

APPENDIX H- GREENHOUSE GAS
Río Puerto Nuevo Flood Control Project
San Juan, Puerto Rico
June 2025

CO₂ is a reference gas, as it is the GHG emitted in the highest volume. The effect of other (non-CO₂) GHGs on global warming is the product of the mass of their emissions and their global warming potential (GWP). The GWP of a gas indicates how much the gas is predicted to contribute to global warming relative to the amount of warming that would be predicted to be caused by the same mass of CO₂. For example, CH₄ and N₂O are substantially more potent GHGs than CO₂, with GWPs of 25 and 298, respectively. Net GHG emissions were calculated using the US Army Corps of Engineers Net Emissions Analysis Tool (NEAT) version 1.2. The NEAT model calculates net emissions based on short-term construction emissions, long-term operational emissions, and the long-term effects of carbon sequestration from wetland restoration. The NEAT model was developed by the USACE Air Quality and GHG Emissions Analysis Sub-Community of Practice (AQ/GHG Sub-CoP) to quantify all net GHG and air pollutant effects relevant to USACE Civil Works and Regulatory projects. NEAT leverages the benefits of pre-existing models by transitioning output data from publicly available air pollutant and GHG emissions models, then integrates that data to compute net effects. The USACE ECO-PCX certified NEAT for national use in December 2023. The GHG analysis can be found in Appendix H, and the results are discussed below.

CO₂ emissions are highly correlated to fuel use. Approximately 99 percent of the carbon in oil and oil products is emitted in the form of CO₂ (USEPA, 2005). Cargo ships and tankers typically burn heavy fuel oil and tugboats typically burn diesel fuel. Emissions factors unique to each fuel type were used to calculate the anticipated GHG emissions, specifically CO₂, CH₄, and N₂O. Emissions factors can be found in EPA's GHG Emissions Factors Hub (<https://www.epa.gov/climateleadership/ghg-emission-factors-hub>). The emissions for each type of GHG were standardized to CO₂e using the equation below.

$$CO_2e = xCO_2 + yN_2O + zCH_4$$

Where:

X = 100-year global warming potential of carbon monoxide or carbon dioxide = 1

Y = 100-year global warming potential of nitrous oxide = 298

Z = 100-year global warming potential of methane = 25

A cost estimate was prepared by USACE for Alternative 4 only. The total amount of fuel required to construct Alternative 4 was based on this cost estimate and is assumed to consist of 100% diesel fuel. A quantitative GHG analysis of Alternative 4 is included below, along with a qualitative discussion of GHG emissions generated under Alternatives 1 and 3.

Alternative 1: No Action (Status quo): ODMDS and La Chuleta.

No construction emissions will be generated under Alternative 1. The continued use of the ODMDS and La Chuleta MMAs will generate O&M emissions that have not been quantified for this analysis. There will be no impacts to the 15.6 acres of wetlands under the No Action Alternative.

Wetland Emissions and Carbon Sequestration

Wetlands play an important but complex role in the global carbon cycle, contributing to greenhouse gas regulation through carbon sequestration. Wetlands may serve as carbon sinks because they store large amounts of carbon in aboveground biomass (e.g., forested wetlands) and soils (e.g., peatlands and coastal marshes); however, wetlands can also emit significant quantities of CH₄ and N₂O to the atmosphere. The US Army Corps of Engineers Net Emissions Analysis Tool (NEAT) calculates different rates of GHG production and sequestration based on the type of aquatic ecosystem. Using the US Fish and Wildlife Service (USFWS) Wetland Mapping Tool, it was determined that existing wetlands within the Bechara area are categorized as Marine & Estuarine – Forested & Shrub. The period of analysis for this study is 50 years, from 2029 to 2079. Annual and lifetime values for CO₂ sequestration and CH₄ and N₂O production were calculated. Annual and project lifetime emissions, based on the 15.6 acres of existing wetlands, are summarized in Table 1-1.

Table 1-1. Estimated GHG Emissions Calculated for the Existing Wetlands in the Bechara MMA

GHG	Wetlands Lost (Ac)	Annual Emissions Production (MT/yr)	Lifetime Emissions Production (MT)	Lifetime Emissions (MT CO ₂ e)
CO ₂	15.6	-14.54	-727.06	-727.06
CH ₄	15.6	0.05	2.71	67.80
N ₂ O	15.6	0.02	0.91	270.33

Total lifetime wetland emissions for No Action Alternative are estimated to be -388.93 MT CO₂e, which reflects the CO₂ sequestration and production of CH₄ and N₂O from the 15.6 acres of existing wetlands.

Alternative 3: Bechara A Material Management Area

Temporary adverse impacts from GHG emissions will occur during the construction of Alternative 3, which includes the placement of dredge material from the Puerto Nuevo River into the 69-acre Bechara A MMA, which includes approximately 15.6 acres of jurisdictional estuarine forested wetlands that will be impacted.

Construction Emissions

Construction is anticipated to last approximately two years and would result in a temporary increase in GHG emissions during that time, consisting primarily of CO₂ generated by internal combustion engines burning diesel fuel. Fuel estimates were based on a construction cost estimate prepared by USACE in 2023. The cost estimate was based on filling the Bechara B MMA, which is approximately 6.5% smaller than the Bechara A MMA. Fuel volumes to construct Alternative 3 were assumed to be 6.5% greater than the Bechara B MMA cost estimate, for purposes of this analysis. A quantitative analysis of construction-related GHG emissions was conducted and the results are summarized in Table 1-2.

Table 1-2. Estimated GHG Emissions for Construction of Alternative 3

GHG	Amount of Fuel (gal)	Emissions Factor (g/gal)	Total Produced (MT)	CO ₂ e (MT)
CO ₂	370,098	10,210.00	3,778.70	3,778.70
CH ₄	370,098	1.01	0.37	9.34
N ₂ O	370,098	0.94	0.35	103.67

Total short-term construction emissions for Alternative 3 are estimated to be 3,891.72 MT CO₂e.

Operations and Maintenance Emissions

Following completion of construction, no O&M emissions are anticipated.

Wetland Emissions and Carbon Sequestration

Annual and lifetime values for the loss of CO₂ sequestration and CH₄ and N₂O production were calculated. Annual and project lifetime emissions, based on the loss of 15.6 acres of wetlands, are summarized in Table 1-3.

Table 1-3. Estimated GHG Emissions Calculated for the Loss of Wetlands Under Alternative 3

GHG	Wetlands Lost (Ac)	Annual Emissions Production (MT/yr)	Lifetime Emissions Production (MT)	Lifetime Emissions (MT CO ₂ e)
CO ₂	15.6	24.09	1,204.33	1,204.33
CH ₄	15.6	-1.33	-66.65	-1,666.15
N ₂ O	15.6	-0.02	-1.15	-341.34

Total lifetime wetland emissions for Alternative 3 are estimated to be -803.16 MT CO₂e, which reflects the loss of CO₂ sequestration and production of CH₄ and N₂O from the 15.6 acres of existing wetlands.

Alternative 4: Bechara B Material Management Area

Temporary adverse impacts from GHG emissions will occur during the construction of Alternative 4, which includes the placement of dredge material from the Puerto Nuevo River into the 65-acre Bechara B MMA, which includes approximately 11.4 acres of jurisdictional estuarine forested wetlands that will be impacted.

Construction Emissions

Construction is anticipated to last approximately two years and would result in a temporary increase in GHG emissions during that time, consisting primarily of CO₂ generated by internal combustion engines burning diesel fuel. Fuel estimates were based on a construction cost estimate prepared by USACE in 2023. A quantitative analysis of construction-related GHG emissions was conducted and the results are summarized in Table 1-4.

Table 1-4. Estimated GHG Emissions for Construction of Alternative 4

GHG	Amount of Fuel (gal)	Emissions Factor (g/gal)	Total Produced (MT)	CO ₂ e (MT)
CO ₂	347,510	10,210.00	3,548.07	3,548.07
CH ₄	347,510	1.01	0.35	8.77
N ₂ O	347,510	0.94	0.33	97.34

Total short-term construction emissions for Alternative 4 are estimated to be 3,654.19 MT CO₂e.

Operations and Maintenance Emissions

Following completion of construction, no O&M emissions are anticipated.

Wetland Emissions and Carbon Sequestration

Alternative 4 includes impacts to approximately 11.4 acres of wetlands. Using the US Fish and Wildlife Service (USFWS) Wetland Mapping Tool, it was determined that existing wetlands within the Bechara area are categorized as Marine & Estuarine – Forested & Shrub. The period of analysis for this study is 50 years, from 2029 to 2079. Annual and lifetime values for the loss of CO₂ sequestration and CH₄ and N₂O production were calculated. Annual and project lifetime emissions, based on the loss of 11.4 acres of wetlands, are summarized in Table 1-5.

Table 1-5. Estimated GHG Emissions calculated for the Loss of Wetland and Aquatic Habitats

GHG	Wetlands Lost (Ac)	Annual Emissions Production (MT/yr)	Lifetime Emissions Production (MT)	Lifetime Emissions (MT CO ₂ e)
CO ₂	11.4	17.66	883.18	883.18
CH ₄	11.4	-0.98	-48.87	-1,221.84
N ₂ O	11.4	-0.02	-0.84	-250.32

Total lifetime wetland emissions for Alternative 4 are estimated to be -588.99 MT CO₂e, which reflects the loss of CO₂ sequestration and production of CH₄ and N₂O from the 11.4 acres of existing wetlands.

Net Emissions Summary

Net emissions were calculated using the NEAT model and are defined for this project as the short-term GHG emissions generated during construction plus the long-term (50-year) impact of filling in wetlands and the subsequent loss of carbon sequestration capability. Lastly, the lifetime GHG emissions for the No Action Alternative were subtracted from the total to yield the net emissions. O&M emission for the No Action Alternative are unknown so the net emissions are likely over-estimated. Net emissions for Alternative 3 are summarized in Table 1-6.

Table 1-6. Net Emissions Summary for Alternative 3

GHG	Construction GHG Emissions (MT)	50-Year Wetland GHG Emissions (MT)	No Action Wetland Emissions (MT)	Net Project Emissions (MT)
CO₂	3,778.70	1,204.33	-727.06	5,710.09
CH₄	0.37	-66.65	2.71	-68.98
N₂O	0.35	-1.15	0.91	-1.70
CO₂e	3,891.72	-803.16	-388.93	3,477.49

Net emissions for Alternative 4 are summarized in Table 1-7.

Table 1-7. Net Emissions Summary for Alternative 4

GHG	Construction GHG Emissions (MT)	50-Year Wetland GHG Emissions (MT)	No Action Wetland Emissions (MT)	Net Project Emissions (MT)
CO₂	3,548.07	883.18	-727.06	5,158.31
CH₄	0.35	-48.87	2.71	-51.23
N₂O	0.33	-0.84	0.91	-1.42
CO₂e	3,654.19	-588.99	-388.93	3,454.15

References

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