-66.87	-66.56	-66.72	0.80	-66.87	-66.56	-50.81	1.18	-51.04	-50.58
Net Benefits=	1.71	1.38	1.44	1.98	-45.45	2.03	-45.85	-45.06	58.54	0.91	58.36	58.72

Sabine Pass to Galveston Bay Feasibility Study
WVA Marsh Mitigation Sensitivity Analysis

Mit 29	Version 2.0				Version 2.0B				Version 1.0			
Marsh	Mean	SD	95% C.I.		Mean	SD	95% C.I.		Mean	SD	95% C.I.	
NET CHANGE IN AAHUs DUE TO PROJECT			Lower	Upper			Lower	Upper			Lower	Upper
A. Future With Project Emergent Marsh AAHUs=	107.64	0.60	107.52	107.76	107.64	0.60	107.52	107.76	98.99	0.34	98.92	99.06
B. Future Without Project Emergent Marsh AAHUs=	59.08	0.38	59.01	59.16	59.08	0.38	59.01	59.16	40.90	0.22	40.86	40.94
Net Change (FWP - FWOP)=	48.56	0.74	48.42	48.70	48.56	0.74	48.42	48.70	58.09	0.40	58.01	58.17
Open Water												
NET CHANGE IN AAHUs DUE TO PROJECT												
A. Future With Project Open Water AAHUs=	38.82	0.19	38.78	38.86	38.82	0.19	38.78	38.86	30.63	0.31	30.57	30.69
B. Future Without Project Open Water AAHUs=	63.40	0.49	63.31	63.50	63.40	0.49	63.31	63.50	45.26	0.42	45.18	45.35
Net Change (FWP - FWOP)=	-24.58	0.53	-24.68	-24.47	-24.58	0.53	-24.68	-24.47	-14.63	0.54	-14.74	-14.53
Total												
TOTAL BENEFITS IN AAHUs DUE TO PROJECT												
A. Emergent Marsh Habitat Net AAHUs=	48.56	0.74	48.42	48.70	48.56	0.74	48.42	48.70	58.09	0.40	58.01	58.17
B. Open Water Habitat Net AAHUs=	-24.58	0.53	-24.68	-24.47	-24.58	0.53	-24.68	-24.47	-14.63	0.54	-14.74	-14.53
Net Benefits=	32.31	0.59	32.19	32.42	23.98	0.91	23.80	24.16	41.93	0.33	41.87	41.99