CEERD-HF-C

MEMORANDUM FOR: Janelle S. Stokes, SWG

SUBJECT: CHL Response to Galveston District Information Request Related to Sabine-Neches Waterway Channel Improvement Project Draft Feasibility Report External Peer Review Comments

1. Attached please find responses to questions developed by the Galveston District (SWG) related to External Peer Review (EPR) comments on the Sabine-Neches Waterway (SNWW) Channel Improvement Project (CIP) Draft Feasibility Report.

2. If you have any questions regarding the attached, please contact Mr. Ty Wamsley (Ty.Wamsley@us.army.mil, (601) 634-2099) or Dr. David B. King Jr. (david.b.king@erdc.usace.army.mil, (601) 634-2087) of the Coastal Processes Branch.

TY V. WAMSLEY
Chief, Coastal Processes Branch

1 Encl

CHL RESPONSE TO GALVESTON DISTRICT INFORMATION REQUEST RELATED TO SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT DRAFT FEASIBILITY REPORT EXTERNAL PEER REVIEW COMMENTS

The below documents responses to questions developed by the Galveston District (SWG) related to External Peer Review (EPR) comments on the Sabine-Neches Waterway (SNWW) Channel Improvement Project (CIP) Draft Feasibility Report. The implications of the EPR comments extend well beyond those related to SWG's questions and well beyond CHL's STWAVE and GENESIS modeling study. The responses below are limited to implications specifically raised in SWG's questions and, with the exception of Comment 13, do not constitute a response to the entirety of the EPR comments.

Galveston District Information Request related to Comment 11:

> *Does the IPET study (USACE, 2007) information on Gulf hurricane physics and sediment regimes have a high potential for changing impact assessments resulting from the STWAVE and GENESIS for the SNWW CIP?*

No. The IPET Study does not make any recommendations that would affect the application of the STWAVE or GENESIS models used in this analysis. The reviewer is apparently referring to recent and on-going work related to assessing hurricane risk across the northern Gulf of Mexico. IPET and related studies are providing new information primarily related to extreme hurricane risk (i.e., hurricanes with 100-year return periods and beyond). The risk in New Orleans area, the focus of the IPET study, is expected to be different from that in the Sabine-Neches Waterway area. Hurricane risk studies for the Sabine area are presently ongoing and would not affect the conclusions from the STWAVE and GENESIS application. The STWAVE and GENESIS study was forced with an hourly wave climate for the 10 year time period from 1990 to 1999, which includes a wide range of wave conditions. The hurricanes and tropical storms that impacted the study area during this time period include Dean (1995), Josephine (1996), Charlie (1998), Frances (1998), and Bret (1999). Thus, hurricane and tropical storm waves were included in an appropriate way as a standard part of the hourly wave data set in the analysis.

Galveston District Information Request related to Comment 12:

> *What is the expected behavior of maintenance material proposed to be placed along 3 miles of Gulf shoreline beginning one-half mile from each jetty (Texas and Louisiana Points)? Beginning with the first maintenance dredging cycle, placement would alternate between TX and LA every 3 years through the 50-period of analysis. What are the expected benefits and impacts to the littoral system?*

To completely address this question would require extensive additional modeling or other analyses beyond the scope of this response. The fact that the surf zone sediments are mostly muds makes the issues substantially more complex than if they were sands. The following information is assimilated from the STWAVE/GENESIS work done for this study, from the reports listed below, and from knowledge of the study area. However, as suggested in EPR Comment 12, this does not represent the comprehensive or complete analyses required to address this issue. A discussion of the complexity of the issues and some qualitative information on expected behavior are provided below.

The net longshore sediment transport direction throughout most of the study area (both sides of the jetties) is to the west, though there are transport direction reversals immediately west of the west jetties and west of Sea Rim State Park (Morang, 2006). The shoreline on the Louisiana side of the jetties is composed of a mixture of muds and sands and portions are modestly accreting while others are modestly eroding (Penland et al., 2003). By contrast, the shoreline on the Texas side is almost entirely composed of mud and is experiencing erosion rates from a few feet to up to 50 ft per year (King, 2007). These are some of the highest erosion rates of anywhere in the country.

A cohesive sediment is one in which the grains are small enough that the attractive forces between particles (electrostatic forces) are stronger than the force of gravity pulling the sediment to the bed. Thus, in suspension, these particles have the tendency to aggregate into loose, diffuse clumps (flocs). Mud and fine-grained sediments are generic terms for cohesive sediments that are generally a mixture of clay (particles having diameters < 4 μm), silt (particles having diameters between 4 and 62 μm), and organic material, possibly mixed with small percentages of sand (particles having diameters > 0.070 mm). A consolidated mud is one that has had the interstitial fluids and voids largely removed through drainage, evaporation, or compaction.

Sediment transport and deposition processes are distinctly different on mud shorelines than on sandy beaches. On sand beaches, the sediment is generally easy to mobilize under typical wave conditions. While the surficial layers of sediment can be extremely active within the surfzone, the sediment is generally assumed to stay completely within the active profile. On consolidated mud beaches, it is generally much harder to mobilize the sediment. However, once mobilized, cohesive sediments are generally carried in suspension until deposited in a less energetic environment; either in deeper water outside the surf zone or in wave-sheltered areas, such as quiet bays and estuaries (Nairn and Willis, 2002), and so, are lost from the littoral system.

Within the surf zone, breaking wave energy is dissipated into turbulent motion. In addition, both within the surf zone and in the areas somewhat further seaward,

additional turbulence is generated within the bottom boundary layer due to the wave-induced orbital water motion and nearshore currents. This turbulence acts to suspend sediment off the bottom, and once a particle is suspended, it takes a characteristic amount of time (which is a function of the grain's settling velocity) to fall back to the bed. For a sufficiently large amount of turbulent energy and a sufficiently small particle, the particle will not have time to fall back to the bed before more turbulent energy is supplied by the passage of the next wave, and thus the particle remains in suspension indefinitely. For the wave conditions characteristic of typical beaches, this condition applies to silts and clays. These size particles do not settle out within the surf zone once they are suspended. This is one of the primary reasons that most of the world's beaches are composed of sediments having diameters greater than 0.10 mm.

However, erosion is not the only process occurring on mud beaches exposed to ocean waves. In mud-rich environments, accretion can occur by poorly understood processes. Morgan et al. (1958) report up to 300 meters of shoreline accretion in two mud arcs, totaling 7.2 km in length along a western Louisiana shoreline in a few days during the passage of Hurricane Aubrey in 1957. At the same time other nearby sections of coastline experienced significant erosion. Studies by Wells and Kemp (1987) in western Louisiana indicate that accretion most frequently occurs during storms, that the process can be very rapid (hours to days) and that much of the accretion is above the mean water line. Huh et al. (1991) report surge deposits of gel-like mud becoming stranded on the upper shoreface during storms. These deposits dried and cracked, occasionally forming mud cobbles which helped armor the shoreline from further attack. PIE (2003) reports evidence of these processes occurring near Sea Rim State Park at the western end of the study area.

If a consolidated mud beach contains some fraction of sand, this sand will stay within the surf zone and be subject to the same forces that cause longshore and cross-shore transport as occur on sandy beaches. On erosive mud shorelines, if the sand is not removed by longshore transport, its percentage will increase because the fines are being removed, and it will form lenses or veneers over the mud substrate. As these lenses thicken, they help protect the underlying mud from further erosion. Nairn (1992) found that approximately 200 m^3/m of sand cover (measured from the top of the beach out to the 4-m contour) halted the erosion process at a series of sites in the Great Lakes, and half that quantity provided some protection to the underlying cohesive sediment.

In smaller quantities, sand can also act to accelerate the erosion of a mud beach. If the consolidated mud is not covered with a sand veneer, any sand present that is mobilized by wave action will act as a scouring agent along the surface of the bed increasing the amount of fine material going into suspension.

The dredge material that is to be placed along the beaches within the study area is expected to be composed largely of unconsolidated muds. These are expected to initially be highly mobile and it is expected that some portion of the material will be rapidly lost from the vicinity of the shoreline. Because of the prevailing wave climate, the mobile material within the surfzone should generally migrate to the west. However, to completely study the issues raised by this question and EPR Comment 12 would require extensive additional analysis, and it is not possible to assess the range of expected benefits and impacts in this complex environment without such further analysis.

Huh, O. K., Roberts, H. H., Rouse, L. J., and Rickman, D. A. 1991. Fine grain sediment transport and deposition in the Atchafalaya and Chenier Plain sedimentary system. Coastal Sediments '91, American Society of Civil Engineers, New York, New York, 817-830.

King, D. B. 2007. Wave and Beach Processes Modeling for Sabine Pass to Galveston Bay, Texas, Shoreline Erosion Feasibility Study. ERDC/CHL TR-07-6. Vicksburg, MS: U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. http://libweb.wes.army.mil/uhtbin/cgisirsi/46cEdwJtmP/ERDC_VBG/320490006/523/857

Morang, A. 2006. North Texas sediment budget for Sabine Pass to San Luis Pass, Texas. ERDC/CHL TR-06-17. Vicksburg, MS: U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. http://libweb.wes.army.mil/uhtbin/cgisirsi/20080104004141/SIRSI/0/518/0/CHL-TR-06-17.pdf/Content/1?new_gateway_db=HYPERION

Morgan, J. P., Nichols, L. G., and Wright, M. 1958. Morphological effect of Hurricane Aubrey. Technical Report #10, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA.

Nairn, R. B. 1992. Designing for Cohesive Shores, Proceedings Coastal Engineering in Canada, J.W. Kamphuis, ed., Department of Civil Engineering, Queens University, Kingston, Canada.

Nairn, R. B. and Willis, D. H. 2002. Erosion, transport, and deposition of cohesive sediments. Coastal Engineering Manual, Part III, Coastal Sediment Processes, Chapter 5, T. Walton, ed., Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, DC.

Pacific International Engineering. 2003. Coastal geomorphology of a non-barrier Gulf of Mexico beach: Analysis for protection of Highway 87 and McFaddin NWR in Jefferson County, Texas. Pacific International Engineering, Austin, TX

Penland, S., Connor, P.F., and Beall, A. 2003. Chapter D.3: Changes in Louisiana's Shoreline: 1855-2002. Dept of Geology and Geophysics, Coastal Research Laboratory, University of New Orleans.

Wells, J.T. and Kemp, G.P. 1986. Interaction of surface waves and cohesive sediments: Field observations and geological significance. Estuarine Cohesive Sediment Dynamics, A. J. Mehta, ed., Springer-Verlag, New York, 43-65.

Galveston District Information Request related to Comment 13A:

Evaluate whether the existing modeling effort is adequate to identify potential impacts and evaluate the particular issues and concerns raised by the EPR reviewers.

The purpose of the STWAVE and GENESIS modeling study was to assess the ***wave-induced*** impacts of the proposed deepening of the SNWW on the open-coastal shorelines adjacent to the project area. The STWAVE/GENESIS modeling was never intended to and does not address transport processes that are not driven by wave breaking, such as changes in tidal flows or changes in channel shoaling rates and locations nor was it intended to quantify the nearshore sediment budget. To address these other issues requires the development of a detailed nearshore sediment budget and additional, more complex modeling. The STWAVE/GENESIS modeling ***is*** adequate for identifying the potential impacts for which it was intended, specifically the wave-induced impacts on the adjacent shorelines due to potential changes in wave refraction and shoaling patterns. The EPR comment raised several issues related to the STWAVE /GENESIS modeling, and these are addressed in the following paragraphs.

Basis for Comment

The review acknowledges that the tools (STWAVE and GENESIS) used to assess the potential shoreline impacts due to changes in wave refraction patterns that will result from a deepening of the Sabine-Neches Waterway ship channel are well known, widely-used models that represent state of the practice in forecast modeling. Although the tools admittedly represent the state of the practice, the review states that the results are presented in a summary format that is unacceptable and insufficient information is provided on the specifics of the model applications. The review further states that no evidence is provided that the models are providing accurate information.

Model Assumptions

The fundamental STWAVE assumptions are as follows:

- Mild bottom slope and negligible wave reflection
- Spatially homogeneous offshore wave conditions
- Steady-state waves, currents, and winds
- Linear refraction and shoaling
- Depth-uniform current
- Bottom friction is neglected

The fundamental GENESIS assumptions are as follows (these assumptions apply to all one-line shoreline change models):

- Arbitrary but constant or unvarying beach profile shape

- Constant landward and seaward limits of beach profile movement (average berm elevation and depth of closure).
- Accretion and erosion are represented by a seaward and landward translation of the beach profile.
- Sand transport is caused by waves breaking at an oblique angle to the shoreline.
- Detailed nearshore circulation in the vicinity of coastal structures is ignored.

The review suggested that two offshore features, Sabine Bank and a prominent asymmetric bulge at 15 ft depth, add bathymetric complexity and significant challenges to the modeling effort. Although we agree that the mentioned bathymetric features are significant, both are well resolved with the 160 ft (48.8 m) square grid cell resolution used in this application of STWAVE and neither poses any significant challenge for the wave transformation calculations made by STWAVE. The assumption of mild bottom slope was well satisfied. Potential inaccuracies in the input bathymetry are not viewed by the study team as being of sufficient importance to warrant costly collection of comprehensive survey data over the 910 square mile offshore study area. STWAVE was used in this study to obtain estimates of wave transformation from the nominal 66 ft (20 m) contour to just prior to breaking (approximate 15 ft contour) for most wave conditions. As such, wave dissipation was not a significant factor in this analysis.

For most wave conditions, wave dissipation was not expected to be a significant factor in this analysis. It was recognized that a muddy seabed has the potential to increase wave dissipation compared to sandy bottoms. However, to determine the extent of dissipation and to include it in any type of realistic manner would require a major field data collection effort and greatly increase the cost of the study. This was clearly not justified. Including dissipation during wave transformation will reduce surfzone wave heights and longshore sediment transport rates. Thus including dissipation will reduce the effect of wave refraction modifications due to changes in the channel bathymetry and reduce the already minor channel impacts on the adjacent shorelines. Thus, not including dissipation provided a conservative estimate of the potential shoreline impacts and was a justified approach.

Input Conditions

The 30 representative offshore wave conditions that were transformed using STWAVE were identified from a statistical analysis of the available wave hindcast information at the offshore boundary of the STWAVE grid. These wave conditions represent bin averaged combinations of wave period and wave angle together with a unit input wave height. Use of a unit wave height is a standard practice technique to obtain estimates of the nearshore wave angle and wave height transformation coefficient (product of refraction and shoaling coefficients, K_rK_s). When the GENESIS simulations are performed the nearshore wave height is obtained as the product of the unique offshore wave height and the computed shoaling and refraction coefficient. The controlling equations (Snell's Law and the conservation of wave energy) are independent of wave height, thus transforming bin averaged wave heights or alternatively transformation of all unique offshore wave heights is not necessary provided wave breaking is not involved.

The review expresses concern that the resolution of the incident wave angle bins used to characterize the offshore wave climate is too coarse and thereby provides only a crude approximation of the offshore wave climatology. The study team disagrees with the review's assessment and provides the following information to support its position.

The five incident wave angle bins used in this study are listed in Table 1 together with their associated wave period bins and the percent occurrence represented by that angle bin - period bin combination. As seen in Table 1, the coarsest resolution in terms of the amount of the offshore wave climatology characterized by a single angle bin occurs in angle bin 1 (oblique waves from the eastern sector), which represents 40.3 percent of the wave climatology. Note that the 40.3 percent of the wave climatology that occurs in this direction sector is characterized by 6 representative wave periods.

In Tables 2 and 3, we look at Angle Band 1 in more detail. We compare the wave height and wave angle differences between the existing condition and with-deepening condition (existing condition minus 50-ft channel condition) obtained using these 6 representative wave conditions (Angle Band 1, Period Bands 1-6) to those obtained using 25 wave conditions derived from applying an 11 degree angle bin resolution and the same 6 wave period bin resolution to represent wave conditions in this direction sector. For each Average Wave Height Difference Cell in Table 2, we subtract the STWAVE output wave heights at each of the 613 nearshore stations obtained using the 50 foot channel grid from those using the existing channel grid and present the average of these differences. Comparing these average differences obtained using a single coarse angle band with five 11 degree narrow angle bands shows that there is minimal change in the wave refraction results using the finer resolution angle bands. In Table 3 we present the same results for the average wave angle differences measured at the 613 shore stations.

In Table 1, the wave direction and period bins are not uniform because the distribution of the offshore wave climatology in terms of incident wave angle and wave period is not uniform. We have employed higher resolution in those wave directions and wave periods where a higher percentage of the waves occur.

The study team acknowledges that sediment transport is sensitive to the breaking wave angle. However, it is important to remember that the study was primarily focused on determining the potential for shoreline change resulting from deepening of the ship channel not on quantifying the absolute magnitude of sediment transport in the study area. Consequently, quantification of the potential changes in sediment transport magnitude is of greater interest than the absolute magnitude of transport in the region. The deepening of the ship channel will not influence the overall wave climatology but it does have the potential to influence wave refraction and shoaling patterns which have been quantified.

Table 1. Percent of wave climatology characterized by representative wave condition.					
Angle bin (deg)	**AB number**	**Period bin (sec)**	**PB number**	**% Occurrence**	**Cumulative % Occurrence in Angle bin**
90 – 25	1	3 – 4	1	9.1	40.3
90 – 25	1	4 – 5	2	9.3	40.3
90 – 25	1	5 – 7	3	17.0	40.3
90 – 25	1	7 – 9	4	4.4	40.3
90 – 25	1	9 – 11	5	0.5	40.3
90 – 25	1	11 – 15	6	<0.1	40.3
25 – 5	2	3 – 4	1	3.7	23.7
25 – 5	2	4 – 5	2	4.1	23.7
25 – 5	2	5 – 7	3	9.3	23.7
25 – 5	2	7 – 9	4	4.7	23.7
25 – 5	2	9 – 11	5	1.3	23.7
25 – 5	2	11 – 15	6	0.6	23.7
5 – -5	3	3 – 4	1	1.5	10.5
5 – -5	3	4 – 5	2	1.9	10.5
5 – -5	3	5 – 7	3	4.0	10.5
5 – -5	3	7 – 9	4	2.4	10.5
5 – -5	3	9 – 11	5	0.6	10.5
5 – -5	3	11 – 15	6	0.1	10.5
-5 – -25	4	3 – 4	1	3.1	12.8
-5 – -25	4	4 – 5	2	2.6	12.8
-5 – -25	4	5 – 7	3	4.2	12.8
-5 – -25	4	7 – 9	4	2.2	12.8
-5 – -25	4	9 – 11	5	0.6	12.8
-5 – -25	4	11 – 15	6	0.1	12.8
-25 – -90	5	3 – 4	1	5.5	12.4
-25 – -90	5	4 – 5	2	2.6	12.4
-25 – -90	5	5 – 7	3	2.7	12.4
-25 – -90	5	7 – 9	4	1.4	12.4
-25 – -90	5	9 – 11	5	0.2	12.4
-25 – -90	5	11 – 15	6	<0.1	12.4

Table 2. Wave Height Differences (existing - 50 ft channel, meters)							
		Period (secs)					
		3-4	4-5	5-7	7-9	9-11	11-15
Angle Band Resolution	**Angle Band**	**Average Wave Height Differences (m)**					
Coarse (AB 1)	25-90	0.0024	0.0062	0.0085	0.0110	0.0145	0.0145
Narrow	25-36	0.0026	0.0063	0.0091	0.0137	0.0172	0.0234
Narrow	36-47	0.0028	0.0065	0.0089	0.0131	0.0160	
Narrow	47-58	0.0022	0.0060	0.0079	0.0106	0.0130	
Narrow	58-69	0.0021	0.0055	0.0067	0.0085	0.0103	
Narrow	69-80	0.0016	0.0043	0.0054	0.0063		

Table 3. Wave Angle Differences (existing - 50 ft channel, degrees)							
		Period (secs)					
		3-4	4-5	5-7	7-9	9-11	11-15
Angle Band Resolution	**Angle Band**	**Average Wave Angle Differences (degrees)**					
Coarse (AB 1)	25-90	0.0245	0.1142	0.3230	0.5987	0.8010	1.0881
Narrow	25-36	0.0294	0.0783	0.2007	0.3980	0.5971	0.7553
Narrow	36-47	0.0049	0.1256	0.2773	0.5351	0.6770	
Narrow	47-58	0.0245	0.1517	0.3785	0.6362	0.8189	
Narrow	58-69	0.0294	0.1452	0.4274	0.7390	0.9184	
Narrow	69-80	0.0131	0.1664	0.4519	0.8010		

Model Output

The review expresses concern regarding inconsistencies with respect to the calculated net transport directions as compared to the net transport directions as indicated by the local geology. The review further provides a plausible explanation of the processes driving the observed local geology immediately east and west of the jetties. The study team, in general, agrees with the review explanation of refraction processes as driving the apparent flow reversal west of the inlet but would add to that process direct blockage of west-bound transport, and wave energy sheltering by the 4.1 mile long navigation jetties. On the east side of the inlet concern is expressed with respect to the calculation of a region of east-bound net transport within 3 miles of the inlet where the geology indicates west-bound net transport. The reason for these inconsistencies is believed to be primarily due to neglecting the navigation jetties in the wave transformation modeling portion of the analysis. However, not considering the jetties was not an oversight but rather intentional. The navigation jetties, if included in the wave transformation modeling, would further lessen the influence of channel deepening on shore face sediment transport processes because the jetties act to block all cross-channel wave refraction and thereby eliminate the influence of changes in channel depth for the entire 4.1 mile length of the jetties. Not including the influence of the jetties in the wave transformation portion of the analysis provided a conservative estimate of the potential shoreline impacts. That is, the analysis as performed, without inclusion of the jetties, maximized wave refraction and shoaling influence of the proposed channel deepening.

Sediment budget development was not a component of the project study plan and no effort was made to develop either a local or regional sediment budget.

Overall Model Capabilities

The review states "results from application of the GENESIS model show transport spikes in the immediate vicinity of Sabine Pass". We believe the reviewer has misinterpreted the presented results. The GENESIS model actually predicts near zero net transport in the immediate vicinity of Sabine Pass. The change in net transport however peaks within about a half mile east and west of Sabine Pass. These peaks in the change in net transport rate are expected and reflect the zones of maximum potential influence of the proposed channel deepening on shore face processes due to changes in wave refraction and shoaling processes. The review suggests that GENESIS is being called upon to provide information that is beyond its capability. The study team disagrees with this position. The GENESIS application to the Sabine-Neches deepening project is well within the expected applicability of one-line models such as GENESIS and this class of model is the only practical numerical shoreline evolution tool for evaluating the potential shoreline impacts of deepening projects on the scale of the proposed Sabine-Neches deepening project. The influence of the jetties on the shoreline evolution portion of the analysis was included in the study. A Gated (Groin) boundary condition was applied in GENESIS at the inlet. Implementation of this boundary condition results in no sand transport across the jetty structures.

Galveston District Request for Comment 13B:

Is it possible to place the STWAVE and GENESIS results in a risk-based context, and would this additional evaluation be valuable given the predicted impacts?

STWAVE and GENESIS are deterministic models. As presently applied, results were not placed in a risk-based context and to do so would require a significant effort. However, such additional work is not warranted. The models calculated insignificant changes in the waves and longshore sediment transport rates within the study area. It is important to note that the STWAVE/GENESIS analysis was extremely conservative in nature and as performed the analysis overestimates any wave-induced impacts to the shoreline as a result of the channel deepening. As previously stated, the results are conservative since the wave dissipation due to the presence of mud and the sheltering effect of the jetties was purposely not included. Applying a risk-based type of analysis would only yield order of magnitude variability within these extremely conservative minor results, which would add no additional practical value and could not be expected to change the specific STWAVE/GENESIS study conclusions.

Galveston District Request for Comment 13C:

> *Given the small impact identified by the STWAVE and GENESIS modeling, would it be necessary to evaluate the long term fate of the ODMDS material using LTFATE and incorporate it into the sediment budget in order to adequately evaluate project effects on shoreline erosion?*

This question apparently arises from the EPR reviewers' recommendation for resolution of Comment 13 but is also related to Comment 12 and the reviewers' assertion that a regional sediment budget is required. The need to evaluate the long-term fate of material placed in Offshore Dredge Material Disposal Sites (ODMDS) adjacent to the channel is unrelated to the findings of the STWAVE/GENESIS modeling. Changes to the shoaling patterns near the jetty tips due to increased channel depth is a concern, but is outside the scope and intended purpose of the STWAVE/GENESIS modeling effort. The STWAVE/GENESIS modeling provides no basis for an opinion about potential increased dredging volumes caused by a deepened channel and the behavior and fate of this (potential) additional material placed in the ODMDS.

The model LTFATE can predict the rate and direction at which material will be leaving the immediate disposal site. Because the disposal site is adjacent to the navigation channel, the model would be useful in determining volumes and rates of dredged material returning to the channel. However, it is not reasonable to expect that the model could be used to track material movement over tens of square miles to determine the percentage that is moving into the surf zone. This answer is appropriate whether the question being addressed is the amount of material returning to the surf zone under the present conditions or the differential amount returning as a result of a deepened channel. Results from an LTFATE modeling effort would be beneficial to the development of a detailed sediment budget and we agree with the reviewers' assertion that the analysis would benefit from the development of a detailed sediment budget.

Galveston District Request for Comment 14A:

Do the engineering models employed for the CIP (STWAVE, GENESIS) contain the capability to add risk and uncertainty analyses?

This question is essentially the same as 13B. As presently developed and applied, placing STWAVE and GENESIS results into a risk-based context would require significant additional effort. Such additional work is not warranted, would not add practical value, and could not be expected to change the specific STWAVE/GENESIS study conclusions.

Galveston District Request for Comment 14B:

What sensitivity analyses or other methods were employed to address uncertainties in ERDC shoreline impact modeling?

The STWAVE/GENESIS modeling study showed that the proposed project has an extremely minimal impact on the wave-induced shoreline dynamics. As previously stated, the STWAVE/GENESIS application was extremely conservative and overestimates expected wave-induced changes. A wide range of wave conditions representing the wave climate was simulated. The sensitivity of the modeling is evident in the discussion provided in response to the question related to Comment 13 above. Tables 2 and 3 provide the sensitivity of changes in wave height and angle for changes in wave period and resolution of angle band. Impacts are extremely small in all cases, and small even though extremely conservative assumptions were made regarding wave dissipation to mud and wave sheltering due to the jetties.

Galveston District Request for Comment 14C:

> *Which of the risks described in EPR comment 14 could significantly affect human health and safety, environmental impacts, or cost and thus potentially change the Recommended Plan?*

This question for Comment 14 relates to concerns raised previously related to the need to place the STWAVE and GENESIS modeling results into a risk based context. As discussed above, as it pertains to STWAVE and GENESIS results and conclusions, risk and uncertainty considerations add no practical value. The implications of Comment 14 go well beyond the issues related to the STWAVE and GENESIS modeling effort.