Aquatic Ecosystem Restoration for Gulf Intracoastal Waterway

Cost Effectiveness / Incremental Cost Analysis
Appendix E DRAFT

Beneficial Use of Dredged Material

Section 204

Goose Island State Park
Aransas County, Texas

January 2023

US Army Corps of Engineers®
Galveston District

(NOTE: This page intentionally left blank.)

Table of Contents

List of Figures

List of Tables

List of Acronyms

AAHU	Average Annual Habitat Unit
CE/ICA	Cost Effectiveness / Incremental Cost Analysis
EGM	Economic Guidance Memorandum
ICA	Incremental Cost Analysis
IDC	Interest During Construction
NER	National Ecosystem Restoration
OMRR&R	Operations, Maintenance, Repair, Replacement, and Rehabilitation

1. Introduction

Comparing benefits and costs for ecosystem restoration provides a challenge to planners and decision makers because benefits and costs are not measured in the same units. Environmental restoration benefits can be measured in habitat units or some other physical unit, while costs are measured in dollars. Therefore, benefits and costs cannot be directly compared. Two analyses are conducted to help planners and decision makers identify plans for implementation, though the analyses themselves do not identify a single ideal plan. These two techniques are cost effectiveness and incremental cost analysis. Use of these techniques are described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies (U.S. Water Resources Council 1983).

Cost effectiveness compares the annual costs and benefits of plans under consideration to identify the least cost plan alternative for each possible level of environmental output, and for any level of investment, the maximum level of output is identified.

Incremental cost analysis of the cost-effective plans is conducted to reveal changes in costs as output levels are increased. Results from both analyses are presented graphically to help planners and decision makers select plans. For each of the best buy plans identified through incremental cost analysis, an “is it worth it?” analysis is then conducted for each incremental measure or plan to justify the incremental cost per unit of output to arrive at a recommended plan.

For this study, the environmental output is the average annual habitat unit (AAHU), which is derived from the product of a Habitat Suitability Index and an alternatives acreage. The development of the AAHU is discussed in detail in the Appendix C – Habitat Modeling.

2. Measures and Alternatives

2.1 Measures

A measure is defined as a means to an end; an act, step, or procedure designed for the accomplishment of an objective. In other words, a measure is a feature (structure), or an activity, that can be implemented at a specific geographic site to address one or more planning objectives. Measures are the building blocks of alternatives and are categorized as structural and non-structural. Equal consideration was given to measures during the planning process while conducting this feasibility study.

2.2 Alternatives

The array of management measures was combined into alternatives that would address ecosystem restoration of the riverine habitats, as well as restore structure and function of the study area. Each of the alternatives listed below could be a standalone plan or be combined with other alternatives to form a suite of plans.

- **Alternative 3A – Saline marsh in existing cells**
- **Alternative 3B – Saline marsh in existing cells and living shoreline**
- **Alternative 3C – Saline marsh in existing cells, addition of new low and high elevation marsh cells***
- **Alternative 3D – Saline marsh in existing cells, addition of new low and high elevation marsh cells***
- **Alternative 3E – Saline marsh in existing cells, addition of new low and high elevation marsh cells and living shoreline**

***** The difference between alternative 3C and 3D is the location of the higher elevation marsh; scale and acreage are identical; alternative 3E added a living shoreline. Alternatives cannot be combined because the environmental team started with a base alternative (3a) and added features to evaluate resulting scales in the other alternatives.

3. Average Annual Habitat Units and Costs

To determine benefits of an environmental restoration plan, future with-project environmental outputs are compared to future without-project outputs. The difference between the two represents the benefits from project implementation. The Average Annual Habitat Units (AAHUs) were calculated using the Annualizer Tool in the Institute for Water Resources Planning Suite II. Appendix C – Habitat Modeling provides further documentation on how AAHUs were calculated for each Future-Without Project (FWOP) and Future-With Project (FWP) condition benefits.

3.1 Existing and Future-Without Project Average Annual Habitat Units

For this study, FWOP baseline conditions are assumed to be the same as existing conditions, given the existing habitat quality. Future-Without Project conditions were estimated by a team of biologists, including representatives from USACE as well as the Texas Parks & Wildlife Department and local representatives.

3.2 Future-With Project Average Annual Habitat Units

Environmental restoration benefits are calculated by subtracting the FWOP AAHU from the FWP AAHU. For the comparison of measures, both environmental outputs and costs were annualized over a 50-year planning horizon using the FY 2023 Federal Discount Rate of 2.5% (per EGM 23-01 dated 15 October 2022).

The resulting benefits are then used, along with annual costs, to identify cost effective plans and perform incremental cost analysis. The calculation of benefits (outputs/AAHUs) are shown in Table 3-1.

Reach	Alternatives	AAHU Benefits	Acres
GIWW along Goose Island State Park	3A	7.87	23
	3B	11.87	29.5
	3C	16.52	39
	3D	17.27	39

3.3 Costs

Total project economic costs were annualized using the Annualizer tool in Institute for Water Resources (IWR) Planning Suite II. A period of analysis of 50 years was used, along with a Federal Discount rate of 2.5%. Prices are expressed in October 2023.

Table 3-2 provides a summary of total and annual costs, including an initial estimate of annualized Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) for each alternative. Project first cost includes construction costs; planning, engineering, and design (PED); construction management; and contingency estimates. Real estate cost was estimated on a per-acre basis for each alternative and includes a contingency factor. Construction durations were estimated to be 9 to 11 months for all alternatives, used to calculate interest during construction (IDC). Construction and related first costs, real estate cost and IDC are summed to calculate the annual investment costs. The annual with-project OMRR&R is added to the annual investment cost to obtain the total annual costs.

Reach	Project First Cost (PFC)	Real Estate	IDC	Economic Cost	Annual Investment Cost	Annual M&AM	Annual OMRRR*	Total Annual Cost
1. GIWW along Goose Island State Park								
ALT 3A	$3,597,200	$1,915,700	$51,400	$5,564,300	$196,200	Included PFC	$0	$196,200
ALT 3B	$4,271,700	$4,383,300	$80,600	$8,735,700	$308,000	Included PFC	$0	$308,000
ALT 3C	$5,400,700	$1,509,200	$78,800	$6,988,700	$246,400	Included PFC	$7,400	$253,800
ALT 3D	$5,447,600	$1,508,100	$79,300	$7,035,100	$248,000	Included PFC	$7,400	$255,400

*ER projects do not have OMRR&R costs since the restoration features are designed to be self-sustaining. Only engineered features are assigned O&M costs such as the new containment levees constructed for sediment placement

Cost Effectiveness and Incremental Cost Analysis

To conduct the CE/ICA analysis, environmental restoration benefits (increase in with-project AAHUs) and annual costs were entered into IWR Planning Suite II. Cost effective plans are defined as the least expensive plan for a given set of benefits, or environmental output. In other words, no other plan would provide the same or more benefits for a lower cost.

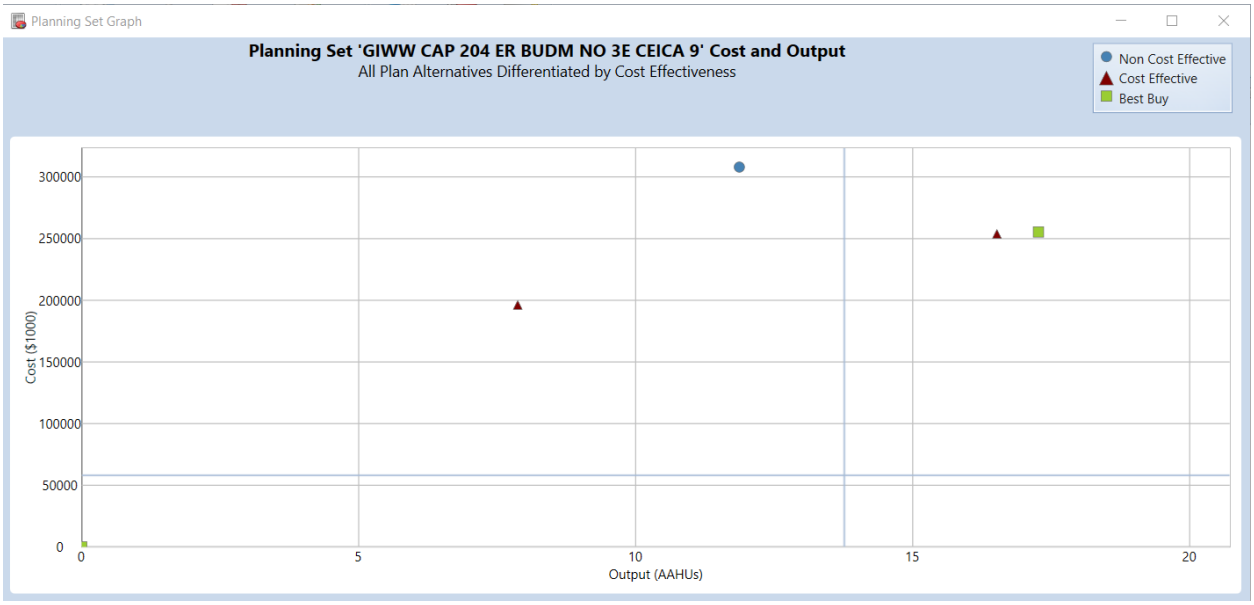
3.3.1 Cost Effective Plans

Table 3-1. Annual Benefits and Annual Cost for Cost Effective Alternatives by Reach

Reach	Alternatives	AAHU	Annual Cost ($1s) October 2019 Prices
GIWW along Goose Island State Park	3A	7.87	$196,200
	3C	16.52	$253,800
	3D	17.27	$255,400

Note that cost effective plans (red triangles) include those identified as “Best Buy” plans (green squares), which will be discussed in the next section.

Figure 3-1. Cost Effective Results



3.3.2 Incremental Analysis and Best Buy Plans

The next step in the CE/ICA analysis is to perform an incremental cost analysis (ICA) on the cost-effective plans. ICA compares the incremental cost per incremental benefit (output or increase in environmental output) among the plans to identify plans that maximize the last dollar spent. Starting with the no action plan, the incremental cost per incremental benefit is calculated from the no action for each cost-effective plan. The plan with the least incremental cost per incremental output is identified as the first of the "with-project" best buy plans. Then starting with that plan, the incremental cost per incremental benefit is calculated between that plan and each remaining cost-effective plan, and the one with the least incremental cost per incremental benefit is identified as the next plan in the array of best buy plans. This process continues until there are there are no remaining plans. The last plan in the best buy array, is typically the "kitchen sink" plan, or the plan that contains all the management measures being analyzed.

From the cost-effective alternatives, two were identified as "Best Buy" plans (including the No Action plan). The result of the analysis is shown graphically in Figure 3-2. The alternative Best Buy plans are:

- **Alternative No Action Plan (by definition)**
- Alternative 3D

Figure 3-2. Incremental Cost Analysis Result

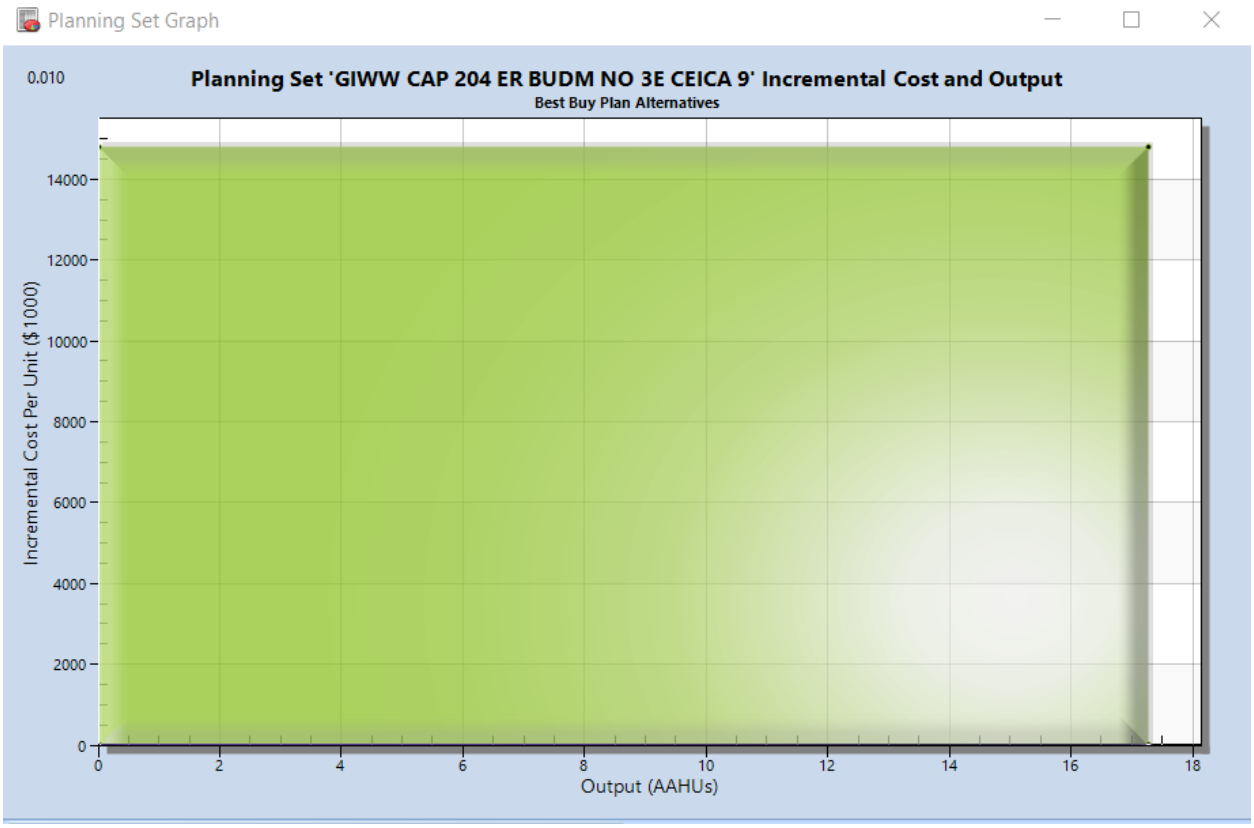


Table 3-2. Best Buy Plans

Plan	Output (AAHU)	Total Annual Cost ($1s)	Avg Cost ($1s/AAHU)	Incremental Cost ($1s)	Incremental Output (AAHU)	Incremental Cost per Output	Plan First + Real Estate Costs
No Action Plan	0	$0	0	0	0	0	$0
Alternative 3D	17.27	$255,400	$14,800	$255,400	17.27	$14,800	$7,000,000

4. "Is It Worth It" Analysis

The Cost Effective—Incremental Cost Analysis presented in the previous section does not lead to a definitive plan for choosing the recommended plan, but rather serves to inform the selection process. Using the results of the CEICA analysis, the benefits associated with the environmental incremental outputs must be evaluated against the incremental increase in costs. This analysis, called the "Is It Worth It?" analysis evaluates each plan, its incremental outputs and costs, and the benefits provided by the plan to make a case that the plan is worth the Federal investment to achieve those benefits.

No Action

Details: (0 AAHUs, $0 Ann Cost)

The No Action plan does not address any of the study objectives and would not restore coastal marsh habitats that would benefit migratory, breeding, and wintering waterfowl, waterbirds, and aquatic organisms. The No Action would also not demonstrate that BU can be effectively used to restore habitat, nor would it address existing or future problems related to degrade/degrading ecosystems or the dredging and placement challenges on the GIWW. This plan is not considered acceptable to the PDT, NFS, or resource agencies.

Pros:

- No surface disturbance or impacts to any natural resources or the human environment.

Cons:

- 0 acres of improved habitat leaving Goose Island in its existing condition.
- Would contribute to the significant national loss of wetland habitats occurring for fish and wildlife species and no efforts to offset this loss would be achieved for the study area.
- Ineffective to improve habitat for nationally significant migratory bird, threatened and endangered species, and aquatic wildlife populations within the study area.
- Material dredged from the GIWW would be placed in another location.

Alternative 3D

Details: 39-acre variable elevation marsh creation (17.27 AAHUs, $255,400 Ann Cost; $14,800 Incremental Cost per AAHU)

The additional federal investment of spending at least $14,800 (incremental cost/incremental output) to realize the last added habitat unit is worth pursuing over the Alternative 3C because it addresses the study objectives and increases the availability of limited and degrading habitat in the study area. It creates 39 acres of salt marsh and creates a more diverse habitat by incorporating low elevation and high elevation marsh cells but places the high elevation marsh cells in a better location, offering greater protection and extending sustainability. This plan is considered acceptable to the PDT, NFS, or resource agencies and is the Tentatively Selected Plan (TSP) for this project.

Pros:

- Demonstrates BU material can be used for ecosystem restoration and utilizes dredge material that would otherwise be placed offshore or in an upland placement area.
- Creates and sustains 39 acres of emergent salt marsh for 50 years after construction with negligible degradation. No interior marsh, low or high elevation, would be anticipated to degrade; however, some degradation may occur to low elevation marsh in new cells north of the high elevation marsh area from RSLC and erosion due to wave action.
    - The higher elevation marsh and interior low elevation marsh is expected to withstand erosion and/or degradation. No loss is expected to occur to the interior marsh due to the added protection from the higher elevation marsh and extent of new marsh cells.
- Creates a critical habitat for nationally significant migratory birds, threatened and endangered species, and aquatic wildlife populations within the study area.
- Contributes to offsetting the national loss of wetland habitats.
- Creates habitat diversity that has greater long-term sustainability for fish and wildlife organisms.
- Best buy plan

Cons:

- The newly created low elevation marsh north of the existing containment levee is likely to undergo some interspersion after 50 years, shifting the marsh to have a greater coverage of open water to emergent marsh.

5. References

1994. "Executive Order No. 12898, 59 FR 7629."

USACE. 2011. "Corps of Engineers Civil Works Cost Definitions and Applicability." Memorandum, Director of Civil Works, Dated 27 Aug 2011.

U.S. Army Corps of Engineers. 2017. Economic Guidance Memorandum, 18-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2018. Washington, D.C.: U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers. 2000. "Planning Guidance Notebook, ER 1105-2-100."

U.S. Environmental Protection Agency. 2020. Internet URL: https://www.epa.gov/heat-islands/heat-island-impacts. Accessed on 01 April 2020.