Critical Thinking Army Corps of Engineers Case Study Example

Case Study Overview:

The West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Project (WSLP) is a recently completed hurricane and storm risk damage reduction study located near New Orleans, Louisiana.

Study Purpose

The primary purpose described in the study authority and overall study goal is to identify the Federal interest in reducing the risk of storm surge damages from hurricanes and tropical storms along the West Shore of Lake Pontchartrain in Louisiana.

Study Area

The study area is located in southeast Louisiana within the Lake Pontchartrain Basin, a large estuarine ecosystem between the Mississippi River, and Lakes Maurepas and Pontchartrain. Lake Maurepas is connected to Lake Pontchartrain, as are two natural tidal passes, and the Inner Harbor Navigation Canal (IHNC), which provides the third tidal connection to Lake Pontchartrain through Lake Borgne, an estuary located east of Lake Pontchartrain and open embayment of the Gulf of Mexico. The Mississippi River is separated from the Lake Pontchartrain Basin by levees, and is connected at two locations, the Bonnet Carré Spillway and through a lock at the IHNC. The spillway is a component of the Mississippi River and Tributaries Flood Control project. An overview of the study area is shown below in **Figure 1**.

- The study area includes residential, industrial, and commercial developments south of Interstate 10 (I-10). West of Laplace, a majority of the developed areas are found between U.S. Highway 61 (US-61) and the Mississippi River levee.
- The population is increasing with suburban and industrial development along the river corridor between Baton Rouge and New Orleans.
- Key industries are located in the river corridor and include the Marathon Oil Refinery, the Nation's third largest refinery. The Port of South Louisiana is the largest volume port in the Western Hemisphere and the ninth largest in the world.
- The area north of I-10 comprises the State of Louisiana's Maurepas Swamp Wildlife Management Area (WMA).

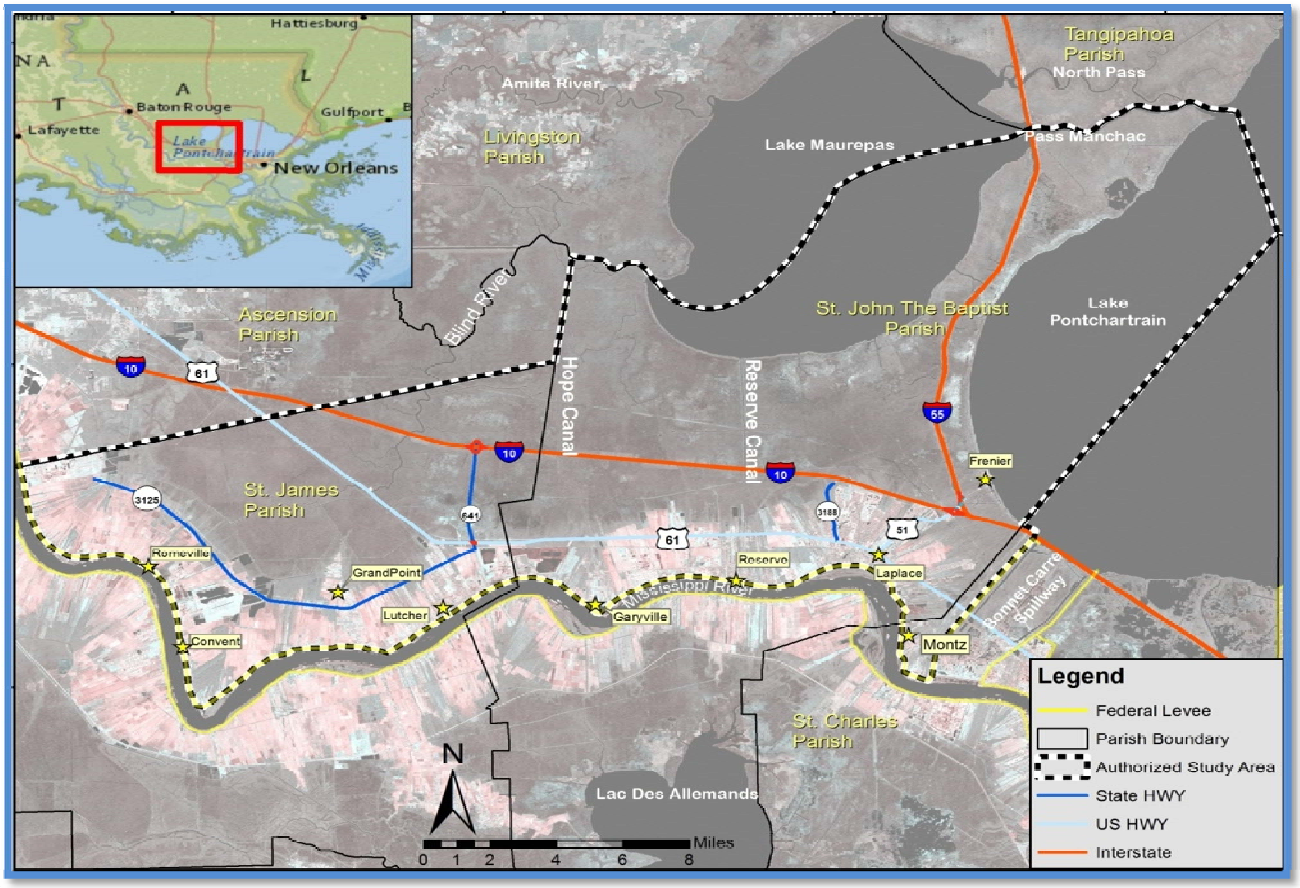

Figure 1 - Study Area Overview - West Shore

- The study area is highly susceptible to wind and tide-generated waves and currents. Since 1855, 70 hurricanes have made landfall within 65 nautical miles of Laplace. In 2012, Hurricane Isaac's surge, measured from 6 to 8 feet in the area, threatened lives and damaged more than 7,000 homes, closed roads and disrupted the nationally-significant energy industry.
- Storm surge blocked facility access to the Port of South Louisiana, closing the port for days.
- Oil refineries were shut down during and after the storm due to the inability to access the facilities. Gasoline and chemical production stopped, impacting an important industrial sector that supports national energy security. Regional and national fuel prices spiked.
- Storm surge flooded ground-level parts of Interstate 10 and access to Interstate 55, blocking critical transportation routes throughout the region.

Problems in the Study Area

1) Hurricane/tropical storm surge results in the flooding of approximately 7,700 structures (6-8 feet in areas).
2) Hurricane evacuation routes become impassable and receive damages during hurricane/tropical storm
3) Slowly draining storm water surges increase the salt content in the soil, resulting in agricultural productivity and crop losses.

Study Opportunities

1) Reduce hurricane storm surge related damages through 2070.

2) Reduce risk to residents' life and health by decreasing flooding to the maximum extent practical.
3) Increase public awareness of hurricane risks in developed flood prone areas.
4) Enhance public awareness of the risk to life and property of development in flood prone areas.
5) Reduce the risk of damage and loss of critical infrastructure, specifically the I-10/I-55 hurricane evacuation routes.

Study Constraints

1) Keep hurricane evacuation routes open before and after storms for emergency response vehicles.
2) Minimize adverse impacts to the Maurepas Swamp Wildlife Management Area and surrounding swamp habitat.
3) No loss of flood protection from existing flood damage risk reduction projects.
4) Minimize infrastructure impacts (pipelines, highways, hospitals, schools, fire stations, and police stations).

MEASURES ORIGINALLY CONSIDERED	
STRUCTURAL	**NON-STRUCTURAL**
Seawall	Full acquisition / buy-out
Floodgates on tidal passes	Flood proofing & elevation
Highway/levee improvements	Floodplain management
Control structures	Acquisition / buy out
Levees / floodwall	Cypress reforestation
	Flood forecast & warning

Initial Array of Alternatives:

The Project Delivery Team (PDT) combined measures into 12 structural alternatives. Alternatives were ranked and screened based on meeting study objectives and avoiding constraints. Please see **Figure 2** and **Figure 3** below for a map of the alternatives that were developed. Additionally, the PDT developed a storm surge map and infrastructure map that were used to screen out many of the initial alternatives that were formulated.

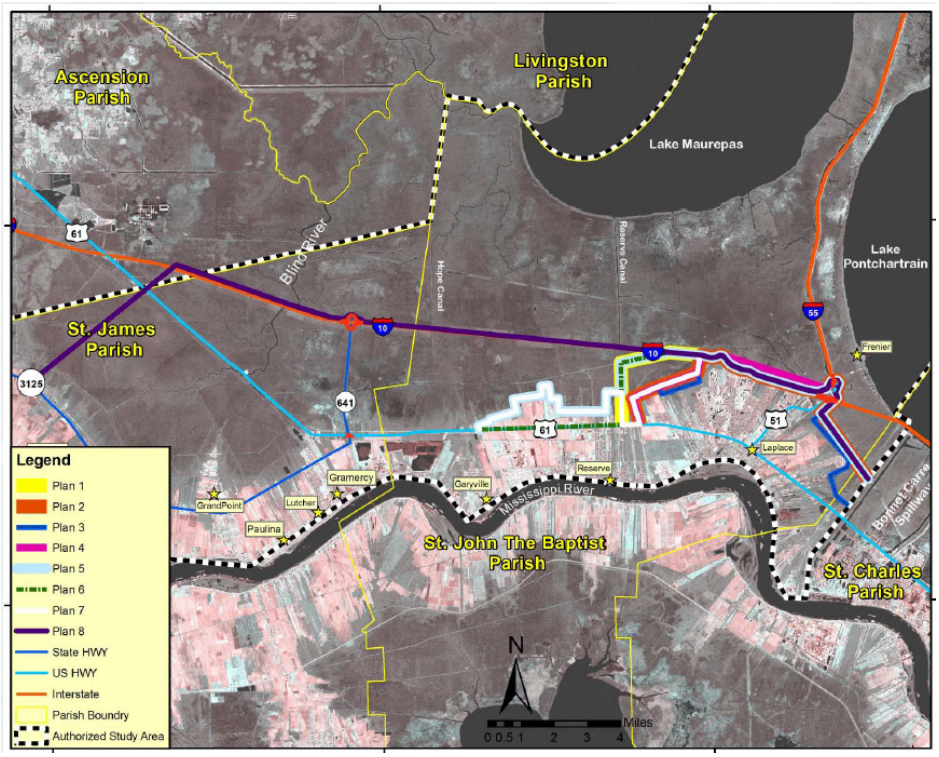

Figure 2 Plans 1-8 - West Shore

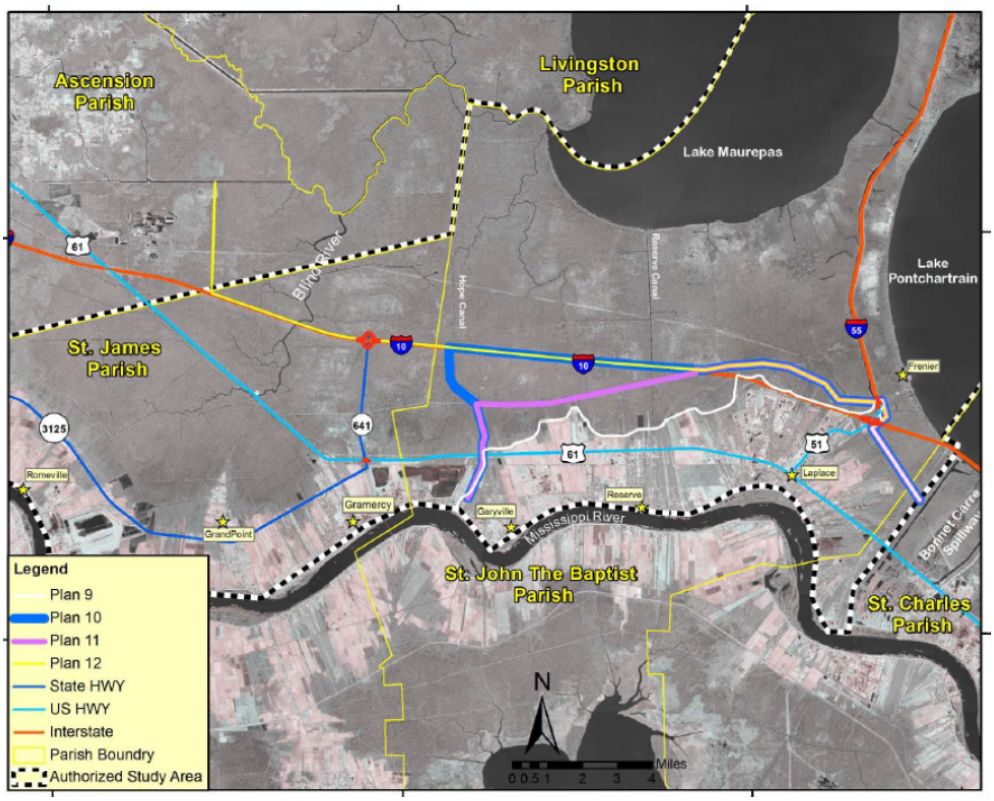

Figure 3 - Plans 9-12 - West Shore

Evaluating the Array of Alternatives:

- Using the aforementioned data and by screening on objectives and constraints, the PDT was able to screen down from 12 to 5 actionable plans.
- The PDT was further able to screen out 2 additional plans since they were redundant or did not meet study objectives. This resulted in the final array, which is shown below in **Figure 4**.

ALTERNATIVE	EXPLANATION
X	No action
A	Levee alignment from Bonnet Carre Spillway to Hope Canal/MS River & non-structural alternative
C	Levee alignment from Bonnet Carre Spillway to Hope Canal/MS River (Avoids a pipeline corridor) & non-structural alternative
D	Levee alignment from Bonnet Carre Spillway to Ascension Parish (mainly follows I-10)

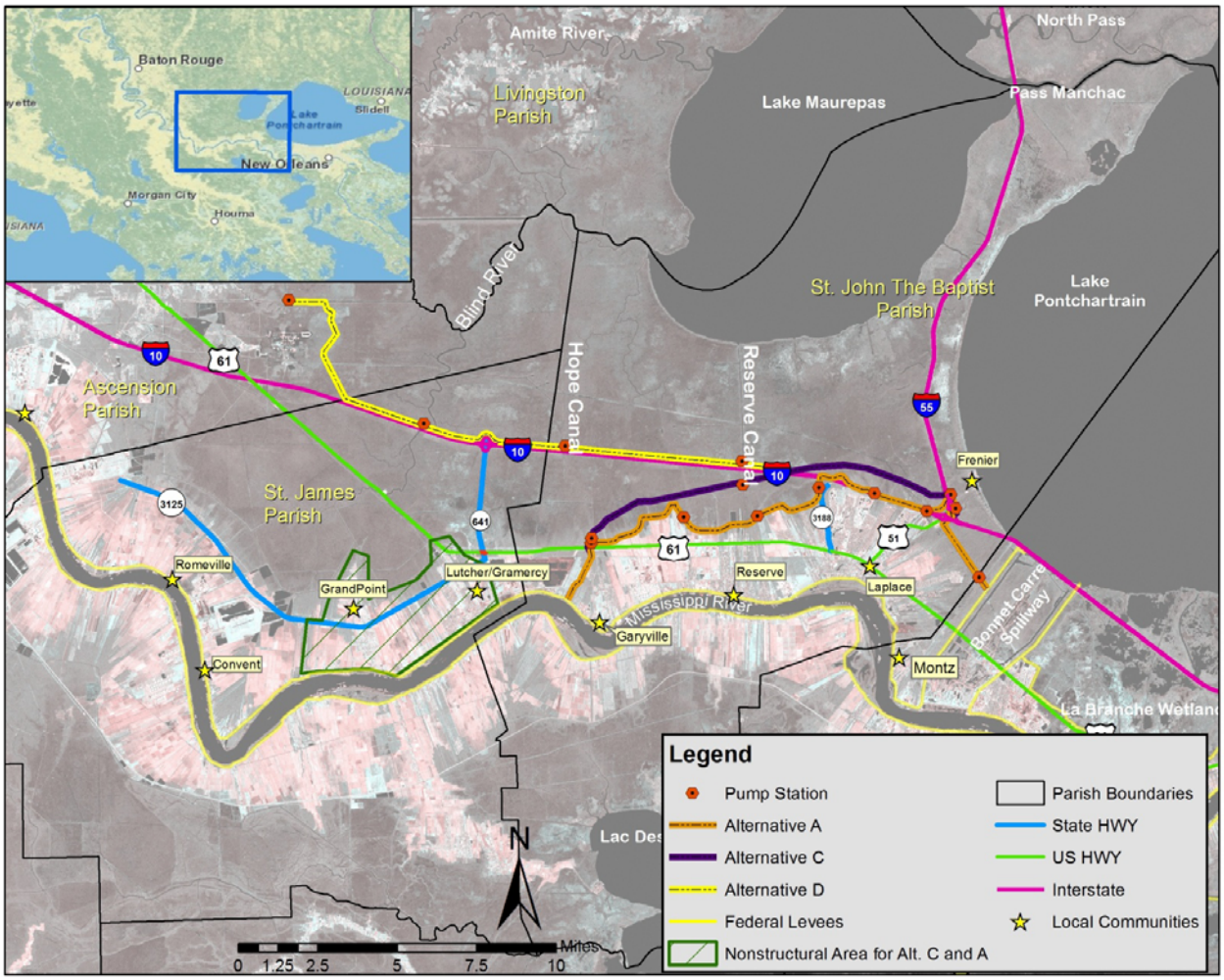

Figure 4 - Final Array of Alternatives - West Shore

COMPARING PLANS: The following information was used by the team to compare the final array and select a TSP. Use the following 4 tables to make your decision on the TSP:

Table 1 - Alternative Overview

ALTERNATIVE A	ALTERNATIVE C	ALTERNATIVE D
Impacts drainage and **70** pipeline crossings	Crosses **36** pipelines	Includes **14** pipeline crossings
Requires **8** pump stations	Requires **4** pump stations	Requires **6** pump stations
Higher O & M (lowers BC ratio)	Least amount of O & M	Highest O & M cost of all three alternatives
Levee length: 20 Miles	Levee length: 18 miles	Levee length: 28 miles
Immediate inundation of developed areas if levee is overtopped	Some room for inundation in swamp behind levee if overtopped	Plenty of room for inundation behind levee if overtopped

Table 2 - West Shore NED Analysis

ALTERNATIVE 100- YEAR LEVEL OF RISK REDUCTION	Costs to Implement ($ millions)	EQUIVALENT ANNUAL BENEFITS ($ MILLIONS)	ANNUAL COST ($ MILLIONS)	BENEFIT TO COST RATIO
A	887.6	59.9	40.5	1.48
C	826.0	59.9	36.8	1.63
D	1,047.1	59.9	46.7	1.28

Table 3 - West Shore Risk Considerations Matrix

Engineering Risk to Cost:

ALTERNATIVE	LEVEES	FLOODWALLS	PUMP STATIONS/Hydraulic Control Structures	PIPELINE CROSSINGS	Induced Damages
A	Low Risk	Low Risk	High Risk	High Risk	Low Risk
C	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Low Risk
D	Medium Risk	Medium Risk	High Risk	Low Risk	High Risk

Environmental Risk Cost:

ALTERNATIVE	Indirect Impacts	Direct Impacts	Mitigation Implementation	Acceptance
A	Low Risk	Low Risk	Low Risk	Low Risk
C	Medium Risk	Medium Risk	Medium Risk	Medium Risk
D	High Risk	Medium Risk	High Risk	High Risk

Note: The risks noted in Table 3 are based on the PDT's understanding of the alternatives at a ROM level. For instance, there was a general consensus that cost associated with mitigation for Alternative A would not change much, whereas costs for Alternative D could balloon in feasibility level of design.

Table 4 -Rough Order of Magnitude Costs by Line Item

	Alternative A	Alternative C	Alternative D
Levees & Floodwalls	$335,898,670	$334,156,997	$339,508,346
Pump Stations	$132,162,500	$112,687,500	$166,437,500
Pipeline Relocations	$70,300,000	$35,100,000	$11,693,750
Real Estate	$3,849,000	$3,283,000	$2,434,000
Direct Habitat Impacts	$17,000,791	$35,710,811	$43,323,364
Indirect Mitigation Cost (15%)	$23,123,679	$54,655,968	$327,687,626
Non-Structural 2070	$305,256,794	$305,256,794	$0
Total Cost w/Non-Structural	**$887,591,434**	**$880,851,070**	**$891,084,586**

As you look through the data for the 3 alternatives, there are a few things you should keep in mind. Some of the concerns PDT members, Vertical Team members and other decision makers discussed leading up to the TSP milestone revolved around the possibility for costs to go up or down based on more detailed levels of design for the alternatives. In terms of risk to the environment, direct and indirect impacts had only been estimated at a very generic level for all three alternatives. It was obvious to the PDT that more swamp habitat were enclosed by both Alternatives C and D (roughly 8,000 acres for Alternative C and over 50,000 acres enclosed by Alternative D). Enclosed swamp habitat is thought to be negatively affected by structures such as levees because they could interfere with tidal influence. Therefore, an alignment such as Alternative C or D would have higher indirect impacts to swamp habitat than an alignment such as Alternative A. The scope and scale of impacts to the swamp were not fully understood when identifying the TSP from the array of alternatives.

There were higher risks that construction costs would increase for Alternative A because of remaining uncertainties associated with overall levee and floodwall alignment impacts. Alternative A has a jagged route to follow and creates some areas along the levee where storm surge could potentially stack and overtop into developed areas. Unlike Alternatives C and D, Alternative A poses a higher risk to the populated areas behind it since any overtopping would immediately inundate developed areas. Also consider that Alternative A crosses nearly 70 pipelines and has 8 pump stations whereas Alternative C

only crosses 36 pipelines and has 4 pump stations. Pipeline relocations, especially in SE Louisiana, can be dangerous as they usually contain HTRW substances such as oil or gas. Thus, the more pipelines that have to be relocated for an Alternative, the higher the cost and the greater the danger when performing the relocations. Additionally, longer levees with more infrastructure (such as pump stations) will ultimately cost the non-Federal sponsor more money over the project lifespan due to operation and maintenance costs they are fully borne by the sponsor. NED calculations capture this cost to the sponsor and higher O&M will lower the net benefits of a project.

Also to be considered: NEPA requires that a Federal agency select the **Least** Environmentally Damaging **Practicable** Alternative (LEDPA). If the agency cannot select the LEDPA, they are responsible for showing why the LEDPA was not chosen.