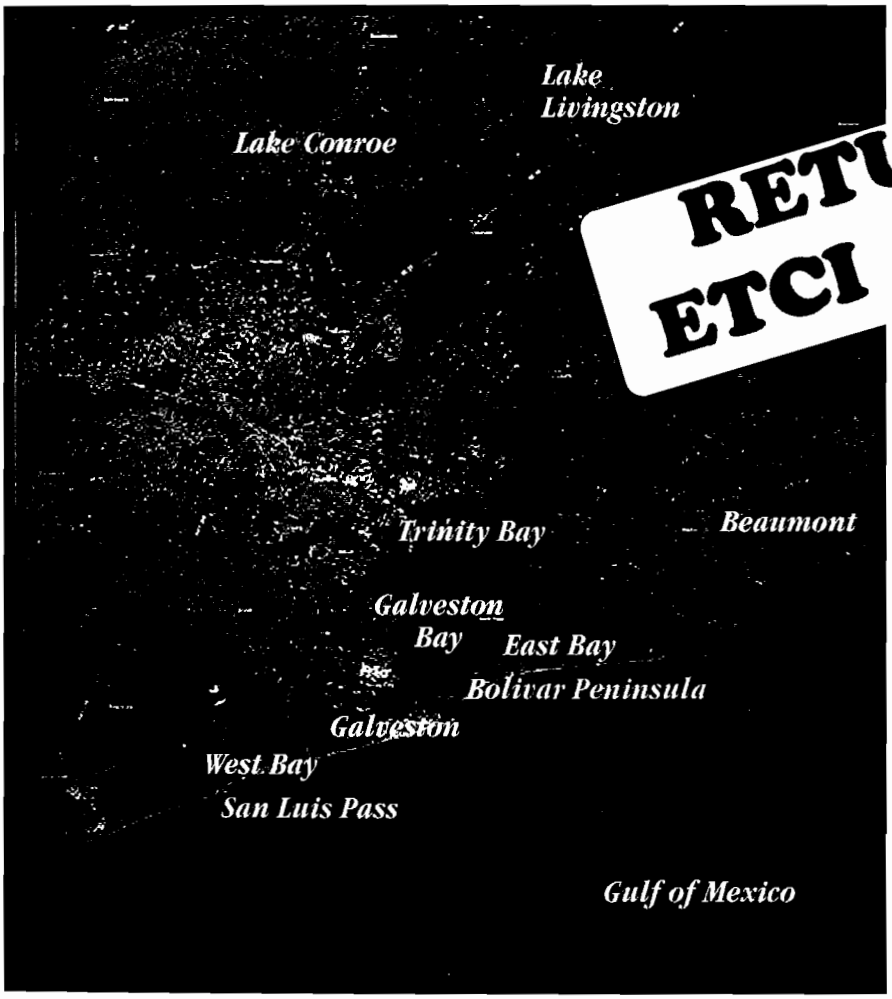
In Support of the U.S. Army Corps of Engineers
Supplemental Environmental Impact Statement for the
Houston/Galveston Navigation Channels, Texas Project

Cumulative Habitat Impact Assessment Summary

Prepared for

PORT OF HOUSTON AUTHORITY



Prepared by

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The Cumulative Impact Subcommittee of the Interagency Coordination Team (ICT) provided guidance and review for the preparation of this report. Members included:

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5.16 Cumulative Impact Assessment Methodology

Cumulative impact has been defined by the President's Council on Environmental Quality (CEQ) (40 CFR 1508.7) as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertakes such other actions". Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Impacts (or effects) include both *direct effects* which are caused by an action and occur at the same time and place as the action, and *indirect effects* which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable (40 CFR 1508.8). Ecological effects refer to effects on natural resources and on the components, structures, and functioning of affected ecosystems, whether direct, indirect, or cumulative.

In assessing cumulative impact, the regulation (40 CFR 1508.27) instructs the consideration of 1) the degree to which the proposed action affects public health or safety, 2) unique characteristics of the geographic area, 3) the degree to which the effects on the quality of the human environment are likely to be highly controversial, 4) the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks, and 5) whether the action is related to other actions with individually insignificant but cumulatively significant impacts on the environment.

Cumulative effects can result from many different activities including addition of materials to the environment from multiple sources, repeated removal of materials or organisms from the environment, and repeated environmental changes over large areas and long periods. More complicated cumulative effects occur when stresses of different types combine to produce a single effect or suite of effects. Large, contiguous habitats can be fragmented, making it difficult for organisms to locate and maintain populations in disjunct habitat fragments. Cumulative impacts may also occur when the timing of perturbations are so close that the effects of one are not dissipated before the next occurs, or when the timing of perturbations are so close in space that their effects overlap.

The Cumulative Impacts Subcommittee of the ICT (the Subcommittee), which includes representatives from Galveston Bay National Estuary Program (GBNEP), National Marine Fisheries Service (NMFS), Texas Parks and Wildlife Department (TPWD), U.S. Army Corps of Engineers (USACE), and U.S. Fish and Wildlife Service (USFWS) agreed to a scope of work (revised from the original scope developed in 1990) encompassing 23 parameters for 10 past, present, and reasonably foreseeable future projects (base projects) viewed as pertinent to the bay's condition. Parameters to be addressed include biological, physical, chemical, socioeconomic, and cultural attributes. The methodology and conclusions described below were developed with the guidance and consensus of the Cumulative Impact Subcommittee of the ICT. Additional information regarding the cumulative impact assessment is published in supporting documentation available upon request.

Cumulative Impact Assessment Methodology

This discussion describes the application of the cumulative impact assessment methodology to the BASELINE scenario, but without the impacts of the Houston Ship Channel or Galveston Channel. The addition of the HGNC project impacts to the BASELINE scenario will be discussed in the Section 7.7 of the SEIS. Projects evaluated in the BASELINE scenario assessment included the following:

- Gulf Intracoastal Waterway (GIWW) Maintenance Dredging,
- San Jacinto River and Tributaries Flood Control Project,
- Buffalo Bayou and Tributaries Flood Control Project,
- Clear Creek Flood Control Project,
- Texas City Channel Modernization,
- Cross Bay Bridge to Galveston,
- Wallisville Salt Control Project,
- Multipurpose Channel to Liberty,
- Tennessee Colony Reservoir, and
- The Trans-Texas Water Plan.

The baywide study area for the cumulative impact assessment was limited to the area represented on digital National Wetland Inventory (NWI) maps, oyster reef maps prepared for the Galveston Bay National Estuary Program, and described in documents identifying important bird nesting habitat in Galveston Bay published by USFWS.

Galveston Bay habitats for cumulative impact assessment were identified from reports developed for the Galveston Bay National Estuary Program and in support of the Houston-Galveston Navigation Channels, Texas Project (HGNC), and included **Submerged Aquatic Vegetation, Bird Nesting Habitat, Intertidal Emergent Wetlands, Palustrine Emergent Wetlands, Palustrine Forested Habitats, Oyster Reef, Intertidal Unconsolidated Shorelines, Open Bay Water,** and **Open Bay Bottom.** Direct impacts which could be quantified in acreage were considered for habitat impact assessment. Indirect impacts which could not be readily enumerated were considered in discussion of impacts, but no attempt was made to enumerate acreage of impact in these instances. In addition to habitats, impacts to specific resource categories described as ecological/biological (finfish/shrimp, terrestrial vegetation, wetland vegetation, submerged aquatic vegetation, birds, mammals, reptile/amphibians, threatened/endangered species, benthos, plankton, and oysters), physical/chemical (topography/bathymetry, circulation/turnover & tides, noise, air resources, water quality, salinity, freshwater inflow, turbidity, sediment quality, oil/gas production, and accidents/spills), and cultural/socioeconomic (cultural resources, land use, employment, services, recreation, tourism, and transportation) were addressed in a more qualitative manner based on information provided by documents reviewed for each project.

Evaluation Criteria

Magnitude of impacts was determined by summing acreage gains and losses as described in the project documents and determined from recent habitat information obtained through GBNEP. Acreage of each habitat in the study area was determined

from NWI maps, existing bay boundary maps, and available literature. A key aspect of this assessment is its use of areal habitat coverage as the response parameter for the impacts being assessed. **Intensity** of impacts was assigned based on each project's impact on the status of each habitat. For example, construction of marsh from dredged material was considered **Intertidal Emergent Wetlands** creation, while conversion of existing marsh to upland dredged material disposal area was considered **Intertidal Emergent Wetlands** destruction. In comparison, temporary degradation of bird nesting colonies during project construction was viewed as disturbance, while temporary barren substrate nesting habitat formed by deposition of dredged material on existing nesting sites (outside of nesting season) was considered enhancement. **Duration** of impacts was assigned based on the length of time the project was expected to impact each bay habitat. Impacts were considered permanent when there was no likelihood that the impacted habitat would return to its preproject conditions within 3 years of construction completion (for example, destruction of marsh to create confined upland disposal areas). Impacts were considered temporary when the impacted habitat was expected to return to its preproject condition within 3 years of construction completion (for example, disturbance of nesting bird colonies by dredging equipment during project construction).

Individual Project Evaluation

Individual project documents were reviewed for impacts to selected habitats based on the evaluation criteria described above. Figures and drawings included with each document were compared to current known habitat coverage, and acreage impacted was calculated for each habitat. In some cases, estimates of habitat within impact areas of known acreage were necessary. For example, estimates of percent coverage of oysters within designated subaqueous unconfined disposal sites for the GIWW were used to calculate **Oyster Reef** impact from that project. No attempt was made to verify published project drawings with as-built drawings or unpublished revised plans, nor were disposal practices proposed in reviewed documents verified for current on-going projects. Project duration estimated in reviewed project documents was utilized for the assessment. In addition no field data was collected to verify project impacts described in reviewed documents.

Gains and losses in habitat acreage were summed for each habitat to obtain a cumulative acreage impact for the magnitude component. The intensity and duration component was determined by summing the habitat acreage for each configuration of intensity and duration conditions. Conditions having the greatest acreage impact were considered as the cumulative impact. For example, **Oyster Reef** experienced cumulative impacts to 828 acres of habitat distributed as follows: 229 acres, permanent destruction; 152 acres, temporary degradation; and 447 acres, permanent degradation. Since a greater number of acres (447) experienced permanent degradation impacts, the cumulative impact to **Oyster Reef** was determined to be 828 acres, permanent degradation. Table 1 summarizes the results of the BASELINE scenario evaluation for each habitat.

Table 1. Results of cumulative habitat impact assessment for the BASELINE scenario.

Habitat	Cumulative Baywide Habitat Impact Net acreage impact for BASELINE scenario
Submerged Aquatic Vegetation	64 acres, permanent destruction
Bird Nesting Habitat	23 acres, temporary degradation
Intertidal Emergent Wetlands	1,128 acres, permanent creation
Palustrine Emergent Wetlands	167 acres, permanent destruction
Palustrine Forested Habitat	1,273 acres, permanent destruction
Oyster Reef	776 acres, permanent degradation
Intertidal Unconsolidated Shorelines	896 acres, permanent destruction
Open Bay Water	4,606 acres, permanent degradation
Open Bay Bottom	4,315 acres, permanent degradation

Summed Project Impacts

Recognizing that the ecosystem exhibits not only characteristics of its components, but also characteristics of its own which arise from combinations and interactions of the components, the cumulative impact assessment methodology was expanded to include a summation of weighted habitat impacts for all projects. Habitats were ranked based on scarcity in the ecosystem, contribution to bay productivity, and general significance in Galveston Bay when compared to each other. The results of the ranking are

Submerged Aquatic Vegetation	9
Bird Nesting Habitat	8
Intertidal Emergent Wetlands	7
Palustrine Emergent Wetlands	6
Palustrine Forested Habitats	5
Oyster Reef	4
Intertidal Unconsolidated Shorelines	3
Open Bay Water	2
Open Bay Bottom	1

Intensity and duration components from each habitat were evaluated according to the following numerical modifiers to allow more complete ranking of whole project impacts:

Intensity	**Rank**	**Duration**	**Rank**
Enhancement/Degradation	1	Temporary	1
Creation/Destruction	2	Permanent	2

Project impacts for each scenario were determined for impacts in each habitat based on the following formula for the sum of all projects in each scenario and defined as a Habitat Assessment Unit (HAU):

(+/- habitat acreage) x (relative ranking) x (intensity) x (duration) = HAU

The products of all habitat results were summed within each scenario to produce a scenario HAU. Table 2 shows the HAU calculation for the BASELINE scenario.

Table 2. Calculation of Habitat Assessment Units (HAU) for the BASELINE scenario.

Habitat	Acres	Weight	Intensity	Duration	HAU
Submerged Aquatic Vegetation	- 64	9	2	2	- 2,304
Bird Nesting Habitat	- 23	8	1	1	- 184
Intertidal Emergent Wetlands	+ 1,128	7	2	2	+ 31,584
Palustrine Emergent Wetlands	- 167	6	2	2	- 4,008
Palustrine Forested Habitat	- 1,273	5	2	2	- 25,460
Oyster Reef	- 776	4	1	2	- 6,208
Intertidal Unconsolidated Shorelines	- 896	3	2	2	- 10,752
Open Bay Water	- 4,606	2	1	2	- 18,424
Open Bay Bottom	- 4,315	1	1	2	- 8,630
Total					- 44,386

Resource Impact Evaluation

Biological/ecological, physical/chemical, and cultural/socioeconomic resource impacts were evaluated based on individual project reviews. Quantitative assessment of resources was not undertaken; however, a qualitative discussion of biological/ecological and physical/chemical resources was accomplished using information published in reviewed documents, as well as information recently made available regarding these resources through GBNEP. For example, recently published oyster maps were used to assess which reefs would likely be impacted by reviewed projects and recently published data on sediment contamination baywide was compared to reviewed project plans to determine the potential for problems associated with disturbing existing contamination. Cultural/socioeconomic resources were evaluated based on information published in reviewed documents only, and were limited to impacts to cultural resources, land use, employment, services, recreation, tourism and transportation. No attempt was made to verify or update this information.

Results

A discussion of habitat impacts is included below.

Submerged Aquatic Vegetation

Based on the results of the impact assessment for the BASELINE scenario, **Submerged Aquatic Vegetation** experienced a baywide net negative impact of 64 acres, permanent destruction. Two projects account for all direct impacts to **Submerged Aquatic Vegetation** in Galveston Bay; the GIWW maintenance dredging and the Multipurpose Channel to Liberty. **Submerged Aquatic Vegetation** habitat is displaced by construction of disposal sites in both projects.

Bird Nesting Habitat

Cumulative impacts evaluation of the BASELINE scenario resulted in a net negative impact as temporary degradation to 23 acres of **Bird Nesting Habitat** in Galveston Bay. Although some enhancement of this habitat was assessed due to creation of temporary barren nesting substrate from deposition of dredged material on existing nesting area, temporary disturbance of nesting colonies due to construction activity surpassed this benefit.

Intertidal Emergent Wetlands

Intertidal Emergent Wetlands experienced a cumulative gain of 1,128 acres through permanent creation in Galveston Bay in the BASELINE scenario. These benefits were derived from creation of marsh associated with proposed disposal of dredged material from the Texas City Channel Project and the Multipurpose Channel to Liberty. Although losses of **Intertidal Emergent Wetlands** will be experienced due to other projects, the gains associated with these two projects counteract these losses.

Palustrine Emergent Wetlands

Assessment of cumulative impacts to **Palustrine Emergent Wetlands** revealed a net loss to this habitat in the BASELINE scenario. Although **Palustrine Emergent Wetlands** was created as a result of the Wallisville Salt Control Project, significant acreage was destroyed as a result of the Multipurpose Channel to Liberty, resulting in a net loss of 167 acres of **Palustrine Emergent Wetlands** baywide through permanent destruction.

Palustrine Forested Habitat

Based on the results of the cumulative impact assessment, **Palustrine Forested Habitat** experienced a net loss of 1,273 acres through permanent destruction. This impact is due solely to the destruction of **Palustrine Forested Habitat** by the Wallisville Salt Control Project.

Oyster Reef

Cumulative impact assessment resulted in a net loss to **Oyster Reef** in Galveston Bay. Negative impacts to reef habitat due to project activity were widespread throughout the bay; however, GIWW Maintenance Dredging resulted in substantial degradation of reef due to repeated deposition of dredged material on subaqueous unconfined disposal sites. Impacts in the BASELINE scenario resulted in a net negative impact on 776 acres of **Oyster Reef** baywide through permanent degradation.

Intertidal Unconsolidated Shorelines

Cumulative impacts of all assessed activities resulted in a net loss to **Intertidal Unconsolidated Shorelines** in Galveston Bay. These impacts were widely scattered in the bay with the Multipurpose Channel to Liberty and the GIWW Maintenance Dredging accounting for the greatest number of acres impacted. The combined impacts resulted in a net negative impact to 896 acres of **Intertidal Unconsolidated Shorelines** through permanent destruction.

Open Bay Water

Cumulative impact assessment of all reviewed projects in the BASELINE scenario revealed a net loss of **Open Bay Water** resulting from project activities. Although these impacts were widely scattered throughout the bay, degradation resulting from the repeated deposition of maintenance material from the GIWW accounted for the largest impact. The combined impact of all projects accounted for a net loss of 4,606 acres of **Open Bay Water** baywide through permanent degradation.

Open Bay Bottom

Although negative impacts to **Open Bay Bottom** were widely scattered throughout the bay, degradation resulting from the repeated deposition of maintenance material from the GIWW presented the greatest impact of the projects reviewed. Net loss to **Open Bay Bottom** from combined project impacts amounted to 4,315 acres through permanent degradation.

Habitat Assessment Units

When evaluating the results of the BASELINE scenario, the summed total of all projects evaluated resulted in a net negative impact to Galveston Bay (- 44,386 HAUs). Individually, **Intertidal Emergent Wetlands** experienced a net positive impact; however, all other categories reflect a negative impact.

Ecological/Biological Resources

Biological and ecological resources will experience a net negative impact from increased turbidity associated with dredging, dredged material disposal, and flood control;

finfish/shrimp, birds, threatened/endangered species, benthos, plankton, oysters, and submerged aquatic vegetation will also be impacted. Disturbance of bay bottom due to open bay disposal and channel dredging is anticipated to provide negative impacts to oysters, benthos, and submerged aquatic vegetation. Changes in freshwater inflow are expected to affect species composition of finfish/shrimp, plankton, and benthos. This impact can be attributed primarily to interbasin transfers associated with the Trans-Texas Water Plan, although Tennessee Colony Reservoir also contributes. Oysters are anticipated to be negatively impacted by increased salinity and freshwater inflow, although some benefit may also be experienced by placing oysters that were previously surviving in marginal areas of the bay (usually too fresh) into more saline waters that encourage better growth. Loss of freshwater marsh and forest habitat is expected to reduce detrital mass which will negatively affect species dependent upon it as a food and nutrient source, in addition to reduction of primary productivity in the bay. These impacts are anticipated to come from Wallisville Salt Control Project and Multipurpose Channel to Liberty project impacts. Positive impacts in the BASELINE scenario are anticipated to be derived from the creation of marsh which will increase nursery habitat for finfish/shrimp and provide rich substrate for benthic organisms. Marsh creation projects are associated with the Texas City Channel project and the Multipurpose Channel to Liberty. Birds will benefit by the periodic deposition of dredged material on existing upland sites due to creation of temporary barren nesting substrate; however, construction operations attributed to the GIWW maintenance dredging project may disturb nesting activity. Mammals, reptiles/amphibians, and terrestrial vegetation will be negatively impacted by deposition of material on existing upland disposal sites. Threatened/endangered species will be negatively impacted in the Trinity River area due to the Multipurpose Channel to Liberty project; however, some benefit may be realized from creation of marsh and creation of barren nesting substrate on existing disposal sites associated with the Texas City Channel, Multipurpose Channel to Liberty, GIWW maintenance dredging. Wetland vegetation will be negatively impacted where wetlands (salt, fresh, forested) is damaged or destroyed; however, marsh creation projects will benefit wetland vegetation.

Physical/Chemical Resources

Increases in both upland and submerged elevations from dredged material disposal in the BASELINE scenario can be expected to change local circulation patterns; however, tides should not be affected. Although water quality baywide appears to be improving, dredging and existing disposal operations are expected to degrade water quality in the project vicinity through increased turbidity, release of bound nutrients, and depletion of oxygen. All projects reviewed cited no concerns with sediment contamination with the exception of the Texas City Channel. Due to interbasin transfers in the Trinity River basin and the resulting decrease in freshwater inflows in conjunction with increasing return flows in the San Jacinto River basin, a significant impact upon freshwater inflow frequency and magnitude to Galveston Bay will occur. Reduction of freshwater inflow is also anticipated as a result of the Tennessee Colony Reservoir. Oil and gas wells north of the Texas City dike will be closed prior to construction of the disposal site (marsh); however, none of the projects reviewed anticipated impacts to exploration or drilling. New and improved channels (Multipurpose Channel to Liberty and Texas City Channel) may increase vessel traffic; however, improved navigation safety may lessen

the existing risk of spills. Temporary negative noise impacts are anticipated in the immediate vicinity of dredging and construction. Air impacts include increase in dredging-related pollutants (NOX, CO, SO2, particulates, hydrocarbons) during project construction periods; however, compliance with the Clean Air Act in this nonattainment area may reduce this impact.

Cultural/Socioeconomic Resources

Cultural impacts are anticipated to be experienced by historical wrecks, homesites, a fort, fossil bones, and shell middens as a result of the BASELINE scenario. A cultural park is planned for development in the Wallisville area. Land use impacts include conversion of present land use to dredged material disposal area, and will account for a loss of upland, wetland, and riparian areas. Developed land in flood plains is anticipated to become barren, while undeveloped land on Galveston Island will become part of a road right-of-way. The projects reviewed do not anticipate providing for increased population to meet employment requirements; therefore, increased demand for services is not generally anticipated. Timing of projects may have the greatest impact on the work force, since specialized labor for navigation projects is limited in the area. For example, if all projects reviewed were under construction at the same time, a much larger labor force would be needed than if projects were phased to accommodate the existing population. Tourist and development pressure on west Galveston Island will create a need for improved police, fire, and water distribution and treatment facilities. Any industrial growth associated with projects will require improvements in associated services. Popular recreation and tourist facilities will be expanded at the Texas City Dike, while flood control projects include the construction of park areas along floodplains. Increased tourist and recreational usage of west Galveston Island is anticipated as a result of improved access due to the Cross Bay Bridge. Increased turbidity and bay bottom impacts associated with dredging and disposal may reduce commercial and recreational income baywide; however timing of projects may result in varied intensity of this impact. For example, if all projects reviewed were in construction at the same time, the impact from turbidity would be much greater than if construction of projects was varied in time. Transportation access will be improved with new channel development projects and maintenance of existing channels. Transportation safety will be improved in all channel projects and hurricane evacuation for west Galveston Island will be improved due to the Cross Bay Bridge.

Conclusions

The BASELINE scenario was found to produce a net negative cumulative impact in Galveston Bay. Although some benefit will be realized through creation of **Intertidal Emergent Wetlands**, negative impacts in all other habitat categories resulted in a net negative impact assessment baywide.

7.7 Cumulative Impacts

To assess the cumulative impacts of the Houston-Galveston Navigation Channels, Texas Project (HGNC), three scenarios were examined using the methodology described in Section 5.16. The WITHOUT PROJECT scenario examined the impacts of the sum of the BASELINE scenario and continued maintenance dredging of the Houston Ship Channel (HSC) and Galveston Channel. The OPEN BAY scenario examined the impacts of the sum of the BASELINE scenario and the proposed open bay unconfined disposal plan of material dredged for the 45′ x 530′ HSC. The BUG scenario evaluated the impacts of the sum of the BASELINE scenario and the proposed beneficial uses plan for the proposed 45′ x 530′ HSC. The results of the scenario impacts are illustrated in Table 1 and are described below.

WITHOUT PROJECT

The summed effects of the BASELINE projects plus continued maintenance dredging of the Houston Ship Channel and Galveston Channel (the WITHOUT PROJECT scenario) resulted in a net negative impact baywide (- 81,404 Habitat Assessment Units [HAUs]). Of all habitats reviewed, only **Intertidal Emergent Wetlands** experienced a net positive impact; however, this benefit was largely negated by net negative impacts in all other habitat categories. Based on the results of this assessment, the continued maintenance of existing projects assessed and the construction of proposed projects evaluated will provide a continuing net negative impact to ecological habitats in Galveston Bay.

As a result of this negative cumulative impact, many living resources evaluated will also be negatively impacted. These impacts are expected to come from loss of nursery habitat, feeding habitat, and nutrient sources resulting from the negative impacts to habitats assessed in this scenario. Although some positive impact will occur due to creation of marsh from dredged material, negative impacts in other habitats outweigh this benefit. Additional negative impact will occur as a result of physical changes in the bay due to deposition of dredged material, changes in freshwater inflow, and changes in hydrodynamics from creation of channels. Cultural and socioeconomic resources are not anticipated to benefit or degrade as a result of impacts of the WITHOUT PROJECT scenario, and their greatest impact may come from timing of projects to meet existing resources.

With OPEN BAY

The summed effects of the BASELINE projects plus implementation of the proposed OPEN BAY plan resulted in overall increased negative impacts baywide when compared to the WITHOUT PROJECT scenario. Less acreage of **Intertidal Emergent Wetlands** will be negatively impacted since use of Disposal Area 15 is not proposed. Fewer acres of **Intertidal Unconsolidated Shoreline** will be impacted due to a reduction in the number of upland disposal sites. Fewer acres of **Bird Nesting Habitat** will be impacted in the OPEN BAY scenario. No additional impacts to **Submerged Aquatic**

Vegetation, Palustrine Emergent Wetlands, and **Palustrine Forested Habitat** are anticipated in the OPEN BAY scenario. **Oyster Reef, Open Bay Bottom,** and **Open Bay Water** habitats experienced increased net negative impact resulting from the project. **Based on the results of the assessment, widening and deepening of the Houston Ship Channel and corresponding open bay unconfined disposal will result in a greater negative impact in Galveston Bay (- 100,650 HAUs) when compared to the WITHOUT PROJECT scenario (greater negative impact by 19,246 HAUs).**

As a result of this negative cumulative impact, many living resources evaluated will be further negatively impacted when compared to the WITHOUT PROJECT condition. These impacts are expected to come from loss of nursery and feeding habitat resulting from increased turbidity due to dredging and subaqueous unconfined disposal and salinity intrusion from the change in channel configuration. Additional negative impact will occur as a result of physical changes in the bay due to creation of new subaqueous dredged material disposal areas and changes in hydrodynamics. Teh most signficnat cultural and socioeconomic resources impacts are anticipated to be derived from loss of fisheries productivity during widening and deepening of the HSC and Galveston Channel and due to subaqueous unconfined disposal effects.

<u>With BUG</u>

Although the summed effects of the BASELINE projects plus implementation of the proposed BUG plan resulted in a net negative impact baywide, the results of the assessment are more positive than either the WITHOUT PROJECT or OPEN BAY scenarios. Although more acreage of **Intertidal Unconsolidated Shoreline** will be negatively impacted, it will be replaced with productive **Intertidal Emergent Wetlands.** This greatly increases the positive net benefit to **Intertidal Emergent Wetlands**. In addition, the construction of a bird nesting island provides a net positive impact to the bay. Fewer **Oyster Reef, Open Bay Water,** and **Open Bay Bottom** acres will be impacted by the project than its OPEN BAY counterpart. No additional impact to **Submerged Aquatic Vegetation, Palustrine Emergent Wetlands,** and **Palustrine Forested Habitat** is anticipated in the BUG scenario. **Based on the results of the assessment, widening and deepening of the Houston Ship Channel and corresponding construction of beneficial uses sites will result in a less negative impact in Galveston Bay (- 22,208 HAUs) when compared with the WITHOUT PROJECT (greater positive impact by 59,196 HAUs) and OPEN BAY scenarios (greater positive impact by 78,442 HAUs).**

Some negative impact to living resources evaluated will occur from dredging turbidity, hydrodynamic and salinity changes, and replacement of bay bottom with beneficial uses sites; however, creation of marsh and bird nesting habitat will balance the negative impact, to produce a net positive influence to living resources. Negative impact will occur as a result of physical changes in the bay from circulation changes associated with creation of beneficial use sites and changes in hydrodynamics due to channel widening and deepening. Cultural and socioeconomic resources are generally anticipated to benefit as a result of impacts of the BUG scenario due to the creation of boater

destinations associated with beneficial use sites. Impact to other socioeconomic parameters examined is dependent primarily on timing of projects to utilize the existing work force efficiently.

Summary

Based on the results of this cumulative impact assessment, continued maintenance dredging of the Houston and Galveston Channels in combination with other proposed projects reviewed will result in a negative impact to the Galveston Bay ecosystem. Impacts associated with the OPEN BAY scenario resulted in a greater net negative impacts when compared with the WITHOUT PROJECT scenario. Although, the BUG scenario resulted in a net negative cumulative impact assessment, the results of the assessment are more positive than the OPEN BAY and WITHOUT PROJECT scenarios. The positive influence exhibited by the BUG Plan illustrates that a project which adversely impacts some components of the bay ecosystem, can provide positive contribution through beneficial uses (marsh creation, bird island construction, others) which exert a larger influence upon many components of the bay ecosystem.

Table 1. Summary of Baywide Cumulative Impacts Comparing the WITHOUT PROJECT Scenario to Two Alternative Plans

Habitat	Baywide Cumulative Impact (Habitat Assessment Units)					
	WITHOUT PROJECT[1]	With OPEN BAY [2]	Compare OPEN BAY and WITHOUT PROJECT	With BUG [3]	Compare BUG and WITHOUT PROJECT	Compare BUG with OPEN BAY
Submerged Aquatic Vegetation	[4]- 2,304	- 2,304	No Change	- 2,304	No Change	No Change
Bird Nesting Habitat	- 440	- 188	+ 252	- 92	+ 348	+ 96
Intertidal Emergent Wetlands	+ 15,792	+ 17,836	+ 2,044	+ 136,052	+ 120,260	+ 118,216
Palustrine Emergent Wetlands	- 4,008	- 4,008	No Change	- 4,008	No Change	No Change
Palustrine Forested Habitat	- 25,460	- 25,460	No Change	- 25,460	No Change	No Change
Oyster Reef	- 8,528	- 10,144	- 1,616	- 3,416	+ 5,112	+ 6,728
Intertidal Unconsolidated Shoreline	- 13,884	- 11,220	+ 2,664	- 14,340	- 456	- 3,120
Open Bay Water	- 29,156	- 45,828	- 16,672	- 72,288	- 43,132	- 26,400
Open Bay Bottom	- 13,416	- 19,334	- 5,918	- 36,352	- 22,936	- 17,018
Scenario Total	**- 81,404**	**- 100,650**	**- 19,246**	**- 22,208**	**+ 59,196**	**+ 78,442**

[1] Ten Base Projects with Existing Channel and Disposal Plans (WITHOUT PROJECT)
[2] Ten Base Projects with Open Bay Plan (OPEN BAY)
[3] Ten Base Projects with Beneficial Uses Group Plan (BUG)
[4] + Positive or beneficial impact
- Negative or adverse impact

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