Resaca Boulevard Resaca Ecosystem Restoration

Cameron County

Brownsville, Texas

Continuing Authorities Program

Section 206, Water Resources Development Act of 1996, as amended

(Section 206 for Aquatic Ecosystem Restoration)

Galveston District

2016

US Army Corps of Engineers ®

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Executive Summary

This detailed project report and integrated Environmental Assessment (DPR/EA) is submitted under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended (33 U.S. Code 2201). This DPR/EA includes a detailed description of and supporting information for the decisions made during the planning process and the assessment of environmental effects necessary to fulfill National Environmental Policy Act (NEPA) requirements.

The purpose of this study is to identify potential aquatic ecosystem restoration alternatives for the Resaca Boulevard Resaca (RBR). The goal of the DPR/EA is to evaluate each proposed alternative, and, through coordination among the Project Delivery Team (PDT) develop a National Ecosystem Restoration (NER) plan. The federal sponsor is the U.S. Army Corps of Engineers (USACE), Galveston District (CESWG); the study non-Federal sponsor (NFS) is the Brownsville Public Utilities Board (BPUB), an affiliate to the City of Brownsville and acting under the auspices of the City of Brownsville, for the study while City of Brownsville is the sponsor for the selected plan design and implementation.

The City of Brownsville is known as the City “on the border by the sea”, referring to its’ proximity to the Mexican border and Gulf of Mexico (**Figure 1**). Historically, distributaries of the Rio Grande River Delta ran through the study area. Resacas are paleochannels and distributaries of the Rio Grande that are filled during flood events, but become isolated pools as floodwaters recede. Beginning in the late 1950’s, the floodplain function of the river was altered due to the construction of a system dams and levees removing the connectivity of the resacas with the river.

Through coordination with the U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Division (TPWD), eight restoration measures were developed to address ecosystem problems and solutions while meeting the goals of the project, which are for the restoration of the RBR aquatic ecosystem through development of a NER plan. These measures include; 1) aquatic and emergent vegetative plantings, 2) riparian plantings, 3) invasive plant species management, 4) bank slope restoration, 5) invasive fish species management, 6) island restoration, and 7) water level management. Alternatives evaluated included a No Action Plan, and all possible combinations of the eight measures. All restoration plans were evaluated using a cost-effective incremental cost analysis (CE/ICA) through the Institute for Water Resources (IWR) Planning Suite Version 2.0.6 to ensure that the most cost-effective plan was selected. Through CE/ICA, five best-buy plans, including the No Action Plan, were identified. The Proposed NER or Recommended Plan includes four measures, 1) aquatic and emergent vegetative plantings, 2) riparian plantings, 3) invasive plant species management, and 4) bank slope restoration.

The NER Plan would restore structure and function of rare vegetative communities which are only present in resaca ecosystems. Restoration of native aquatic emergent and riparian plants along with bank slope restoration will filter stormwater runoff and reduce sediment loading in the RBR while providing shading and habitat for wildlife species, including many state and federally listed species. The NER Plan would provide a total of 5.4 Average Annual Habitat Units (AAHU) compared to the 0.03 AAHU of the future without project condition. With the implemented NER plan, the RBR ecosystem would provide a total of 5.43 AAHU over 16.31 acres of resaca habitat.

The total investment cost, which includes lands, easements, right of ways, relocation and disposal areas, and construction costs, is approximately $951,206. As the non-federal sponsor, the City of Brownsville would provide the lands required for the recommended plan and would be responsible for all operation, maintenance, repair, replacement, and rehabilitation costs (OMRR&R). The Proposed NER Plan provides relatively high ecosystem benefits relative to costs. Furthermore, the Proposed NER Plan would accomplish the objectives of this study, restoration of ecosystem structure and function of the RBR and improve conditions for associated rare, threatened, or endangered species and globally imperiled vegetative communities.

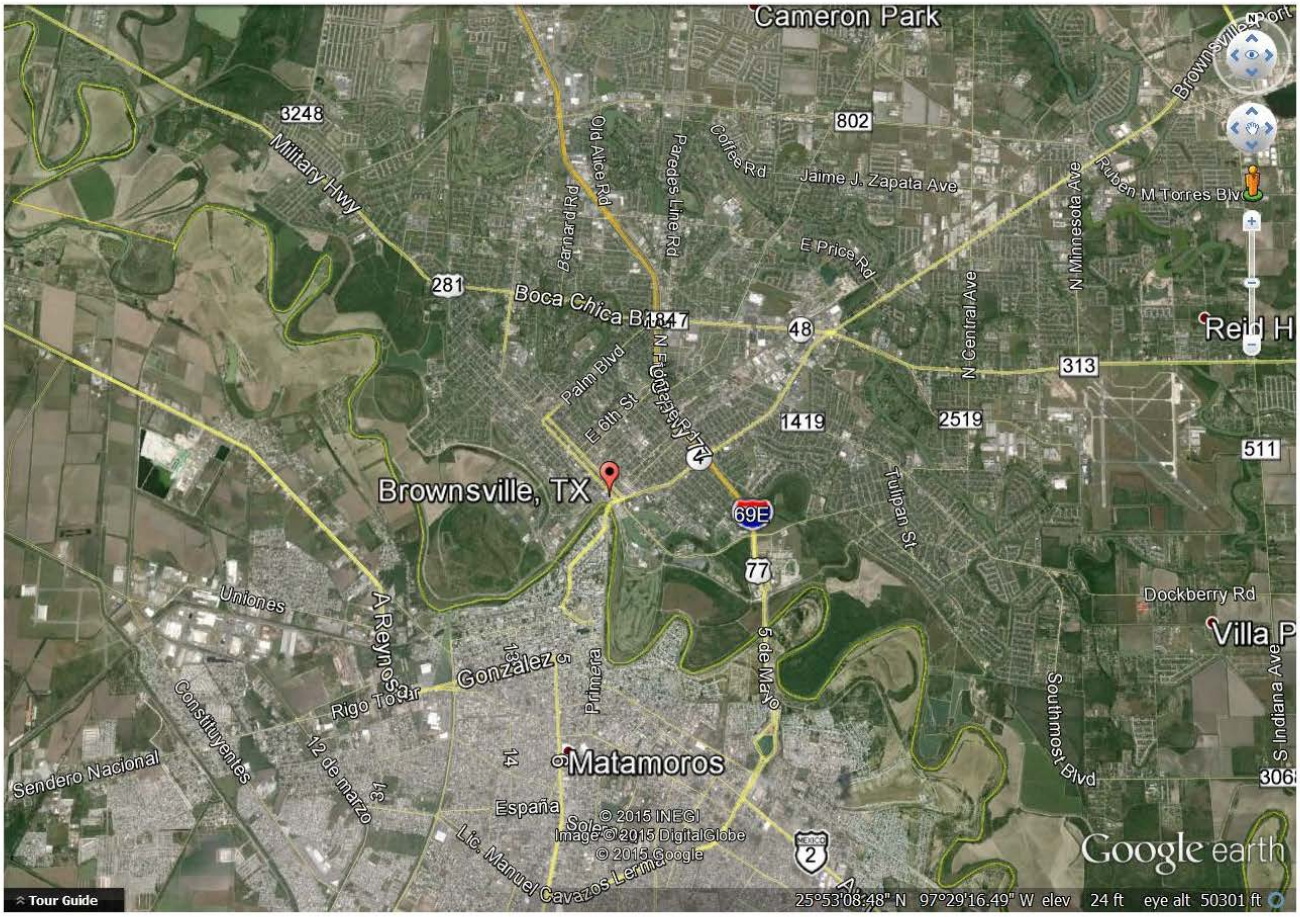

Figure 1. Brownsville, Texas

Introduction

Resacas are rare ecosystems comprised of water bodies that were once part of the Rio Grande River system. In many cases, the resacas have become disconnected from the Rio Grande floodplain due to agriculture and urbanization. Without water management, most resacas would dry out for extended time periods. Resaca Boulevard Resaca (RBR) is a disconnected urbanized resaca within the City of Brownsville (Figure 1). The habitat quality of RBR is degraded and no longer supports the historic level of floral and faunal diversity. RBR is maintained by the Brownsville Public Utilities Board (BPUB), an affiliate to the City of Brownsville and acting under the auspices of the City of Brownsville, for the purposes of water supply and flood reduction. Development is present along the eastern bank (private homes) while the western bank is largely undeveloped but is overrun with non-native, invasive vegetation. Invasive fish species are also present within the RBR. By removing invasive plant species, re-planting with native species, and grading the bank slopes, reestablishment of a healthy resacas biome is anticipated. The urbanized resacas have the potential to provide rare habitat for a variety of native wildlife species including migratory and residential birds, amphibians, fish, insects, small mammals, and reptiles. The vegetation community is the foundation of the food web of the ecosystem, and by restoring the aquatic and riparian vegetation with native species, the RBR would support a diverse community of invertebrates, fishes, amphibians, reptiles, birds, and mammals unique to the resaca ecosystems.

1.0 STUDY INFORMATION

The RBR restoration, at Brownsville, Texas, study was performed under Section 206 (Ecosystem Restoration) of the Continuing Authorities Program (CAP). The project delivery team (PDT), through the planning process, has identified a tentatively selected NER plan that addresses degraded ecosystem structure and function problems in the Resaca Boulevard study area. The study process and recommended plan are documented in this Detailed Project Report (DPR). An Environmental Assessment (EA) is integrated into the DPR for compliance with the National Environmental Policy Act (NEPA). For CAP studies the approval level of the report is USACE Southwestern Division (SWD).

The non-Federal sponsor (NFS) is City of Brownsville for the Design and Implementation phase.

1.1 STUDY AUTHORITY

The RBR Ecosystem Restoration Study was conducted under the authority of the Section 206 CAP of the Water Resources Development Act (WRDA) of 1996 (Public Law (P.L.) 104-303). Under the authority provided by Section 206, the USACE may participate in planning, engineering and design, and construction of projects to restore degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition when the restoration would improve the environment, is in the public interest, and is cost-effective, as described in the USACE Planning Guidance Notebook (Engineering Regulation [ER] 1105-2-100).

1.2 PURPOSE AND SCOPE

Purpose

Resacas are incredibly unique aquatic resources that support equally unique and endangered riparian habitats. Found only in the lower Rio Grande Valley (LRGV) of Texas and Mexico, these aquatic and riparian habitats support a diverse native subtropical fish and wildlife

community that has evolved to the flood ecology of the resacas. E. Dan Klepper (2008) poetically illustrates these ecologically significant resources:

> *"The thorn scrub, a snarl of hundreds of botanical species, weaves a thick, dark mat that leaves little room for daylight. Sun rays, blazing unimpeded across the Rio (Grande) flatlands, are reluctant to penetrate the scrub. Once the beams collide with the scrub's green wall, their radiance is all but snuffed out. Only dim fragments of light remain, lingering like curling whiffs of smoke.*
>
> *Resacas, with their marshy habitats composting in remnant floodwaters, are important components of the Rio Grande's Tamaulipan thorn scrub and are invariably the source of both its dampness and decay. These ancient river channels provide conduits for floodplains to negotiate periodic and natural inundations. The resulting resacas form arterial, snakelike patterns across the landscape. Before the advent of dams along the Rio Grande, resacas performed nature's own flood control and assisted wildlife that depended on the peculiar environs to survive and thrive.*
>
> *Nature, in fact, loves a resaca. It is the womb from which all manner of bugs and beasts are born. Its water harbors shore, song, and sea birds; the nimble branchwork above it gives rise to nests, eggs, and wings; and its mud coddles and then recycles frogs, turtles, and insects. Quietly watching a resaca in scrub shadow grants witness to a semitropical world in full swing – green jays chatter and feed, dragonflies strafe the water's edge, bobcats drink, and then scatter.*
>
> *But once daylight lags, darkness comes quickly to a resaca's thorn scrub, and night is its inhabitants' milieu. Great horned owls haunt the canopy, ocelots stalk prey, Mexican tree frogs squeak like bed springs, indigo snakes thread the resaca cattails, and Rio Grande lesser sirens (a type of salamander) surface the mud with a click-click-click of odd, amphibian song. Fireflies ignite and beacon a crazy course through an impenetrable morass so remarkably dense that humans are no more hamstrung by it in darkness than they are by the light of day"*

The RBR has been heavily impacted by urban development and an altered flooding regime that has resulted in the alteration of aquatic and riparian habitats associated with the resaca ecosystem. The purpose of the study is to identify and implement ecosystem restoration measures to restore the ecosystem structure and function of the RBR.

Scope

This CAP report describes the existing and future without-project conditions with regard to the degraded RBR aquatic ecosystem. This report documents the water related resource problems and opportunities, planning objectives and constraints, and the planning process. The scope of this study is to utilize the planning process to determine if there is an ecosystem restoration project which is in the Federal Interest, which meets the goals and objectives of the NFS, and can ultimately be recommended for implementation. The PDT has studied the problems associated with the degraded resaca ecosystem, developed objectives to address specific problems, generated an array of measures to restore the lost ecological functions, and determined which combination of measures should be combined to form alternatives in order to provide the highest level of ecological lift for the dollars required to implement. The result of the analysis will identify a NER plan.

The EA integrated into this report has been prepared pursuant to Section 102 of the NEPA of 1969 as implemented by the regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508 and ER 200-2-2). The objectives of NEPA are to ensure consideration of the environmental aspects of the Proposed Action in Federal decision-making processes, to disclose environmental information to the public, and collect their input before decisions are made and actions are taken. The PDT has determined that the proposed restoration of the RBR would provide significant ecological benefits with limited temporary and minor negative environmental effects during construction (noise, clearing, etc.); therefore, an EA is the appropriate level of documentation under NEPA. The EA provides sufficient evidence for determining whether to prepare an Environmental Impact Statement (EIS) or Finding of No Significant Impact (FONSI). This EA evaluates the potential environmental impacts associated with sixteen alternatives, including the No Action alternative. The scope for impact analysis of the alternatives under consideration in this EA is limited to the boundaries of the RBR study area (**Figure 2**).

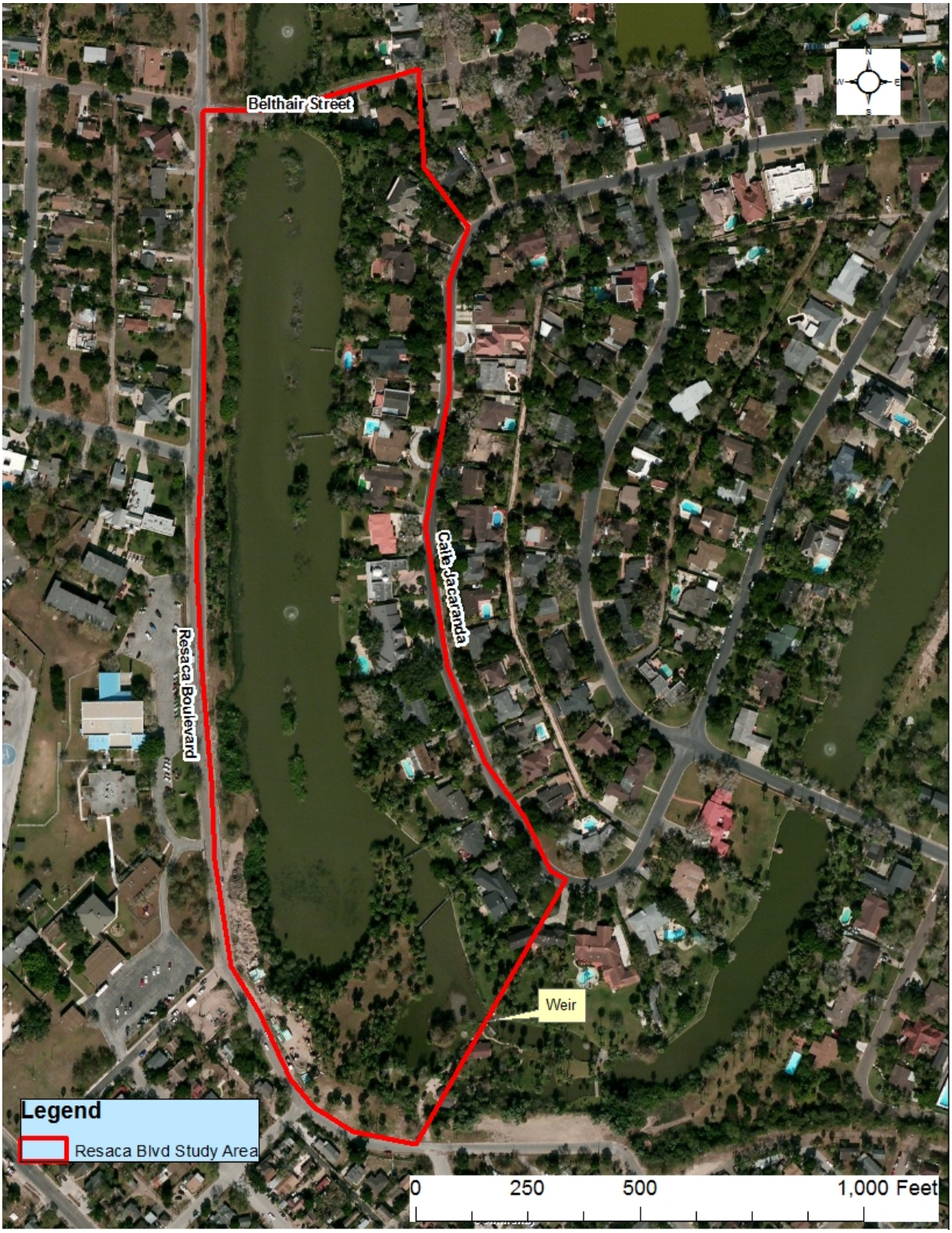

Figure 2. Resaca Boulevard Resaca Study Area

1.3 LOCATION OF THE STUDY AREA

The study area includes the RBR and surrounding lands between Belthair Street to downstream of the weir located at the southern end of the resaca. It encompasses approximately 29.5 acres of resaca, islands, shoreline, parkland and residential areas between Resaca Boulevard and Calle Jacaranda **(Figure 2)**. The RBR is located in the City of Brownsville located in the southern portion of Cameron County, Texas (**Figure 3**). The RBR (shown in green in figure 3) is a part of the Town Resaca system (shown in blue in Figure 3) that flows west to east across the southern section of Brownsville.

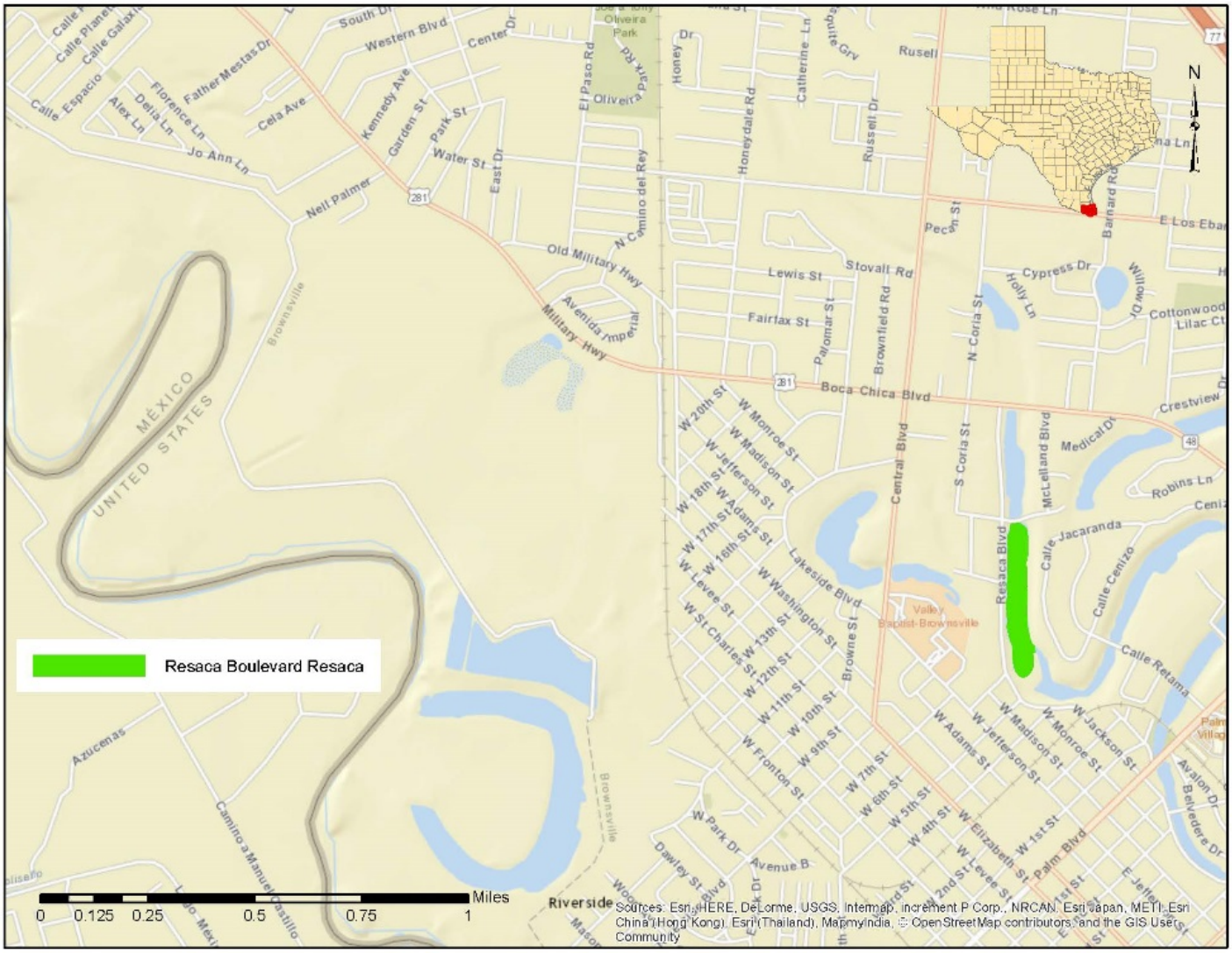

Figure 3. Location of Resaca Boulevard Resaca

1.4 HISTORY OF THE INVESTIGATION

The CAP study was initiated in July 2014 when a Federal Interest Determination (FID) Report was completed. Concurrence from SWD on the FID was received in August 2014, and the Federal Cost Sharing Agreement (FCSA) was signed in January 2015. The FID identified the project as being of Ecological and National significance; thus, warrants a final report. A Feasibility Scoping Meeting (FSM) was held in November 2015 to obtain SWD buy-in on the preliminary future without-project (FWOP) conditions and the alternatives to be evaluated. A site visit and inter-agency team meeting was held in December 2015 to develop FWOP conditions, reference site conditions, and identify modeling components. The TSP milestone was conducted on 2 June, 2016.

1.5 PRIOR REPORTS AND EXISTING PROJECTS

USACE Studies and Reports

In 2002 the NFS and USACE began efforts to study all of the resacas in the Brownsville city limits for the purpose of rainwater management, ecosystem restoration, and water storage capacity. Although extensive modeling and coordination was conducted for this study, no final reports were developed during the 2002 study. The USACE Engineering Research and Development Center (ERDC) produced a technical report in 2012 defining a community based index model for the Brownsville resaca ecosystems. The report concluded immense potential for resacas restoration exists within Brownsville. Although the ERDC model addressed structural and ecological functions of the resaca habitats, the model was not developed around the specific ecosystem restoration measures proposed in this study. Because the ERDC model could not fully model the ecosystem benefits of the proposed measures, it was not used for this study.

Non-USACE Water Resource Projects

BPUB has initiated a broader resaca restoration plan throughout Brownsville. The most recent study was completed in 2011 which updated the 2006 City of Brownsville Drainage report. The report analyzed seven watersheds within Brownsville and assessed flood risks within the area for planning purposes. BPUB is actively seeking grants for restoration on many of the resacas within Brownsville. BPUB's restoration efforts focus primarily on flood control and debris removal. Restoration work has already been completed or is in progress in several of the resacas. BPUB completed dredging of Cemetery Resaca in July 2013, and began dredging Dean Porter Park Resaca in late October 2015. Bank stabilization and native plantings began at Cemetery Resaca in October 2015 with completion expected in April 2016. In addition, BPUB began dredging RBR in January 2016. The dredging plan would leave a 15-foot buffer between the shoreline and the interior resaca leaving a shallow shelf for potential restoration of aquatic vegetation. The RBR dredging is scheduled to be completed in June 2016. This would allow the current 206 CAP ecosystem restoration study a partially "clean" footprint for restoring native vegetation. The remainder of the project footprint will have to undergo invasive plant removal before any native plantings occur.

2.0 PLAN FORMULATION

Plan formulation is the process of identifying problems and opportunities for improvement, establishing objectives, identifying measures, formulating alternatives, determining benefits, estimating costs, comparing plans and ultimately determining a recommended plan.

For this 206 study, plan formulation of this aquatic ecosystem restoration project was determined in part by quantifying benefit values gained by restoring native aquatic, emergent, and riparian vegetation habitats in varying quantities and configurations. In addition to restoring globally imperiled vegetation communities in and of itself, these communities provide habitat for a variety of species, including rare amphibian species. Measures were combined into sixteen alternatives. These alternatives, or plans, were evaluated against FWOP conditions to determine the plan which would provide the most ecological benefits. The sixteen alternatives were compared against each other using cost-effectiveness and incremental cost analyses (CE/ICA). Quantification of benefits and estimation of costs is a primary component of recommended plan identification.

2.1 PROBLEMS AND OPPORTUNITIES

The first step in the planning process is the identification of problems (i.e., undesirable conditions to be resolved) and opportunities (i.e., positive conditions that the NER plan may improve) that the PDT seeks to address. RBR is experiencing problems associated with urbanization such as shore-line hardening, erosion, and loss of native plant species.

Opportunities are conditions that the NER plan may improve and can be a used as criteria during plan selection.

2.1.1 PROBLEMS

Under natural processes, resacas are formed during extreme flooding events when the Rio Grande diverts its course and forms a new connection with the Gulf of Mexico. The rerouted river leaves behind a disconnected waterbody up to 40-50 miles long. Between these extreme flooding events that rerouted the river, more frequent flooding events deposit sediments and segment the relict channel into a series of ponded areas referred to as resacas. The resacas would naturally maintain water capacity due to frequent flooding of the Rio Grande which would flush out sediments and replenish the resaca; thereby maintaining the aquatic habitats of the resacas.

Before the resacas were physically connected to the Rio Grande and each other through a series of canals, culverts, and pumps, the water surface profile would vacillate in concert with frequent flood events. The water in the resacas would be replenished by flooding and the water in the resacas would then recede through to evaporation and transpiration, sometimes to the extent where the resacas would dry up.

Because of the dynamic hydrology and the subtropical climate of the area, unique and highly diverse floral and faunal communities evolved around the resacas. The vegetation associated with the resacas would transition throughout the life cycle of the resacas. Texas Ebony Resaca

Forest or Subtropical Texas Palmetto Woodlands vegetation communities would dominate lower areas around the resaca perimeter and transition to Texas Ebony/Snake-eyes vegetation communities as elevations increased. Once a resaca becomes isolated from the flooding of the Rio Grande, it begins to silt in and riparian vegetation transitions into a more arid riparian Texas Ebony/Snake-eyes Shrubland and finally an upland Texas Ebony-Anacua/Brasil Forest communities. A list of plant species comprising these native riparian resaca vegetation communities are provided in **Appendix 1 - Appendix 3.**

Historically, the natural loss of resaca habitats due to sedimentation was mitigated by the formation of new resacas in other areas of the floodplain as the channel of the Rio Grande migrated over time. However, the construction of the Falcon (1954) and the Amistad Dams (1968), the construction of the Anzalduas (1960) and Retamal (1975) water diversion dams, and the construction of approximately 102 miles of levees have altered the hydrology of the Rio Grande. As such, the river does not migrate across the landscape to form new resacas, and the river no longer provides the necessary natural flushing and replenishment of the remaining resaca system to support the unique resaca hydrology and associated habitats. Currently, the resaca systems remain connected to the Rio Grande through a series of water diversion and irrigation canals; however, the seasonal flooding and deposition of nutrient rich sediments no longer occurs.

The vegetation communities that have evolved around the resaca ecosystems exhibit high biodiversity and are restricted to the Lower Rio Grande Valley (LRGV) of Texas (Cameron, Hidalgo, and Willacy Counties) and Mexico. Since the early 1870s and the introduction of irrigation, the loss of native desert thornscrub vegetation, including resaca habitats, to cultivated agriculture uses has resulted in the loss of 95 percent of thorn-scrub habitat in the LRGV and 99 percent of riparian resaca habitats (Jahrsdorfer and Leslie, 1988). Over the last 25 years, agricultural lands and remaining thorn-scrub habitat has also been lost to urbanization, Cameron County populations increased over 60 percent from 1990 to 2014 (US Census Bureau, 2015). The agricultural history and rapid urbanization of the area has resulted in the loss of 99 percent of resaca dependent habitats in Texas. Because of these losses, the vegetation communities associated with the resacas are globally imperiled with extinction (G1: Texas Ebony Resaca Forest; G2: Subtropical Texas Palmetto Woodland and Texas Ebony/Snake-eyes Shrubland)(NatureServe, 2015). NatureServe's G1 ranking is designated for critically imperiled species or communities that are at a very high risk of extinction due to extreme rarity, very steep declines, or other factors. The G2 ranking is for imperiled species or communities at high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors. The three vegetation associations of the resacas have evolved specifically with the dynamics of the resacas and the Rio Grande and are found nowhere else on earth. The restricted range, the threat of extinction due to the loss of the hydrologic function of the resacas, and the very steep declines in the extent of the vegetation are major factors in the NatureServe ranking of these communities.

The loss of the resaca habitats has been a primary driver for the designation of a substantial number of species in the LRGV by the USFWS and TPWD as rare, threatened, and endangered (**See Section 2.3.14;** Table 4). Because of the linear features of resaca systems, fish and

wildlife species utilize the resaca habitats, particularly in the more rural resacas, as travel corridors facilitating emigration and genetic flow of rare species such as the ocelot (*Leopardus pardalis*) and jaguarundi (*Herpailurus yaguarondi*). Although these species may avoid urban areas, numerous other rare species such as the red-crowned parrot (*Amazona viridigenalis*), black-spotted newt (*Notophthalmus meridionalis*), South Texas siren (*Siren sp 1*), Brownsville common yellowthroat (*Geothlypis trichas insperata*), and Tamaulipan agapema (*Agapema galbina*) still utilize urban resacas when suitable habitat is available.

Problem 1 – The altered hydrology of the Rio Grande and urbanization have resulted in the loss of structure and function of the resacas' aquatic and riparian habitats, including the loss of rare and endangered vegetation communities.

Problem 2 – Non-native and invasive species are prolific within the existing conditions of the study area. Invasive species are impacting native species recruitment and survival resulting in a loss of historic structure and function of the resaca ecosystem.

2.1.2 OPPORTUNITIES

Study opportunities are defined as actions or benefits that could be realized assuming the proposed restoration action is implemented. These opportunities may include actions that go beyond the study scope or authorization of the USACE but create conditions for another entity to produce additional benefits. The opportunities include actions that are either catalyzed by the proposed project or would not have been created for consideration without the project.

The proposed project would improve the habitat conditions required to support viable breeding populations of the black-spotted newt and South Texas sirens. The improved habitat conditions would provide the opportunity for federal and state resource agencies or non-governmental conservation organizations to reestablish or enhance black-spotted newt and South Texas siren populations in RBR. The Gladys Porter Zoo in Brownsville houses the captive breeding program for the black-spotted newt and could be the source of a potential reintroduced population in the RBR if appropriate conditions are met. This study has an opportunity to provide additional functional resaca habitat to assist with conservation efforts of the black-spotted newt.

In addition, the resacas provide significant habitat to migratory birds and bird species found nowhere else in the United States. The LRGV is a prime birding destination for birders throughout the world as evidenced by the establishment of the World Birding Center in the area. The restoration of the RBR provides an opportunity to increase high quality birding sites within the birding network of the Center, thereby increasing the birding experience in the Valley while bringing in ecotourism dollars.

Opportunity 1 – Utilize the 15-foot shelf along the resaca shoreline left behind from the ongoing dredging operations of the RBR to restore native aquatic, emergent, and riparian shoreline vegetation and slope. The restored vegetation would provide habitat for fish, amphibian, and avian species such as the Brownsville common yellowthroat, American black duck (*Anas rubripes*), least grebe (*Tachybaptus doninicus*), and other waterbirds.

Opportunity 2 – Plant native species to restore the native riparian vegetation communities (Texas Ebony Resaca Forest and Subtropical Texas Palmetto Woodland) associated with the resaca ecosystems and increase the spatial extent of these globally imperiled communities. The restoration of these rare vegetation communities would provide habitat for numerous rare species dependent on resaca ecosystems.

Opportunity 3 – Restore islands that have been eroded within the resaca to provide additional habitat and area for restoration of structure and function within RBR.

2.2 PLANNING OBJECTIVES AND CONSTRAINTS

2.2.1 NATIONAL OBJECTIVES

The USACE objective in ecosystem restoration is to contribute to NER. Contributions to NER outputs are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in the ecological resource quality restored and quantity of acres restored.

2.2.2 PLANNING OBJECTIVES

The planning objective is to restore, to the extent practicable, the lost or degraded structure and function of the Resaca Boulevard Resaca ecosystem to support fish and wildlife species dependent on the unique resaca ecosystems.

2.2.3 PLANNING CONSTRAINTS

Planning constraints are factors that restrict the plan formulation resulting in a project alternative that could not be implemented. Planning constraints for the RBR study include multi-purpose use. BPUB and the City of Brownsville utilize the resacas for floodwater control, raw water storage, recreation, eco-tourism, and for ecological benefits. The recommended restoration plan must balance restoring the function and structure of RBR while maintaining the other NFS purposes.

2.3 EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT

This section describes the existing conditions and expected conditions in the future that affect plan formulation and selection of a recommended plan. In addition, it includes discussion on the affected environment as it relates to NEPA. The affected environment is the natural and physical environment as well as the relationship of people with the environment.

Because the RBR study area is located in an urban area and maintained by the City of Brownsville and the adjacent residential land owners, the FWOP conditions for aquatic and riparian habitats would continue to be equivalent to the existing conditions. Mowing and maintenance of the study area would continue and non-native species would continue to dominate the study area. The only resaca component that would be expected to change in the FWOP condition would be the loss of the island remnants and its associated habitats. Therefore, the ecological value of the RBR would continue to decline with the loss of island habitats.

2.3.1 CLIMATE

Brownsville has a subtropical climate with a maritime influence from the Gulf of Mexico. The mean annual temperature is 74.6° F with an average high temperature of 92.6° F in August and an average low temperature of 68.7° F in January. The region does experience occasional freezes; however, low temperatures do not last long. Average rainfall for Brownsville is 27.37 inches with most of the precipitation resulting from tropical storms during the fall hurricane season. Because annual precipitation is affected by tropical storm events, annual precipitation can greatly fluctuate annually.

In Texas, temperatures are expected to increase by 4° F by 2050 due to greenhouse gas emissions to the atmosphere. The intensity of tropical storm activity and resulting precipitation is expected to increase; however, these pulsed periods of high precipitation are expected to be followed by increasingly extended periods of drought (U.S. EPA, 2013). Although temperatures are expected to increase according to the latest climate models, future changes in precipitation resulting from climate change is highly variable and has a high level of uncertainty (Schmandt et al., 2011).

2.3.2 GEOLOGY AND TOPOGRAPHY

The RBR is located on Quaternary alluvial deposits of the LRGV. The geologic formation associated with the resaca channel consists of floodplain deposits dominated by mud (Qam) with the adjacent upland habitats consisting of floodplain deposits dominate by silt and sand (Qas) (USGS, 1987).

The topography of the RBR study area is consistent with the flat topography associated with large river delta areas with an elevation of 25 feet above mean sea level. Drainage swales and drains direct local storm water runoff into RBR.

2.3.3 SOILS

Within the RBR study area, historic soils were comprised of Laredo silty clay loam. The Laredo soils consist of deep, well-drained, calcareous soils found on old flood plains and delta with nearly level to gentle slope. These soils are still represented within the study area; however, the cut and fill activities often associated with urban complexes have resulted in modifications to the Laredo silty clay loam soils; therefore, soils within the study area are now classified as Laredo-Urban land complex soils (USDA, 1977). The soil complex consists of stratified layers of silt loam and silty clay loam extending 72 inches into the soil profile. The Laredo soils are not designated as prime farmland soils.

2.3.4 LAND USE

The study area is contained in an urbanized section of Brownsville. Land use is dominated by residential neighborhoods on the eastern portion of the study area and urban park-like open space along the western portion. The study area is relatively maintained as a mowed landscape with the eastern bank of the resaca bulkheaded to prevent erosion of the resident's back yards.

2.3.5 AQUATIC RESOURCES

The 10-acre RBR is one of the many resacas in the Town Resaca system of Brownsville. The urbanization of the study area and land use practices of the maintained lawn and park space have contributed to the decline of the aquatic health of the RBR. The following sections describe the existing, degraded condition of the aquatic ecosystem of the RBR.

2.3.6 SURFACE WATER

As noted in **Section** 2.1.1, the life cycle of natural resacas were historically driven by the seasonal flooding of the Rio Grande. Although the primary water source of the RBR is still the Rio Grande, the Town Resaca system is connected by pipelines maintained by the BPUB instead of flooding of the Rio Grande floodplains. Stormwater runoff from the surrounding neighborhoods also contributes to the surface waters of the RBR. The Town Resaca system ultimately drains into the Lower Laguna Madre via the Brownsville Navigation District Ship Channel downstream of the Impala Pump Station (TWDB, 2006).

2.3.7 WETLANDS

The National Wetland Inventory classifies the RBR as a freshwater pond (USFWS, 2016). Because the RBR is maintained at a relatively constant elevation, potential wetlands within the study area are limited to an extremely narrow fringe along the resaca edge. The quality of the wetland fringe is adversely impacted by the non-native, invasive species encroaching on the resaca edge, the bulkheading on the east side of the resaca, and the cut bank nature of the western shoreline of the resaca.

2.3.8 WATER QUALITY

In general, existing water quality data for resacas is limited. The Texas Council on Environmental Quality (TCEQ) is currently investigating pollutant loads and impairments of resaca water quality resulting from nonpoint sources (TCEQ, 2015a). Results of the study are expected at the end of 2016.

However, water quality measurements were collected at the adjacent Cemetery and Dean Porter Resacas within the Town Resaca system. Results of the water quality analysis indicate that the resaca oxygen levels and pH are indicative of waters enriched with a high nutrient load (BPUB, 2013). High pH and dissolved oxygen (percent saturation) above 100 percent indicate high photosynthetic rates in the resacas. Abundant phytoplankton, benthic algae, and/or aquatic plants are responding to the excess nutrients introduced into the resacas from fertilizer runoff from lawns and other non-point sources. Nightly respirations of these plants decrease oxygen levels until sunrise. Average dissolved oxygen concentrations for RBR ranged 5.1 mg/L to 9.2 mg/L. Although dissolved oxygen concentrations exceeded the water quality criterion of 5.0 mg/L set for the Rio Grande (TCEQ, 2012) throughout much of the year, oxygen levels decreased significantly during the summer months (**Table 1**). Water temperatures ranged from 59° F in January to 87° F in August.

Table 1. Resaca Boulevard Resaca Water Quality

Month	Dissolved Oxygen (mg/L)	Water Temp. °F	pH	Specific Conductance (µS/cm)
January	9.2	59	8.0	1,267
February	7.9	69	8.3	1,405
May	5.1	79	8.1	1,238
July	6.5	86	8.1	2,006
August	6.3	87	8.1	1,228
November	7.5	70	8.2	1,377
December	7.5	67	8.1	1,332

McIntosh (2014) assessed water quality in three resacas east of the City of Brownsville (two resacas located within the Sabal Palm Sanctuary) and one within the eastern city limits of Brownsville (Fort Brown Resaca), with similar results (Table 2). Water temperatures in the resacas ranged from 54° F in the winter to 95° F in the summer. Dissolved oxygen in the resacas ranged from 2.1 to 12.8 mg/L. Similar to the Boulevard Resaca, the three resacas evaluated by McIntosh are considered eutrophic. In addition to collecting standard water quality parameters for the resacas, McIntosh also analyzed the resacas for total phosphorous, nitrite, nitrate, and ammonia. Nutrient loading was within the TCEQ water quality limits; however, these resacas were not adjacent to residential areas.

Table 2. Average Annual Water Quality Parameters for Three Cameron County Resacas

Water Quality Parameter	Resaca 1	Resaca 2	Resaca 3	TCEQ Criteria[1]
Water Temperature (°F)	77.7	79.3	75.3	95
pH	8.1	8.3	7.9	Low 6.5, High 9.0
Dissolved Oxygen (mg/L)	7.2	9.4	6.6	4.0
Secchi Disk Transparency (ft)	0.7	1.3	0.9	-
Specific Conductance (µS/cm)	1,216	1,315	1,263	-
TP (mg/L PO_4^{3-})	0.656	1.058	0.550	0.69
Nitrite (mg/L NO_2^- -N)	0.007	0.005	0.005	-
Nitrate (mg/L NO_3^- -N)	0.020	0.010	0.013	1.1
Ammonia (mg/L NH_3-N)	0.299	0.254	0.264	0.46

[1]TCEQ(2015b)

2.3.9 GROUNDWATER

The groundwater of the study area is contained within two major hydrogeologic units. Both aquifers yield moderate to high quantities of fresh to moderately saline water. In general, the shallow zones of the aquifer contain highly mineralized water overlying fresh to slightly saline water while the deeper zones yield poorer water quality (Preston, 1983).

2.3.10 AQUATIC HABITAT

Historically, the resacas provided robust and diverse aquatic habitat for fish and wildlife species in the LRGV. Native aquatic plant species found in resacas include coontail (*Ceratophyllum demersum*), spikerush (*Eleocharis* spp.), pennywort (*Hydroctyle* spp.), water primrose (*Ludwigia* spp.), smartweed (*Polygonum* spp.), bulrush (*Scirpus* spp.), and pondweed (*Potamogeton* spp.). Due to the encroachment of urban land uses and the spread of non-native, invasive plant species, giant cane (*Arundo donax*), elephant ear (*Colocasia esculenta*), hydrilla (*Hydrilla verticillata*), parrotfeather (*Myriophyllum aquaticum*), Eurasian watermilfoil (*M. spicatum*), and salt cedar (*Tamarisk* spp.) have become established in RBR. The nutrification of the resacas caused by the fertilization of adjacent lawns has also resulted in a significant algal colony growth in the RBR.

Fish surveys of the Brownsville resacas conducted between 1853 and 1886 reveal that the resacas historically supported a diverse fish community indicative of relatively high water quality (**Table 3**). However, as the aquatic habitat has declined, so has the diversity and health of the fish community. Recent fish surveys of the Town Lake resacas conducted by Texas Parks and Wildlife (TPWD) and others indicate a shift in the fish community towards species more tolerant of lower water quality and non-native, invasive fish species such as the vermiculated sailfin catfish (*Pterygophlichthys disjunctivus*), common carp (*Cyprinus carpio*), and blue tilapia (*Oreochromis aurea*).

Table 3. Fish Species of the Town Lake Resacas

Scientific Name **Bold =non-native**	**Common Name**	**Late 1800's**	**Survey 1960-1980**	**2013**
Lepisosteus oculatus	Spotted gar		X	X
Lepisosteus osseus	Longnose gar		X	
Gambusia affinis	Western mosquitofish	X	X	X
Poecilia formosa	Amazon molly		X	X
Poecilia latipinna	Sailfin molly	X	X	
Cyprinodon variegates	Sheepshead minnow	X	X	X
Fundulus grandis	Gulf killifish		X	
Fundulus similis	Longnose killifish	X		
Lepomis cyanellus	Green sunfish	X		
Lepomis gulosus	Warmouth		X	
Lepomis macrchirus	Bluegill	X	X	X
Lepomis megalotis	Longear sunfish	X		
Lepomis microlophus	Redear sunfish		X	
Micropterus salmoides	Largemouth bass		X	X
Pomoxis annularis	White crappie		X	
Pomoxis nigromaculatus	Black crappie		X	
Pterygophlichthys disjunctivus	**Vermiculated sailfin catfish**			X

Scientific Name Bold =non-native	Common Name	Late 1800's	Survey 1960-1980	2013
Ameiurus natalis	Yellow bullhead	X		
Ictalurus furcatus	Blue catfish	X	X	
Ictalurus punctatus	Channel catfish		X	X
Campostoma anomalum	Central stoneroller	X		
Cyprinella lutrensis	Red shiner	X		
Cyprinus carpio	**Common carp**		X	X
Dionda melenops	Spotted minnow	X		
Dionda serena	Nueces roundnose minnow	X		
Hybognathus amarus	Rio Grande silvery minnow	X		
Notemigonus chrysoleucus	Golden shiner	X		
Notropis braytoni	Tamaulipas shiner		X	
Notropis stramineus	Sand shiner	X		
Phenacobius mirabilis	Suckermouth minnow	X		
Pimephales promelas	Fathead minnow	X		
Pimephales vigilax	Bullhead minnow	X		
Dorosoma cepedianum	Gizzard shad		X	X
Dorosoma petenense	Threadfin shad		X	X
Menidia beryllina	Inland silversides		X	X
Ictiobus bubalus	Smallmouth buffalo	X	X	X
Carpiodes carpio	River carpsucker		X	
Cichlasoma cyanoguttatum	Rio Grande cichlid	X	X	
Oreochromis aurea	**Blue tilapia**		X	X
Aplodinotus grunniens	Freshwater drum	X	X	
Astyanax mexicanus	Mexican tetra	X		
Anguilla rostrata	American eel	X		
Gobiomorus dormitor	Bigmouth sleeper	X		
Etheostoma lepidum	Greenthroat darter	X		
Mugil cephalus	Striped mullet		X	
Morone chrysops	White bass		X	
Sciaenops ocellatus	Red drum		X	
Gobiosoma bosc	Naked goby		X	
Palaemontes spp.	Grass shrimp			X
***Macrobrachium* spp.**	**Giant freshwater prawn**			X

The use of landscaping fertilizers and chemicals on adjacent lands have also impacted the aquatic habitat for the amphibian community of the RBR. Amphibians partially respirate through their skin and, due to the permeability of their skin, amphibians are extremely sensitive to degraded water quality and contamination. The exposure to toxicants is further

exacerbated by the lack of a viable riparian habitat buffer to filter potential contaminants from entering the RBR.

2.3.11 TERRESTRIAL RESOURCES

Most of the non-developed terrestrial habitat of the RBR is primarily limited to the western and southern edges of the resaca. The terrestrial habitats in these areas, as well as the residential lawns along the eastern portion of the study area are highly maintained. Within the study area, non-native, invasive plant species have invaded, outcompeting the extremely limited native resaca plant species that remain. Historically RBR contained a three acre contiguous island. The island provides habitat for migratory and residential birds, other upland wildlife and fringe habitat for aquatic vegetation and associated species. Over time the island has eroded to approximately 0.35 acre segments. This section describes the existing conditions for terrestrial resources within the study area.

2.3.12 VEGETATION

The RBR study area is located in the Tamaulipan Biotic Province and within the South Texas Plains ecoregion as defined by Omernick (1987). Due to the irregular precipitation patterns, vegetation in the LRGV must be drought tolerant (Crosswhite, 1980). Historically, the vegetation associated with the resacas was comprised of three unique vegetation communities: Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland. Plant species associated with these three vegetation communities are listed in Appendix 1. The riparian forest is associated with the more mesic lower elevations of the resaca boundaries while the Texas ebony/snake-eyes shrubland is found at slightly higher elevations. For resacas supporting palmetto woodlands, the vegetation community is found in both higher and lower elevations. These vegetation communities support high plant species diversity and form dense overstory and shrub canopies.

The vegetation of the study area is dominated by non-native, invasive species such as Brazilian peppertree, salt cedar, Chinese tallow, giant cane, KR bluestem, Bermudagrass, and buffelgrass. The eastern portion of the RBR study area is vegetated with ornamental species and non-native lawn grasses. The western portion of the RBR study area is dominated by Brazilian peppertree hedges that border the resaca with a maintained non-native grassland extending to Resaca Boulevard (**Figure 4**). Washington fan and Texas sabal palms are interspersed throughout the study area forming a park-like landscape on the western side of the RBR. Although a few native species representative of the native resaca habitats such as Texas ebony, brasil, coma, and lotebush were identified in the study area, they comprised an insignificant portion of the existing vegetative community.

Figure 4. (Left) RBR with invasive Brazilian peppertree dominating the shoreline. (Right) RBR riparian area consisting of a maintained grassland with Washington fan and Texas sabal palms (BPUB hydraulic dredge pipe for RBR running through the area).

2.3.13 WILDLIFE

The LRGV has historically provided unique habitat for an incredibly diverse vertebrate faunal community. The confluence of subtropical, southwestern desert, and coastal influences result in the presence of wildlife species found nowhere else in the U.S. The endangered ocelot and jaguarundi utilize non-urban resaca habitats as travel corridors and incorporate the adjacent areas into their reproductive and foraging habitats.

Two major migratory bird flyways, the Mississippi and the Central, converge in the LRGV as migratory birds are funneled between the Gulf of Mexico to the east and arid desert habitats to the west. The ranges of the red-crowned parrot, red-billed pigeon, white-tipped pigeon, groove-billed ani, white-collared seed-eater, green jay, brown jay, rose-throated becard, tropical kingbird, plain chachalaca, clay-colored robin, long-billed thrasher, and Altamira oriole reach their northern extremes in the LRGV. In addition to providing valuable breeding and stopover habitats for Neotropical migrants, the LRGV provides valuable habitat for an

abundance mammals, reptiles, amphibians, and invertebrate species, including numerous rare, threatened, and endangered species.

Avian species observed within the study area include the mallard, black-bellied whistling duck, great egret, yellow-crowned night heron, least tern, green parakeet, golden-fronted woodpecker, Inca dove, white-winged dove, tropical kingbird, and great kiskadee.

2.3.14 THREATENED & ENDANGERED SPECIES

The U.S. Fish and Wildlife Service (USFWS) threatened and endangered species list for Cameron County identifies 10 endangered, 4 threatened, and 2 candidate species (**Table 4**). In addition to these species, TPWD has listed additional species as State endangered and threatened and are monitoring the conservation status of numerous other rare species of concern in Cameron County. Many of these species including the ocelot, jaguarundi, and black-striped snake, rely on non-urban resacas for breeding, foraging, and escape cover habitats. Species such as the red-crowned parrot, black-spotted newt, south Texas siren, and southern yellow bat are known to occur in urban resaca habitats in the City of Brownsville. The bolded species listed in **Table 4** indicate species that utilize resaca habitats in the LRGV.

During site surveys, no rare, threatened, or endangered species were observed within the RBR study area. Although no amphibian surveys were conducted at the RBR, the habitat quality of the shoreline and adjacent riparian habitat is not conducive to supporting rare amphibians.

Table 4. Rare, Threatened, and Endangered Species of Cameron County, TX*

Common Name	Scientific Name	USFWS	TPWD	Resaca Habitat
	Amphibians			
Black-spotted newt	***Notophthalmus meridionalis***		T	R
Mexican treefrog	***Smilisca baudinii***		T	R
Sheep frog	***Hypopachus variolosus***		T	R
South Texas siren	***Siren sp 1***		T	R
White-lipped frog	***Leptodactylus fragilis***		T	R
	Birds			
Audubon's oriole	***Icterus graduacauda audubonii***		SOC	R
Brownsville common yellowthroat	***Geothlypis trichas insperata***		SOC	R
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*		T	R
Common black-hawk	*Buteogallus anthracinus*		T	R
Eskimo curlew	*Numenius borealis*		E	
Gray hawk	*Asturina nitida*		T	R
Interior least tern	*Sterna antillarum athalassos*	E	E	
Northern aplomado falcon	*Falco femoralis septentrionalis*	E	E	
Northern beardless-tyrannulet	*Campostoma imberbe*		T	R
Peregrine falcon	*Falco peregrinus*		T	R

Common Name	Scientific Name	USFWS	TPWD	Resaca Habitat
Piping plover	*Charadrius melodus*	T	T	
Red knot	*Calidris canutus rufa*	T	T	
Red-crowned parrot	*Amazona viridigenalis*	C		R
Reddish egret	*Egretta rufescens*		T	
Rose-throated becard	***Pachyramphus aglaiae***		T	R
Sennett's hooded oriole	***Icterus cucullatus sennettii***		SOC	R
Snowy plover	*Charadrius alexandrinus*		SOC	
Sooty tern	*Sterna fuscata*		T	
Sprague's pipit	*Anthus spragueii*	C	SOC	
Texas Botteri's sparrow	*Aimophila botterii texana*		T	
Tropical parula	***Parula pitiayumi***		T	R
Western burrowing owl	*Athene cunicularia hypugaea*		SOC	
White-faced ibis	*Plegadis chihi*		T	R
White-tailed hawk	*Buteo albicaudatus*		T	
Wood stork	*Mycteria americana*		T	R
Zone-tailed hawk	*Buteo albonotatus*		T	
	Fishes			
American eel	*Anguilla rostrata*		SOC	
Mexican goby	***Ctenogobius claytonii***		T	R
Opossum pipefish	*Microphis brachyurus*		T	
Rio Grande shiner	***Notropis jemezanus***		SOC	R
Rio Grande silvery minnow	*Hybognathus amarus*		E	R
River goby	*Awaous banana*		T	R
Smalltooth sawfish	*Pristis pectinata*		E	
	Insects			
A royal moth	***Sphingicampa blanchardi***		SOC	R
Manfreda giant-skipper	***Stallingsia maculosus***		SOC	R
Smyth's tiger beetle	*Cicindela chlorocephala smythi*		SOC	
Subtropical blue-black tiger beetle	*Cicindela nigrocoerulea subtropica*		SOC	
Tamaulipan agapema	***Agapema galbina***		SOC	R
	Mammals			
Coues' rice rat	***Oryzomys couesi***		T	R
Jaguar	*Panthera onca*		E	
Jaguarundi	*Herpailurus yaguarondi*	E	E	R
Mexican long-tongued bat	*Choeronycteris mexicana*		SOC	
Ocelot	*Leopardus pardalis*	E	E	R
Plains spotted skunk	*Spilogale putorius interrupta*		SOC	

Common Name	Scientific Name	USFWS	TPWD	Resaca Habitat
Southern yellow bat	***Lasiurus ega***		T	R
West Indian manatee	*Trichechus manatus*	E	E	
White-nosed coati	*Nasua narica*		T	R
	Mollusks			
False spike mussel	*Quadrula mitchelli*		T	
Salina micket	*Potamilus metnecktayi*		T	R
Texas hornshell	*Popenaias popeii*		T	
	Reptiles			
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	E	E	
Black-striped snake	*Coniophanes imperalis*		T	R
Green sea turtle	*Chelonia mydas*	T	T	
Keeled earless lizard	*Holbrookia propinqua*		SOC	
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E	
Leatherback sea turtle	*Dermochelys coriacea*	E	E	
Loggerhead sea turtle	*Caretta caretta*	T	T	
Northern cat-eyed snake	***Leptodeira septentrionalis septentrionalis***		T	R
Speckled racer	***Drymobius margaritiferus***		T	R
Texas horned lizard	***Phrynosoma cornutum***		T	
Texas indigo snake	***Drymarchon melanurus erebennus***		T	R
Texas scarlet snake	*Cemophora coccinea lineri*		T	
Texas tortoise	*Gopherus berlandieri*		T	
	Plants			
Bailey's ballmoss	***Tillandsia baileyi***		SOC	R
Buckley's spiderwort	*Tradescantia buckleyi*		SOC	R
Green Island echeandia	*Echeandia texensis*		SOC	
Large selenia	*Selenia grandis*		SOC	R
Lila de los llanos	*Echeandia chandleri*		SOC	
Marsh-elder dodder	***Cuscuta attenuata***		SOC	R
Mexican mud-plantain	***Heteranthera mexicana***		SOC	R
Plains gumweed	***Grindelia oolepis***		SOC	
Runyon's cory cactus	*Coryphantha macromeris var. runyonii*		SOC	
Runyon's water-willow	***Justicia runyonii***		SOC	R
Shinner's rocket	***Thelypodiopsis shinnersii***		SOC	R
Siler's huaco	*Manfreda sileri*		SOC	
South Texas ambrosia	*Ambrosia cheiranthifolia*	E	E	R
South Texas spikesedge	***Eleocharis austrotexana***		SOC	R

Common Name	Scientific Name	USFWS	TPWD	Resaca Habitat
Star cactus	*Astrophytum asterias*		E	
Texas ayenia	***Ayenia limitaris***	E	E	
Texas milk vetch	*Astragalus reflexus*		SOC	
Texas stonecrop	*Lenophyllum texanum*		SOC	
Wright's trichocronis	*Trichocoronis wrightii var. wrightii*		SOC	R
Yellow-flowered alicoche	*Echinocereus papillosus*		SOC	

*T=Threatened, E=Endangered, SOC=Species of Concern, R=Resaca Species

2.3.15 AIR QUALITY

The study area is located in Cameron County which is currently in attainment or unclassified status for all National Ambient Air Quality Standards (NAAQS) criteria pollutants as established and monitored by the EPA (USEPA, 2015).

2.3.16 NOISE

Baseline noise levels within the study area are typical of urban residential areas. Vehicular traffic and residential maintenance activities such as lawn mowing comprise the majority of noise impacts within the study area.

2.3.17 LIGHT

Existing artificial light sources within the RBR study area can be attributed to streetlights, motorized traffic, and fugitive light sources from the adjacent neighborhood. Because of the urban landscape, sky glow (diffuse light escaping from urban sources) is also a source of fugitive light.

2.3.18 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

2.3.18.1 SOCIOECONOMICS

RBR is located in Brownsville, Cameron County, Texas. Brownsville, the county seat of Cameron County, had an estimated 2014 population of 183,046 persons and 50,207 households (USCB, 2016). Major industries include petrochemicals, shipping, agriculture and food processing, and light manufacturing (Handbook of Texas, 2016). Unemployment is traditionally high, and is currently 6 to 7 percent (BLS, 2016). In 2014, the ethnic makeup of the city was 88% white, 0.4% African American, 0.4% Native American, 0.7% Asian. Of the total population, 93.2% were Hispanic or Latino. The median household income from 2010 to 2014 was $32,288 with about 35.7% of persons living below the poverty level. Brownsville has one of the highest percentages of residences living below the federal poverty level in the U.S. (BLS, 2016).

The RBR project area is located entirely in zip code 78520 on the west side of Brownsville. In comparison to the city over-all, the immediate project area has a median household income of $64,412, is 90 percent Hispanic, with 15.8 percent living below the poverty level. Median home value is $193,856 (City-Data, 2016). On the east bank of Boulevard Resaca there is a

subdivision of large custom homes, while west of the resaca is commercial property including Incarnate Word Academy, Valley Baptist Medical Center, and Villa Maria Language Institute.

2.3.18.2 ENVIRONMENTAL JUSTICE

In compliance with Executive Order 12898, Federal Action to Address Environmental Justice in Minority and Low-Income Populations, an analysis was performed to determine whether the proposed project will have a disproportionate adverse impact on minority or low-income population groups in the vicinity of the project area. This analysis included an examination of characteristics of residential populations in the project areas, based on U. S. Census Bureau data.

The breakdown of the population of Brownsville by ethnic group from the 2010 U.S. Census is provided in **Table 5** below. For comparison, the breakdown for Cameron County, the State of Texas, and U.S. in 2014 are also shown (USCB 2016). The table also shows median household income and the percent of persons living below the poverty level. Based on the census figures, the population of Brownsville consists of a higher percentage of Hispanic and low income populations than the state or U.S populations. Hispanic origin is a cultural identity that can include any race. Although the immediately adjacent subdivision is clearly not impoverished, the project vicinity is, and could be characterized as an Environmental Justice population subject to consideration under E.O. 12898.

Table 5. Demographic Information for Brownsville, TX.

	Brownsville 2010	Cameron County 2014	Texas 2014	U.S. 2014
Ethnicity				
White	88.0 %	97.2 %	80.0 %	77.4%
African American	0.4 %	0.9 %	12.5 %	13.2 %
Native American	0.4 %	0.6 %	1.0 %	1.2 %
Asian	0.7 %	0.8 %	4.5 %	5.4%
Native Hawaiian/Pacific Islander	< 0.05 %	0.1 %	0.1 %	0.2 %
Two or more races	1.5 %	0.5 %	1.8 %	2.5 %
Hispanic or Latino Origin	93.2 %	88.7 %	38.6 %	17.4 %
Income & Poverty, 2008 to 2012				
Median Household Income	$32,482	$33,390	$52,576	$53,482
Persons Living in Poverty	35.7 %	34.53 %	17.2 %	14.8 %

Source: (USCB, 2016)

2.3.19 CULTURAL RESOURCES

The no action alternative has No Potential to Effect historic resources. Any potential undertaking (Alternatives 1-16) all involve minor habitat restoration activities (riparian and aquatic emergent planting, light grading, island creation and invasive plant management). The Area of Potential Effect (APE) for archeological resources coincides with the RBR Study Area. The Texas Archeological Sites Atlas was consulted on February 5, 2016 and no known archeological sites are within the APE. Deeply buried archeological deposits due to the

prevalence of prehistoric occupation near water sources are possible, but are not probable due to the construction of the Resaca Boulevard and homes in the area which has disturbed the soils. Borrow materials for the island would be from commercial sources. Should the project involve ground disturbance no further than 36 inches, the undertaking has no Potential to Effect historic archeological resources due to previous ground disturbance, the surface nature (less than 36 inches) of the ground disturbance and the commercial source of the fill materials.

No built historic resources are directly affected by the undertaking. The visual APE extends beyond the Study Area to encompass the west side of RBR and the rear of the homes along Calle Jacaranda. Due to the nature of the undertaking (minor habitat restoration), the undertaking does not have the potential to visually adversely alter the setting of any historic resources within the APE as the area will visually remain a heavily vegetated marshy area with no built structures under implementation of any of the study alternatives. All of the alternatives restore the setting and do not diminish the integrity of setting and location. Should any historic resources be present in the APE, implementation of Alternatives 1-16 have no potential to diminish integrity and therefore has no Potential to Effect historic resources.

Since the undertaking has No Potential to Effect historic properties as defined in 36 CFR 800.16(y), there are no further obligations under Section 106 and no need to identify if historic properties are present within the APE. Appropriate records of this finding shall be kept in USACE files. Should ground disturbance greater than 36 inches be anticipated, Section 106 consolation with the Texas Historical Commission shall occur to identify potential historic archeological properties.

2.3.20 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR, Inc.) in the vicinity of the RBR, located in Brownsville, Texas east of Resaca Boulevard and south of Belthair Street. This environmental records search was conducted at the request of the USACE RPEC, Environmental Technical Services Branch (USACE, CESWF-PEC-T), on behalf of the NEPA and Cultural Resources Section (USACE, CESWG-PM-J), for the purpose of identifying any sites where hazardous substances or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water which might impact a proposed restoration project to remove accumulated sediment, trash, and debris from the subject resaca. A final report listing all such sites found in the records search was submitted on 11 March 2016 by EDR, Inc. according to requirements of ASTM E1527-13 Standard Practice for Environmental Site Assessments. The search area extended in a one mile radius around the subject resaca from latitude (north) 25.918939 degrees and longitude (west) 97.507279 degrees. Additionally, EDR, Inc. conducted a records search to identify oil, gas, and water wells within the search area and provided historical aerial photographs and topographic maps of the area within and adjacent to the search area. More details of the report findings will be discussed in the EA (Appendix 11); however, no impacts were identified for RBR.

2.3.21 VISUAL AESTHETICS

The presence of residential and commercial properties adjacent to resacas in the Brownsville area, exhibit the aesthetic draw of people to water-based landscapes. The residents on the eastern shoreline of the resaca have a view of the resaca and the Brazilian peppertree and giant cane tree line on the opposite shore with Washington fan and sabal palms extending beyond the shrub canopy. Although the RBR can be seen between breaks in the non-native, riparian vegetation, the Brazilian peppertree forms a dense hedge that blocks much of the view of the street. By removing the non-native vegetation along the western bank and re-planting with native species, the western bank aesthetics will be changed to a more open vista until the newly planted vegetation becomes established.

3.0 DEVELOPMENT OF ALTERNATIVE PLANS

Plan formulation is the deliberate activity of developing an optimal strategy for solving problems and achieving a desired set of goals. The goal of the RBR study is to restore the structure and function of the RBR ecosystem that would support the unique and rare biota dependent on the resaca's aquatic and riparian habitats. The plan formulation for the ecosystem restoration of the RBR study uses established, documented, and proven methodologies in an incremental approach. To quantify and assess existing and future habitat conditions for the RBR study area, with and without the study alternatives, a Resaca Reference Condition Model (RRCM) was developed utilizing data from high quality resaca sites within the Resaca de la Palma State Park, the Nature Conservancy's Southmost Preserve, and Camp Lula Sams in and near the City of Brownsville (**Figure 7**). Seven measures were analyzed and developed into alternatives. These measures are discussed below.

3.1 INITIAL SCREENING OF MEASURES

Minimal restoration of the RBR should address at least one of the degraded or lost structural/functional elements of the resaca ecosystem. The maximum level of restoration achievable for the study area would begin to address all the loss of function and structure listed for the RBR. A description of each management measure identified is provided below.

In several of the descriptions of measures below, the RBR was compared to high quality reference resacas observed in the Brownsville area with the measure addressing a means to return the RBR to a reference condition. This concept was further developed and modeled for the quantification of habitat quality in the assessment of alternatives. The development of this model and further explanation of the reference resaca conditions are discussed in Section 3.1.9.

3.1.1 RIPARIAN PLANTING MEASURE A

As stated in **Section** 2.1.1, the resaca's riparian vegetation communities are critically imperiled with extinction. Measure A includes the restoration of a Subtropical Texas Palmetto Woodland habitat by planting species representative of this community (**Appendix 1**) within the riparian zones of the RBR and, for alternatives including the island restoration measure,

the restoration of a Texas Ebony Resaca Forest habitat (**Appendix 2**) on the island. The restoration of the Texas Ebony/Snake-eyes Shrubland vegetation community is not compatible with the lower floodplain elevations of the RBR; therefore, it is not included in the riparian planting measure. Because it takes many years for these vegetation associations to mature, native south Texas grassland species would be planted to provide interim habitat, to minimize the spread of non-native invasive species, and to stabilize the riparian soils while the target vegetative community becomes established. Early successional native plant species such as Rio Grande clammyweed (*Polanisia dodecandra ssp. riograndensis*), tallow weed (*Plantago hookeriana*), red-seeded plantain (*Plantago rhodosperma*), slender grama (*Bouteloua repens*), Texas panicum (*Urochloa texana*), green sprangletop (*Leptochloa dubia*), shortspike windmillgrass (*Chloris x subdolistachya*), and hooded windmillgrass (*C. cucullata*) would be included in the grassland seed mix in order to compete with non-native invasive species and ensure early establishment of native species. Additional species such as little bluestem (*Schizachyrium scoparium*), false rhodesgrass (*Trichloris crinita*), plains bristlegrass (*Setaria leucopila*), hairy grama (*Bouteloua hirsuta*), whiplash pappusgrass (*Pappophorum bicolor*), orange zexmania (*Wedelia hispida*), awnless bush sunflower (*Simsia calva*), and wand-like bundleflower (*Desmanthus virgatus*) and/or others would be planted to establish a diverse, native grassland habitat while the target vegetation matures.

The restoration of the native resaca vegetation would provide valuable habitat for resident and migratory wildlife species, especially rare amphibians associated with the resaca. As observed in high quality resaca sites used as references, the canopy of the riparian vegetation is incredibly dense and one of the limiting factors for plant growth is the availability of sunlight. The resaca edge provides an opportunity for many species to capture sunlight by growing horizontally and at a low angle along the resaca edge to capture this resource. As such, the riparian vegetation along the shoreline as observed in reference resacas is extensive. The extension of the riparian canopy into and over the water provides essential food and cover habitat for both fish and amphibian species as well as introducing allochthonous organic material into the aquatic food web.

The ecosystem functions of native riparian vegetation include the filtration of surface runoff, stabilization of the shoreline, flow attenuation, shading along the edge of the resaca, and wildlife habitat for reproduction, cover, and foraging. The grassland species identified above can be used to stabilize localized erosion along swales feeding into the resaca and reduce sedimentation into the resaca while providing habitat for invertebrate species. If needed, natural "green" armoring using willow (*Salix interior or S. nigra*), log or rock vanes, or other natural armoring methods could be utilized in localized areas of erosion. If hard structures are required to stabilize the erosional areas, large rock, or some type of similar design, should be utilized to provide stabilization while also providing habitat structure, through careful design consideration, for aquatic and riparian species.

Red-crowned parrots are listed as a Candidate species under the ESA by the USFWS. The parrots inhabit Tamaulipan scrub dominated habitats dominated by coma, Texas ebony, and other thorny legumes averaging 15 to 25 feet in height. The parrots are opportunistic foragers and feed on ebony, coma, and anacua seeds (Gelbach, 1987). These plant species are target

components of the resaca ecosystem restoration study. In the LRGV, red-crowned parrots often nest in abandoned nest cavities in dead Washington fan and Texas sabal palms. These nest cavities are often excavated by golden-fronted woodpeckers and are taken over by the parrots as the cavities expand and age (Cliff Shackelford, TPWD, pers. comm., 2016).

The riparian planting measure would include the creation of red-crowned parrot nesting structures within the RBR study area. Several dead palm trees with nest cavities were identified during initial site surveys. These dead palms would be left in place. In addition, several dead and/or fallen Washington fan and sabal palms from other city properties could be collected and erected on the RBR project site for the red-crowned parrots and other native species that utilize cavities and decaying woody material. The palm trunks could be placed into holes and backfilled or tied off and supported by posts so that 20 to 30 feet of the palm extends above ground. Golden-fronted woodpeckers would then excavate nest cavities into the trunks until the parrots take the nest over. If appropriate, existing Washington fan palms could be treated with herbicide to create nest cavities in the more distant future. The three levels of palm decay would ensure the sustainability of red-crowned nest cavities. The existing dead standing palms provide immediate nest cavities, the erected palm trunks would provide near future nest cavities, and the herbicide treated palms would provide supplemental nest cavities in the more distant future if appropriate.

3.1.2 BANK SLOPE RESTORATION MEASURE B

Natural banks and shorelines are significant features of a stable, functioning aquatic systems providing habitat for fish, wildlife, and plant species. Additionally, natural banks are more effective at absorbing erosive energies during flood events and from fetch. The shorelines observed in high quality reference resacas exhibited gradual slopes of 1:10 or greater between the riparian and aquatic habitats. The relaxed slope of the reference resacas allows the dissipation of erosive energies to be spread over a greater area, reducing bank erosion and sedimentation of the resacas. This measure would restore the slopes of the RBR shoreline to reference conditions by sculpting the 15-foot, undredged shelf left after the BPUB dredging activities are completed. If appropriate, clean material from the dredging operation could be stockpiled and used as fill material along the shelf to restore the gradient. A gradual transition between the aquatic and riparian habitats is vital for amphibians as they transition from aquatic to terrestrial forms.

3.1.3 AQUATIC AND EMERGENT SPECIES PLANTING MEASURE C

Aquatic and emergent plant species provide habitat for invertebrate, fish, amphibian, and bird species found in the resacas. This measure would entail planting of native aquatic and emergent vegetation along the shoreline of the resacas. Native aquatic and emergent plant species such as flatsedges (*Cyperus spp.*), spikerush (*Eleocharis spp.*), mudplantain (*Heteranthera spp.*), water primrose (*Ludwigia peploides*), water clover (*Marsilea macropoda*), smartweed (*Polygonum spp.*), bulrush (*Scirpus spp.; Schoenoplectus spp.*), and other species would be planted to establish aquatic habitat in the RBR.

The restoration of native aquatic and emergent vegetation would provide reproductive, foraging, and protective cover habitats for fish and amphibian species as well as foraging habitat for waterbirds and waterfowl. In addition, the vegetation would assist in the stabilization of the near shore substrate and improve water quality within the RBR.

3.1.4 ISLAND RESTORATION MEASURE D

Historically, the RBR supported approximately three acres of island habitat (**Figure 5**). Over time, erosive forces from floodwaters and wave action from wind have segmented the island into several smaller islands now encompassing approximately 0.35 acres. This measure would include restoration of the island with fill and topsoil to support the growth of Texas Ebony Resaca Forest plant species (**Appendix 2**). The slope of the shoreline transition from the aquatic to terrestrial habitat of the island will mirror that of the reference resaca shorelines with gradients less than 1:10. The low gradient will extend under water for 10-15 feet to provide substrate for native emergent vegetation.

Figure 5. Resaca Boulevard Resaca Island Loss of Habitat

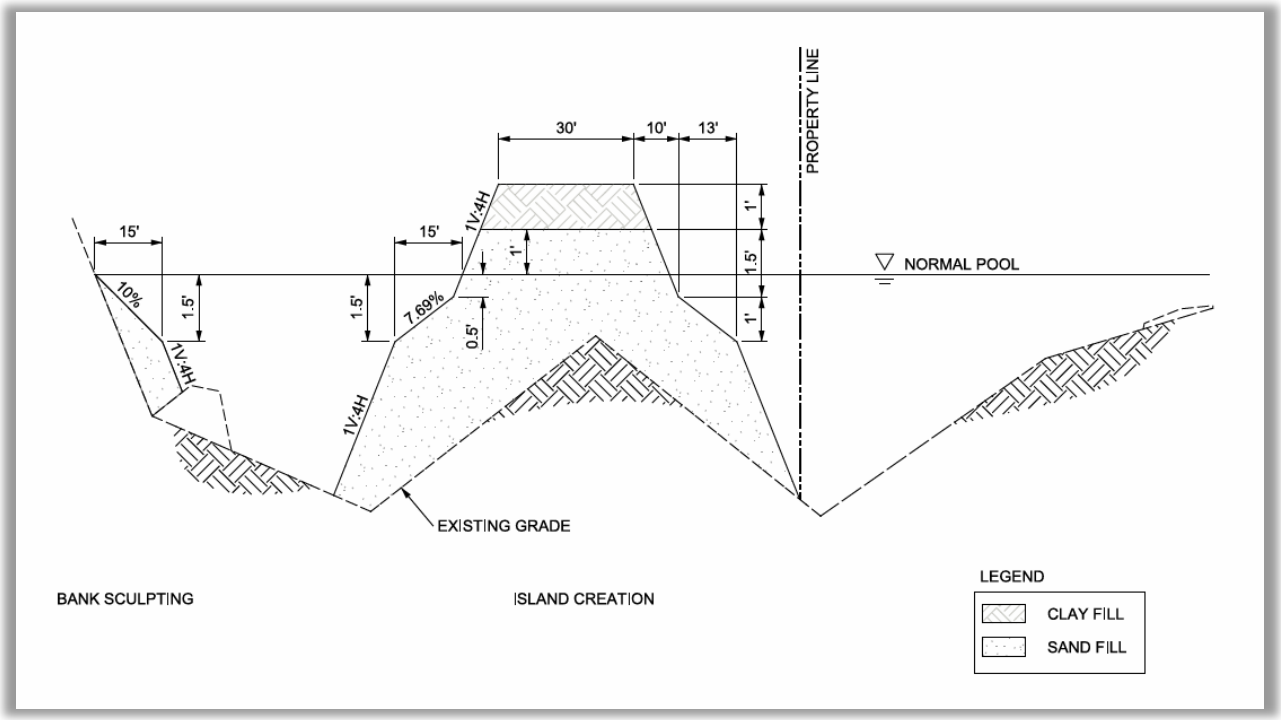

Figure 6. Proposed Island Cross Section

The re-creation of island habitats with native plant species would provide refuge sites for wildlife, including migratory bird species that may utilize the islands for nesting, roosting, or foraging habitat. The emergent wetland habitats surrounding the islands would provide additional habitat for fish and wildlife species, particularly amphibians and waterbirds. The shade from the vegetation extending out from the islands would also benefit aquatic resources by providing shade, that in combination with the land-side riparian shading, may mediate water temperatures and increase dissolved oxygen concentrations.

3.1.5 POOL ELEVATION MANAGEMENT MEASURE E

The natural hydrologic processes of resacas involve highly fluctuating surface water elevations. Historically, the resacas were replenished by stormwater runoff and Rio Grande floodwaters, and the resacas would draw down between events. Fluctuating water levels influence the vegetation and fish and wildlife habitat of the resacas.

Allowing the RBR to drawdown to the scale of natural resacas would not be compatible with other uses of the Town Resaca system including water supply and stormwater management. However, seasonal management of the RBR pool elevation on a smaller scale may still provide benefits to riparian and emergent vegetation. In addition, the fluctuation of pool elevations provide a dynamic habitat that may provide benefits to fish and wildlife species. The existing weir at the downstream end of the RBR is fitted with 6-inch boards which can control water levels in the resaca. This measure would also entail a seasonal 6 to 12 inch drawdown timed to facilitate the transition of juvenile salamanders from aquatic to terrestrial habitats.

3.1.6 INVASIVE PLANT SPECIES MANAGEMENT MEASURE F

Due to urbanization and the continued maintenance of the existing vegetation, invasive non-native plant species have proliferated within the RBR study area. The removal and the continued management of non-native invasive species from the area is essential for the long-term sustainability of the ecosystem restoration for RBR. This measure would include the appropriate mechanical, chemical, and/or biological control of non-native species within the study area. The measure would also include the development of an invasive species management plan to address the encroachment of non-native invasive species throughout the life of the project.

3.1.7 INVASIVE FISH SPECIES MANAGEMENT MEASURE G

The vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*) has been introduced into the resaca system either as a means to control algae or as released pets from aquarium hobbyists. While feeding, the catfish plow through the substrates grazing on algal films attached to submerged surfaces such as rocks, wood, aquatic vegetation, and occasionally fish eggs and invertebrates attached to the substrate. The catfish also feed on detritus, sediment, and wood. The rooting behavior of the catfish disturb smaller aquatic insects, fishes, and amphibians, and compete for limited resources displacing native organisms. In addition, the catfish burrows into the banks of the resaca, destabilizing the banks and leading to increased bank erosion.

This measure would include the physical removal or chemical control of the catfish in combination with excluding the immigration of catfish from adjacent resacas. Adult catfish from adjacent resacas would be excluded utilizing 3-4 inch mesh or grating on inlets and outlets to the RBR to decrease the re-establishment of the catfish into the resaca. Continued monitoring and management of the catfish would be required for this restoration measure to be viable. The removal of the catfish would increase survival of target restoration species and ensure that the restored aquatic habitats are not degraded by the burrowing behavior of the catfish.

3.1.8 MEASURES EVALUATED FOR ALTERNATIVES

Potential restoration measures were screened early in the formulation process based on identified risks, anticipated level of ecosystem benefits, and potential impacts on other water uses. With the exception of the resaca surface water elevation management measure, all restoration measures were carried forward in the formulation of alternatives. Because the water level measure may affect flood risk management and water supply uses of the Town Resaca system, this measure was screened from the suite of restoration measures.

To quantify and assess existing and future habitat conditions for the RBR study area, with and without the study alternatives, a RRCM was developed utilizing data from high quality resaca sites within the Resaca de la Palma State Park, the Nature Conservancy's Southmost Preserve, and Camp Lula Sams in and near the City of Brownsville **(Figure 7)**. The RRCM is comprised of three modules with each module dedicated to one of the three resaca vegetation communities: Texas Ebony Resaca woodland, Subtropical Texas Palmetto

Woodland, and Texas Ebony/Snake-eyes Shrubland (not used in this study). Each RRCM module is comprised of three components to quantify habitat quality: vegetation composition, resaca bank structure, and an invasive species metric. The vegetation composition metric is a goodness of fit index based on the species diversity and composition of the site compared to the reference resacas. The resaca bank structure metric is a goodness of fit index based on the stream bank topography and the composition and extent of the terrestrial and emergent vegetation canopy overhanging the shoreline. Finally, the invasive species metric incorporates an index accounting for the percent of the vegetative community dominated by non-native and invasive species.

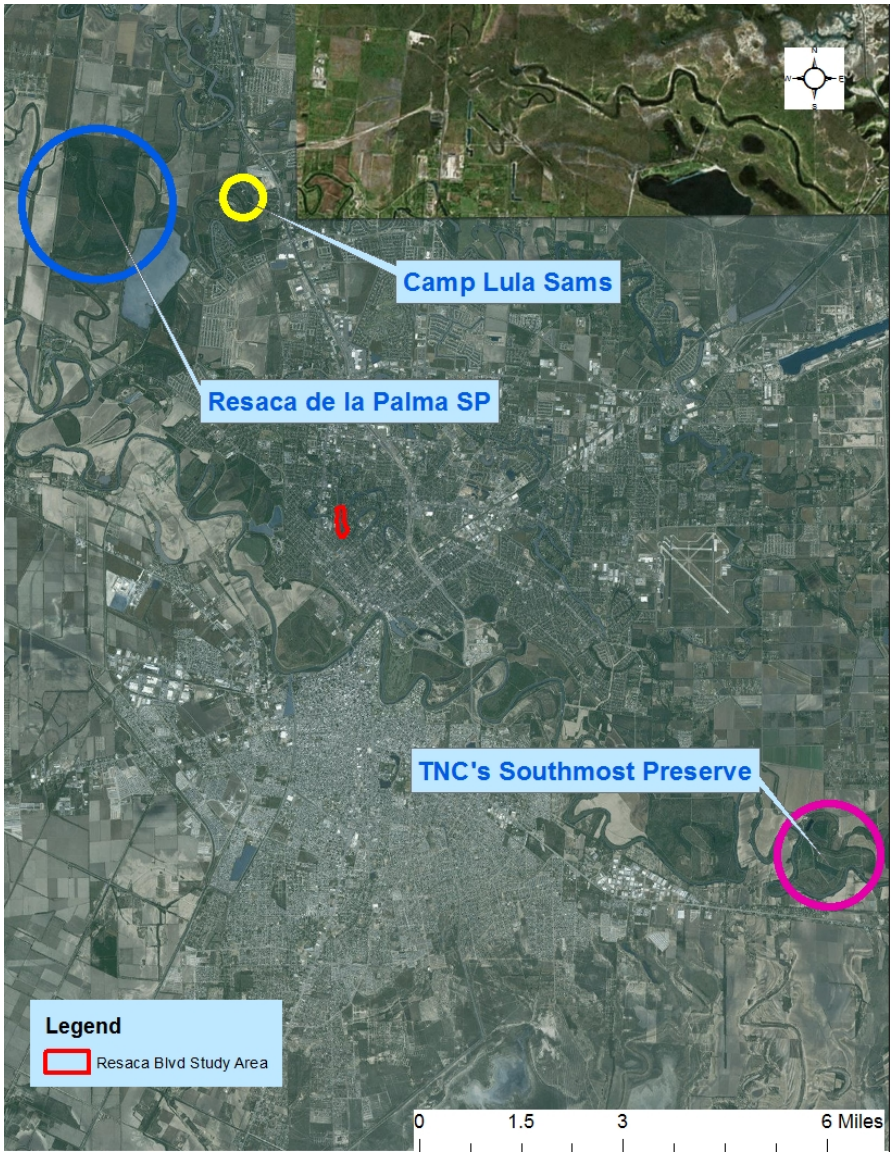

Figure 7. Location of RBR Reference Resacas

Each of these indices were incorporated into an overall Resaca Reference Condition Index (RRCI) with a score of 1.0 indicating a resaca where the habitat quality equals or exceeds the high quality reference resaca habitats. An RRCI of 0.0 describes a completely modified resaca where there is no semblance of the native resaca ecosystem intact.

4.0 COST ANALYSIS

Costs were evaluated for each of the six possible restoration measures carried forward for alternative formulation. Average Annual Cost Units (AACUs) were calculated and compared to AAHUs as described in **Section 6.0** below.

4.1 COST METHODOLOGY SUMMARY

Features were added to each alternative in ascending order which explains why the costs went low to high in that same chronological order. The values in the Engineering Appendix 7 represent the Total Project Cost therefore they will include all costs associated with the project such as real estate acquisition, design, construction, planning, supervision and contingency.

The final alternative selected may or may not be the lowest cost. The final alternative selected will be the one where the ecological benefits still justify the cost associated with obtaining those benefits. When the PDT can no longer justify the incremental cost of an alternative for the incremental benefit obtained, the plan selection process ceases. Therefore cost is only one dynamic of the process and no conclusion can be based on costs alone. In order to make an alternative selection, other factors of the project such as benefits are analyzed.

5.0 ALTERNATIVE FORMULATION

Based on the management measures identified in **Section 3.0**, fully formed plans were assembled by combining compatible management measures into an array of nine potential alternatives (***Table 6***). Riparian and aquatic plantings and invasive plant species management were included in each action alternative.

Table 6. Measures Included in each of the RBR Fully Formed Plans

	Riparian Planting	Bank Slope Restoration	Invasive Fish Species Control	Island Creation	Aquatic/ Emergent Species Plantings	Invasive Plant Species Mgmt
No Action	-	-	-	-	-	-
1	X	-	-	-	X	X
2	X	X	-	-	X	X
3	X	-	X	-	X	X
4	X	X	X	-	X	X
5	X	-	-	X	X	X
6	X	X	-	X	X	X
7	X	-	X	X	X	X
8	X	X	X	X	X	X

5.1 NO ACTION ALTERNATIVE

The no action alternative would not include any of the ecosystem restoration measures identified for the RBR study. The existing habitat would continue to be maintained as a park-like landscape dominated by non-native and invasive plant species. The RBR would continue to provide marginal habitat for a small number of generalist fish and wildlife species that are tolerant of low quality habitats. No additional acreage would be added to the spatial extent of the critically imperiled resaca vegetation communities and no additional habitat would be provided for the highly specialized wildlife species that utilize resaca habitats.

5.2 ALTERNATIVE 1 –RIPARIAN PLANTINGS AND AQUATIC PLANTINGS (MEASURES A & C)

Alternative 1 includes the removal of Brazilian peppertree, giant cane, athel, Chinese tallow, KR bluestem, Bermuda grass, and other non-native plant species with the exception of the Washington fan palms. Although the fan palms are found throughout the study area, they are not considered an invasive species. In addition to the Texas sabal palms, the fan palms provide habitat for the red-crowned parrot, a federal candidate species, and the southern yellow bat, a state listed threatened species. Therefore, the fan palms would not be included in the list of non-native species to be removed from the site.

Alternative 1 would also include the planting of 0.75 acres of native aquatic and emergent plant species on the 15-foot wide shelf along the perimeter of the resaca left behind from the City's dredging operations (**Figure 8**). In addition to herbaceous aquatic and emergent plant species, the aquatic plantings would include shrub species such as black mimosa and retama. The riparian area would be revegetated with 4.6 acres of native plant species representative of the Subtropical Texas Palmetto Woodland vegetation association (**Appendix 1**).

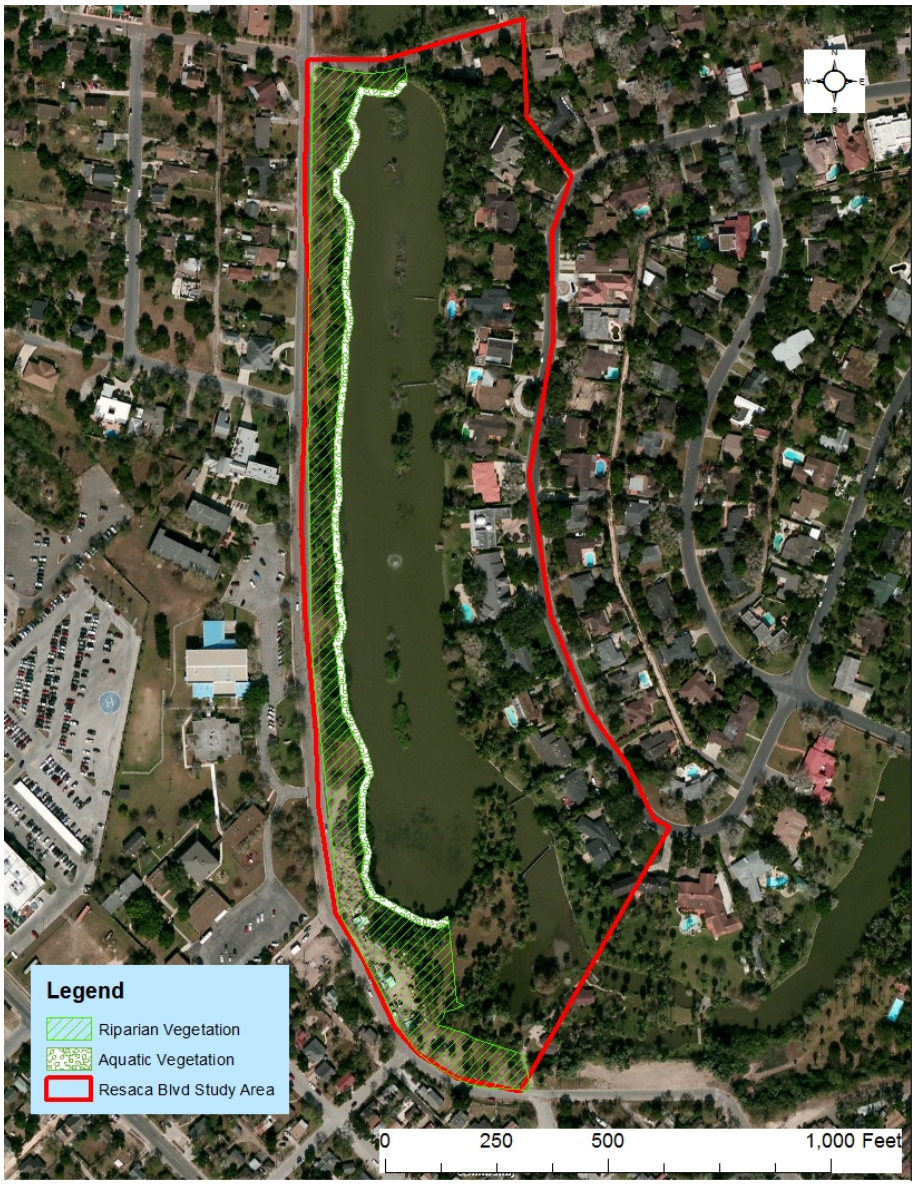

Figure 8. Spatial Extent of Alternative 1 Restoration Measures

5.3 ALTERNATIVE 2 – AQUATIC AND RIPARIAN PLANTINGS/BANK SLOPE RESTORATION

Alternative 2 includes the aquatic and riparian plantings as presented in Alternative 1 (**Section** 5.2) and the shaping of the 15-foot wide shelf along the perimeter of the resaca. The shoreline of the RBR is essentially a vertical drop cutbank from the riparian edge to the resaca bed. The resaca bank slope restoration measure would restore the resaca/riparian shoreline to a more gradual gradient of 1:10 or less to mimic the slopes observed at the reference resaca sites. The sculpted bank would then be revegetated with native aquatic and emergent plant species as described above for Alternative 1. The more gradual shoreline gradient, in combination with the planting of native aquatic, emergent, and riparian vegetation significantly increases

the habitat quality for native amphibians, including state threatened amphibians such as the black-spotted newt, Mexican treefrog, South Texas siren, and white-lipped frog while discouraging colonization of vermiculated sailfin catfish, which prefer steeper slopes.

5.4 ALTERNATIVE 3 - AQUATIC AND RIPARIAN PLANTINGS/SAILFIN CATFISH CONTROL

Alternative 3 includes the aquatic and riparian plantings as presented in Alternative 1 (**Section** 5.2) and the control of the non-native invasive vermiculated sailfin catfish. The catfish control measure includes the installation of excluder devices such as 3-4" grating on the inlet and weir outfall structures in combination with the biannual (every two years) removal of sailfin catfish. The physical removal of sailfin catfish and other non-native species within RBR would utilize a combination of electroshocking and seining techniques to minimize adverse impacts to the native fish community. The removal of the catfish would decrease the herbivory impacts on the aquatic vegetation and the destabilization of the resaca banks resulting from the sailfin catfish's burrowing habits resulting in increased erosion, sedimentation, and turbidity. In addition, the native fish community would benefit with the reduced competition for food and habitat and a decreased predation on fish eggs.

5.6 ALTERNATIVE 4 - AQUATIC AND RIPARIAN PLANTINGS/BANK SLOPE RESTORATION/SAILFIN CATFISH CONTROL

Alternative 4 combines the measures and realizes the benefits of Alternatives 2 and 3 (**Sections 5.30 and 5.4**); the alternative includes the planting of native aquatic and riparian plant species, the sculpting of the 15-foot shelf along the perimeter of the resaca, and the control of sailfin catfish in the RBR. The combination of the bank slope restoration and catfish control provides additional habitat benefits as the bank slope restoration would remove the vertical face of the resaca edge. The more relaxed gradient does not provide the habitat structure for the sailfin catfish to burrow; therefore the available reproductive habitat for the catfish would be decreased (Jan Hoover, USACE-ERDC, 2016). With a reduction in reproductive habitat and resulting decrease in population size for the catfish, the survival of aquatic vegetation and native fish species would increase.

5.7 ALTERNATIVE 5 - AQUATIC AND RIPARIAN PLANTINGS/SMALL ISLAND RESTORATION

Alternative 5 includes the aquatic and riparian plantings as presented in Alternative 1 (**Section 5.20**) and the restoration of an island in the northern portion of the RBR. The RBR contains several remnants of islands extending through the middle of the resaca that have eroded over time. Over time, these islands have been overrun with non-native invasive plant species, further degrading the island habitat. The island restoration measure includes the removal of the vegetation on the islands and the expansion and reconnection of the northernmost islands of the RBR (**Figure 9**) to create a one acre island. The new island would be vegetated with native plant species consistent with the globally imperiled Texas Ebony Resaca Forest vegetation association (**Appendix 2**) and aquatic and emergent vegetation adjacent to the islands. With the restoration of the riparian habitats addressed in Alternative 1, the construction of the island adds an additional 0.27 acres of aquatic and emergent habitat and 0.56 acres of Texas Ebony Resaca Forest on the island (**Table 8. Habitat Acreages for Riparian and Small Island Restoration**).

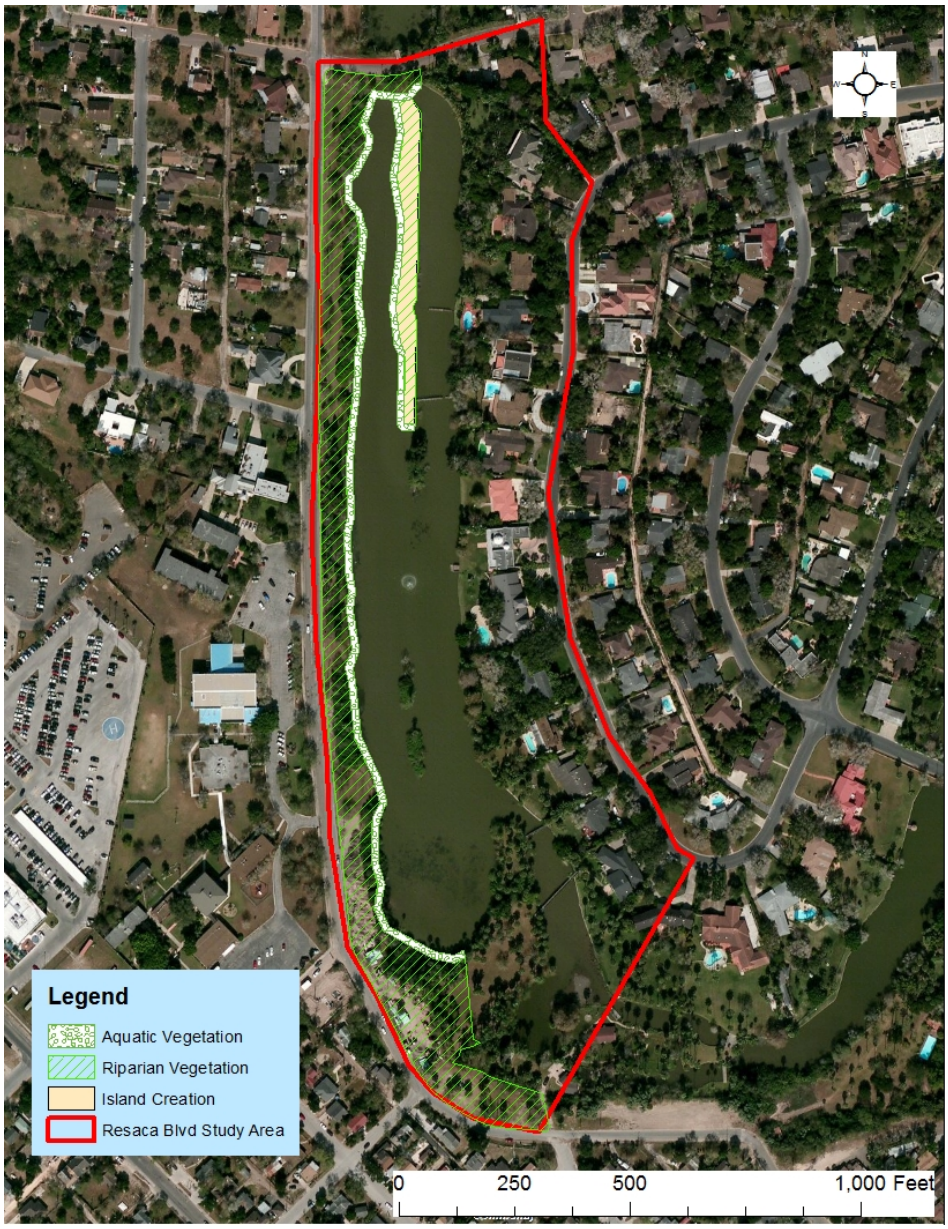

Figure 9. Spatial Extent of Alternative 5 Restoration Measures

Table 8. Habitat Acreages for Riparian and Small Island Restoration

Habitat	Acres of Habitat		Total
	Riparian (Alts 1,2,3, & 4)	Island 1 (Alts 5,6,7, & 8)	
Subtropical Texas Palmetto Woodland	4.62	0.00	4.62

Texas Ebony Resaca Forest	0.00	0.56	0.56
Aquatic/Emergent Vegetation	0.74	0.27	1.01
Total	5.36	0.73	6.19

5.8 ALTERNATIVE 6 - AQUATIC AND RIPARIAN PLANTINGS/SMALL ISLAND RESTORATION/BANK SLOPE RESTORATION

Alternative 6 combines the measures included in Alternative 2 (**Section** 5.3) and Alternative 5 (**Section** 5.7). This alternative includes the aquatic and riparian plantings, island restoration, and the sculpting of the banks along the resaca and island shoreline. Alternative 6 increases the habitat value for aquatic and amphibian species by creating additional edge habitat around the shoreline and islands. The bank slope restoration along the islands edges would be consistent with the 15-foot bench along the outside perimeter of the resacas described in Alternative 2.

5.9 ALTERNATIVE 7 - AQUATIC AND RIPARIAN PLANTINGS/SMALL ISLAND RESTORATION/SAILFIN CATFISH CONTROL

Alternative 7 combines the measures included in Alternative 3 (**Section 5.4** and Alternative 5 (**Section** 5.7). This alternative includes the aquatic and riparian plantings, island restoration/creation, and the control of sailfin catfish within the RBR. The planting of the aquatic and emergent vegetation would occur on the existing bench along the outside of the resaca left after dredging; however, the island banks would be constructed to mimic the low gradient structure of the reference resacas. Therefore the island banks would still provide habitat for aquatic species and valuable transition area for amphibian species as they move between terrestrial and aquatic habitats.

5.10 ALTERNATIVE 8 - AQUATIC AND RIPARIAN PLANTINGS/SMALL ISLAND RESTORATION/BANK SLOPE RESTORATION/SAILFIN CATFISH CONTROL

Alternative 8 combines all four measures considered for the restoration of the RBR: aquatic and riparian plantings, island restoration, sculpting of the resaca and island banks, and the control of sailfin catfish. This alternative produces the greatest benefits (29.1 AAHUs) when compared to similar alternatives, 1-7.

5.11 ALTERNATIVE 9 - AQUATIC AND RIPARIAN PLANTINGS/MEDIUM ISLAND RESTORATION

Alternative 9 entails the same measures as Alternative 5; however, the size of the island increases from 0.56 acres to 0.91 acres. Alternative 9 adds 0.35 acres of Texas Ebony Resaca Forest and 0.42 acres of aquatic and emergent vegetation surrounding the island over Alternative 5.

Table 9. Habitat Acreages for Riparian and Medium Island Restoration

Habitat	Acres of Habitat		Total
	Riparian	Island 2	

	(Alts 1,2,3, & 4)	(Alts 9,10,11,12)	
Subtropical Texas Palmetto Woodland	4.62	0.00	4.62
Texas Ebony Resaca Forest	0.00	0.91	0.91
Aquatic/Emergent Vegetation	0.74	0.69	1.43
Total	5.36	1.50	6.96

5.12 ALTERNATIVE 10 – 12 AQUATIC AND RIPARIAN PLANTINGS/MEDIUM ISLAND ALTERNATIVES

Alternatives 10 through 12 mirror the measures identified in Alternatives 6 through 8; however, as with Alternative 9 described above, Alternatives 10 through 12 include the construction of the medium sized island.

5.13 ALTERNATIVE 13 - AQUATIC AND RIPARIAN PLANTINGS/LARGE ISLAND RESTORATION

Alternative 13 entails the same measures as Alternatives 5 and 9; however, the size of the island increases from 0.56 and 0.91 acres respectively to 1.43 acres. Alternative 13 adds 0.52 acres of Texas Ebony Resaca Forest and 0.36 acres of aquatic and emergent vegetation surrounding the island over Alternative 9.

Table 7. Habitat Acreages for Riparian and Large Island Restoration

Habitat	Acres of Habitat		Total
	Riparian (Alts 1,2,3, & 4)	Island 3 (Alts 13,14,15,16)	
Subtropical Texas Palmetto Woodland	4.62	0.00	4.62
Texas Ebony Resaca Forest	0.00	1.43	1.43
Aquatic/Emergent Vegetation	0.74	1.05	1.79
Total	5.36	2.48	7.84

5.14 ALTERNATIVE 14 – 16 AQUATIC AND RIPARIAN PLANTINGS/LARGE ISLAND

Alternatives 14 through 16 mirror the measures identified in Alternatives 6 through 8; however, as with Alternative 13 described above, Alternatives 14 through 16 include the construction of the large sized island.

6.0 EVALUATION AND COMPARISON OF ALTERNATIVES

The evaluation of alternatives for ecosystem restoration studies is conducted through a Cost Effective/Incremental Cost Analysis (CE/ICA). This analysis requires two criteria for alternative comparisons: an ecological benefit and a cost criterion. The Resaca Reference Condition Model (RRCM) was used to determine potential benefits gained with regard to the ecosystem restoration objective. The RRCM utilizes a reference condition goodness of fit metric (criteria) to assess the aquatic and riparian structure and function from pre-restoration conditions through completed restoration which can be quantified by comparing habitat components of the temporal RBR habitats to high-quality resacas (reference resacas) in the area. Therefore,

the RRCM index outputs quantify how well restoration measures, or combinations of measures, restore the target resaca to reference conditions.

The RRCM index is multiplied by the number of acres over which the measure(s) will be applied to derive the associated Habitat Units (HUs). The HUs are annualized over a 50 year period to obtain Average Annual HUs (AAHUs). AAHUs for the future without-project condition were subtracted from the future with project condition to determine the AAHU benefit for each fully formed plan; this represents the level of ecological lift of a plan over the future without-project condition. First costs were calculated for each alternative and annualized over 50 years at 3.25 percent to get average annual costs (AAC).

6.1 COST EFFECTIVE AND INCREMENTAL COSTS ANALYSIS

Incremental Cost Analysis (ICA) was performed using the USACE Institute for Water Resources

(IWR) Planning Suite, version 2.0.6.1. This version of the Planning Suite has been certified for use as a planning model in USACE studies. IWR Planning Suite evaluated the cost effectiveness (CE) of each alternative and performed an incremental cost analysis (ICA) on the remaining cost effective alternatives. Each unique measure combination is referred to as a plan. All possible combinations of measures were formulated and then carried forward as alternative plans. To identify the cost-effective and non-cost-effective plans, all plans were sorted by Total AAHU production. Cost-effective plans are defined as those where greater benefit can be produced at a cost lesser or equal to that of previous plans. The ICA procedure identified five cost-effective plans from the 16 plan alternatives.

The cost-effective plans were then evaluated based on incremental cost per unit output (i.e., incremental AACU divided by incremental AAHU) to identify the best-buy plans. Best-buy plans are those that have the lowest incremental cost per output at a given level of cost. Because the No Action Plan does not have an associated cost, it is identified as the first best-buy plan. Each successive plan is then compared to the No Action Plan until the next best-buy plan producing greater output per cost than previous plans is selected. Plans producing less output than the best-buy plan are removed from the analysis, and the last identified best-buy plan becomes the baseline for comparison of successive plans. ICA identified four best-buy plans, in addition to the No Action Plan, which can be assessed using tabular and graphical summaries. Utilizing the list of final management measures, a suite of fully formed plans was developed for the RBR. Comparison and ranking ultimately provides an array of alternatives that, for their cost, provide the best return in ecological benefit.

All fully formed plans and associated AAHU and AAC were input into the IWR Planning Suite. The purpose of this CE/ICA is to find a cost-effective final array of the incrementally justified plans. This final array would indicate which alternatives provide the best incremental annual benefit for the incremental annual cost. The final array of plans is referred to as the best buy array.

Table 8 displays the fully formed plans and associated AAHU and AAC. **Figure 10** graphically represents the incremental cost analysis of the final array of alternatives and **Table 9** presents the costs and benefits characteristics for the final array. **Figure 11** displays the final array of

alternatives resulting from CE/ICA analysis. **Table 10** lists the cost and benefit parameters for the final alternatives array.

For CAP studies a cost certification is not required; however, the study must not exceed the Federal project limit of 10 million dollars.

Table 8: Average Annual Habitat Units (AAHU) and Average Annual Cost (AAC) for Alternative Comparison during the Resaca Boulevard Resaca Ecosystem Restoration Study

Alternative	AAHU (Lift)	AAC ($1,000)
No Action	0.00	0.00
1 – P[1]	2.30	44.6
2 - P+B	5.43	45.3
3 - P+C	2.51	75.3
4 - P+B+C	5.72	76.0
5 - P+I1	2.51	76.1
6 - P+I1+B	5.84	76.4
7 - P+I1+C	2.66	107.3
8 - P+I1+B+C	6.15	107.7
9 - P+I2	2.68	107.4
10 - P+I2+B	6.22	107.7
11 - P+I2+C	2.83	138.6
12 - P+I2+B+C	6.55	139.0
13 - P+I3	2.87	151.3
14 - P+I3+B	6.66	151.6
15 - P+I3+C	3.01	182.5
16 - P+I3+B+C	7.01	182.9

[1]P=Aquatic and emergent plantings, riparian plantings, invasive plant species management, and red-crowned parrot nests; B=bank slope restoration; C=Invasive fish species management; I=Island restoration

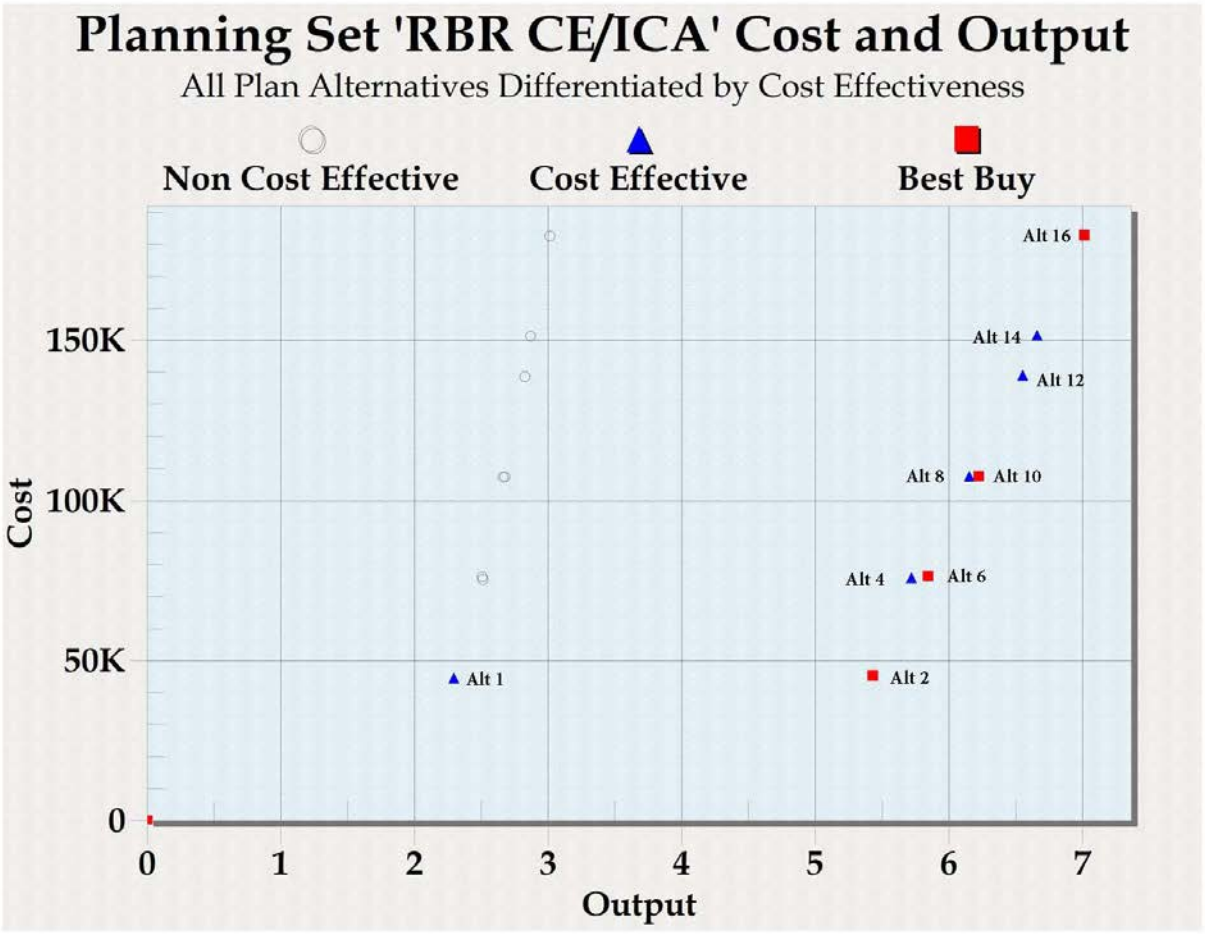

Figure 10. Graphic representation of the cost effectiveness of each alternative.

Table 9. Cost Effective and Best Buy Plans for the RBR

Alternative	Cost Effective	Best Buy
No Action	X	X
1 – P[1]	X	
2 - P+B	X	X
3 – P+C		
4 - P+B+C	X	X
5 – P+I1		
6 - P+I1+B	X	X
7 – P+I1+C		
8 - P+I1+B+C	X	
9 – P+I2		
10 - P+I2+B	X	X
11 – P+I2+C		
12 - P+I2+B+C	X	
13 – P+I3		
14 - P+I3+B	X	
15 – P+I3+C		
16 - P+I3+B+C	X	X

[1]P=Aquatic and emergent plantings, riparian plantings, invasive plant species management, and red-crowned parrot nests; B=bank slope restoration; C=Invasive fish species management; I=Island restoration

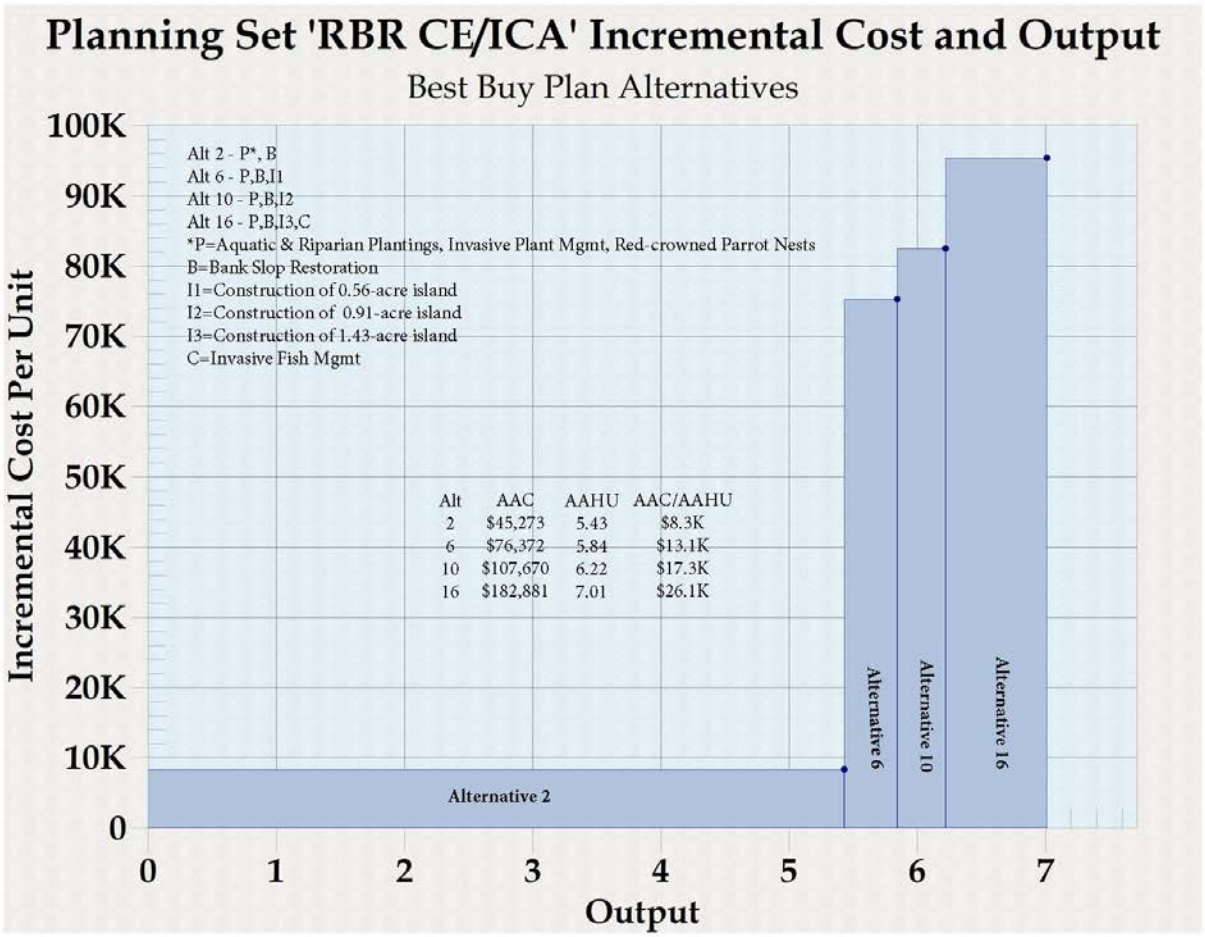

Figure 11. Final Array of Alternatives resulting from the CE/ICA for RBR

Table 10: Cost and Benefit Parameters for the Final Alternative Array of Best Buy Alternatives

Cost and Benefit Category	Alternative			
	2	6	10	16
First Cost	$1,107,206	$1,949,206	$2,673,144	$3,893,834
Average Annual Cost	$45,273	$76,372	$107,429	$182,881
Total AAHU (with project)	5.43	5.84	6.22	7.01
Existing AAHU	0.03	0.03	0.03	0.03
With Project Acres	16.31	16.31	16.31	16.31
With Project AAHU/Acre	0.33	0.36	0.38	0.43
Existing AAHU/Acre	0.00	0.00	0.00	0.00
Incremental Benefit (AAHU)	5.43	0.41	0.38	0.79
AAC/AAHU ($1,000)	$8.3	$13.1	$17.3	$26.1
Incremental Annual Cost ($1,000)	$45.3	$31.1	$31.3	$75.2
Incremental Annual Cost/Incremental AAHU ($1,000)	$8.4	$75.2	$82.5	$95.4
Total Cost/Acre ($1,000)	$67.9	$119.5	$163.9	$238.7
AAC/Acre ($1,000)	$2.8	$4.7	$6.6	$11.2

The final array of alternatives represents an incremental cost ranking of those plans that best meet some level of restoration to the RBR area and improves the study area's ability to provide habitat to a diversity of fish and wildlife species. Some plans come closer to fully meeting the restoration objectives than others, but all provide some level of restoration that is cost effective.

6.2 ALTERNATIVE COMPARISON

Each plan within the final array represents an incremental increase in the level of restoration which can be viewed from two perspectives – quality of restoration achieved and quantity of acres restored (riparian versus riparian plus islands). Because all of the action plans in the final array of alternatives represent some level of restoration and provide habitat for a diverse community of fish and wildlife species, additional criteria need to be considered through a "is it worth it" analysis to help differentiate each alternative from the others in selecting the recommended NER plan.

GETTING FROM THE NO ACTION TO ALTERNATIVE 2

The no action plan is included as a point of comparison to other alternatives. With the no action plan, the RBR would continue to exist in its degraded state with the existing invasive species and fragmented habitats providing extremely limited fish and wildlife benefits. These conditions may worsen over time as the little remaining native vegetation (mature palms and limited native shrubs) senesce with little opportunity for regrowth due to the dominance of non-native invasive species. Under the no action plan, there would be no increase in habitat benefits for fish and wildlife species; therefore, the PDT determined that the no action plan is not an acceptable alternative.

Alternative 2 provides 5.43 AAHUs of benefit for an AAC of $8,300 per HU. Alternative 2 restores 4.62 acres of globally imperiled Subtropical Texas Palmetto Woodland community habitat, 0.74 acres of aquatic emergent habitat, and provides additional benefits to 10.95 acres of open water resaca. The sculpting of the banks provides optimal habitat connection for rare amphibian species as they transition from their aquatic to terrestrial life stage. Bank sculpting will also discouraging colonization of vermiculated sailfin catfish, which prefer steeper slopes. The restoration of dense vegetation also provides habitat for a diverse invertebrate community that serves a vital role in the food web for avian and amphibian species in the study area. In addition, several rare invertebrate species such as the royal moth (*Sphingicampa blanchardi*) and the Tamaulipan agapema (*Agapema gabina*) require Texas Ebony and Brasil, respectively, as host plants during their caterpillar stage. These two species are important components of the Texas Ebony Resaca Forest and Subtropical Texas Palmetto Woodland. This alternative is worth the Federal investment.

IS IT WORTH IT? - ALTERNATIVE 6

In addition to the restoration of 4.62 acres of Subtropical Texas Palmetto Woodland, a vegetation association critically imperiled with elimination (G2S2), and 0.74 acres of native aquatic and emergent vegetation provided with Alternative 2, Alternative 6 restores an additional 0.56 acres of Texas Ebony Resaca Forest, a vegetation association critically imperiled with extinction (G1S1). The Texas Ebony Resaca Forest would be established on a 0.56-acre island constructed by expanding the existing small islands at the northern end of the resaca. In addition, 0.69 acres of aquatic and emergent vegetation around the island would be established.

Alternative 6 provides a 7-percent increase in benefits for an additional 0.41 AAHUs . The restoration of the globally imperiled Texas Ebony Resaca Forest on the restored islands and the creation of additional aquatic and emergent habitats would result in an incremental AAC of $75,200 per HU. This alternative would result in a total of 5.84 AAHUs. Because of the significant increase in incremental cost for a marginal increase in benefits, Alternative 6 is not worth the federal and local investment. The significantly higher incremental costs compared to the marginal increases in benefits further excludes the remainder of the Best Buy Plans in the final suite of RBR alternatives.

6.3 TENTATIVELY SELECTED PLAN

Alternative 2 is recommended as the NER Plan and the Tentatively Selected Plan (TSP). This alternative maximizes the area of restoration and restores 4.62 acres of Subtropical Palmetto Woodland, a G2G2 vegetation association, that provide essential habitat for rare wildlife species. This alternative provides the most practicable alternative to address the ecosystem restoration objectives for the RBR.

6.4 RISK AND UNCERTAINTY

Risk-based analysis shall be used to compare plans in terms of the likelihood and variability of their physical performance, economic success and residual risks. Key uncertainties were identified early in the study phase and monitored throughout the plan formulation process.

These uncertainties are discussed below with a description of the associated risk and steps taken throughout the formulation process to reduce that risk.

The following risks have been identified for the RBR study.

1. Real Estate: The NFS will condemn land it holds in fee. This will enable the NFS to attain fee simple tile for the TSP to be built on the west bank.
2. Environmental: There is uncertainty involved in the development of the RRCM and how well it will function for CE/ICA benefits. The RRCM is not yet approved although for a CAP study approval is not required. Monitoring will be required to determine how well the selected plan is producing projected benefits. Uncertainty on the results are inherent for any restoration project.

6.5 DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

Alternative 2 is recommended as the NER Plan and the Tentatively Selected Plan (TSP). This alternative provides the most restoration benefit practicable to the degraded structure and function that has resulted from the altered hydrology and proliferation of invasive species within the RBR ecosystem. The TSP restores 4.62 acres of South Texas Palmetto Woodland vegetation community associated with the RBR that provides essential habitat for rare wildlife species. This alternative includes aquatic and emergent plantings, riparian plantings, invasive plant species management, and bank slope restoration. In total, 16.3 acres of resaca habitats including open water, shoreline, and riparian habitats would be restored by the TSP. Furthermore, the TSP capitalizes on all the opportunities previously identified. The TSP provides additional functional habitat in support of conservation efforts for the black-spotted newt, South Texas siren, and red-crowned parrot, and therefore, the TSP establishes a future opportunity for another federal or state agency or NGO to reintroduce or enhance these protected species populations in the RBR.

6.6 PROJECT-SPECIFIC CONSIDERATIONS

Construction of the Recommended Plan would include grading along the western edge of the Resaca.. Conducting earth moving operations adjacent to and in the resaca will require careful planning and execution in order to minimize negative impacts during construction. Best Management Practices (BMPs) will be specified to reduce unwanted sediment transport into the resaca as well as to help contain any turbidity and prevent it from spreading downstream. Where fill material will be placed underwater, the design will specify using a granular fill material and working outward from the bank to build a stable platform as construction progresses. In order to support the required vegetation, the granular fill will be capped with a fine grained material suitable for the specified plantings.

6.7 PED ACTIVITIES

Before any detailed design work may begin, additional survey data will have to be obtained to establish the existing topography and bathymetry. The Design Documentation Report could be produced concurrently with the survey work in order to accurately capture the design intent of the PDT. Once the survey is available, it will be used as the base for designing

the proposed grades of the bank sculpting measures. With the final grades established, a planting plan can be designed and the construction drawings produced. Construction quantities will then be calculated and the construction specifications prepared. Upon completion and certification of all necessary reviews, the approved plans and specifications will be used to solicit bids and award the construction contract.

6.8 REAL ESTATE REQUIREMENTS

Non-Federal Sponsor

The District Engineer, Galveston District, U.S. Army Corps of Engineers (USACE), is responsible for the overall management of the study and report preparation. The City of Brownsville, Texas is the non-federal sponsor to execute the model Project Partnership Agreement (PPA) and will responsible for provision of all required Lands, Easements, Rights of Way, Relocations, and Disposals (LERRDs) and for Operation and Maintenance (O&M) of the completed project.

Real Estate Requirements

West Bank of Resaca

The NFS is required to have fee title for ecosystem restoration projects (Engineering Regulation (ER) 405-1-12; 12-9). Fee title or Fee Simple Estate is defined by The Dictionary of Real Estate Appraisal, fifth edition, as:

> *"Absolute ownership unencumbered by any other interest or estate, subject only to the limitations imposed by the governmental powers of taxation, eminent domain, police power, and escheat."*

The City of Brownsville owns 10.77 acres on the west bank of the Resaca that was conveyed by the following two deeds and are illustrated on the survey which can be found as exhibit "B". The property was not purchased with Federal Funds.

A. Houston and Brownsville Development Company conveyed 76.4 acres to City of Brownsville dated 25 of November 1933 (Vol 253 Page 93, exhibit "B") with the following restriction:

   "It being distinctly understood and agreed that all of above property is conveyed and is by the city accepted for use as public parks, and playground, for roads and streets, for drainage and other related public purposes and shall always be used and maintained for such purposes."

B. Deed from Sisters of the Incarnate Word Convent of Brownsville To City of Brownsville for 7.58 acres of land dated 12 January 1934 (Vol 253 Page 103, exhibit "B") with the following restriction:

   "Purpose of roads, streets, parks and drainage; and it is further stipulated that no public playground or public recreation places whatsoever are to be maintained or permitted on the aforesaid tract of 7.58 acres"

The sponsor has agreed to condemn its property to clear title.

The interest that the city holds is less than fee. There one possible options available:

1. The City of Brownsville acting as the sponsor can condemn their property to clear title.

In a meeting on 26 August 2016 among City of Brownsville Assistant City Manager, City Attorney, BPUB and Galveston District, the City of Brownsville is committed to providing fee simple title for land on which the selected project plan will be built. The City attorney (Paul Radcliff) expressed to the City personnel at the meeting that condemnation is required to procure a fee simple status for the project.

Required Documents from the Sponsor

Currently, Real Estate is waiting to hear back from City of Brownsville regarding the Real Estate Form "Assessment of Non-Federal Sponsor Real Estate Acquisition Capability" to finish the Real Estate Plan.

7.0 ENVIRONMENTAL CONSEQUENCES

This section of the DPR/EA describes the potential effects of the No Action and alternative plans on the resources within the study area. Because the RBR the study area land use consists of residential and park-type landscapes, the environmental conditions of the resacas in the future without project would continue to reflect the existing conditions of the RBR. The resaca is in the process of being dredged to restore the hydrologic capacity of the resaca, and the assumption is that the resaca would be maintained by BPUB, under direction by the City of Brownsville per the PPA, for the life of the project.

7.1 CLIMATE

No Action

Because of the limited scale of the RBR study area, none of the alternatives, including the No Action Alternative, would affect climatic conditions. Due to the high uncertainty regarding the impacts of climate change on precipitation patterns in Texas (Schmandt et al., 2011), the impacts of climate change on the success of restoration efforts in unknown.

TSP and other Action Alternatives

The proposed project would utilize site-specific native plant species that have evolved to the resaca ecosystem and cyclical drought patterns. Construction measures would utilize management and irrigation strategies to ensure the successful establishment of vegetation in the project area. The composition of the native vegetative communities would be better adapted to weather extremes anticipated as the result of climate change. The effects of climate change on resaca flows are similarly uncertain as prolonged drought periods may adversely impact aquatic resources in the RBR and the region.

7.2 GEOLOGY AND TOPOGRAPHY

No Action

Since the No Action Alternative would leave the resaca in its existing condition, no adverse impacts to the RBR geology would occur.

TSP and other Action Alternatives

Although most of the action alternatives require some combination of bank regrading or grading of the riparian habitats for plantings, the depth of excavation for these measures would not impact any the geology of the project area.

7.3 SOILS

Because the study area is located within the city limits of Brownsville, Section 1541(b) of the Farmland Protection Policy Act (FPPA) of 1980 and 1995, 7 U.S.C. 4202(b), does not apply to prime farmland soil types within the study area. Furthermore, the soil structure within the RBR study area has been previously disturbed and is now more consistent with urban soil complexes.

No Action

Under the No Action Alternative, soils would not be directly impacted by ground disturbance; however, sediment transport would remain unbalanced requiring continued maintenance of the resaca due to erosion and sedimentation.

TSP and other Action Alternatives

Under implementation of any of the action alternatives, several activities have the potential to expose soils. For each alternative, the upper soil profile would be excavated to remove the non-native seedbank, herbicide would be applied to prevent non-native species from resprouting, the exposed subsoil would then be ripped to a depth of 12-inches, 8 inches of organic topsoil would be distributed throughout, and the affected area revegetated with site-specific native vegetation to stabilize soils and restore the ecological functions. During project implementation, appropriate BMPs would be applied to reduce and control runoff and erosion until the vegetation becomes sufficiently established.

Implementation of any of the action alternatives would result in temporary impacts to soils during construction since the removal of vegetation would expose the soils to increased wind and water erosion. Additionally, soils would improve in richness over time due to the large contribution of organic matter from the establishment of native trees and shrubs.

7.4 LAND USE

No Action

The RBR study area is located within a residential area. Under the No Action Alternative this wouldn't change.

TSP and other Action Alternatives

Ecosystem restoration of the RBR is consistent with the existing land uses and enhances the general quality of life for local residents. Because existing disposal sites would be used, there

would be an inconsequential impacts to the disposal site resulting from implementation of the proposed alternatives.

7.5 AQUATIC RESOURCES

No Action

Under the no action alternative the RBR would continue to be maintained by the City for various water resource needs. Urbanization would continue to have detrimental effects on aquatic resources and proliferation of invasive aquatic vegetation and fish would also continue.

TSP and other Action Alternatives

Each proposed alternative for the RBR study would restore a level of ecosystem function to the RBR. The resaca resources for the RBR encompass the ecological elements that comprise a healthy, functional, aquatic ecosystem, including the aquatic and riparian environments in the RBR study area. Because the RBR study is an ecosystem restoration study, impacts to the RBR resources are designed to be beneficial. The potential impacts to aquatic resources resulting from the implementation of each alternative are assessed below.

7.6 SURFACE WATER

No Action

Under the no action alternative surface water quality would continue to be affected by urbanization surrounding RBR. As noted in **Section 2.1.1**, the life cycle of natural resacas were historically driven by the seasonal flooding of the Rio Grande. Although the primary water source of the RBR is still the Rio Grande, the Town Resaca system is connected by pipelines maintained by the BPUB instead of flooding of the Rio Grande floodplains. Stormwater runoff from the surrounding neighborhoods also contributes to the surface waters of the RBR.

TSP and other Action Alternatives

The proposed alternatives would all result in minor and temporary impacts to surface waters during construction of any of the proposed restoration measures. Restoration of native vegetation and bank slope restoration would result in reduced erosion and turbidity to the RBR, providing beneficial impacts to surface waters. Restoration of Texas Ebony and Subtropical Texas Palmetto Woodland communities would provide shading for the RBR resulting in a higher level of DO in surface waters.

7.7 WETLANDS

The RBR is a jurisdictional water of the U.S. and subject to protection under Sections 401 and 404 of the CWA. Although a USACE permit would not be issued for the proposed ecosystem restoration (USACE does not permit its own actions), probable construction activities associated with implementation of any of the proposed action alternatives have been reviewed by USACE (Galveston Regulatory Branch), and would be covered by Nationwide Permit (NWP) 27, Stream and Wetland Restoration Activities.

In Texas, all activities carried out in compliance with the terms and conditions of NWP 27 are also considered to be in compliance with Section 401 of the CWA and do not require separate permitting for Water Quality Certification from TCEQ. A more detailed description of how the proposed alternatives meet the criteria set forth under NWP 27 is provided in the Environmental Compliance, Section 404 of the Clean Water Act section of this integrated EA.

No Action

Under the No Action Alternative, there would be no direct impacts to waters of the U.S. other than those that routinely occur from any on-going maintenance activities.

Action Alternatives

For Alternatives 5-8, 9-12, and 13-16, there would be loss of 0.27, 0.91, and 1.43 acres of open water habitat as the construction of islands would replace this habitat with Texas Ebony Resaca Forest habitats. The quality of the remaining resaca would increase significantly with the restoration of native aquatic and emergent plant species and the restoration of the historical bank slope structure.

TSP Alternative

Under the TSP, temporary impacts would occur during the sculpting of the resaca banks; however, the ecological benefits of the restoration of native aquatic and emergent plant species and the bank slope outweigh the temporary disturbance impacts of fringe wetland areas.

7.8 WATER QUALITY

TCEQ has not assessed the resacas as part of the Section 303(d) list for aquatic uses; however, the agency is planning on assessing the resacas in the LRGV to include them in future 303(d) reports. Stormwater, which is important to surface water quality, has the potential to introduce sediments and other contaminants (petroleum products, landscaping chemicals, etc.) into the resacas. Generally, higher densities of development (i.e. urban areas such as the RBR study area) require greater degrees of storm water management due to higher proportions if impervious surfaces and rapid runoff that occurs following a storm.

No Action Alternative

Under the No Action Alternative, there would be no direct impacts to surface waters, except those resulting from routine maintenance required to repair erosion and/or remove sediment and the existing disturbance resulting from urbanization would remain.

TSP and other Action Alternatives

Implementation of all of the action alternatives would directly impact RBR water quality through construction activities associated with excavation and recontouring the banks, invasive vegetation removal, islands, and planting areas. During the construction period, these impacts are expected to temporarily degrade water quality as a result of ground disturbing activities. Erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt revegetation of disturbed areas would

be required during construction to reduce and control siltation or erosion impacts. In addition, every construction project poses a potential contamination risk from petroleum or chemical spills. The contractor would be required to prepare and follow a site-specific Spill Prevention Plan during construction, which would include the use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination. Thus, impacts to surface waters during construction are considered to be temporary and insignificant.

Impacts to water quality following implementation of any of the action alternatives is expected to be increasingly beneficial moving from the smaller to the larger proposed islands. This is because each subsequently larger island adds addition areas of restoration that will benefit surface water impacts.

As previously discussed, Section 401 Water Quality Certification would not be required as activities conducted under a NWP 27 would comply with Section 401 of the CWA.

7.9 GROUNDWATER

No Action

No impacts to groundwater is anticipated under the no action alternative.

TSP and other Action Alternatives

The proposed RBR ecosystem restoration project would not impact groundwater resources within localized aquifers.

7.10 Aquatic Habitat

No Action Alternative

Under the No Action Alternative, the aquatic habitat of the RBR would continue to be dominated by non-native, invasive aquatic plant species, which would continue to serve as a seed source for dispersal downstream. Existing erosion and bank instability would limit the development of high quality, aquatic habitat and the quality of the RBR aquatic ecosystem would continue to decline.

Action Alternatives

As part of ecosystem restoration, all action alternatives include the reestablishment of site-specific, native plant species. Alternatives 1-4 would include the planting of 0.74 acres of emergent vegetation along the 15-foot shelf left behind after the ongoing dredging operations are completed. Due to the increased emergent habitat provided by the restoration of the island habitats, Alternatives 5-8, 9-12, and 13-16 would restore 1.01, 1.43, and 1.79 acres of emergent vegetative habitat respectively. Native vegetation would improve water quality by filtering out sediments and chemical constituents. Additionally, it would provide forage, cover, and organic inputs to the resaca ecosystem, developing the lower trophic levels utilized by fish and wildlife species that have been absent from the RBR for the last hundred years or so.

TSP Alternative

Alternative 2 (as well as Alternatives 4, 6, 8, 10, 12, 14, and 16) provide measures to restore the bank slope along portions of the resaca perimeter. The re-establishment of the bank slope interface provides critical structural habitat for amphibian species as they transition between the aquatic and terrestrial lifeforms. The restoration of the banks also re-establishes a natural connection between terrestrial and aquatic ecosystems required for other mammalian, avian, invertebrate, and plant resources.

7.11 TERRESTRIAL RESOURCES

Each proposed alternative for the RBR study would restore a level of riparian resaca ecosystem function to the RBR. The riparian resources for RBR encompass the ecological elements that comprise a healthy, functional, riparian ecosystem that links the upland, riparian, and aquatic habitats within the resaca system. Because the RBR study is an ecosystem restoration study, impacts to the RBR resaca resources are designed to be beneficial. The potential impacts to riparian resources resulting from the implementation of each alternative are assessed below.

7.12 VEGETATION

No Action Alternative

Under the No Action Alternative, there would be no direct impacts; however, the riparian habitat would continue to be routinely mowed and maintained. The existing non-native, invasive species would continue to provide a seed source for dispersal downstream, continuing the spread of non-native, invasive species.

TSP and other Action Alternatives

As part of ecosystem restoration, all alternatives include the re-establishment of site-specific, native plant species. The bank slopes of the resaca would be planted with native plant species making these areas highly productive environments for many species of fish, reptiles, amphibians, birds, and mammals. There would be significant beneficial effects from the planting of native riparian vegetation. Appropriate native vegetation would improve water quality by filtering out sediments and chemical constituents. Additionally, it would provide forage, cover, and organic inputs to the resaca ecosystem, developing the lower trophic levels utilized by fish and wildlife species. For each of the action alternatives, the proposed vegetation would further increase the organic allochthanous material to the aquatic system and provide the energy to the lower trophic organisms that drive and support the resaca ecosystem.

The appropriate use of BMPs such as erosion control practices and tree protection devices at construction sites would protect existing trees and large blocks of vegetation/habitat adjacent to construction areas. Temporary construction impacts may also apply to vegetation within staging areas. Additionally, temporary impacts to vegetation within temporary construction easements may occur. Installation of appropriate vegetation within the RBR would provide connectivity with adjacent resacas, more closely mimicking historical conditions.

7.13 WILDLIFE

No Action

Under the No Action Alternative, the wildlife habitat conditions of the RBR would remain unchanged. The surrounding RBR neighborhoods and the non-native invasive species dominated habitats of the RBR would provide the only habitat for wildlife species in the area. Although these habitats provide marginal wildlife habitat, the fragmented and heavily modified habitats limit the diversity of populations of lower trophic level organisms in the resaca, thereby limiting the diversity of the wildlife community.

TSP and other Action Alternatives

As discussed in the Plan Formulation section of this report, there would be significant long-term beneficial effects on fish and wildlife populations from the implementation of the proposed alternatives through the geographic expansion and improved quality of their respective habitats. By restoring the natural form and function of the resacas, native fish populations could populate areas that have not been favorable for their existence or survival. Water quality improvements (resulting from planting riparian and aquatic vegetation) would improve habitat conditions for intolerant native species, and would restore balance to the native tolerant/native intolerant species over time.

The restoration of riparian vegetative structure would provide additional wildlife habitat (food, shelter, and reproductive resources) for mammals, amphibians, reptiles, and birds. The restoration measures would also connect adjacent resaca habitats. The proposed study area, which is located in the Central and Mississippi Flyway for migratory waterfowl and neotropical migrant bird species, would increase the amount of scarce riparian habitat and water resources along this migratory bird corridor. The ability of these species to find adequate resource along their migration route ultimately determines their ability to arrive at their breeding grounds in a healthy condition to establish territories, find mates, reproduce, and fledge young. For birds breeding in the riparian zones of the southwest, the improvement of the habitat increases the breeding bird's ability to successfully breed and fledge young.

Where construction or disposal is proposed, there would be an increased level of human disturbance, such as noise, vehicular traffic, and construction equipment, which could lead to temporary localized displacement of affected existing fish and wildlife populations. Mortality of fish or wildlife individuals is possible during construction phase, but would be rare, as most species would avoid the areas of disturbance.

7.14 THREATENED & ENDANGERED SPECIES

No Action Alternative

Under the No Action Alternative, there would be no added benefits to Federal- or State-listed species.

TSP and other Action Alternatives

As no Federally listed threatened and endangered species are expected to occur within the study area under the existing conditions, no adverse impacts to these species would occur. However, the restoration of the RBR may provide habitat for the red-crowned parrot, a Candidate species under the ESA, as nesting habitat for this species would be created under each Action Alternative. In addition, habitat for the black-spotted newt (under investigation by the USFWS for listing) would be created with all alternatives that incorporate bank slope restoration as a measure.

7.15 AIR QUALITY

No Action Alternative

Under the No Action Alternative, there would be no adverse impacts to air quality within the study area.

TSP and other Action Alternatives

For the action alternatives, there would be a short-term inconsequential impact to air quality during implementation. Construction would generate fugitive dust from ground disturbing activities (e.g., grading, demolition, soil piles, etc.) in addition to the emissions of all criteria pollutants from the combustion of fuels in construction equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of BMPs during construction (e.g. application of water for dust control) would minimize these emissions, including the use of cleaner burning fuels and energy efficient equipment.

7.16 NOISE

No Action

Under the No Action Alternative, there would be periodic noise attributed to heavy equipment during routine maintenance of the RBR.

TSP and other Action Alternatives

For the action alternatives heavy equipment such as backhoes, front-end loaders, and dump trucks would cause short-term, localized increases in noise levels. These short-term increases are not expected to substantially affect adjacent noise sensitive receptors. Construction activities would increase noise levels temporarily at locations immediately adjacent to the study area, but would be attenuated by distance, topography, and vegetation. Noise levels created by construction equipment would vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed, and the condition of the equipment. The equivalent sound level of the construction activity also depends on the fraction of time that the equipment is operated over the period of time of the construction. Construction would occur during daylight hours, thus reducing the Day-night Average Sound Levels and the chances of causing annoyances. The use of BMPs such as keeping equipment

in good operating condition, proper training, and providing appropriate health and safety equipment would minimize the potential noise impacts associated with the proposed action. Construction would be conducted in accordance with City ordinances.

7.17 LIGHT

No Action

Under the No Action and Action Alternatives, the existing light sources in the RBR study area would remain.

TSP and other Action Alternatives

The action alternatives would not introduce additional lighting to the RBR study area. Construction would occur during daylight hours and no construction lighting would be required. Therefore, no adverse impacts from lighting would be anticipated.

7.18 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

No Action

There would be no direct or indirect impacts to the local economy. There would be no impacts to Environmental Justice populations present in the project area. Under the No action Alternative, no changes would be made to the socioeconomic environment of the RBR neighborhoods.

TSP and other Action Alternative

It is not anticipated that the proposed project would directly or indirectly have any appreciable impact on the local economy through jobs creation or other means. Brownsville includes populations that could be characterized as minority or low-income population groups, subject to consideration under E.O. 12898. The proposed work does not, however, disproportionately target or impact Environmental Justice populations. As an ecosystem restoration project, the project is expected to have a positive impact on all population groups by improving the habitat, and potentially, the water quality, of Boulevard Resaca. Trails would provide opportunities for walking and bird watching for the general public. None of the proposed action alternatives would result in a disproportionate impact of protected socioeconomic resources within the RBR study area. Since the project is located near residential areas where children may be present, EO 13045 is considered in this EA (see Environmental Compliance section of this Chapter). The construction area would be flagged or otherwise fenced. Therefore, issues regarding Protection of Children are not anticipated.

7.19 CULTURAL RESOURCES

No Action Alternative

Under the No Action Alternative, cultural resources would not be impacted by the USACE undertaking. Any significant cultural resources will remain deeply buried and protected.

Overall, no known significant impact to cultural resources under the No Action alternative would occur.

TSP and other Action Alternatives

The restoration of riparian habitats would require the removal of the top six inches of existing soil to reduce the non-native seed bank and ripping to a depth of 12-18 inches to reduce compaction and provide suitable strata for deep root growth. Soils accumulate rapidly in alluvial riparian settings; therefore, cultural bearing deposits would not expected within the first 18-24 inches of top soil. As such, implementation of the planting measures for any of the Action Alternatives would result in no significant consequences to cultural resources. Also, the addition of soil to establish island habitats would not adversely affect cultural resources.

Coordination with the Texas SHPO resulted in the development of a draft Programmatic Agreement to ensure compliance with Section 106 of the NHPA. To minimize the impacts to resources that may be encountered during construction, an archeological monitor would be on site to identify cultural resources should they be discovered. The monitor will assess the significance of the resource and mitigate the impacts to sites determined to be eligible for the NRHP before ground disturbing activities would be allowed to continue in the vicinity. In this way, no significant impacts for the implementation of the action alternatives would be expected.

7.20 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

No Action Alternative

Under the No Action Alternative, no HTRW impacts are anticipated.

TSP and other Action Alternatives

A complete search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR, Inc.) in the vicinity of the RBR. This environmental records search was conducted for the purpose of identifying any sites where hazardous substances or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water which might impact a proposed restoration project to remove accumulated sediment, trash, and debris from the subject resaca. A final report listing all such sites found in the records search was submitted on 11 March 2016 by EDR, Inc. according to requirements of ASTM E1527-13 Standard Practice for Environmental Site Assessments. The search area extended in a one mile radius around the subject resaca from latitude (north) 25.918939 degrees and longitude (west) 97.507279 degrees. Additionally, EDR, Inc. conducted a records search to identify oil, gas, and water wells within the search area and provided historical aerial photographs and topographic maps of the area within and adjacent to the search area.. The exposure of any unanticipated hazardous materials unearthed during excavation activities would be dealt with in a manner consistent with Engineering Regulation 1165-2-132 Hazardous, Toxic and Radioactive Waste Guidance for Civil Works Projects. The complete report is included in (Appendix 11). There were two identified water test wells reported in RBR, however neither was reported to have been used and are no considered to have adverse impacts under any of the action alternatives.

To minimize potential impacts from hazardous and regulated materials during construction, all fuels, waste oils, and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein.

The refueling of machinery would be done following accepted guidelines, and all vehicles would have drip pans, when not in use, to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of five gallons or more would be contained immediately within an earthen dike, and the application of an absorbent (e.g., granular, pillow, sock, etc.) would be used to absorb and contain the spill. Any major spill of a hazardous or regulated substance would be reported immediately to City of Brownsville, BPUB and USACE environmental personnel who would notify appropriate Federal and State agencies.

Additionally, all construction personnel would be briefed as to the correct procedures for preventing and responding to a spill. All waste oil and solvents would be recycled if practicable. All non-recyclable hazardous and regulated wastes would be collected, characterized, labeled, stored, transported, and disposed of in accordance with all Federal, State, and local regulations, including the proper waste manifesting procedures. A Spill Prevention Plan would be in place prior to the start of construction, and all personnel shall be briefed on the implementation and responsibilities of this plan. Adoption and full implementation of the construction measures described above would reduce the adverse hazardous/regulated substances impacts to insignificant levels.

7.21 VISUAL AESTHETICS

No Action Alternative

The No Action Alternative would result in the same continuously mowed and maintained landscape and invasive species do0minated habitats of the existing conditions.

TSP and other Action Alternatives

The action alternatives would alter the visual aesthetics of the RBR by restoring native vegetation and island habitats. The diversity of native plant species and vertical structure would emulate natural resaca habitats of the region, creating a more natural view shed within the RBR.

8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action would not entail any significant irretrievable or irreversible commitments of resources. Construction of ecosystem restoration measures would require minor consumption of petroleum products, and importing materials such as rock, soil, gravel, and vegetation. The Proposed Action would entail long-term sustainability of restored environmental resources.

9.0 INDIRECT EFFECTS

Indirect effects, as defined by CEQ's regulations, are "caused by the proposed action and occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced

changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 Code of Federal Regulations [CFR] 1508.8). Indirect effects differ from direct impacts associated with the construction and operation of the proposed project and are caused by an action or actions that have an established relationship or connection to the proposed project. However, indirect effects can be linked to direct effects in a causal chain, which can be extended as indirect effects that produce further consequences.

As previously discussed, implementation of the proposed action would directly result in a net beneficial impact to the RBR and the associated vegetation and wildlife. In addition, the proposed RBR ecosystem restoration measures would result in benefits that extend further outside the study area for several notable environmental resources. These benefits would increase over time as the RBR habitats develop and mature.

The indirect effects were examined for the study area as identified in Figure 1. As discussed below, even though portions of the indirect effects study area are located outside the proposed RBR restoration limits, these areas would receive ecological benefits resulting from restoration activities.

Wildlife often utilizes riparian habitats, especially in urban landscapes, as travel corridors to move between patches of habitat. The proposed study would extend the existing wildlife corridor located upstream and downstream of RBR facilitating the dispersal and gene flow into previously isolated patches of habitat.

The establishment of native plant species in the study area and the removal and control of nonnative, invasive species provides significant indirect benefits. The seed production of the vegetation in the study area can be transported downstream, especially during flood events, and deposited downstream. Under the No Action Alternative, these seeds would generally be comprised of non-native invasive species resulting in increased maintenance costs for invasive species control efforts in the soon to be completed resaca restoration projects such as the Cemetery Resaca restoration. With implementation of the recommended plan, the seed source would generally be comprised of native species adapted to the conditions of the floodway and would support and enhance ongoing restoration efforts at the Cemetery Resaca. The improved riverine habitats of the RBR would improve water quality downstream as the aquatic, wetland, and riparian vegetation would filter pollutants and sediments. The habitat restored as the result of the RBR would connect with the resacas habitats up and downstream.

10.0 CUMULATIVE IMPACTS

CEQ regulations define a cumulative impact as an effect 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 person undertakes such other actions (40 CFR Section 1508.7). Relatively minor individual impacts may collectively result in significant cumulative impacts. Project-related direct and indirect impacts must be analyzed in the context of non-project-related impacts that may affect the same resources. Cumulative

impacts are the incremental impacts that the project's direct or indirect impacts have on a resource in the context of other past, present and future impacts on that resource from related or unrelated activities. Unlike direct impacts, quantifying cumulative impacts may be difficult since a large part of the analysis requires forecasting future trends of resources in the study area and future projects that may impact these resources.

The initial step of the cumulative impacts analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. The proposed action would not contribute to a cumulative impact if it would not have a direct or indirect effect on the resource. Similarly, CEQ guidance recommends narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, the cumulative impact analysis for RBR was focused on those resources that were substantially directly or indirectly impacted by the study and resources that were at risk or in declining health even if the direct/indirect impacts were insignificant.

The resources considered for cumulative impacts assessment include: resaca habitat (riparian and aquatic vegetation) and wildlife. Each of these resources would be substantially directly and/or indirectly impacted by the RBR study. For the purposes of this cumulative impact analysis, the resource study area for riverine habitat and wildlife is the floodplain area of the RBR.

Past, present and future projects influencing riverine habitats and wildlife in the cumulative study area are presented in Table (Need a table identifying resaca dredging (Dean Porter and Cemetery) and Cemetery Resaca, NPS resaca Restoration Camp Lula Sams, TNC, etc.). Transportation, utility, development, and other construction projects have occurred in the past and impacted resaca resources in the RBR cumulative study area. After 1972, these impacts would have been regulated by USACE under the Clean Water Act. These types of development projects would be expected to continue in the future and would be regulated through the USACE permitting process.

The health and historic context of the resaca habitat and wildlife resources, specifically migratory birds utilizing the Central and Mississippi Flyways, has been described in previous sections of this report (Existing Conditions, Alternative Formulation, and Consequences). In fact, the historic and continued decline of these resources lies at the core of the significance and need for the RBR ecosystem restoration project.

10.1 RESACA HABITAT

Past impacts specific to the resaca habitats are documented in previous sections of this report. Over the past 125 years, pristine resaca habitats in Cameron County have been lost due to demand for natural resources, agriculture, urbanization, flood risk management projects on the Rio Grande. As urban sprawl incorporates the remaining areas of Cameron County, the importance of resaca habitats and their associated floodplains in the outer areas of the county has been realized. As a result, with the exception of some non-cultivated agricultural areas, much of the resacas have been severely degraded. Several restoration projects have been and are currently under construction including the Cemetery Resaca, Palo

Alto Battlefield Resacas, Resaca de la Palma State Park, and the Nature Conservancy's Southmost Preserve. The conservation of resaca resources in Cameron County continues to be a priority and initiatives by the City, USFWS, TPWD, TNC, NPS, and others are making progress in increasing the extent of restored and protected resaca habitats. Although future restoration and conservation initiatives will undoubtedly continue, the City and Cameron County are one of the top urban growth centers in the U.S. As a result urban pressures would continue to encroach on the county's suburban and rural resaca ecosystems. Because of projected future population growth and subsequent urbanization, the sustainability and ecological viability of resaca habitats for fish and wildlife as well as human uses, highlights one of the greatest ecological needs of the region. The proposed action would effectively provide 7.8 acres of a connected, restored resaca system along a critical corridor for the birds utilizing the Central and circum-Gulf Mississippi Flyways.

10.2 WILDLIFE

Fish and wildlife inhabiting the RBR prior to urbanization and channelization would have consisted of a diverse community of native invertebrate, fish, amphibian, reptile, mammal, and bird species. As the area urbanized, wildlife species intolerant of urban impacts such as the jaguar, ocelot, jaguarundi, and Texas tortoise migrated out of the area over time and species tolerant of urbanization now thrive. After urbanization encroached on resaca habitats, the aquatic habitat that supported a diverse community of amphibians and aquatic invertebrates disappeared, further reducing wildlife diversity in the urbanized areas. Finally, the introduction of non-native fish and wildlife species such as vermiculated catfish, tilapia, tetras, house mice, Norway rats, European Starlings, Rock Doves, and feral cats and vegetative species such as buffelgrass, Bermuda grass, KR bluestem, and giant cane that have reduced habitat values, placed increased demands on scarce wildlife resources, and resulted in the non-native species out-competing native species. Currently the habitat conservation efforts discussed in the habitat section above have mitigated these effects in some limited areas, but without additional restoration of riverine and terrestrial habitats, improvements to the viability and diversity of fish and wildlife would be limited.

In the earlier discussion of direct impacts of the proposed actions, substantial beneficial effects were recognized that improve habitat not only for migratory birds and other upper tier trophic species, but more importantly for lower trophic level organisms that support these more visible and mobile species. As further discussed, these beneficial impacts are not limited to the RBR study area, but expand further into Cameron County. For migratory birds, the benefits of the proposed RBR habitats might be realized several thousand miles away after the successful breeding and fledging of young on the arctic tundra.

The proposed actions alone cannot ensure the continued survival and existence of migratory birds and other organisms depending on riverine resources in the southwest. However, the proposed actions can contribute to the cumulative conservation, preservation, and restoration efforts underway both locally, regionally, nationally, and internationally. Locally, previous and ongoing resaca restoration efforts will improve migratory bird habitats in the Brownsville area. Additional conservation efforts in the region, including the implementation of the NWR Conservation Plans, conservation easements initiated by non-governmental

conservation organizations, and international initiatives such as the Partners in Flight and Joint Ventures will continue to provide pieces of the migratory bird habitat puzzle that will ensure migratory birds have the resources to complete migration and successfully breed and fledge young.

The cumulative habitat incorporated into these migratory bird conservation efforts are predicated on the establishment of the lower trophic levels by ensuring that aquatic, riparian, and upland habitats properly function ecologically.

10.3 Mitigation Requirements

No mitigation would be required with the implementation of the TSP.

11.0 ENVIRONMENTAL COMPLIANCE

This section demonstrates how the Proposed Action would comply with applicable environmental laws and regulations.

Table 11 presents the status of compliance with all environmental laws and regulations for the proposed action.

Table 11. Relationship of Plan to Environmental Protection Statutes and Other Environmental Requirements

Policies	Compliance of Plan
Public Laws	
Archeological and Historic Preservation Act, 1974, as amended	In Progress
Archeological Resources Protection Act, 1979, as amended	In Progress
Clean Air Act, 1977, as amended*	Compliant
Clean Water Act, 1972, as amended*	Compliant
Coastal Zone Management Act, 1972, as amended	Not Applicable
Endangered Species Act, 1973, as amended*	Compliant
Farmland Protection Policy Act	Not Applicable
Fish and Wildlife Coordination Act, 1958, as amended*	In Progress
Magnuson Fisheries Conservation and Management Act	Not Applicable
Migratory Bird Treaty Act, 1918, as amended*	Compliant
National Environmental Policy Act, 1969, as amended	In Progress
Rivers and Harbors Act, 1899	Compliant
Wild and Scenic Rivers Act, as amended	Not Applicable
Native American Graves Protection and Repatriation Act, 1990	Not Applicable
National Historic Preservation Act, 1966, as amended	In Progress
Executive Orders	
Environmental Justice (E.O. 12898)*	Compliant
Protection of Children (E.O. 13045)	Compliant
Flood Plain Management (E.O. 11988)	Compliant
Protection of Wetlands (E.O. 11990)	Compliant
Invasive Species (E.O. 13112)*	Compliant
Migratory Birds (E.O. 13186)*	Compliant
Others	
FAA Advisory Circular 150-5200-33*	Compliant

*For additional information, see the following sections

11.1 Section 176(c) Clean Air Act

Federal agencies are required by this Act to review all air emissions resulting from Federal funded projects or permits to ensure conformity with the State Implemented Plans (SIP) in non-attainment areas. The Brownsville, Texas area is currently in attainment for all air emissions; therefore, the proposed study would be in compliance with the Clean Air Act.

11.2 Clean Water Act

USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the United States, including wetlands. Although USACE does not issue itself permits for construction activities that would affect waters of the United States, USACE must meet the legal requirement of the Clean Water Act. The impacts RBR ecosystem restoration associated with the Recommended Plan would be minimal, the project would provide an

ecological lift, and would meet the terms and conditions of NWP 27. Therefore the project would qualify for authorization under NWP 27, which does not require an individual alternatives analysis and evaluation pursuant to Section 404(b) (1) guidelines. Further, since the TCEQ has issued 401 water quality certification for NWP 27, the proposed project would be in compliance with Section 401 of the Clean Water Act.

Section 402 of the Clean Water Act and Chapter 26 of the Texas Water code require construction activities that disturb areas greater than 1 acre to obtain a National Pollution Discharge Elimination System (NPDES) Construction General Permit. Bank stabilization construction operations would meet water quality standards set forth by Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code by preparing and following a Storm Water Pollution Plan (SWPPP) approved by the USACE and the Texas Commission of Environmental Quality (TCEQ). This SWPPP would outline measures for the contractor to implement during construction activities to minimize pollution in storm water runoff. A TCEQ Notice of Intent (NOI) would be filed prior to any ground disturbing activities.

SECTION 404 OF THE CLEAN WATER ACT

USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the United States, including wetlands. Although USACE does not issue itself permits for construction activities that would affect waters of the United States, USACE must meet the legal requirement of the Act. As stated in Chapter 4, Wetlands and Waters of the U.S. the proposed project would meet the qualifications for a NWP 27. Activities authorized under NWP 27 include: -the removal of accumulated sediments, the installation, removal, and maintenance of small water control structures, dikes, and berms,

the installation of current deflectors, the enhancement, restoration, or creation of riffle and pool stream structure, **the placement of in-stream habitat structures, modifications of the stream bed and/or banks to restore or create stream meanders,** the backfilling of artificial channels and drainage ditches, the removal of existing drainage structures, **the construction of small nesting islands,** the construction of open water areas, the construction of oyster habitat over un-vegetated bottom in tidal waters, **activities needed to reestablish vegetation, including plowing or disking for seed bed preparation and the planting of appropriate wetland species, mechanized land clearing to remove non-native invasive, exotic or nuisance vegetation, and other related activities.**

Aforementioned activities highlighted in bold are those that apply to the RBR proposed alternatives. The TSP would result in the loss of 1.4 acres of open water habitat that would be replaced by Texas Ebony Resaca Forest habitat. Under a NWP 27, the conditions for a water quality certification would be met and a Section 401 water quality certification would not be required by the TCEQ.

The construction activities that disturb upland areas (land above Section 404 jurisdictional waters) are subject to National Pollutant Discharge Elimination System (NPDES) requirements of Section 402(p) of the Clean Water Act (CWA). Within Texas, TCEQ is the permitting authority and administers the Federal NPDES program through its Texas Pollutant Discharge Elimination System (TPDES) program. Construction activities that disturb one or more acres

are subject to complying with TPDES requirements. Operators of construction activities that disturb 5 or greater acres must prepare a Storm Water Pollution Prevention Plan (SWPPP), submit a Notice of Intent to TCEQ, conduct onsite posting and periodic self-inspection, and follow and maintain the requirements of the SWPPP. During construction, the operator shall assure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pick-up, etc.), promptly clean-up accidental spills, utilize BMPs onsite, and stabilize site against erosion before completion.

11.3 Environmental Justice, Executive Order 12898

EO 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" dated February 11, 1994, requires all Federal agencies to identify and address disproportionately high and adverse effect of its programs, policies, and activities on minority and low-income populations. Data was compiled to assess the potential impacts to minority and low-income populations within the study area. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Even though minorities account for a large portion of the local population, construction of the proposed alternatives would not have a disproportionately high or adverse effect on these populations. Because of the high number of Spanish speaking individual in the RBR area, public meetings had and will continue to have translators. All notices regarding the project would have Spanish versions and construction signs would be posted in both Spanish and English. No environmental justice concerns are anticipated and the Proposed Action would be consistent with EO 12898.

11.4 Executive Order 13045, Protection Of Children

EO 13045 "Protection of Children from Environmental Health Risks" dated April 21, 1997 requires Federal agencies to identify and address the potential to generate disproportionately high environmental health and safety risks to children. This EO was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults.

Short-term impacts on the protection of children would be expected. Numerous types of construction equipment such as backhoes, bulldozers, graders, and dump trucks, and other large construction equipment would be used throughout the duration of construction of the Proposed Action. Because construction sites and equipment can be enticing to children, construction activity could create an increased safety risk. The risk to children would be greatest in construction areas near densely populated residential neighborhoods. During construction, safety measures would be followed to protect the health and safety of residents as well as construction workers. Barriers and "No Trespassing" signs would be placed around construction sites to deter children from playing in these areas, and construction vehicles and equipment would be secured when not in use. Since the construction area would be flagged or otherwise fenced, issues regarding Protection of Children are not anticipated.

11.5 Invasive Species, Executive Order 13112

Executive Order (EO) 13112 recognizes the significant contribution native species make to the wellbeing of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of the invasion of non-native plants and wildlife species in the United States. This EO establishes processes to deal with invasive species, and among other items establishes that Federal agencies "will not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions." One of the measures consistent with all of the restoration alternatives is the control of non-native invasive species and the revegetation of project, construction, and staging areas with native plant species.

The urbanization of the RBR study area has caused degradation of the resaca environment resulting in the loss of an aquatic environment supporting native aquatic species. Linked to the aquatic degradation is the loss of native riparian vegetation species, which is vital to the aquatic environment and supports native residential and migratory, game and nongame wildlife species. Virtually no natural, native resaca environment remains. The loss of appropriate native riparian vegetation has resulted in the loss of the necessary components for the life cycle of the numerous insect species, which are the vital prey base for the native aquatic and riparian-dependent insectivore species. The imbalance in the predator/prey relationship has assisted in the invasion of non-native invasive species into the aquatic and riparian habitats. The measures included in the ecosystem restoration study would reduce the invasive plant species and the seed bank in the top six inches of topsoil and replace them with native plant species adapted to the study area. Required operation and maintenance of the RBR study area by the non-Federal sponsor during long-term management of that area would keep the negative influence of non-native invasive plants at a minimum. The Proposed Action would be in compliance with EO 13112 by restoring native aquatic and riparian vegetation species to the degraded habit. The RBR floodway is dominated by non-native invasive plant species.

11.6 National Historic Preservation Act Section 106 Compliance

Letters were mailed to the State Historic Preservation Office and appropriate Indian Tribes in January 2016 to initiate Section 106 coordination (see Appendix 10). In addition, letters, along with a Notice of Availability, will be sent to the SHPO and appropriate Indian Tribes at the initiation of the required public review period prior to finalization of the NEPA process.

11.7 Advisory Circular - Hazardous Wildlife Attractants on or Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife in the vicinity of public-use airports. The circular provides guidance

on wetlands in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife. In response to the Advisory Circular, the United States Army as well as other Federal agencies, signed a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The closest airport known, the Brownsville International Airport, is 4.25 miles from the RBR. Coordination with the FAA has been initiated and is ongoing.

11.8 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) requires Federal agencies that are impounding, diverting, channelizing, controlling, or modifying the waters of any stream or other body of water to consult with the USFWS and appropriate State fish and game agency to ensure that wildlife conservation receives equal consideration in the development of such projects. From the initial stages of the RBR study, the USFWS and TPWD have been involved in the planning process. Both agencies provided comments through regular briefings throughout the planning process, and the USFWS signed a planning aid letter fully supporting the RBR (Appendix 10 (still need to coordinate with USFWS). USFWS, TPWD, and TNC biologists participated in the habitat surveys and provided comments on the Resaca Reference Conditions Model used to assess existing and future RBR habitat conditions. USFWS and TPWD will continue to be involved, as agency resource availability permit, throughout the RBR study. A draft Coordination Act Report supporting Alternative 14 is expected from the USFWS following the public review period of the draft integrated EA. A draft letter asking for USFWS concurrence stating FWCA and ESA requirements were fulfilled by USACE will be included in the FWCA Appendix 10 when this document is approved for public review.

11.9 Migratory Bird Treaty Act/Executive Order 13186

The importance of migratory non-game birds to the nation is embodied in numerous laws, executive orders, and partnerships. The Fish and Wildlife Conservation Act demonstrates the Federal commitment to conservation of non-game species. Amendments to the Act adopted in 1988 and 1989 direct the Secretary to undertake activities to research and conserve migratory non-game birds. EO13186 directs Federal agencies to promote the conservation of migratory bird populations, including restoring and enhancing habitat. Migratory Non-game Birds of Management Concern is a list maintained by the USFWS. The list helps fulfill a primary goal of the USFWS to conserve avian diversity in North America. Additionally, the USFWS' Migratory Bird Plan is a draft strategic plan to strengthen and guide the agency's Migratory Bird Program. The proposed ecosystem restoration would contribute directly to the U.S. Fish and Wildlife Service Migratory Bird Program goals to protect, conserve, and restore migratory bird habitats to ensure long-term sustainability of all migratory bird populations. Vegetative clearing is expected during the initial construction of the restoration. However, since the area of activity is relatively small, the project areas will be surveyed for nesting activity prior to construction. USFWS will be contacted if nesting activity is reported.

11.10 Endangered Species Act

USACE and the U.S. Fish and Wildlife Service have been coordinating regarding the Endangered Species Act. No threatened and endangered species or critical habitats occur within the area of the Recommended Plan but coordination will continue regarding Section 7 of the Endangered Species Act (ESA).

11.11 Flood Plan Management Executive Order 11988

EO 11988 requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of flood plain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities." The Water Resources Council Flood plain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the flood plain. The eight steps reflect the decision-making process required in Section 2(a) of the EO. The eight steps and responses to them are summarized below.

1. Determine if the proposed action is in the base flood plain.

The project site is located in Zone A based on the City of Brownsville, Texas, Cameron County flood insurance rate map with an effective date of December 1, 1978.

2. If action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.

Other than the "No Action" alternative, there is not a practicable alternative because the purpose of the project is to perform an ecosystem restoration on the water body within the flood plain.

3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

A Notice of Intent was sent to the surrounding residents informing them of the project and its location within the floodplain. No negative response was received.

4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base, impacts resulting from these actions should also be identified.

The project does not change the floodplain and has no impact on the 100 year water surface elevation.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.

This is not applicable since the project does not change the floodplain and has no impact.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternatives and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action' alternative.

This is not applicable since the project does not change the floodplain and has no impact.

7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.

This is not applicable since the project does not change the floodplain and has no impact.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

The selected project is the most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

12.0 PLAN IMPLEMENTATION REQUIREMENTS

Project implementation for ecosystem restoration projects is comprised of three phases – Preconstruction Engineering and Design (PED), construction, and monitoring and adaptive management.

12.1 PRECONSTRUCTION ENGINEERING AND DESIGN

The PED phase is cost shared 65% Federal and 35% non-federal for the resaca ecosystem restoration. Prior to initiating the PED phase, the design team must develop a Project Management Plan (PMP) which defines the scope, work breakdown structure, schedule, and budget to complete PED. Additional items in the PMP are related to value management and engineering, quality control, communication, change management, and acquisition strategy. The draft PMP must be developed, negotiated, and agreed upon by all parties of the PED phase prior to initiation of the PED phase.

A number of activities are expected to take place on site during soil disturbing activities during PED. These include the completion of a Design Documentation Report (DDR), plans and specifications (P&S), execution of the Project Partnership Agreement (PPA), and contract award activities.

The development of the DDR includes completing the final design of project features. As a part of the DDR, the team will complete any ground surveys, utility surveys, and testing for subsurface conditions as necessary to complete final design. The resaca bank slope modifications will be further defined based on surveys, hydraulic analysis, and testing. Design parameters for all project features will be defined for development of the plans and specifications. Continued coordination with SHPO will ensure requirements for archeological resource investigations and mitigation continue to be met. If required, an archeologist will be available on site during soil disturbing activities for monitoring, identification, and proper

documentation/preservation of any cultural resources that might be uncovered during construction.

P&S includes the development of project construction drawings and specifications, estimation of final quantities, and completion of the government cost estimate. Drawings and specifications are made available to contractors interested in bidding on the construction of the proposed project. Arrangements for onsite archeological monitoring during construction should be finalized prior to the conclusion of P&S so they may be documented in the PPA.

A PMP for the construction phase must be developed, negotiated, and agreed upon by all parties of the construction phase prior to initiation of the construction phase.

The PPA is a binding agreement between the Federal government and the non-Federal sponsor which must be approved and executed prior to the start of construction. The PPA sets forth the obligations of each party. The non-Federal sponsor must agree to meet the requirements for non-Federal responsibilities which will be identified in future legal documents. Some of the likely responsibilities are:

Provide 35 percent of total ecosystem restoration costs as further specified below:

Provide 25 percent of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for ecosystem restoration features;

Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to ecosystem restoration;

Provide all lands, easements, and rights-or-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features; and

Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share there for, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

Shall not use the ecosystem restoration features or lands, easements, or rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with the Act;

For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;

Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto: Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or

under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project.

Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

Comply with Section 221 of Public Law 91- 611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

12.2 REAL ESTATE ACQUISITION

The non-Federal sponsor is responsible for the lands, easements, rights-of-way, relocations, and disposal areas required for project construction, operation, and maintenance of the RBR. Following the execution of the PPA, the non-Federal sponsor will be provided a right-of-way map delineating the real estate necessary for construction, operation, and maintenance of the proposed project. Real estate activities will be coordinated between City of Brownsville Real Estate Office, BPUB's and the Real Estate Office at the Galveston District. Also, prior to any solicitation of construction contracts for the RBR, the District Chief of Real Estate is required to certify in writing that sufficient real property interest is available to support construction of the contract.

12.3 CONTRACT ADVERTISEMENT AND AWARD

Once the PPA is executed, the plans and specifications completed, and the rights of entry provided to SWG, a construction contract will be solicited and advertised. Prior to awarding the contract, the non-Federal sponsor must provide any applicable cash contribution. The contract will be awarded to the lowest responsive bidder and notice to proceed can be expected within 30-45 days from bid opening.

12.4 PROJECT CONSTRUCTION

After award of the construction contract, the Government will manage project construction. Up to 5 contracts may be awarded. Inherent with this contract, a warranty period for actual construction items and plantings will be specified. Planting of aquatic, emergent, and riparian habitats will begin once the earthwork is complete for an area. Planting will occur over at least two seasons within the same planting area. There will be a 2-year contract period

beyond each specific planting period to ensure the plantings are alive and thriving. This activity includes removing and control of non-native, invasive species, watering (if needed), and replacement vegetation to ensure a minimum survival rate. Performance standards for the establishment of vegetation and control of non-native and invasive species will be refined during PED. During construction, an archeologist may be required to monitor excavation. Should any significant cultural resources be identified, mitigation procedures will take place prior to further excavation. Total implementation time is expected to be 30 months.

12.5 MONITORING AND ADAPTIVE MANAGEMENT

Monitoring and, if necessary, adaptive management will occur for a period of three years as evidence for successful establishment of the project prior to the project being turned over to the non-Federal sponsor for operation and maintenance. Monitoring efforts will be conducted with City of Brownsville and its' affiliate BPUB and USACE personnel. In an effort to ensure the success of the proposed action, the restoration measures implemented will be periodically surveyed to provide feedback on the response of the ecosystem and its resources to the management measures taken. By connecting the ecosystem response to the restoration as well as the management measures, potential beneficial adaptations and adjustments to the project or management plan can be identified to ensure continued success of the project. This is especially true of the plantings that will have to be frequently monitored from their initial planting until reasonable stabilization is achieved. To accomplish this goal, periodic monitoring of the restoration measures will be conducted over a three-year period beginning after the completion of the construction of project features and the initial plantings. An adaptive management and monitoring plan is being developed. City of Brownsville through it affiliation with BPUB and in accordance with the PPA will implement the plan to ensure successful establishment and maintenance of riverine habitat throughout the RBR study area.

12.6 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R)

The non-Federal sponsor is responsible for the OMRR&R of the completed project. SWG, in cooperation with City of Brownsville and its affiliate BPUB, will draft an OMRR&R plan which also includes management strategies for sustainable resaca ecosystem management. SWG will provide the OMRR&R plan upon successful completion of the project construction, prior to turning over the project to the non-Federal sponsor for OMRR&R. OMRR&R of the proposed restoration project is comprised of the structural integrity of the west bank features, plantings, and other restoration features. OMRR&R costs are estimates at $10,427 per year. It is assumed that after five years, plantings would become self-sustaining and OMRR&R costs would decrease accordingly for the remainder of the planning horizon.

Resaca Banks

Routine maintenance will include periodic inspection, repair of localized erosion, removal of debris, and replacement of dislodged riprap or rock, if applicable.

Aquatic, Emergent, and Riparian Plantings

Some vegetation loss will likely occur during years 3-5 of the project. Replacement beyond the warranty period may be necessary to maintain the species and vertical structure diversity of the habitats. Invasive species management will be a significant component of the OMRR&R plan in an effort to control the invasion of non-native and native noxious plant species. An increase in debris may occur during and after flood events. The removal of this debris is accounted for in the OMRR&R estimate.

Routine maintenance of the red-crowned nest structures may be required to ensure structural integrity of the nest structure and to remove the nests of any non-target mammalian, avian, or invertebrate species.

13.0 COST APPORTIONMENT

Under Section 206 of the CAP guidance, the NFS shall provide 35 percent of the cost of construction of any project carried out under Section 206, including provision of all lands, easements, rights-of-way, and necessary relocations. No more than $10 million in Federal funds may be allotted under a Section 206 project.

14.0 VIEW OF NON-FEDERAL SPONSOR, LETTER OF SUPPORT

City of Brownsville is identified as the non-Federal sponsor. BPUB supports the City of Brownsville as an affiliated organization. The City of Brownsville supports the recommended plan and intends to participate in its implementation.

15.0 SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

The USFWS, TPWD, NPS, and the Nature Conservancy are supportive of the recommended plan. The recommended plan fulfills a number of their missions and objectives. These agencies have been involved in the development of a conceptual ecosystem model, data collection, and habitat model development and have provided crucial input throughout the study. Letters from these agencies announcing their support for the recommended plan are expected once the public review period I complete.

The RBR Ecosystem Restoration Project incorporates environmental sustainability by restoring some of the form and function of a natural resaca system to create endangered aquatic and riparian habitats. The plan is consistent with all applicable laws and policies, and the Corps and its non-Federal sponsor met the corporate responsibility and accountability for the project in accordance with those laws and policies. The study team used appropriate ways and means to assess cumulative impacts to the environment through NEPA and the use of engineering models, environmental surveys, and coordination with natural resource agencies. As a result of employing a risk management and system approach throughout the life cycle of the project, the project design evolved to address as many concerns as possible with no mitigation required to address adverse impacts.

15.1 PUBLIC VIEWS AND RESPONSES

Appendix 9 provides public comments received by residents of the RBR community.

15.2 COORDINATION

Appendix 10 provides documentation of the agency coordination to date regarding the study. The PDT is continuing to work with the USFWS Corpus Christi Ecological Service Office in the development of the Fish and Wildlife Coordination Act Report.

16.0 RECOMMENDATION

I recommend that the restoration plan as generally described in the Detailed Project Report and Integrated Environmental Assessment be implemented under the authority of Section 206 of the WRDA of 1996, Public Law 104-303, with such modifications as in the discretion of the appropriate authority may be deemed advisable. The total project cost is currently estimated to be $951,206.

Prior to the commencement of construction, local interests must agree to meet the requirements for the NFS as outlined in this report and future legal documents. The City of Brownsville has demonstrated that they have the authority and financial capability to provide all sponsor requirements for the implementation, operation, and maintenance of the project. The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation, evaluation, and development of individual project under the U.S. Army Corps of Engineers Continuing Authority Programs.

Lars N. Zetterstrom
Colonel, U.S. Army Corps of Engineers
District Engineer

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