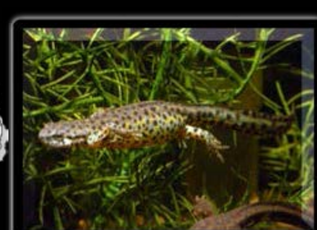
The Resacas

In the Vicinity of the City of Brownsville, Texas
Interim Ecosystem Restoration Feasibility Study and Environmental Assessment

Appendices




US Army Corps of Engineers ®
Fort Worth District
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Appendix A

Brownsville Resacas

Natural Resources Appendix

NATURAL RESOURCES APPENDIX

Introduction

This appendix was developed to provide supporting information for the feasibility report and integrated environmental assessment. The information includes historic and existing conditions, future without project conditions, environmental consequences, and planning constraints, and future with project conditions of resaca restoration alternatives. This appendix also describes the plan formulation process for the estimation of environmental benefits.

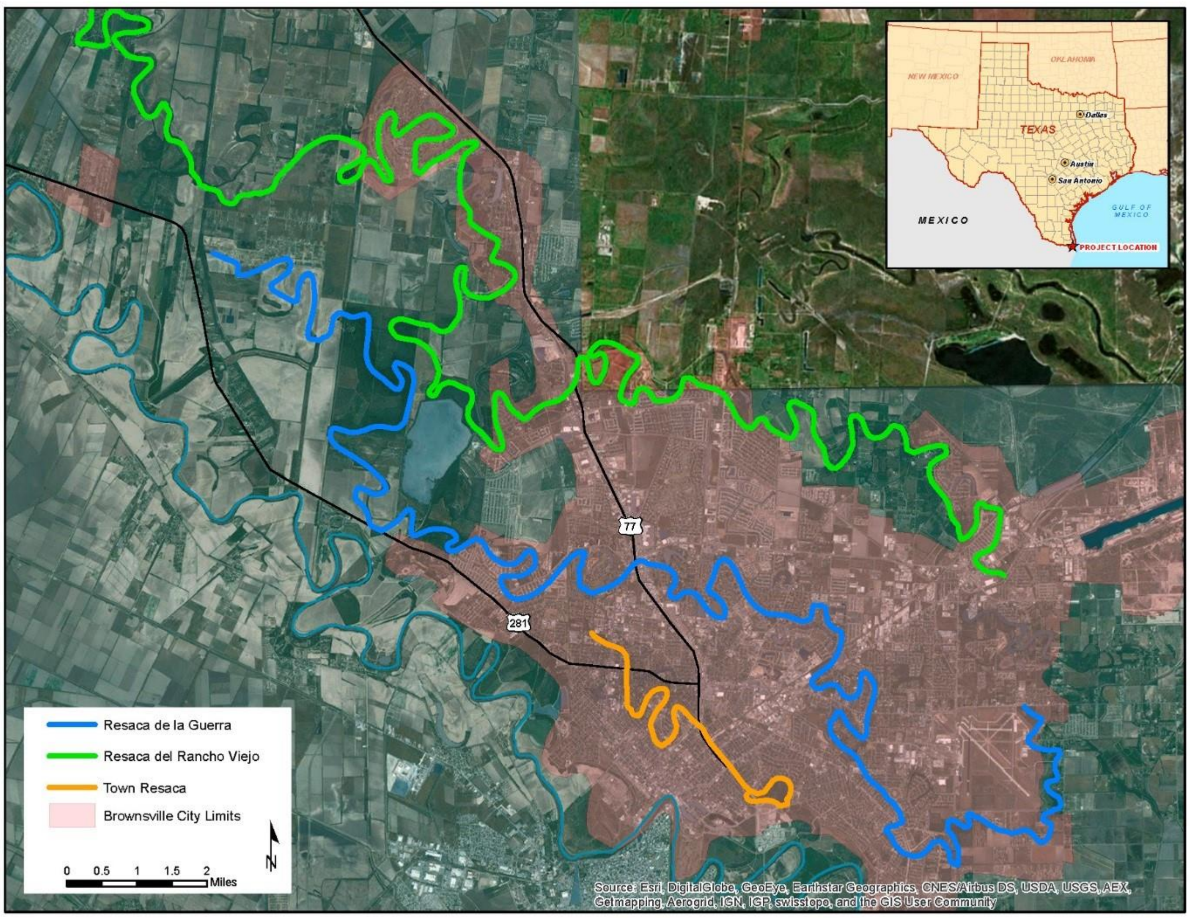


Figure A-1: Resaca de la Guerra, Resaca del Rancho, and Town

The City of Brownsville is located at the southern tip of Cameron County, Texas (Figure A-1). The study area includes three separate resaca systems: Resaca de la Guerra transecting the middle portion of the city, Resaca del Rancho Viejo stretching west to east across the northern portion of Brownsville, and the Town Resaca system located at the southwestern portion of the city. The study area encompasses the parts of the resaca systems from the edge of the western Brownsville city limit to the eastern city limit boundary, inclusive of Cameron County inholdings.

Resacas are paleochannels of the lower Rio Grande located within the Holocene floodplain in Cameron County, Texas, and Tamaulipas, Mexico. The resacas are isolated, narrow bodies of shallow water with natural depths averaging around 4-6 feet. Although the resacas have not been directly connected to the Rio Grande for 50 to 60 years, overbank flooding of the Rio Grande and stormwater runoff once maintained the resacas as permanently and temporarily flooded ecosystems. Today, there are approximately 3,500 acres of degraded Resaca habitat of varying habitat quality in the vicinity of the City of Brownsville, in areas ranging in size from less than an acre to over several hundred acres.

The resacas are the aquatic habitats of the South Texas thornscrub ecosystem. The South Texas thornscrub is an arid ecosystem consisting of aquatic and riparian components. The resacas provide essential habitat for a unique community of fish and wildlife resources that have adapted to the resacas.

Within the last 100 to 150 years, much of the lower Rio Grande floodplain has been converted to agriculture and urban development, altering the floodplain dynamics of the river and the resacas. The construction of many flood risk management projects in the Rio Grande basin, and most recently the Falcon, Amistad, and Anzalduas Dams on the Rio Grande, have significantly altered the hydrology of the lower Rio Grande floodplains. These flood risk management projects have caused the resacas to be hydraulically isolated from the Rio Grande by virtually eliminating floods.

Currently, the Brownsville resacas are interconnected with a system of dams, levees, culverts, weirs, and storm water pipes. The purpose, in part, is to convey stormwater runoff during heavy rain and storm events. However, the resacas are perched features on the landscape and the stormwater function is relatively minor. The resacas also serve a variety of other uses such as water supply and irrigation, recreation, and habitat for a diverse bird and wildlife population, including several protected species. The resacas are an extremely rare habitat/ecosystem, and they’re known as sites of cultural heritage. The Brownsville Public Utility Board (BPUB) has been investigating ways of restoring the resacas to a more natural state. Some small pockets of restoration efforts have begun, but the city has plans for a large-scale restoration effort.

Other problems for the resacas are due to their location in a highly urbanized locale, which exposes the resaca to non-point source pollution affecting the health of this ecosystem. Decades of development along the resacas has resulted in replacement of native plant species with non-native ornamental and invasive species. Urbanization adjacent to the resacas has converted much of the habitat in this area converting from native thornscrub to turf grass, non-native invasive vegetation, and ornamental shrubs and trees. These changes have destroyed or degraded the resacas habitat and ecosystem.

Resacas are an integral component of the high biodiversity found in this region, as they provide the major source of fresh surface water outside of the Rio Grande proper. Some rural resacas have retained the aquatic and riparian vegetation characteristic of the main river channel, and remnants of this vegetation can be observed at many urban resacas. The resaca’s native riparian communities are predominantly comprised of three dense, thornscrub vegetation associations: Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony-Snake Eyes Shrubland. These vegetation associations are found exclusively in the Lower Rio Grande Valley and are considered critically imperiled with extinction or elimination [G1S1, G2S2, G1S1, respectively (Diamond, 1993)]. The U.S. Fish and Wildlife Service (USFWS) estimates that 99 percent of the dense native riparian thornscrub vegetation along the U.S. side of the Rio Grande has been cleared for agriculture and urban development.

The thornscrub vegetation surrounding resacas in Mexico is essentially non-existent. The riparian communities along the margins of undeveloped resacas in Texas provide a significant portion of these rare native vegetation communities in the area and the restoration of this habitat along impacted resacas provides a unique ecosystem restoration opportunity.

The purpose of Civil Works ecosystem restoration is to restore significant aquatic ecosystem functions, structure, and dynamic processes that have been degraded. In an effort to return aquatic and riparian habitat structural and functional benefits to the resacas, the Brownsville Public Utilities Board and the U.S. Army Corps of Engineers (USACE) have partnered to conduct this ecosystem restoration study.

Resaca Functions

Under natural processes, resacas are formed during events when the Rio Grande diverts from its previous channel and forms a new connection with the Gulf of Mexico. The new river course behind a disconnected waterbody that may be up to 40 miles long. Between these channel altering events, more frequent flooding events would deposit sediments and would segment the relict channel into a series of ponded areas referred to as resacas. Historically, most resacas were not hydrologically connected and the water in the resacas was provided via seasonal Rio Grande flood events. Larger flood events would also function to flush out sediments and replenish the resaca riparian areas with nutrients.

Through natural succession, resacas would tend to fill with sediments when they were isolated from the floodplain as the Rio Grande migrated farther away. Historically the loss of resacas due to natural sedimentation was accompanied by the formation of new resacas as the Rio Grande formed new pathways. However, the construction of Falcon (1954) and Amistad Dams (1968), the construction of 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. The river has not migrated across the landscape to form new resacas in more than 150 years. Similarly, the Rio Grande no longer provides the natural flushing and replenishment of the remaining resaca systems necessary to support the resaca hydrology and habitats. Currently, the resaca systems are connected to the Rio Grande through a series of man-made water diversion and irrigation canals. However, the man made connection does not provide seasonal flooding or deposition of nutrient rich sediments.

The historically dynamic hydrology and the subtropical climate of the area supported a unique and highly diverse floral and faunal resacas communities. The vegetation associated with the resacas would naturally transition through successional life cycles. Texas Ebony Resaca Forest or Subtropical Texas Palmetto Woodlands vegetation communities would dominate the lower, wetter areas around the resaca perimeter. These communities would transition to Texas Ebony/Snake-eyes vegetation communities as elevations increased away from the resaca.

Once a resaca became isolated from the floodplain of the Rio Grande, successional pressures would drive the transition of riparian vegetation into a more arid riparian Texas Ebony/Snake-eyes Shrubland and finally an upland Texas Ebony-Anacua/Brasil Forest community.

The vegetation communities that have evolved around the resaca ecosystems exhibit high biodiversity and exist only in the lower Rio Grande valley (LRGV) of Texas (Cameron, Hidalgo, and Willacy Counties) and Mexico.

Resource Significance

In compliance with the Council of Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations (CFR) 1500.1(b), 1501.7(a)(2) and (3), and 1502.2(b)), guidance for U.S. Army Corps of Engineers (USACE) ecosystem restoration projects require the identification of significant resources and attributes that are likely to be affected by one or more of the alternative plans (U.S. Water Resources Council, 1983). "Significant" is defined as "likely to have a material bearing on the decision-making process" (Apogee Research, Inc., 1996). Resource significance is determined by the importance and non-monetary value of the resource based on institutional, public, and technical recognition in the study area. The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (also known as Principles and Guidelines or P&G) defines these significance criteria as:

- Institutional Recognition: The importance of the resource or attribute is acknowledged in the laws, adopted plans, and other policy statements of public agencies or private groups.
- Public Recognition: The resource or attribute is considered important by some segment of the general public.
- Technical Recognition: The importance of the resource or attribute is based on scientific or technical knowledge or judgment of critical resource characteristics.

Institutional Recognition

Significance based on institutional recognition means that the importance of the environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies or private groups. The institutional recognition of resource significance for the Brownsville Resacas is demonstrated through the presence of species protected by the Endangered Species Act and the Migratory Bird Treaty Act. The red-crowned parrot is listed by the USFWS as a candidate species for listing under the Endangered Species Act and is known to occur within the study area. In addition, the restoration of the Resaca del Rancho Viejo system could contribute to the USFWS efforts in establishing an east-west travel corridor of the endangered ocelot, jaguarundi, and other species between eastern and western tracts of the Lower Rio Grande National Wildlife Refuge (NWR) and Resaca de la Palma State Park. (Figure A- 2).

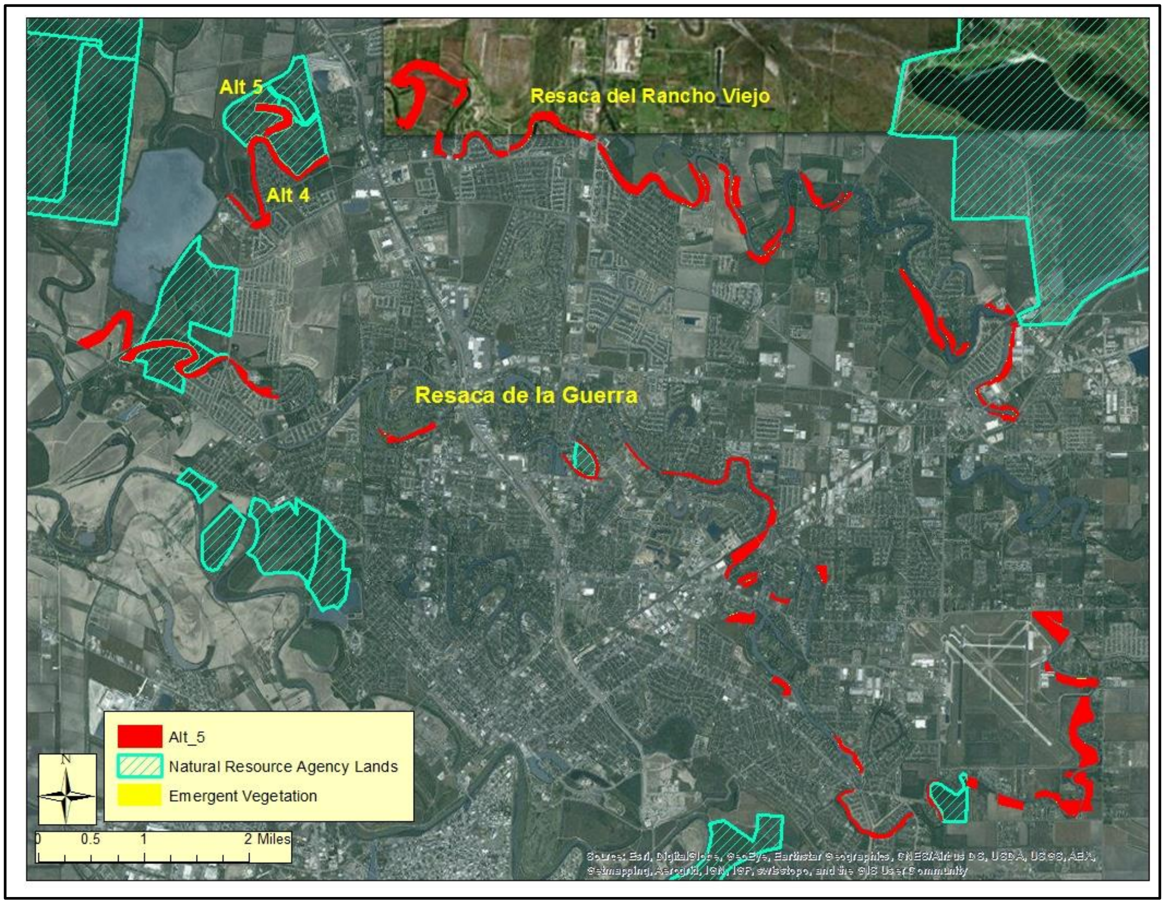


Figure A- 2: Habitat Connectivity and Resaca Habitats

The importance of the restoration of thorn-scrub and resaca habitats is well documented in the ocelot and jaguarundi recovery plans and the USFWS Wildlife Refuge Comprehensive Conservation Plans for the LRGV and Laguna Atascosa National Wildlife Refuge (USFWS, 1990, 2010, 2013, 2016b). Numerous rare, threatened, and endangered species designated by Texas Parks and Wildlife Department (TPWD) specifically depend on resaca and thorn-scrub habitats. These include the South Texas siren, black-spotted newt, Brownsville common yellowthroat, Audubon's oriole, rose-throated becard, tropical parula, southern yellow bat, black-striped snake, Texas indigo snake, Vasey's adelia, and Runyon's water-willow. Table A-1 lists the state and federal species designated as rare, threatened, or endangered. Table A-1 lists five species of amphibians, 27 species of birds, seven species of mammals, seven species of mollusks, 13 species of reptiles, and 23 species of plants. Table A-2 lists the TPWD species of concern and indicates the global and state status. Table A-2 listss 25 species of mammals, 32 species of birds, 22 species of reptiles and amphibians, 19 species of fishes, 30 species of invertebrates, and 62 species of plants of concern. Institutional recognition is also demonstrated by the presence of species protected by the Migratory Bird Treaty Act of 1918 and the Migratory Bird Conservation Act of 1929. The resaca ecosystems provide critical habitat for breeding, migratory, and wintering birds unique to the LRGV and protected by these Acts. Recognition is further demonstrated by the presence of the World Birding Center (WBC), a public/non-governmental organization (NGO) cooperative comprised of a network of nine unique birding sites in the LRGV. The World Birding Center includes the Resaca de la Palma State Park, located within the study area, that provides both ecological benefits and ecotourism dollars to the local economy. A list of birds that occur in the adjacent and nearby Resaca de la Palma State park and Bentsen Rio Grande State Park are presented in Table A-3. Table A-3 lists 365 birds that have been documented in these parks. This large number of birds supports local ecotourism for bird watchers from around the world.

Table A-1: Rare, Threatened, and Endangered Species

Common Name	Scientific Name	Listing1	Utilizes Aquatic/ Riparian Habitats	Habitat within Resacas Study Area
Amphibians				
Black-spotted Newt	*Notophthalmus meridionalis*	ST	Yes	Yes
Mexican Tree Frog	*Smilisca baudinii*	ST	Yes	Yes
Sheep Frog	*Hypopachus variolosus*	ST	Yes	Yes
South Texas Siren	*Siren sp 1*	ST	Yes	Yes
White-lipped Frog	*Leptodactylis fragilis*	ST	Yes	Yes
Birds				
American Peregrine Falcon	*Falco peregrinus anatum*	ST	Yes	Yes2
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	SOC	Yes	Yes2
Audubon's Oriole	*Icterus graduacauda audubonii*	SOC	Yes	Yes
Brown Pelican	*Pelecanus occidentalis*	ST	Yes	No
Brownsville Common Yellowthroat	*Geothlypis tricha insperata*	SOC	Yes	Yes
Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*	ST	Yes	Yes
Common Blackhawk	*Buteogallus anthracinus*	ST	Yes	Yes
Gray Hawk	*Asturina nitida*	ST	Yes	Yes
Interior Least Tern	*Sterna antillarum athalassos*	SE	Yes	No
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	FE,SE	No	No
Northern Beardless-Tyrannulet	*Campostoma imberbe*	ST	Yes	Yes
Piping Plover	*Charadrius melodus*	FT,ST	Yes	No
Red Knot	*Calidris canutus rufa*	FT, SOC	Yes	No
Red-crowned Parrot	*Amazona viridigenalis*	FC	Yes	Yes
Reddish Egret	*Egretta rufescens*	ST	Yes	No

Rose-throated Becard	*Pachyramphus aglaiae*	ST	Yes	Yes
Sennett's Hooded Oriole	*Icterus cucullatus sennetti*	SOC	Yes	Yes
Snowy Plover	*Charadrius alexandrinus*	SOC	Yes	No
Sooty Tern	*Sterna fuscata*	ST	Yes	No
Sprague's Pipit	*Anthus spragueii*	SOC	No	No
Texas Botteri's Sparrow	*Aimophila botterii texana*	ST	No	No
Tropical Parula	*Parula pitayumi*	ST	Yes	Yes
Western Burrowing Owl	*Athene cuniclaria hyougaea*	SOC	No	No
White-faced Ibis	*Plegadis chihi*	ST	Yes	Yes2
White-tailed Hawk	*Buteo albicaudatus*	ST	Yes	No
Wood Stork	*Mycteria americana*	ST	Yes	Yes2
Zone-tailed Hawk	*Buteo albonotatus*	ST	Yes	Yes
Fishes				
American Eel	*Anguilla rostrata*	SOC	Yes	Yes
Mexican Goby	*Ctenogobius claytonii*	ST	Yes	Yes
Opossum Pipefish	*Microphis brachyurus*	ST	Yes	Yes
Rio Grande Shiner	*Notropis jemezanus*	SOC	Yes	No
Rio Grande Silvery Minnow	*Hybognathus amarus*	FE,SE	Yes	Yes5
River Goby	*Awaous banana*	ST	Yes	Yes
Smalltooth Sawfish	*Pristis pectinata*	SE	Yes	No
Mammals				
Cave myotis bat	*Myotis velifer*	SOC	No	Yes4
Coues' Rice Rat	*Oryzomys couesi*	ST	Yes	Yes
Ghost-faced bat	*Mormoops megalophylla*	SOC	No	Yes4
Jaguar	*Panthera onca*	SE	Yes	Yes5
Jaguarundi	*Herpailurus yaguarondi*	FE,SE	Yes	Yes
Mexican Fawnsfoot	*Truncilla cognata*	ST	Yes	No
Mexican Long-tounged Bat	*Choeronycteris mexicana*	SOC	No	Yes4
Mollusks				
Ocelot	*Leopardus pardalis*	FE,SE	Yes	Yes
Plains Spotted Skunk	*Spilogale putorius interrupta*	SOC	No	No
Salina Mucket	*Potamilus metnecktayi*	ST	Yes	Yes
Southern Yellow Bat	*Lasiurus ega*	ST	Yes	Yes
Texas Hornshell	*Popenaias popeii*	ST	Yes	No
West Indian Manatee	*Trichechus manatus*	SE	Yes	No
White-nosed Coati	*Nasua narica*	ST	Yes	No
Reptiles				
Atlantic Hawksbill Sea Turtle	*Eretmochelys imbricata*	FE,SE	Yes	No
Black-striped Snake	*Coniophanes imperalis*	ST	Yes	Yes
Green Sea Turtle	*Chelonia mydas*	FT,ST	Yes	No
Keeled Earless Lizard	*Holbrookia propinqua*	SOC	Yes	No
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	FE,SE	Yes	No
Leatherback Sea Turtle	*Dermochelys coriacea*	FE,SE	Yes	No
Loggerhead Sea Turtle	*Caretta carette*	FT,ST	Yes	No
Northern Cat-eyed Snake	*Leptodeira septentrionalis septentrionalis*	ST	Yes	Yes
Speckled Racer	*Drymobius margaritiferus*	ST	Yes	Yes
Texas Horned Lizard	*Phrynosoma cornutum*	ST	No	Yes
Texas Indigo Snake	*Drymarchon melanurus erebennus*	ST	Yes	Yes
Texas Scarlet Snake	*Cemophora coccinea lineri*	ST	No	No
Texas Tortoise	*Gopherus berlandier*	ST	No	Yes
Plants				
Bailey's Ballmoss	*Tilandsia baileyi*	SOC	Y	Y
Big red sage	*Salvia pentstemenoides*	SOC	Y	Y

Buckley's Spiderwort	*Tradescantia buckleyi*	SOC	N	N
Correll's false dragon-head	*Physostegia correllii*	SOC	Y	Y
Green Island Echeandia	*Echeandia texensis*	SOC	N	N
Large Selenia	*Selenia grandis*	SOC	Y	Y
Lilia de los Llanos	*Echeandia chandleri*	SOC	N	N
Marsh Elder Dodder	*Cuscuta attenuata*	SOC	Y	Y
Mexican Mud-plantain	*Heteranthera mexicana*	SOC	Y	Y
Plains Gumweed	*Grindelia oolepis*	SOC	N	N
Runton's Water-willow	*Justicia runyonii*	SOC	Y	Y
Runyon's Cory Cactus	*Coryphantha macromeris var runyonii*	SOC	N	N
Shinners' Rocket	*Thelypodiops shinnersi*	SOC	Y	Y
Siler's Huaco	*Manfreda sileri*	SOC	N	N
South Texas Ambrosia	*Ambrosia cheiranthiflois*	FE,SE	Y	N
South Texas Spikesedge	*Eleocharis austrotexana*	SOC	Y	Y
Star Cactus	*Astrophytum asterias*	FE,SE	N	N
Texas Ayenia	*Ayenia limitaris*	FE,SE	N	N
Texas Milk Vetch	*Astragalus reflexus*	SOC	N	N
Texas Stonecrop	*Lenophyllum texanum*	SOC	N	N
Vasey's Adelia	*Adelia vaseyi*	SOC	Y	Y
Wright's Trichocoronis	*Trichcoromis wrightii var. wrightii*	SOC	Y	Y
Yellow-flowered Alicoche	*Echinocereus papillosus*	SOC	N	N
1FE-Federal-listed Endangered, FT-Federal-listed Threatened, SE – State-listed Endangered; FC –Candidate for Federal Listing; ST – State-listed Threatened; SOC – State Species of Concern, 2Potential migrant, 3Study area is at the limits of known range 4Potential foraging area, 5Historic, Extirpated from study area, TPWD (2016), USFWS (2016a)				

Table A-2: TPWD Species of Concern

Species	Specific Epithet	Global/State Ranking
MAMMALS		
Pallid bat	*Antrozous pallidus*	G5/S5
Nelson's pocket mouse	*Chaetodipus nelsoni*	G5/S?
Hog-nosed skunk	*Conepatus leuconotus*	G5/S4
Ord's kangaroo rat	*Dipodomys ordii parvabullatus*	G5/S4
Attwater's pocket gopher	*Geomys attwateri*	G4/S4
Texas pocket gopher	*Geomys personatus davisi*	G4T2/S2
Strecker's pocket gopher	*Geomys streckeri*	G4T1/S1
Frio pocket gopher	*Geomys texensis bakeri*	G2QT2/S2
Jaguarundi	*Herpailurus yaguarondi*	G4/S1
Southern yellow bat	*Lasiurus ega*	G5/S1
Ocelot	*Ocelot*	G4/S1
Ghost-faced bat	*Mormoops megalophylla*	G4/S2
Long-tailed weasel	*Mustela frenata*	G5/S5
Cave myotis	*Myotis velifer*	G5/S4
White-nosed coati	*Nasua narica*	G5/S2?
Mink	*Neovision vison*	G5/S4
Desert shrew	*Notiosorex crawfordii*	G5/S4
Big free-tailed bat	*Nyctinomops macrotis*	G5/S3
Coues rice rat	*Oryzomys couesi aquaticus*	G5T3?/S2
Mountain lion	*Puma concolor*	G5/S2
Eastern mole	*Scalopus aquaticus*	G5/S5
Western spotted skunk	*Spilogale gracilis*	G5/S5
Eastern spotted skunk	*Spilogale putorius*	G4T/S4
Brazilian free-tailed bat	*Tadarida brasiliensis*	G5/S5
American badger	*Taxidea taxus*	G5/S5

Species	Specific Epithet	Global/State Ranking
BIRDS		
Mottled Duck	*Anas fulvigula*	G4/S4B
Northern Pintail	*Anas acuta*	G5/S3B,S5N
Scaled Quail	*Callipepla squamata*	G5/S4B
Northern Bobwhite	*Colinus virginianus*	G5/S4B
Wild Turkey	*Meleagris gallopavo*	G5/S5B
Hook-billed Kite	*Chondrohierax uncinatus*	G4/S2
Northern Harrier	*Circus cyaneus*	G5/S2B,S3N
Common Black-hawk	*Buteogallus anthracinus*	G4G5/S2B
Harris's Hawk	*Parabuteo unicinctus*	G5/S3B
Red-shouldered Hawk	*Buteo lineatus*	G5/S4B
Gray Hawk	*Buteo nitidus*	G5/S2B
Swainson's Hawk	*Buteo swainsoni*	G5/S4B
Mountain Plover	*Charadrius montanus*	G3/S2
Least Tern	*Sternula antillarum*	G4/S3B
Green Parakeet	*Aratinga holochlora*	G3/S3
Red-crowned Parrot	*Amazona viridigenalis*	G2/S2
Ferruginous Pygmy-owl	*Glaucidium brasilianum*	G5/S3B
Burrowing Owl	*Athene cunicularia*	G4/S3B
Northern Beardless-tyrannulet	*Camptostoma imberbe*	G5/S3B
Scissor-tailed Flycatcher	*Tyrannus forficatus*	G5/S3B
Loggerhead Shrike	*Lanius ludovicianus*	G4/S4B
Bell's Vireo	*Vireo bellii*	G5/S3B
Sprague's Pipet	*Anthus spragueii*	G4/S3N
Tropical Parula	*Parula pitiayumi*	G5/S3B
Cassin's Sparrow	*Aimophila cassinii*	G5/S4B
Grasshopper Sparrow	*Ammodramus savannarum*	G5/S3B
Lark Sparrow	*Chondestes grammacus*	G5/S4B
Summer Tanager	*Piranga rubra*	G5/S5B
Painted Bunting	*Passerina ciris*	G5/S4B
Dickcissel	*Spiza americana*	G5/S4B
Eastern Meadowlark	*Sturnella magna*	G5/S5B
Orchard Oriole	*Icterus spurious*	G5S4B
REPTILES AND AMPHIBIANS		
Spiny softshell turtle	*Apalone spinifera*	X
Black-striped snake	*Coniophanes imperialis*	
Western diamondback rattlesnake	*Crotalus atrox*	S4
Reticulate collared lizard	*Crotaphytus reticulatus*	G3/S2
Texas indigo snake	*Drymarchon melanurus erebennus*	G4/S3
Texas tortoise	*Gopherus berlandieri*	G4/S2*
Western hognosed snake	*Heterodon nasicus*	X
Southern earless lizard	*Holbrookia lacerata subcaudalis*	X
Northern earless lizard	*Holbrookia propinqua propinqua*	SX
Sheep frog	*Hypopachus variolosus*	G5/S2
White-lipped frog	*Leptodactylus variolosus*	G5/S1
Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*	G5T5/S2
Black-spotted newt	*Notophthalmus meridionalis*	G1/S1 or S2?
Texas horned lizard	*Phrynosoma cornutum*	G4G5/S4
Rio Grande cooter	*Pseudemys gorzugi*	S2
Texas blind snake	*Rena dulcis*	X

Species	Specific Epithet	Global/State Ranking
Mexican burrowing toad	*Rhinophrynus dorsalis*	G5/S2
Rio Grande siren (large form)	*Siren sp.*	GNRQ/S2
Massasagua	*Sistrurus catenatus*	X
Mexican blackhead snake	*Tantilla atriceps*	X
Ornate box turtle	*Terrapene ornate*	G5/S3
Red-eared slider	*Trachemys scripta*	X
	FISHES	
American eel	*Anguilla rostrata*	G4/S5
Alligator gar	*Atractosteus spatula*	X
Rio Grande blue sucker	*Cycleptus sp.*	X
Plateau shiner	*Cyprinella lepida*	G1G2/S1S2
Proserpine shiner	*Cyprinella proserpina*	G3/S2
Nueces River shiner	*Cyprinella sp.*	G1G2Q/S1S2
Devils River pupfish	*Cyprinodon eximius ssp.*	X
Manantial roundnose minnow	*Dionda argentosa*	G2/S2
Devil's River minnow	*Dionda diaboli*	G1/S1
Nueces roundnose minnow	*Dionda serena*	G2/S2
Rio Grande darter	*Etheostoma grahami*	G2G3/S2
San Felipe gambusia	*Gambusia clarkhubbsi*	G1/S1
Blotched gambusia	*Gambusia senilis*	G3G4/SX
Rio Grande silvery minnow	*Hybognathus amarus*	G1G2/SX
Headwater catfish	*Ictalurus lupus*	G3/S2
Texas shiner	*Notropis amarus*	X
Tamaulipas shiner	*Notropis braytoni*	X
Rio Grande shiner	*Notropis jemezanus*	X
Longnose dace	*Rhinichthys cataractae*	X
	INVERTEBRATES	
A mining bee	*Andrena scotoptera*	G1*S1*
Rio Grande gold tarantula	*Aphonopelma moderatum*	G2G3*/S2?*
Rio Grande thread-legged katydid	*Arethaea phantasma*	G2?*/S2?*
Texas Austrotinodes caddisfly	*Austrotinodes texensis*	G2/S2
American bumblebee	*Bombus pensylvanicus*	GU/SU*
Sonoran bumblebee	*Bombus sonorus*	GU/SU*
A mayfly	*Caenis arwini*	G1G3/S2?*
Brownsville meadow katydid	*Conocephalus resacensis*	G2?*/S2?*
Percosius skipper	*Decinea percosius*	G1G3/S1S3*
Acacia fairy shrimp	*Dendrocephalus acacioidea*	G1/S1*
Gladiator short-winged katydid	*Dichopetala gladiator*	G2?*/S2?*
Glossy wolfsnail	*Euglandina texasiana*	G1G2/S1S2*
Tamaulipan clubtail	*Gomphus gonzalezi*	G2/S2*
Devils River Springs riffle beetle	*Heterelmis sp.*	G1*/S1*
A mayfly	*Latineosus cibola*	G1G2/S1?*
A leaf-cutting beetle	*Megachile parksi*	G1*/S1*
Texas angle-wing	*Microcentrum minus*	G1?*/S1?*
Texas minute moss beetle	*Neocylloepus boeseli*	G1G2*/S1*
Daedelus sheildback katydid	*Pediodectes daedelus*	G1?*/S1?*
Mitchell's shieldback katydid	*Pediodectes mitchelli*	G1?*/S1?*
Pratt's shieldback katydid	*Pediodectes pratti*	G1?*/S1?*
A mining bee	*Perdita fraticincta*	G1*/S1*
A mining bee	*Perdita tricincta*	G1*/S1*
Texas hornshell	*Popenaias popeii*	G1/S1
Salina mucket	*Potamilus metnecktayi*	G1/S1
White scrubsnail	*Praticolella candida*	G2/S2*
Hidalgo scrubsnail	*Praticolella trimatris*	G2/S2*

Species	Specific Epithet	Global/State Ranking
Nueces crayfish	*Procambarus nueces*	G1/S1
Golden orb	*Quadrula aurea*	G1/S2*
Manfreda giant-skipper	*Stallingsia maculosus*	G1G2/S1S2
PLANTS		
Texas trumpets	*Acleisanthes crassifolia*	G2/S2
Wright's trumpets	*Acleisanthes wrightii*	G2/S2
Vasey's adelia	*Adelia vaseyi*	G3/S3
Silvery wild-mercury	*Argythamnia argyraea*	G2/S2
Prostrate milkweed	*Asclepias prostrata*	G1G2/S1S2
Texas milkvetch	*Astragalus reflexus*	G3/S3
Star cactus	*Astrophytum asterias*	G2/S1S2
Kleberg saltbush	*Atriplex klebergorum*	G2/S2
Anacacho orchid	*Bauhinia lunarioides*	G3/S1
South Texas rushpea	*Caesalpinia phyllanthoides*	G2/S1
Two-flower stick-pea	*Calliandra biflora*	G3/S3
Chihuahuan balloon-vine	*Cardiospermum dissectum*	G2G3/S3
Crown tickseed	*Coreopsis nuecensis*	G3/S3
Runyon's cory cactus	*Coryphantha macromeris var. runyonii*	G5T2T3/S2S3
Nickel's cory cactus	*Coryphantha nickelsiae*	G2/SH
Tree dodder	*Cuscuta exaltata*	G3/S3
Net-leaf bundleflower	*Desmanthus reticulates*	G3/S3
Yellow-flowered alicoche	*Echinocereus papillosus*	G3/S3
Fitch's hedgehog cactus	*Echinocereus reichenbachii ssp. fitchii*	G5T3/S3
Black lace cactus	*Echinocereus reichenbachii var. albertii*	G5T1Q/S1
Gregg's wild-buckwheat	*Eriogonum greggii*	
Low spurge	*Euphorbia peplidion*	G3/S3
Johnston's frankenia	*Frankenia johnstonii*	G3/S3
Woolly butterfly-weed	*Gaura villosa ssp. parksii*	G5T3/S3
South Texas gilia	*Gilia ludens*	G3/S3
Dimmit sunflower	*Helianthus praecox ssp. hirtus*	G4T2Q/S2
Mexican mud-plantain	*Heteranthera mexicana*	G2G3/S1
Drummond's rushpea	*Hoffmannseggia drummondii*	G3/S3
Slender rushpea	*Hoffmannseggia tenella*	G1/S1
Correll's bluet	*Houstonia correllii*	G1/S1
Greenman's bluet	*Houstonia croftiae*	G3/S3
Greenman's bluet	*Houstonia parviflora*	G3/S3
Texas stonecrop	*Lenophyllum texanum*	G3/S3
St. Joseph's staff	*Manfreda longiflora*	G2/S2
Siler's huaco	*Manfreda sileri*	G3/S3
Walker's manioc	*Manihot walkerae*	G3/S3
Shortcrown milkvine	*Matelea brevicoronata*	G3/S3
Falfurrias milkvine	*Matelea radiata*	GH/SH
Arrowleaf milkvine	*Matelea sagittifolia*	G3/S3
Heartleaf evening-primrose	*Oenothera cordata*	G3/S3
Bushy whitlow-wort	*Paronychia congesta*	G1/S1
McCart's whitlow-wort	*Paronychia maccartii*	G1/S1
Bristle nailwort	*Paronychia setacea*	G3/S3
Rydberg's scurfpea	*Pediomelum humile*	G1/S1
Sand sheet leaf-flower	*Phyllanthus abnormis var. riograndensis*	G5T3/S3
Zapata bladderpod	*Physaria thamnophila*	G1/S1

Species	Specific Epithet	Global/State Ranking
South Texas yellow clammyweed	*Polanisia erosa ssp. breviglandulosa*	G5T3T4/S3S4B
Stinking rushpea	*Pomaria austrotexana*	G3/S3
Texas almond	*Prunus minutiflora*	G3G4/S3S4
Texas peachbush	*Prunus texana*	G3G4/S3S4
South Texas false cudweed	*Pseudognaphalium austrotexanum*	G3/S3
Large selenia	*Selenia grandis*	G3/S3
Jones' selenia	*Selenia jonesii*	G3/S3
Billie's bitterweed	*Tetraneuris turneri*	G3/S3
Burridge greenthread	*Thelesperma burridgeanum*	G3/S3
Shinner's rocket	*Thelypodiopsis shinnersii*	G2/S2
Ashy dogweed	*Thymophylla tephroleuca*	G2/S2
Bailey's ballmoss	*Tillandsia baileyi*	G2G3/S2
Buckley's spiderwort	*Tradescantia buckleyi*	G3/S3
Small-leaved yellow velvet-leaf	*Wissadula parvifolia*	G1/S1
Texas shrimp-plant	*Yeatesia platystegia*	G3G4/S3S4
Jones's rainlily	*Zephyranthes jonesii*	G3/S3

Table A-3: Bird Species Occurring in Resaca de la Palma State Park and Bentson Rio Grande State Park

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Anatidae						
Black-bellied Whistling Duck	*Dendrocygna autumnalis*	C	C	C	U	X
Fulvous Whistling Duck	*Dendrocygna bicolor*	U		U	R	
Greater White-fronted Goose	*Anser albifrons*			U	U	
Snow Goose	*Chen caerulescens*			U	U	
Ross' Goose	*Chen rossii*			R	R	
Canada Goose	*Branta canadensis*			X	X	
Muscovy Duck	*Cairina moschata*	U	U	U	U	
Wood Duck	*Aix sponsa*	R	R	X	R	
Gadwall	*Anas strepera*	U		R	C	
American Wigeon	*Anas Americana*	U		R	C	
Mexican Duck	*Anas platyrhynchos diazi*	R	R	R	R	X
Mallard	*Anas platyrhynchos*	R	R		R	
Mottled Duck	*Anas fulvigula*	C	C	C	C	X
Blue-winged Teal	*Anas discors*	C		C	C	X
Cinnamon Teal	*Anas cyanoptera*	R		R	R	
Northern Shoveler	*Anas clypeata*	C	R	C	C	
Northern Pintail	*Anas acuta*				C	
Green-winged Teal	*Anas crecca*	C			C	
Canvasback	*Aythya valisineria*	C		U	U	
Redhead	*Aythya americana*	C		C	C	
Ring-necked Duck	*Aythya collaris*	U		U	C	
Greater Scaup	*Aythya marila*	R				
Lesser Scaup	*Aythya affinis*	C		C	C	
Bufflehead	*Bucephala albeola*	U		C	C	

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Hooded Merganser	*Lophodytes cucullatus*				R	
Masked Duck	*Nomonyx dominicus*	X	X	X	X	
Ruddy Duck	*Oxyura jamaicensis*	C	R	C	C	X
Cracidae						
Plain Chachalaca	*Ortalis vetula*	C	C	C	C	X
Odontophoridae						
Northern Bobwhite	*Colinus virginianus*	F	C	F	U	X
Phasianidae						
Wild Turkey	*Meleagris gallopavo*	X	X	X	X	
Podicipedidae						
Least Grebe	*Tachybaptus dominicus*	C	C	C	C	X
Pied-billed Grebe	*Podilymbus podiceps*	C	U	C	C	
Eared Grebe	*Podiceps nigricollis*	R		R	R	
Ciconiidae						
Jabiru	*Jabiru mycteria*		X			
Fregatidae						
Magnificent Frigatebird	*Fregata magnificens*				X	
Phalacrocoracidae						
Neotropic Cormorant	*Phalacrocorax brasilianus*	C	C	U	U	X
Double-crested Cormorant	*Phalacrocorax auritus*	C		C	C	
Anhingidae						
Anhinga	*Anhinga anhinga*	C	U	U	U	X
Pelecanidae						
American White Pelican	*Pelecanus erythrorhynchos*	C	C	C	C	
Brown Pelican	*Pelecanus occidentalis*	R	R	R	R	
Ardeidae						
American Bittern	*Botaurus lentiginosus*	R		R	R	
Least Bittern	*Ixobrychus exilis*	R	R	R	X	X
Bare-throated Tiger-heron	*Tigrisoma mexicanum*	X				
Great Blue Heron	*Ardea Herodias*	C	C	C	C	
Great Egret	*Ardea alba*	C	C	C	C	
Snowy Egret	*Egretta thula*	C	C	C	C	
Little Blue Heron	*Egretta caerulea*	C	C	C	R	
Tricolored Heron	*Egretta tricolor*	U	U	U	U	
Reddish Egret	*Egretta rufescens*		X	X	X	
Cattle Egret	*Bubulcus ibis*	U	U	U	U	
Green Heron	*Butorides virescens*	C	C	C	C	X
Black-crowned Night-heron	*Nycticorax nycticorax*	U	U	C	R	X
Yellow-crowned Night-heron	*Nyctanassa violacea*	C	U	C	R	
Threskiornithidae						
White Ibis	*Eudocimus albus*	C	C	C	U	
White-faced Ibis	*Plegadis chihi*	C	U	C	U	
Roseate Spoonbill	*Platalea ajaja*	C	C	C	C	
Ciconidae						
Wood Stork	*Mycteria americana*		U	U		
Cathartidae						
Black Vulture	*Coragyps atratus*	C	C	C	C	
Turkey Vulture	*Cathartes aura*	A	C	A	C	

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Pandionidae						
Osprey	*Pandion haliaetus*	R	X	R	R	
Accipitridae						
Hook-billed Kite	*Chondrohierax uncinatus*	R	R	R	R	X
Swallow-tailed Kite	*Elanoides forficatus*	R	X	R		
White-tailed Kite	*Elanus leucurus*	U	U	U	U	X
Snail Kite	*Rostrhamnus sociabilis*		X			
Mississippi Kite	*Ictinia mississippiensis*	C		C		
Bald Eagle	*Haliaetus leucocephalus*	X				
Northern Harrier	*Circus cyaneus*	U		U	U	
Sharp-shinned Hawk	*Accipiter striatus*	C		C	U	
Cooper’s Hawk	*Accipiter cooperii*	C	X	C	R	X
Northern Goshawk	*Accipiter gentilis*		V		V	
Harris’ Hawk	*Parabuteo unicinctus*	C	C	C	C	X
Roadside Hawk	*Buteo magnirostris*	X			X	
Gray Hawk	*Buteo plagiatus*	R	R	R	R	X
Red-shouldered Hawk	*Buteo lineatus*	C	R	R	C	
Broad-winged Hawk	*Buteo platypterus*	A		A		
Short-tailed Hawk	*Buteo brachyurus*		X	X	X	
Swainson’s Hawk	*Buteo swainsoni*	A	X	A		
White-tailed Hawk	*Buteo albicaudatus*	C	C	C	C	
Zone-tailed Hawk	*Buteo albonotatus*				X	
Red-tailed Hawk	*Buteo jamaicensis*	C	F	C	C	
Ferruginous Hawk	*Buteo regalis*	R			R	
Falconidae						
Collared Forest-falcon	*Micrastur semitorquatus*	X				
Crested Caracara	*Caracara cheriway*	U	U	U	U	
American Kestrel	*Falco sparverius*	C	R	C	C	
Merlin	*Falco columbiarius*	R		R	R	
Aplomado Falcon	*Falco femoralis*	X				
Peregrine Falcon	*Falco peregrines*	R	X	R	R	
Prairie Falcon	*Falco mexicanus*				X	
Rallidae						
King Rail	*Rallus elegans*	R	R	R	R	X
Virginia Rail	*Rallus limicola*	R		R	R	
Sora	*Porzana carolina*	U		U	R	
Purple Gallinule	*Porphyrio martinica*	U	R			
Common Gallinule	*Gallinula galeata*	C	C	C	C	X
American Coot	*Fulica americana*	A	C	A	A	X
Gruidae						
Sandhill Crane	*Grus canadensis*	U		C	C	
Charadriidae						
Black-bellied Plover	*Pluvialis squatarola*	U	R	U	U	
American Golden-plover	*Pluvialis dominica*	C				
Semipalmated Plover	*Charadrius semipalmatus*	U	U	U	U	
Killdeer	*Charadrius vociferous*	C	C	C	C	X
Recurvirostridae						
Black-necked Stilt	*Himantopus mexicanus*	C	C	C	C	X

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
American Avocet	*Recurvirostra americana*	C	U	C	C	
Jacanidae						
Northern Jacana	*Jacana spinosa*		X	X	X	
Scolopacidae						
Spotted Sandpiper	*Actitis macularius*	U	U	U	U	
Solitary Sandpiper	*Tringa solitaria*	U	U	U	U	
Greater Yellowlegs	*Tringa melanoleuca*	C	U	C	U	
Willet	*Tringa semipalmata*				R	
Lesser Yellowlegs	*Tringa flavipes*	C	U	C	C	
Upland Sandpiper	*Bartramia longicauda*	C		C		
Whimbrel	*Numenius phaeopus*	X				
Long-billed Curlew	*Numenius americanus*	C	U	C	C	
Hudsonian Godwit	*Limosa haemastica*	U				
Semipalmated Sandpiper	*Calidris pusilla*	U		U		
Western Sandpiper	*Calidris mauri*	C	U	C	C	
Least Sandpiper	*Calidris minutilla*	C	C	C	C	
White-rumped Sandpiper	*Calidris fuscicollis*	U				
Baird's Sandpiper	*Calidris bairdii*	U		U		
Pectoral Sandpiper	*Calidris melanotos*	C	U	U		
Dunlin	*Calidris alpina*	C		C	C	
Stilt Sandpiper	*Calidris himantopus*	C	U	C	U	
Buff-breasted Sandpiper	*Tryngites subruficollis*	U		U		
Short-billed Dowitcher	*Limnodromus griseus*	C	C	C	C	
Long-billed Dowitcher	*Limnodromus scolopaceus*	A	C	A	A	
Wilson's Snipe	*Gallinago delicata*	U		U	U	
Wilson's Phalarope	*Phalaropus tricolor*	C		U	U	
Laridae						
Laughing Gull	*Leucophaeus atricilla*	A	A	A	A	
Franklin's Gull	*Leucophaeus pipixcan*	A		A	R	
Ring-billed Gull	*Larus delawarensis*	C	R	C	C	
Least Tern	*Sternula antillarum*		R	R		
Gull-billed Tern	*Gelochelidon nilotica*	U	U	U	U	
Caspian Tern	*Hydroprogne caspia*	U	U	U	U	
Black Tern	*Chlidonias niger*	U	U	U		
Forster's Tern	*Sterna forsteri*	C	C	C	C	
Black Skimmer	*Rynchops niger*	C	C	C	C	
Columbidae						
Rock Pigeon	*Columbia livia*	C	C	C	C	
Red-billed Pigeon	*Patagioenas flavirostris*		R	R		X
Eurasian Collared-dove	*Streptopelia decaocto*	U	U	U	U	
White-winged Dove	*Zenaida asiatica*	A	A	A	A	X
Mourning Dove	*Zenaida macroura*	A	A	A	A	X
Inca Dove	*Columbina inca*	C	C	C	C	X
Common Ground-dove	*Columbina passerina*	C	C	C	C	X
Ruddy Ground-dove		X				
White-tipped Dove	*Leptotila verreauxi*	U	U	U	U	X
Cuculidae						
Yellow-billed Cuckoo	*Coccyzus americanus*	U	C	R		X

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Black-billed Cuckoo	*Coccyzus erythropthalmus*	R		R		
Greater Roadrunner	*Geococcyx californianus*	U	U	U	U	X
Groove-billed Ani[4]	*Crotophaga sulcirostris*	U	C	C	R	X
Tytonidae						
Barn Owl	*Tyto alba*	U	U	U	U	X
Strigidae						
Eastern Screech-owl	*Megascops asio*	U	U	U	U	X
Great Horned Owl	*Bubo virginianus*	U	U	U	U	X
Ferruginous Pygmy-owl	*Glaucidium brasilianum*	X	X	X	X	
Elf Owl	*Micrathene whitneyi*	X	C	U		X
Burrowing Owl	*Athene cunicularia*			R	R	
Mottled Owl	*Strix virgata*	X				
Long-eared Owl	*Asio otus*	R				
Stygian Owl	*Asio stygius*	X				
Short-eared Owl	*Asio flammeus*	R		R	R	
Caprimulgidae						
Lesser Nighthawk	*Chordeiles acutipennis*	U	C	C	R	X
Common Nighthawk	*Chordeiles minor*	C	C	C		
Common Pauraque	*Nyctidromus albicollis*	U	U	U	U	X
Chuck-will's-widow	*Caprimulgus carolinensis*	U		U		
Eastern Whip-poor-will	*Caprimulgus vociferus*	R		R		
Apodidae						
Chimney Swift	*Chaetura pelagica*	C	U	U		
Trochilidae						
Green Violetear	*Colibri thalassinus*		X			
Lucifer Hummingbird	*Calothorax Lucifer*		X			
Buff-bellied Hummingbird	*Amazilia yucatanensis*	U	U	U	U	
Ruby-throated Hummingbird	*Archilochus colubris*	C		C	X	
Black-chinned Hummingbird	*Archilochus alexandri*	U	U	R	R	
Anna's Hummingbird	*Calypte anna*	X				
Allen's Hummingbird	*Selasphorus sasin*	X			X	
Broad-billed Hummingbird	*Cynanthus latirostris*			X		
Rufous Hummingbird	*Selasphorus rufus*	R	X	R	R	X
Trogonidae						
Elegant Trogon					X	
Alcedinidae						
Ringed Kingfisher	*Megaceryle torquata*	U	U	U	U	X
Belted Kingfisher	*Megaceryle alcyon*	U	R	U	U	
Green Kingfisher	*Chloroceryle americana*	U	U	U	U	X
Picidae						
Golden-fronted Woodpecker	*Melanerpes aurifrons*	C	C	C	C	X
Yellow-bellied Sapsucker	*Sphyrapicus varius*	U		U	U	
Ladder-backed Woodpecker	*Picoides scalaris*	U	U	U	U	X
Northern Flicker	*Colaptes punctigula*	R		U	U	
Psittacidae						
Green Parakeet	*Psittacara holochlorus*	X	X	X	X	
Tyranidae						
Northern Beardless-tyrannulet	*Campostoma imberbe*	R	R	R	R	X

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Olive-sided Flycatcher	*Contopus cooperi*	R		R		
Eastern Wood-Pewee	*Contopus virens*	U		U		
Yellow-bellied Flycatcher	*Empidonax flaviventris*	R		R		
Acadian Flycatcher	*Empidonax virescens*	R		R		
Alder Flycatcher	*Empidonax alnorum*	R		R		
Willow Flycatcher	*Empidonax traillii*	R		R		
Least Flycatcher	*Empidonax minimus*	R		R	R	
Gray Flycatcher	*Empidonax wrightii*	X				
Cordilleran Flycatcher	*Empidonax occidentlais*	X				
Black Phoebe	*Sayornis nigricans*	U	U	U	U	X
Eastern Phoebe	*Sayornis phoebe*	R		U	U	
Say's Phoebe	*Sayornis saya*			R	R	
Dusky-capped Flycatcher	*Empidonax oberholseri*	X				
Vermilion Flycatcher	*Pyrocephalus rubinus*	R	R	R	R	
Ash-throated Flycatcher	*Myiarchus cinerascens*	U		R	R	
Great Crested Flycatcher	*Myiarchus crinitus*	R	R	R		
Brown-crested Flycatcher	*Myiarchus tyrannulus*	U	U	U		X
Great Kiskadee	*Pitangus sulphuratus*	U	U	U	U	X
Social Flycatcher	*Myiozetetes similis*	X				
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*		X			
Piratic Flycatcher	*Legatus leucophaius*		X			
Tropical Kingbird	*Tyrannus melancholicus*	R	R	R	R	
Couch's Kingbird	*Tyrannus couchii*	U	U	U	R	X
Western Kingbird	*Tyrannus verticalis*	U	U			X
Eastern Kingbird	*Tyrannus tyrannus*	U		U		
Scissor-tailed Flycatcher	*Tyrranus forficatus*	C	U	C	R	X
Tityridae						
Masked Tityra	*Tityra semifasciata*				X	
Rode-throated Becard	*Pachyramphus aglaiae*	X			X	
Laniidae						
Loggerhead Shrike	*Lanius ludovicianus*	U	R	U	U	
Vireonidae						
White-eyed Vireo	*Vireo griseus*	U	U	U	U	X
Bell's Vireo	*Vireo bellii*	R	R	R		
Yellow-throated Vireo	*Vireo flavifrons*	R		R		
Blue-headed Vireo	*Vireo solitaries*	U		U	U	
Warbling Vireo	*Vireo gilvus*	U		U		
Philadelphia Vireo	*Vireo philadelphicus*	U		R		
Red-eyed Vireo	*Vireo olivaceus*	U		U		
Yellow-green Vireo	*Vireo flavoviridis*		R	R		
Corvidae						
Green Jay	*Cyanocorax yncas*	C	C	C	C	X
Blue Jay	*Cyanocitta cristata*	X				
Tamaulipas Crow	*Corvus imparatus*			X		
Chihuahuan Raven	*Corvus cryptoleucus*	U	U	U	U	
Aludidae						
Horned Lark	*Erempphila alpestris*	R	R	R	R	X
Hirundinidae						

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Purple Martin	*Progne subis*	C	U	C		
Tree Swallow	*Tachycineta bicolor*	C		C	C	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	U	U	U	R	
Bank Swallow	*Riparia riparia*	C	C	C		X
Cliff Swallow	*Petrochelidon pyrrhonota*	U	U	U		X
Cave Swallow	*Petrochelidon fulva*	C	C	C	C	X
Barn Swallow	*Hirundo rustica*	C	C	C	R	X
Paridae						
Black-crested Titmouse	*Baeolophus atricristatus*	U	U	U	U	X
Remizidae						
Verdin	*Auriparus flaviceps*	U	U	U	U	X
Sittidae						
Red-breasted Nuthatch	*Sitta Canadensis*	R			R	
Certhidae						
Brown Creeper	*Certhia americana*	R				
Troglodytidae						
Cactus Wren	*Campylorhynchus brunneicapillus*	R	R	R	R	X
Carolina Wren	*Thryothorus ludovicianus*	C	C	C	C	
Bewick's Wren	*Thryomanes bewickii*	U	U	U	U	X
House Wren	*Troglodytes aedon*	U		U	U	
Winter Wren	*Troglodytes hiemalis*	R			R	
Sedge Wren	*Cistothorus platensis*	R		R	R	
Marsh Wren	*Cistothorus palustris*	R		R	R	
Polioptilidae						
Blue-gray Gnatcatcher	*Polioptila caerulea*	U	R	U	U	
Regulidae						
Golden-crowned Kinglet	*Regulus satrapa*			R	R	
Ruby-crowned Kinglet	*Regulus calendula*	U		U	U	
Turdidae						
Eastern Bluebird	*Sialia sialis*	U	R	U	U	
Veery	*Catharus fuscescens*	R		R		
Gray-cheeked Thrush	*Catharus minimus*	R		R		
Swainson's Thrush	*Catharus ustulatus*	U		U		
Hermit Thrush	*Catharus guttatus*	R		U	U	
Wood Thrush	*Hylocichla mustelina*	R		R		
Clay-colored Thrush	*Turdus grayi*	R			R	X
White-throated Thrush	*Turdus assimilis*	X	X		X	
Rufous-backed Robin	*Turdus rufopalliatus*	X				
Varied Thrush	*Ixoreus naevius*	X				
Aztec Thrush	*Ridgwayia pinicola*	X				
American Robin	*Turdus migratorius*	R	R	R	U	
Mimidae						
Gray Catbird	*Dumetella carolinensis*	U		U	U	
Northern Mockingbird	*Mimus polyglottos*	C	C	C	C	X
Sage Thrasher	*Oreoscoptes montanus*				X	
Long-billed Thrasher	*Toxostoma longirostre*	U	U	U	U	X
Curve-billed Thrasher	*Toxostoma curvirostre*	R	R	R	R	X
Sturnidae						

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
European Starling	*Sturnus vulgaris*	R	R	R	R	
Motacillidae						
American Pipit	*Anthus rubescens*	U		U	U	
Sprague's Pipit	*Anthus spragueii*	R		R	R	
Bombycillidae						
Cedar Waxwing	*Bombycilla cedrorum*	U			U	
Parulidae						
Ovenbird	*Seiurus aurocapilla*	R		R	R	
Worm-eating Warbler	*Helmitheros vermivorum*	R	R			
Louisiana Waterthrush	*Parkesia motacilla*	R		R		
Northern Waterthrush	*Parkesia noveboracensis*	R		R	R	
Golden-winged Warbler	*Vermivora chrysoptera*	R		R		
Blue-winged Warbler	*Vermivora cyanoptera*	R		R		
Black-and-white Warbler	*Mniotilta varia*	U	R	U	R	
Prothonotory Warbler	*Protonotaria citrea*	R		R		
Swainson's Warbler	*Limnothlypis swainsonii*	R				
Tennessee Warbler	*Oreothlypis peregrine*	U		U	X	
Orange-crowned Warbler	*Oreothlypis celata*	U		U	U	
Nashville Warbler	*Oreothlypis ruficapilla*	U		U	R	
Mourning Warbler	*Geothlypis philadelphia*	R		R		
MacGillivray's Warbler	*Geothlypis tolmiei*		R		R	
Kentucky Warbler	*Geothlypis formosa*	R		R		
Common Yellowthroat	*Geothlypis trichas*	C	R	R	R	X
Hooded Warbler	*Setophaga citrina*	R		R		
American Redstart	*Setophaga ruticilla*	U		R	R	
Cerulean Warbler	*Setophaga cerulea*	R				
Northern Parula	*Setophaga americana*	U	R	U	R	
Tropical Parula	*Setophaga pitiayumi*	R	R	R	R	X
Magnolia Warbler	*Setophaga magnolia*	R		R		
Bay-breasted Warbler	*Setophaga castanea*	R		X		
Blackburnian Warbler	*Setophaga fusca*	R		R		
Yellow Warbler	*Setophaga petechia*	U	U	U	R	
Chestnut-sided Warbler	*Setophaga pensylvanica*	R		R		
Palm Warbler	*Setophaga palmarum*		X			
Pine Warbler	*Setophaga pinus*			R	R	
Yellow-rumped Warbler	*Setophaga coronata*	U		U	C	
Yellow-throated Warbler	*Setophaga dominica*	R		R	R	
Prairie Warbler	*Setophaga discolor*			X		
Black-throated Gray Warbler	*Setophaga nigrescens*			R	R	
Townsend's Warbler	*Setophaga townsendi*	R			R	
Black-throated Green Warbler	*Setophaga virens*	R		R	R	
Golden-crowned Warbler	*Basileuterus culicivorus*	X				
Canada Warbler	*Cardellina Canadensis*	R		R		
Wilson's Warbler	*Cardellina pusilla*	R		R	R	
Painted Redstart	*Myioborus pictus*	X				
Yellow-breasted Chat	*Icteria virens*			R		X
Emberizidae						
White-collared Seedeater	*Sporophila torqueola*		X	X		X

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Yellow-faced Grassquit	*Tiaris olivaceus*			X		
Olive Sparrow	*Arremonops rufivirgatus*	C	C	C	C	X
Green-tailed Towhee	*Piplio chlorurus*	R			R	
Spotted Towhee	*Pipilo maculatus*	X		X	X	
Cassin's Sparrow	*Peucaea cassinii*	U	U	R	R	
Chipping Sparrow	*Spizella passerina*	U		U	U	
Clay-colored Sparrow	*Spizella pallida*	U		U	U	
Field Sparrow	*Spizella pusilla*				R	
Vesper Sparrow	*Pooecetes gramineus*	U		U	U	
Lark Sparrow	*Chondestes grammacus*	U	U	U	U	
Black-throated Sparrow	*Amphispiza bilineata*	R				
Lark Binting	*Calamospiza melanocorys*	X				
Savannah Sparrow	*Passerculus sandwichensis*	C		C	C	
Grasshopper Sparrow	*Ammodramus savannarum*	U	R	U	R	
Fox Sparrow	*Passerella iliaca*	X				
Le Conte's Sparrow	*Ammodramus leconteii*	R		R	R	
Song Sparrow	*Melospiza melodia*				U	
Lincoln's Sparrow	*Melospiza lincolnii*	U		U	U	
Swamp Sparrow	*Melospiza Georgiana*	R		R	R	
White-throated Sparrow	*Zonotrichia albicollis*	R			R	
White-crowned Sparrow	*Zonotrichia leucophrys*	C		C	C	
Dark-eyed Junco	*Junco hyemalis*	X				
Cardinalidae						
Summer Tanager	*Piranga rubra*	U	R	U	R	
Scarlet Tanager	*Piranga olivacea*	R		R		
Western Tanager	*Piranga ludoviciana*	R		R		
Crimson-collared Grosbeak	*Rhodothraupis celaeno*	X		X		
Northern Cardinal	*Cardinalis cardinalis*	U	U	U	U	X
Pyrrhuloxia	*Cardinalis sinuatus*	R	R			
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	R		R		
Black-headed Grosbeak	*Pheucticus melanocephalus*	X				
Blue Bunting	*Cyanocompsa parellina*	R			R	
Blue Grosbeak	*Passerina caerulea*	R	R	R		
Lazuli Binting	*Passerina amoena*	R			R	
Indigo Bunting	*Passerina cyanea*	U		U	R	
Varied Bunting	*Passerina versicolor*	X	X	X	X	
Painted Bunting	*Passerina ciris*	U	U	R		X
Dickcissel	*Spiza americana*	U	U	U		
Icteridae						
Red-winged Blackbird	*Agelaius phoeniceus*	A	A	A	A	X
Eastern Meadowlark	*Sturnella magna*	U	U	U	U	
Western Meadowlark	*Sturnella neglecta*				C	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	U		U	R	
Brewer's Blackbird	*Euphagus cyanocephalus*	U		U	U	
Great-tailed Grackle	*Quiscalus mexicanus*	A	A	A	A	X
Bronzed Cowbird	*Molothrus aeneus*	A	A	U	U	X
Brown-headed Cowbird	*Molothrus ater*	C	C	C	C	X
Black-vented Oriole	*Icterus wagleri*	X				

Common Name	Scientific Name	Season				Breeding Habitat[1]
		Spring	Summer	Fall	Winter	
Orchard Oriole	*Icterus spurious*	U	U	R		X
Hooded Oriole	*Icterus cucullatus*	U	U	U	U	X
Bullock's Oriole	*Icterus bullockii*		R		R	
Altamira Oriole	*Icterus gularis*	C	C	C	C	X
Audubon's Oriole	*Icterus graduacauda*	X	X	X		X
Baltimore Oriole	*Icterus galbula*	U		R		
Scott's Oriole	*Icterus parisorum*	R	R			
Fringillidae						
House Finch	*Carpodacus mexicanus*	X	X	X	X	
Red Crossbill	*Loxia curvirostra*		X			
Pine Siskin	*Spinus pinus*	R		R	U	
Lesser Goldfinch	*Spinus psaltria*	U	U	U	U	X
American Goldfinch	*Spinus tristus*	U		U	U	
Passeridae						
House Sparrow	*Passer domesticus*	U	U	U	U	X
A-Abundant; C-Common; U-Uncommon; R-Rare; X-Very Rare						

The National Park Service (NPS) operates the Palo Alto Battlefield National Historic Park (NHP) within the study area, which is adjacent to a restoration area on Resaca de la Guerra. The NPS is active in the control of the non-native, invasive Brazilian peppertree and restoration of resaca riparian habitats at the park.

The TPWD is dedicated to the restoration of native thornscrub habitat, including resaca communities. The TPWD manages numerous tracts at the Las Palomas Wildlife Management Area and Resaca de la Palma State Park. The restoration commitments are outlined in the TPWD Land and Water Resources Conservation and Recreation Plan (TPWD, 2015) and the Texas Conservation Action Plan (TPWD, 2012).

The local sponsor, the City of Brownsville, has initiated a Resaca Restoration Plan and is using the restoration of Cemetery Resaca within the Town Resaca system as a pilot project to test the feasibility and success of ecosystem measures. The sponsor has also partnered with the USACE on a Continuing Authorities Program (CAP) Section 206 aquatic ecosystem restoration project at Resaca Boulevard Resaca also located in Town Resaca. The Section 206 study was used to inform this feasibility study.

The recognition and commitment of national, regional, and local agencies in the conservation and restoration of resacas demonstrates the institutional significance of the resaca ecosystems. The relationship of the following legislative and executive orders is specifically discussed in regard to institutional recognition criteria of significance.

Fish and Wildlife Conservation Act of 1956

The Fish and Wildlife Conservation Act of 1956 encourages all federal agencies to utilize their statutory and administrative authority to conserve and promote the conservation of nongame fish and wildlife and their habitats. The Brownsville Resacas fall within the scope of this act.

Fish and Wildlife Coordination Act of 1958

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended, recognizes the contribution of wildlife resources to the nation. The USFWS, National Park Service (NPS), TPWD, and The Nature Conservancy (TNC) have dedicated resources to coordinate with USACE to develop, refine, and assess a set of measures that would ultimately yield identification of a preferred plan. The habitats that would be restored would meet the intent and provisions of the FWCA by recognizing the vital contribution of wildlife resources to Brownsville, south Texas, and the nation. Institutional significance is demonstrated by the interest, commitment, and recognition given to this study by the USFWS, NPS, TPWD, and TNC. The Act recognizes that historical losses to resacas and their associated riparian habitats have become cumulatively important as nationally recognized resources. Similarly, the restoration of these habitats would be shown to be nationally significant.

Migratory Bird Treaty Act

The U.S. recognized the critical importance of migratory birds by ratifying international, bilateral conventions for the conservation of migratory birds. These conventions impose obligations on the U.S. for the conservation of migratory birds and their habitats, and through the Migratory Bird Treaty Act, the U.S. has implemented these migratory bird conventions with respect to the U.S. The Act prohibits the taking, possessing, importing/exporting, selling, and transporting of any listed migratory bird, its parts, nest, or eggs. Included in the protection provided by this Act are all North American diurnal birds of prey, except bald and golden eagles which are provided protection under the Bald and Golden Eagle Protection Act. A list of bird species known to occur in resaca and riparian habitats at the Resaca de la Palma State Park and Bentsen Rio Grande State Park, including migratory birds protected under the Migratory Bird Treaty Act, are presented in Attachment 2. The two state parks are located adjacent to and near the study area and represent birds expected to occupy the restored resacas.

North American Bird Conservation Initiative

The North American Bird Conservation Initiative (NABCI) is a trinational declaration of intent between the U.S., Canada, and Mexico to strengthen cooperation on the conservation of North American birds throughout their ranges and habitats. The U.S. NABCI Committee is a coalition of government agencies, private organizations, and bird initiatives in the United States comprised of representatives from the following entities:

- U.S. Fish and Wildlife Service
- American Bird Conservancy
- Association of Fish and Wildlife Agencies
- Association of Joint Venture Management Boards
- Bureau of Land Management
- Department of Defense
- Ducks Unlimited
- Farm Service Agency
- Migratory Shorebird and Upland Game Bird Working Group
- National Audubon Society
- National Flyway Council
- National Park Service
- Natural Resources Conservation Service
- North American Waterfowl Management Plan
- Partners in Flight
- Resident Game Bird Working Group
- The Nature Conservancy
- U.S. Forest Service
- U.S. Geological Survey
- U.S. Shorebird Conservation Plan
- Waterbird Conservation for the Americas
- Wildlife Management Institute

The NABCI divided North America into 67 ecologically distinct Bird Conservation Regions (BCRs) based on similar bird communities, habitats, and resource management issues. The Brownsville Resacas are located in the Tamaulipan Brushlands region (BCR 36).

The Tamaulipan Brushlands BCR encompasses most of south Texas west of the Gulf Coastal Plains and extends into northeastern Mexico. The BCR provides habitat representing the northernmost extent of several tropical species ranges and the southernmost extent to numerous North American temperate species.

North American Waterfowl Management Plan

Established in 1986, the North American Waterfowl Management Plan (NAWMP) is an international plan to reverse the downward trend in waterfowl populations. The goal of the plan is to protect, restore, and enhance wetland habitat and increase waterfowl population numbers. An update to the plan in 1998 was signed by the U.S., Canada, and Mexico and lists wetland, aquatic systems, grassland, forest, and riparian areas as habitats critical to waterfowl. Thirty-six Important Waterfowl Habitat Areas have been identified by the USFWS, three of which are represented within Texas, and include east Texas, the gulf coast, and the playa lakes region. South Texas, including the Brownsville area, provides a critical link between the three priority waterfowl habitat areas as it is located along the Mississippi and Central Flyways. The USFWS specifies that conservation efforts should include national and regional planning for both migratory and endemic waterfowl species. Between 1986 and 2009, $4.5 billion was invested to secure, protect, restore, enhance and manage 15.7 million acres of waterfowl priority landscapes in North America. The NAWMP was updated again in 2004 and NAWMP Science Support Team (NSST) prioritized conservation needs for waterfowl species based on socioeconomic importance of the species, the species population trend, and the vulnerability of the population to decline (NAWMP, 2004). Conservation priority designations in the NAWMP (High, Moderately High, Moderate, and Moderately Low) reflect the conservation need during the breeding and/or nonbreeding seasons. The Gadwall and Redhead are identified as waterfowl species known to occur in Cameron County and are considered priority species by the NSST for the Tamaulipan Brushlands BCR.

North American Waterbird Conservation Plan

The Waterbird Conservation for the Americas (WCA) initiative was established in 1998 to address threats to waterbirds and their habitats. The goal of the WCA is to sustain and restore waterbird populations and breeding, migratory, and nonbreeding habitats in North America, Central America, and the Caribbean. The WCA identified and ranked the conservation concern for waterbird species throughout North America by BCRs as Highly Imperiled, High Concern, Moderate Concern, Low Concern, Not Currently at Risk, and Information Lacking (Kushlan et al., 2002). Species with significant population declines and either low populations or some other high risk factor were designated as Highly Imperiled species. Declining species of High Concern species are declining and have some potential threat as well. Moderate Concern species are either declining with moderate threats or distributions, stable with known or potential threats and moderate to restricted distributions, or small risk with relatively restricted distributions. The list of waterbirds identified within the Tamaulipan Brushlands BCR and their use of resaca habitats are provided in Table A-4.

Table A-4: WCA (2002) Waterbirds within Tamaulipan BCR Noting Species Utilizing Resaca Habitat

Species	Resaca Habitat
Anhinga	X
Black Skimmer	X
Black-crowned Night-heron	X
Bonaparte's Gull	
Eared Grebe	X
Forster's Tern	X
Gull-billed Tern	X
Least Tern	
Little Blue Heron	X
Neotropic Cormorant	X
Roseate Spoonbill	X
Snowy Egret	X
Tricolored Heron	X
White Ibis	X
White Pelican	X
Yellow-crowned Night-heron	X

Shorebird Conservation Plan

The U.S. Shorebird Conservation Plan is a partnership of state and federal agencies and non-governmental conservation organizations. The Shorebird Conservation Plan was developed to protect and restore shorebird populations and their migratory, breeding, and nonbreeding habitats. The plan categorizes the conservation concern and risk for North American shorebirds into five categories: 1) species not at risk, 2) species of low concern, 3) species of moderate concern, 4) species of high concern, and 5) highly imperiled species (Brown et al., 2001). Cameron County species that are categorized as Highly Imperiled, High Concern, and Moderate Concern and their use of resaca habitats are identified in Table A-5.

Table A-5: North American Shorebird Conservation Plan Species of Concern (Brown et al., 2001) for Tamaulipan BCR Noting Species Utilizing Resaca

Species	Resaca Habitat
Highly Imperiled	
Long-billed Curlew	X
Mountain Plover	
Piping Plover	
Snowy Plover	
Species of High Concern	
American Woodcock	
Marbled Godwit	
Red Knot	
Ruddy Turnstone	
Sanderling	
Short-billed Dowitcher	X
Solitary Sandpiper	X
Western Sandpiper	X
Whimbrel	
Wilson’s Plover	
Species of Moderate Concern	
American Avocet	X
Black-bellied Plover	X
Dunlin	X
Greater Yellowlegs	X
Killdeer	X
Least Sandpiper	X
Lesser Yellowlegs	X
Stilt Sandpiper	X
Willet	

USFWS Birds of Conservation Concern

The 1988 amendment (Public Law 100-653, Title VIII) to the FWCA directs the USFWS to identify migratory nongame bird species, subspecies, and populations that would become candidates for listing under the ESA if additional conservation actions are not implemented. In response to this mandate, the USFWS (2008) compiled a list of Birds of Conservation Concern (BCC) on three scales: the BCRs, USFWS Regions, and a National scale. The USFWS used the conservation assessment scores in the Partners in Flight North American Landbird Conservation Plan (Rich et al., 2004), the United States Shorebird Conservation Plan (Brown et al., 2001), and the North American

Waterbird Conservation Plan (Kushlan et al., 2002) to identify abundance, population trends, distribution, threats, and the importance of an area to a species to identify Birds of Conservation Concern for each BCR. The birds of conservation concern for the Tamaulipan BCR is provided in Table A-6.

Table A-6:USFWS (2008) Birds of Conservation of Concern for Tamaulipan BCR Noting Species Utilizing Resaca

Species	Tamaulipan Brushland
Altamira Oriole	X
Audubon's Oriole	X
Bell's Vireo	X(c)
Buff-bellied Hummingbird	X
Burrowing Owl	X
Cassin's Sparrow	X
Chestnut-collared Longspur	X(nb)
Curve-billed Thrasher	X
Dickcissel	X
Elf Owl	X
Green Parakeet	X(d)
Gull-billed Tern	X
Harris' Hawk	X
Hooded Oriole	X
Lark Bunting	X(nb)
Lesser Yellowlegs	X(nb)
Long-billed Curlew	X(nb)
Mountain Plover	X(nb)
Orchard Oriole	
Painted Bunting	X
Snowy Plover	X(c)
Solitary Sandpiper	X(nb)
Sprague's Pipit	X(nb)
Summer Tanager	X
Swainson's Hawk	X
Tropical Parula	X
Varied Bunting	X
Verdin	X
White-collared Seedeater	X
(b) ESA delisted, (c) non-listed subspecies or population of Threatened or Endangered species, (d) MBTA protection uncertain or lacking, (nb) non-breeding in this BCR	

Partners in Flight

Partners in Flight (PIF) is a cooperative partnership between federal, state, and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, academia, and private individuals. Partners include the following:

- Federal Agencies
    - U.S. Geological Survey
    - National Park Service
    - Bureau of Land Management
    - U.S. Fish and Wildlife Service
    - Department of Defense
    - U.S. Forest Service
    - U.S. Environmental Protection Agency
    - Natural Resources Conservation Service
    - U.S. Army Corps of Engineers
    - U.S. Department of State
- State Wildlife Resource Agencies
- Non-governmental Organizations
- Private Industry

The goals of PIF are to create a coordinated network of conservation partners to secure sufficient commitment and resources to implement and support scientifically-based landbird conservation plans at multiple scales. In an effort to prioritize conservation needs, PIF assessed the conservation vulnerability for landbird species and assigned a score to each species based on biological criteria such as population size, breeding distribution, non-breeding distribution, threats to breeding habitats, threats to non-breeding areas, and population trends (Panjabi et al., 2005). In addition to providing conservation scores for each species on a continental scale, scores are also calculated for each BCR. Based on the conservation scores, appropriate conservation action categories are assigned to each species depending on the threat of extinction (Table A-7). These conservation actions are required for improving or maintaining the current population status of the species.

Table A-7: PIF Conservation Action Categories (Punjab et al. 2005) and for Tamaulipan BCR Noting Species Utilizing Resaca

Conservation Action Category	Vulnerability Risk	Species
Critical Recovery	Species subject to very high regional threats. Critical recovery actions are needed to prevent likely extirpation or to reintroduce a species that has been extirpated.	Bell's Vireo Common Yellowthroat
Immediate Management	Species subject to high regional threats and large population declines. Conservation action is needed to reverse or stabilize significant, long-term population declines. Lack of action may result in extirpation of species.	Scaled Quail Buff-bellied Hummingbird Summer Tanager Painted Bunting Hooded Oriole Bullock's Oriole Audubon's Oriole
Management Attention	Species subject to moderate regional threats and moderate to large declines OR subject to high regional threats but no large decline. Management or other conservation actions are required to reverse or stabilize significant, long-term population declines or mitigate threats.	Northern Bobwhite Harris' Hawk Swainson's Hawk White-tailed Hawk Green Parakeet Yellow-billed Cuckoo Golden-fronted Woodpecker Verdin Cactus Wren Curve-billed Thrasher Cassin's Sparrow Lark Sparrow Pyrrhuloxia Dickcissel Orchard Oriole Altamira Oriole
Planning and Responsibility	Species are of continental concern, but not regional concern. Long-term planning actions are required to ensure sustainable populations are maintained.	Inca Dove Common Ground-dove Greater Roadrunner Eastern Screech-owl Elf Owl Ladder-backed Woodpecker Couch's Kingbird Scissor-tailed Flycatcher Chihuahuan Raven Cave Swallow Long-billed Thrasher Olive Sparrow

DoD Partners in Flight

The Department of Defense PIF program consists of a cooperative network of natural resources personnel from military installations across the U.S. DoD PIF works collaboratively with other avian conservation initiatives to conserve migratory and resident bird species and their habitat on DoD lands. The DoD PIF works beyond installation boundaries to facilitate cooperative partnerships, determine the current status of bird populations, and prevent the listing of additional birds as threatened or endangered. The DoD PIF (US DoD, 2011, 2002) has developed a list of species of concern for bird's utilizing DoD lands (Table A-8).

Table A-8: DoD PIF (2011) Priority Species

Species
Baird's Sparrow
Bald Eagle
Blue-winged Warbler
Buff-breasted Sandpiper
Burrowing Owl
Cactus Wren
Cerulean Warbler
Chuck-will's-widow
Common Nighthawk
Dickcissel
Eastern Meadowlark
Golden Eagle
Golden-winged Warbler
Grasshopper Sparrow
Gull-billed Tern
Harris' Sparrow
Henslow's Sparrow
Kentucky Warbler
King Rail
Least Tern
Loggerhead Shrike
Long-billed Curlew
Mountain Plover
Northern Bobwhite
Northern Goshawk
Olive-sided Flycatcher
Painted Bunting
Prairie Falcon
Prairie Warbler
Red-headed Woodpecker
Rusty Blackbird
Snowy Plover
Sprague's Pipit
Swainson's Warbler
Swallow-tailed Kite
Upland Sandpiper
Western Yellow-billed Cuckoo
Whip-poor-will
Wilson's Plover

National Audubon Society and the American Bird Conservancy

In 2014, the Audubon Society and the American Bird Conservancy published the Watchlist 2014 (Rosenberg et al., 2014) documenting a Red-list of bird species in the U.S. that were rapidly declining in numbers and/or had very small populations or limited ranges, and faced major conservation threats and a Yellow-list of bird species that were either declining or rare. Watchlist 2014 includes three Red-listed species and 27 Yellow-listed species that can be found in resaca habitats of Cameron County (Table 7).

Table A-9: Birds of Resaca, Cameron County on Watchlist 2014

Red-list Species	Yellow-list Species	
Mottled Duck Reddish Egret	Swallow-tailed Kite	Lucifer Hummingbird
Red-crowned Parrot	King Rail	Rufous Hummingbird
	Lesser Yellowlegs	Allen's Hummingbird
	Whimbrel	Elegant Trogon
	Hudsonian Godwit	Olive-sided Flycatcher
	Short-billed Dowitcher	Tamaulipas Crow
	Buff-breasted Sandpiper	Wood Thrush
	Dunlin	Sprague's Pipit
	Semipalmated Sandpiper	Prothonotory Warbler
	Gull-billed Tern	Kentucky Warbler
	Black Skimmer	Cerulean Warbler
	Chuck-wills-widow	Prairie Warbler
	Eastern Whip-poor-will	Canada Warbler
		Audubon's Oriole

Executive Order 13186 (Migratory Birds)

The importance of migratory non-game birds to the nation is embodied in international treaties, 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. Executive Order 13186 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. Rangewide protection, restoration and enhancement of terrestrial and aquatic habitats and landscapes are crucial to maintain and conserve migratory birds.

Because the Brownsville resacas study area supports species of concern and their habitats which are addressed in numerous avian joint ventures, conservation organizations, and interagency and international cooperative plans, their institutional significance is recognized from both a regional, national, and international perspective. Aquatic and riparian ecosystem restoration of the resacas study area would support the goals of each of these plans and cooperative initiatives as the degraded habitat within the study area would increase the quality of breeding, foraging, wintering, and migration habitats for numerous bird species. Institutional significance is further supported as the restored habitats would support many of the species of concern identified in the tables above.

Water Resources Development Act of 1986

The restored ecosystem functions that would be provided by the eventual recommended plan for the Brownsville resacas study can be considered significant by the USACE because the restoration of these functions meet with the spirit of the Water Resources Development Act of 1986.

Water Resources Development Act of 1990

Section 307(a) of the Water Resources Development Act of 1990 established an interim goal of no overall net loss of wetlands in the U.S. and set a long-term goal to increase the quality wetlands, as defined by acreage and function. The Brownsville resacas ecosystem restoration study would result in a gain of wetlands and waters of the U.S. and the proposed study would restore the ecological and hydraulic function to the resacas.

Executive Order 13112 (Invasive Species)

Executive Order 13112 recognizes the significant contribution native species make to the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of non-native species invasion and to provide restoration of native species and habitat conditions in ecosystems that have been invaded. As the resacas study would replace non-native vegetation with site-specific native vegetation, it would be in compliance with Executive Order 13112.

Public Recognition

Significance based on public recognition means that some segment of the general public recognizes the importance of an environmental resource. People engaged in activities that reflect an interest in or concern for a particular resource evidences public recognition. Recognition of public significance for the Brownsville resacas area can best be demonstrated by the public support of the BPUB's resaca education and restoration efforts. The BPUB has incorporated the resaca restoration into their website and has a dedicated multimedia page on the restoration efforts. In addition to restoring resaca habitats along Town Resaca, the BPUB and the City of Brownsville have partnered with the Children's Museum in Dean Porter Park along Dean Porter Resaca to develop an exhibit on the ecological value of resacas in the City of Brownsville and Cameron County. The exhibit draws over 50,000 visitors per year.

BPUB's and the City of Brownsville's level of commitment in resaca restoration is expressed in the sponsorship of the Resaca Boulevard Resaca Section 206, an aquatic ecosystem restoration CAP, scheduled for design and construction in fiscal year 18. The BPUB and USACE held public meetings and workshops in December to seek community participation in the development of a conceptual restoration plan for Brownsville Resacas.

The Nature Conservancy has designated resaca ecosystems as high priority habitats for conservation and restoration efforts. One of those is the 1,034-acre Southmost Preserve, managed by the non-profit and home to the majority of remnant Subtropical Texas Palmetto Woodland habitats in the U.S. The preserve is located southeast of the Brownsville city limits adjacent to the Audubon Society's Sabal Palm Sanctuary dedicated to the conservation of avian habitats associated with the palmetto woodlands and resaca habitats.

The Audubon Society and the American Bird Conservancy have been engaged in the study providing technical support identifying restoration needs for migratory and resident bird populations dependent on the resaca communities.

Camp Lula Sams, an 85.7-acre ecologically based youth camp facility centered on segments of Resaca del Rancho Viejo, is engaged in citizen science and public educational activities associated with South Texas and resaca ecosystems. The staff coordinates closely with TNC, the TPWD, and the USFWS in the restoration and management of the resacas at Camp Lula Sams. The camp draws approximately 12,000 campers/visitors each year.

Technical Recognition

Significance based on technical recognition requires identification of critical resource characteristics such as scarcity, representativeness, status and trends, connectivity, critical habitat, and biodiversity. Technical recognition of resources varies across geographic areas and spatial scales. The existing conditions section of this document provides evidence supporting the technical significance of the resources, specifically the scarcity, connectivity, status, and trends of the resources. Further support for the technical significance of resources is demonstrated by the numerous hydrological and biological research efforts completed, planned, and underway by the Gladys Porter Zoo in Brownsville, the San Antonio Zoo, the University of Texas Rio Grande Valley, the University of Texas at Austin, and other academic institutions.

The ecological significance of the resacas, the global declining trend of resaca health, and the rarity of the vegetation, fish, and wildlife depending on resaca ecosystems all bolster the technical recognition of resource significance. The institutional section of this document also provides evidence of the technical significance of the resources, specifically the scarcity, status, and trends of the resources.

The TPWD released the Texas Conservation Action Plan (TPWD, 2012) identifying Species of Greatest Conservation Need (SGCN) for ecoregions throughout the state, including the South Texas ecoregion (Table A-10). Included in the list are several species that would benefit from the aquatic and riparian ecosystem restoration measures within Brownsville Resaca Study Area (Table A-11).

Aquatic species such as spiny softshell turtle, slider, Texas shiner, alligator gar, and blue sucker would benefit from the reconnection of fragmented aquatic habitats. Riparian SGCN such as the swamp rabbit, Strecker's chorus frogs, Bell's Vireo, and Louisiana Waterthrush would also benefit from the restoration of riparian grassland, shrubland, and woodland habitats. In addition, species that rely on riparian corridors for foraging habitat, including bat SGCN such as the Brazilian free-tailed bat and ghost-faced bat, would benefit from the improved habitat for forage species.

Table A-10: TPWD Species of Concern

Species	Specific Epithet	Global/State Ranking
MAMMALS		
Pallid bat	*Antrozous pallidus*	G5/S5
Nelson's pocket mouse	*Chaetodipus nelsoni*	G5/S?
Hog-nosed skunk	*Conepatus leuconotus*	G5/S4
Ord's kangaroo rat	*Dipodomys ordii parvabullatus*	G5/S4
Attwater's pocket gopher	*Geomys attwateri*	G4/S4
Texas pocket gopher	*Geomys personatus davisi*	G4T2/S2
Strecker's pocket gopher	*Geomys streckeri*	G4T1/S1
Frio pocket gopher	*Geomys texensis bakeri*	G2QT2/S2
Jaguarundi	*Herpailurus yaguarondi*	G4/S1
Southern yellow bat	*Lasiurus ega*	G5/S1
Ocelot	*Ocelot*	G4/S1
Ghost-faced bat	*Mormoops megalophylla*	G4/S2
Long-tailed weasel	*Mustela frenata*	G5/S5
Cave myotis	*Myotis velifer*	G5/S4
White-nosed coati	*Nasua narica*	G5/S2?
Mink	*Neovision vison*	G5/S4
Desert shrew	*Notiosorex crawfordii*	G5/S4
Big free-tailed bat	*Nyctinomops macrotis*	G5/S3
Coues rice rat	*Oryzomys couesi aquaticus*	G5T3?/S2
Mountain lion	*Puma concolor*	G5/S2
Eastern mole	*Scalopus aquaticus*	G5/S5
Western spotted skunk	*Spilogale gracilis*	G5/S5
Eastern spotted skunk	*Spilogale putorius*	G4T/S4
Brazilian free-tailed bat	*Tadarida brasiliensis*	G5/S5
American badger	*Taxidea taxus*	G5/S5
BIRDS		
Mottled Duck	*Anas fulvigula*	G4/S4B
Northern Pintail	*Anas acuta*	G5/S3B,S5N
Scaled Quail	*Callipepla squamata*	G5/S4B
Northern Bobwhite	*Colinus virginianus*	G5/S4B
Wild Turkey	*Meleagris gallopavo*	G5/S5B
Hook-billed Kite	*Chondrohierax uncinatus*	G4/S2
Northern Harrier	*Circus cyaneus*	G5/S2B,S3N
Common Black-hawk	*Buteogallus anthracinus*	G4G5/S2B
Harris's Hawk	*Parabuteo unicinctus*	G5/S3B
Red-shouldered Hawk	*Buteo lineatus*	G5/S4B
Gray Hawk	*Buteo nitidus*	G5/S2B
Swainson's Hawk	*Buteo swainsoni*	G5/S4B
Mountain Plover	*Charadrius montanus*	G3/S2
Least Tern	*Sternula antillarum*	G4/S3B
Green Parakeet	*Aratinga holochlora*	G3/S3
Red-crowned Parrot	*Amazona viridigenalis*	G2/S2
Ferruginous Pygmy-owl	*Glaucidium brasilianum*	G5/S3B
Burrowing Owl	*Athene cunicularia*	G4/S3B
Northern Beardless-tyrannulet	*Camptostoma imberbe*	G5/S3B
Scissor-tailed Flycatcher	*Tyrannus forficatus*	G5/S3B
Loggerhead Shrike	*Lanius ludovicianus*	G4/S4B

Species	Specific Epithet	Global/State Ranking
Bell's Vireo	*Vireo bellii*	G5/S3B
Sprague's Pipet	*Anthus spragueii*	G4/S3N
Tropical Parula	*Parula pitiayumi*	G5/S3B
Cassin's Sparrow	*Aimophila cassinii*	G5/S4B
Grasshopper Sparrow	*Ammodramus savannarum*	G5/S3B
Lark Sparrow	*Chondestes grammacus*	G5/S4B
Summer Tanager	*Piranga rubra*	G5/S5B
Painted Bunting	*Passerina ciris*	G5/S4B
Dickcissel	*Spiza americana*	G5/S4B
Eastern Meadowlark	*Sturnella magna*	G5/S5B
Orchard Oriole	*Icterus spurious*	G5S4B
REPTILES AND AMPHIBIANS		
Spiny softshell turtle	*Apalone spinifera*	X
Black-striped snake	*Coniophanes imperialis*	
Western diamondback rattlesnake	*Crotalus atrox*	S4
Reticulate collared lizard	*Crotaphytus reticulatus*	G3/S2
Texas indigo snake	*Drymarchon melanurus erebennus*	G4/S3
Texas tortoise	*Gopherus berlandieri*	G4/S2*
Western hognosed snake	*Heterodon nasicus*	X
Southern earless lizard	*Holbrookia lacerata subcaudalis*	X
Northern earless lizard	*Holbrookia propinqua propinqua*	SX
Sheep frog	*Hypopachus variolosus*	G5/S2
White-lipped frog	*Leptodactylus variolosus*	G5/S1
Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*	G5T5/S2
Black-spotted newt	*Notophthalmus meridionalis*	G1/S1 or S2?
Texas horned lizard	*Phrynosoma cornutum*	G4G5/S4
Rio Grande cooter	*Pseudemys gorzugi*	S2
Texas blind snake	*Rena dulcis*	X
Mexican burrowing toad	*Rhinophrynus dorsalis*	G5/S2
Rio Grande siren (large form)	*Siren sp.*	GNRQ/S2
Massasagua	*Sistrurus catenatus*	X
Mexican blackhead snake	*Tantilla atriceps*	X
Ornate box turtle	*Terrapene ornate*	G5/S3
Red-eared slider	*Trachemys scripta*	X
FISHES		
American eel	*Anguilla rostrata*	G4/S5
Alligator gar	*Atractosteus spatula*	X
Rio Grande blue sucker	*Cycleptus sp.*	X
Plateau shiner	*Cyprinella lepida*	G1G2/S1S2
Proserpine shiner	*Cyprinella proserpina*	G3/S2
Nueces River shiner	*Cyprinella sp.*	G1G2Q/S1S2
Devils River pupfish	*Cyprinodon eximius ssp.*	X
Manantial roundnose minnow	*Dionda argentosa*	G2/S2
Devil's River minnow	*Dionda diaboli*	G1/S1
Nueces roundnose minnow	*Dionda serena*	G2/S2
Rio Grande darter	*Etheostoma grahami*	G2G3/S2
San Felipe gambusia	*Gambusia clarkhubbsi*	G1/S1

Species	Specific Epithet	Global/State Ranking
Blotched gambusia	*Gambusia senilis*	G3G4/SX
Rio Grande silvery minnow	*Hybognathus amarus*	G1G2/SX
Headwater catfish	*Ictalurus lupus*	G3/S2
Texas shiner	*Notropis amarus*	X
Tamaulipas shiner	*Notropis braytoni*	X
Rio Grande shiner	*Notropis jemezanus*	X
Longnose dace	*Rhinichthys cataractae*	X
INVERTEBRATES		
A mining bee	*Andrena scotoptera*	G1*S1*
Rio Grande gold tarantula	*Aphonopelma moderatum*	G2G3*/S2?*
Rio Grande thread-legged katydid	*Arethaea phantasma*	G2?*/S2?*
Texas Austrotinodes caddisfly	*Austrotinodes texensis*	G2/S2
American bumblebee	*Bombus pensylvanicus*	GU/SU*
Sonoran bumblebee	*Bombus sonorus*	GU/SU*
A mayfly	*Caenis arwini*	G1G3/S2?*
Brownsville meadow katydid	*Conocephalus resacensis*	G2?*/S2?*
Percosius skipper	*Decinea percosius*	G1G3/S1S3*
Acacia fairy shrimp	*Dendrocephalus acacioidea*	G1/S1*
Gladiator short-winged katydid	*Dichopetala gladiator*	G2?*/S2?*
Glossy wolfsnail	*Euglandina texasiana*	G1G2/S1S2*
Tamaulipan clubtail	*Gomphus gonzalezi*	G2/S2*
Devils River Springs riffle beetle	*Heterelmis sp.*	G1*/S1*
A mayfly	*Latineosus cibola*	G1G2/S1?*
A leaf-cutting beetle	*Megachile parksi*	G1*/S1*
Texas angle-wing	*Microcentrum minus*	G1?*/S1?*
Texas minute moss beetle	*Neocylloepus boeseli*	G1G2*/S1*
Daedelus sheildback katydid	*Pediodectes daedelus*	G1?*/S1?*
Mitchell’s shieldback katydid	*Pediodectes mitchelli*	G1?*/S1?*
Pratt’s shieldback katydid	*Pediodectes pratti*	G1?*/S1?*
A mining bee	*Perdita fraticincta*	G1*/S1*
A mining bee	*Perdita tricincta*	G1*/S1*
Texas hornshell	*Popenaias popeii*	G1/S1
Salina mucket	*Potamilus metnecktayi*	G1/S1
White scrubsnail	*Praticolella candida*	G2/S2*
Hidalgo scrubsnail	*Praticolella trimatris*	G2/S2*
Nueces crayfish	*Procambarus nueces*	G1/S1
Golden orb	*Quadrula aurea*	G1/S2*
Manfreda giant-skipper	*Stallingsia maculosus*	G1G2/S1S2
PLANTS		
Texas trumpets	*Acleisanthes crassifolia*	G2/S2
Wright’s trumpets	*Acleisanthes wrightii*	G2/S2
Vasey’s adelia	*Adelia vaseyi*	G3/S3
Silvery wild-mercury	*Argythamnia argyraea*	G2/S2
Prostrate milkweed	*Asclepias prostrata*	G1G2/S1S2
Texas milkvetch	*Astragalus reflexus*	G3/S3
Star cactus	*Astrophytum asterias*	G2/S1S2
Kleberg saltbush	*Atriplex klebergorum*	G2/S2

Species	Specific Epithet	Global/State Ranking
Anacacho orchid	*Bauhinia lunarioides*	G3/S1
South Texas rushpea	*Caesalpinia phyllanthoides*	G2/S1
Two-flower stick-pea	*Calliandra biflora*	G3/S3
Chihuahuan balloon-vine	*Cardiospermum dissectum*	G2G3/S3
Crown tickseed	*Coreopsis nuecensis*	G3/S3
Runyon's cory cactus	*Coryphantha macromeris var. runyonii*	G5T2T3/S2S3
Nickel's cory cactus	*Coryphantha nickelsiae*	G2/SH
Tree dodder	*Cuscuta exaltata*	G3/S3
Net-leaf bundleflower	*Desmanthus reticulates*	G3/S3
Yellow-flowered alicoche	*Echinocereus papillosus*	G3/S3
Fitch's hedgehog cactus	*Echinocereus reichenbachii ssp. fitchii*	G5T3/S3
Black lace cactus	*Echinocereus reichenbachii var. albertii*	G5T1Q/S1
Gregg's wild-buckwheat	*Eriogonum greggii*	
Low spurge	*Euphorbia peplidion*	G3/S3
Johnston's frankenia	*Frankenia johnstonii*	G3/S3
Woolly butterfly-weed	*Gaura villosa ssp. parksii*	G5T3/S3
South Texas gilia	*Gilia ludens*	G3/S3
Dimmit sunflower	*Helianthus praecox ssp. hirtus*	G4T2Q/S2
Mexican mud-plantain	*Heteranthera mexicana*	G2G3/S1
Drummond's rushpea	*Hoffmannseggia drummondii*	G3/S3
Slender rushpea	*Hoffmannseggia tenella*	G1/S1
Correll's bluet	*Houstonia correllii*	G1/S1
Greenman's bluet	*Houstonia croftiae*	G3/S3
Greenman's bluet	*Houstonia parviflora*	G3/S3
Texas stonecrop	*Lenophyllum texanum*	G3/S3
St. Joseph's staff	*Manfreda longiflora*	G2/S2
Siler's huaco	*Manfreda sileri*	G3/S3
Walker's manioc	*Manihot walkerae*	G3/S3
Shortcrown milkvine	*Matelea brevicoronata*	G3/S3
Falfurrias milkvine	*Matelea radiata*	GH/SH
Arrowleaf milkvine	*Matelea sagittifolia*	G3/S3
Heartleaf evening-primrose	*Oenothera cordata*	G3/S3
Bushy whitlow-wort	*Paronychia congesta*	G1/S1
McCart's whitlow-wort	*Paronychia maccartii*	G1/S1
Bristle nailwort	*Paronychia setacea*	G3/S3
Rydberg's scurfpea	*Pediomelum humile*	G1/S1
Sand sheet leaf-flower	*Phyllanthus abnormis var. riograndensis*	G5T3/S3
Zapata bladderpod	*Physaria thamnophila*	G1/S1
South Texas yellow clammyweed	*Polanisia erosa ssp. breviglandulosa*	G5T3T4/S3S4B
Stinking rushpea	*Pomaria austrotexana*	G3/S3
Texas almond	*Prunus minutiflora*	G3G4/S3S4
Texas peachbush	*Prunus texana*	G3G4/S3S4
South Texas false cudweed	*Pseudognaphalium austrotexanum*	G3/S3
Large selenia	*Selenia grandis*	G3/S3
Jones' selenia	*Selenia jonesii*	G3/S3

Species	Specific Epithet	Global/State Ranking
Billie's bitterweed	*Tetraneuris turneri*	G3/S3
Burridge greenthread	*Thelesperma burridgeanum*	G3/S3
Shinner's rocket	*Thelypodiopsis shinnersii*	G2/S2
Ashy dogweed	*Thymophylla tephroleuca*	G2/S2
Bailey's ballmoss	*Tillandsia baileyi*	G2G3/S2
Buckley's spiderwort	*Tradescantia buckleyi*	G3/S3
Small-leaved yellow velvet-leaf	*Wissadula parvifolia*	G1/S1
Texas shrimp-plant	*Yeatesia platystegia*	G3G4/S3S4
Jones's rainlily	*Zephyranthes jonesii*	G3/S3
G1/S1 – Critically imperiled (Global/State) – At very high risk of extinction due to extreme rarity, very steep declines, or other factors G2/S2 – Imperiled (Global/State) – At high risk of extinction due to very restricted range, very few populations, steep declines, or other factors G3/S3 – Vulnerable (Global/State) – At moderate risk of extinction due to restricted range, relatively few populations, recent and widespread declines, or other factors G4/S4 – Apparenly Secure (Global/State) – Uncommon but not rare; some cause for long-term concern due to declines or other factors G5/S5 – Secure (Global/State) – Common; widespread and abundant GU/SU – Unrankable (Global/State) – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. N# - National Ranking T# - Intraspcific Taxon – Status of subspecies or varieties Q – Questionable Taxonomy ? – Denotes inexact rank B – Breeding Population H – Possibly Extirpated X - Extirpated		

Table A-11: TPWD Species of Greatest Conservation Need

Species	Scientific Name	Global/State Ranking	Resaca Habitat
Birds			
Northern Harrier	Circus cyaneus	G5/S2B,S3N	X
Common Black-hawk	Buteogallus anthracinus	G4G5/S2B	X
Harris's Hawk	Parabuteo unicinctus	G5/S3B	X
Zone-tailed Hawk	Buteo albonotatus	G4/S3B	X
Mountain Plover	Charadrius montanus	G3/S2	X
Chuck-will's-widow	Caprimulgus carolinensis	G5/S3S4B	X
Scissor-tailed Flycatcher	Tyrannus forficatus	G5/S3B	X
Loggerhead Shrike	Lanius ludovicianus	G4/S4B	
Bell's Vireo	Vireo bellii	G5/S3B	X
Sprague's Pipet	Anthus spragueii	G4/S3N	X
Kentucky Warbler	Oporornis formosus	G5/S3B	X
Grasshopper Sparrow	Ammodramus savannarum	G5/S3B	X
Reptiles			
Texas indigo snake	Drymarchon melanurus erebennus	G4/S3	X
Fishes			
Headwater catfish	Ictalurus lupus	G3/S2	X

1Global Conservation Ranking/State Conservation Ranking
GX/SX – Presumed Extinct; not located despite intensive searches and virtually no likelihood of discovery
GH/SH – Missing; known from only historical occurrences but still some hope of discovery
G1/S1 – Critically Imperiled; At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, 0r other factors
G2/S2 – Imperiled; At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors
G3/S3 – Vulnerable; At moderate risk of extinction due to restricted range , relatively few populations (often 80 or fewer), recent and widespread declines, or other factors
G4/S4 – Apparently Secure; Uncommon but not rare; some cause for long-term concern due to declines or other factors
G5/S5 – Secure; Common, widespread and abundant
G#G#/S#S# - Range Rank; A numeric range rank (e.g. G2G3/S2S3) is used to indicate the range of uncertainty in the status of a species.
B – Breeding; Conservation status refers to the breeding population of the species
N – Nonbreeding; Conservation status refers to the non-breeding population of the species

As evidenced by the numerous conservation and management cooperatives established to address adverse impacts to avian populations in North America, migratory birds are of great ecological value and contribute immensely to biological diversity. Cameron County provides essential feeding and resting habitat for migratory birds and is located in the heart of the Central and Mississippi Flyways. Over 300 species of birds are listed as Nearctic-Neotropical migrants in North America, and over 98-percent of those have been recorded in Texas. Of the more than 600 species of birds documented in Texas, 54-percent are neotropical species which depend on Texas to provide nesting or migration habitats. Many of these species are specifically dependent on south Texas riparian areas. Neotropical migratory birds have been declining in numbers for several decades. Initially, the focus of conservation for this important group of birds was focused on breeding habitat and wintering grounds; however, recently it has been recognized that the loss, fragmentation, and degradation of migratory stop-over habitat is potentially the greatest threat to the survival and conservation of neotropical birds. In arid areas of the United States, stop-over sites are restricted to small defined habitats along shelter belts, hedgerows, desert oases and riparian corridors.

The resacas offer aquatic and riparian corridors in south Texas and provide an opportunity for the birds to replenish fat reserves, provide shelter from predators and water for re-hydration prior to continuing, what is for most neotropicals, a trip of over 1000 miles one-way. During the fall migration, the Brownsville area is located towards the end of the long flight, and therefore, provides the vital link between having enough fat reserves to complete the trip or perish.

Conservation priorities identified by the Rio Grande Joint Ventures (RGJV, 2014; TPWD, 2006) that are applicable to the study area include:

- Riparian corridors, especially where above-ground stream flow occurs;
- Habitat fragmentation;
- Alteration of hydrologic regimes;
- Invasive plants;
- Urban development; and
- Limited water resources.

Bird migration is a physically demanding activity that places extreme energy demands on birds. Compounding these energy requirements, the migration bookends the breeding and reproduction season of the birds where the energy demands approach those needed for migration. Energy reserves may be severely depleted for many bird species as they have flown non-stop over the Gulf of Mexico. In order to fuel migration energy demands, productive foraging and resting stop over habitats must be found along the migration corridor. Aquatic and riparian habitats are some of the most productive and diverse ecosystems in North America, especially in the arid southwest, and therefore are heavily utilized by migrating birds. Historically, the aquatic and riparian habitats in the Brownsville area would have been one of the first productive stopover habitats for northbound migratory birds.

The institutional, public and technical, recognition builds the case of the national significance for the proposed project. The national significance determines whether or not the proposed project is in the federal interest and worthy of the expenditure of federal funds. As presented in the institutional recognition section above, the proposed project would address numerous laws and initiatives for the conservation of fish and wildlife species. In addition, the involvement of educational institutions and public grass root efforts for resaca conservation and restoration exhibit the public and technical recognition. Because of the demonstrated institutional, public, and technical recognition, the proposed project satisfies the national significance requirement of the ecosystem restoration program.

Existing Conditions

This section describes the existing conditions. The discussion includes 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.

Existing Ecosystem-level Function and Degradation

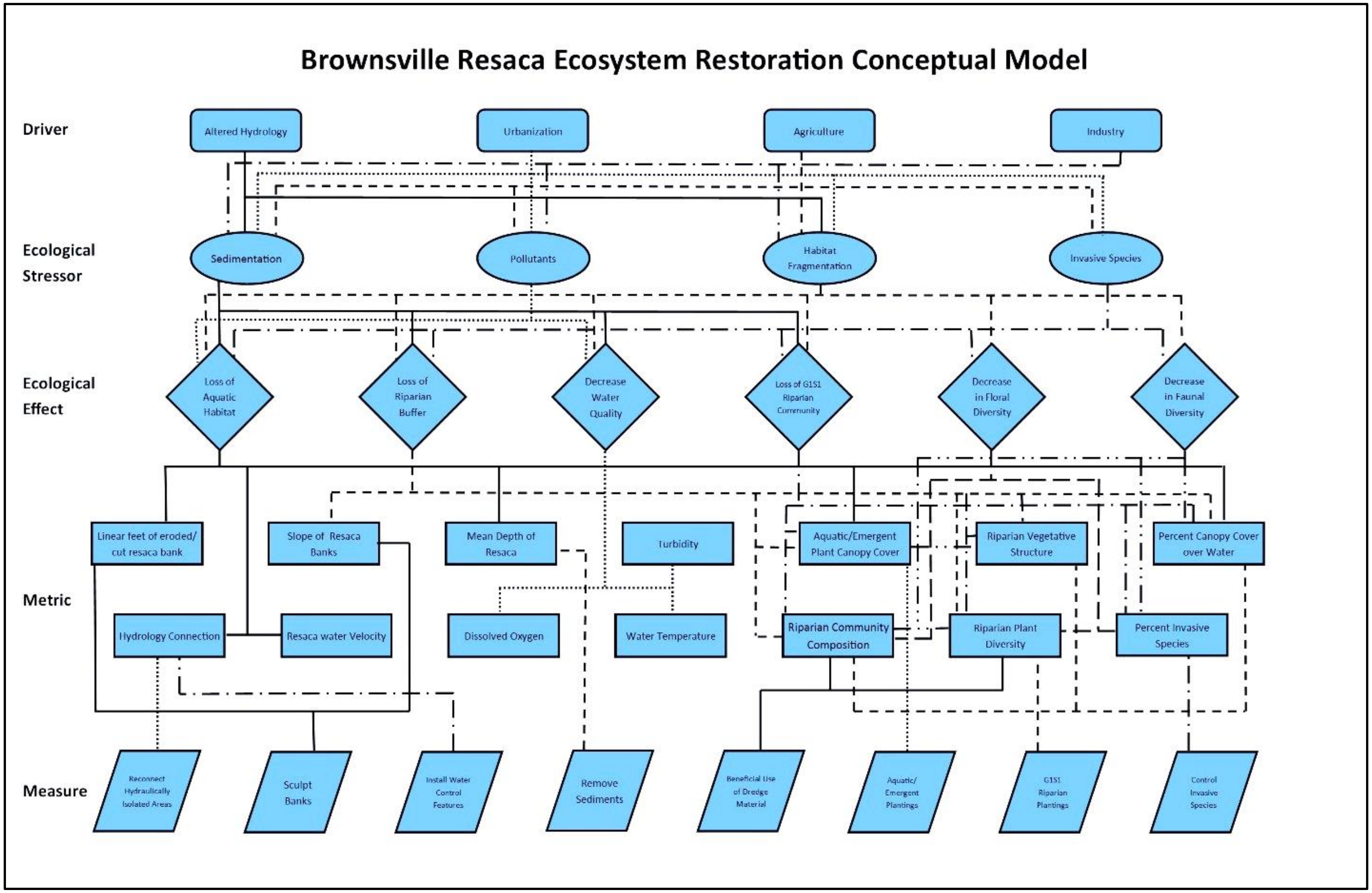
Since the early 1870s and the introduction of irrigation, the loss of native thornscrub vegetation, including resaca habitats, to cultivated agriculture uses has resulted in the loss of 95 percent of thorn-scrub habitat in the LRGV and 99 percent of riparian resaca habitats (Jahrsdorfer and Leslie, 1988).

The agricultural history and rapid urbanization of the area has resulted in the loss of 99 percent of resaca dependent habitats in Texas. Functioning resacas and the native vegetation associated with them have essentially been eliminated from the Mexican side of the Rio Grande due to agricultural practices and urbanization associated with the City of Matamoras. Relatively high quality native thorn-scrub and resaca habitats within the U.S. can be found at the Resaca de la Palma State Park (1,200 acres), The Nature Conservancy’s Southmost Preserve (1,034 acres), the Audubon Society’s Sabal Palm Sanctuary (527 acres), and Camp Lula Sams (86 acres).

Small pockets of native resaca habitats are interspersed throughout the remaining watershed. Agriculture and increased urbanization have adversely impacted the resaca ecosystem. Introduction of the Brazilian peppertree, giant cane, salt cedar, guinea grass, and other non-native, invasive species have displaced the native vegetation communities of the resacas. A conceptual model of the drivers affecting the resacas and the resulting effect is presented in Figure A-3. Because of these losses, the vegetation communities associated with the resacas are globally imperiled with extinction according to the rankings from NatureServe. 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. Texas Ebony Resaca Forest is ranked G1, Subtropical Texas Palmetto Woodland and Texas Ebony/Snake-eyes Shrubland are ranked G2 (NatureServe, 2015). 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 USFWS and TPWD to designate a substantial number of species in the LRGV as rare, threatened, and endangered. Because of the linear features of resaca systems, fish and wildlife species utilize the resaca habitats as travel corridors facilitating emigration and genetic flow. In the more northern resaca systems, the travel corridors are used by federally endangered species such as the ocelot (Leopardus pardalis) and jaguarundi (Herpailurus yaguarondi). Although these species may avoid heavily urbanized areas, numerous other species such as the federally listed red-crowned parrot (Amazona viridigenalis) and state listed 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.

Figure A-3: Resaca Conceptual Ecological Model



Resource Categories

Relevant Resources Found in the Planning Area. The resources affected by potential alternatives. The existing conditions are discussed for each resource category, and then the forecast is presented. These resource categories consist of:

Air Quality

- Climate

Water Resources

- Surface Water
    - Town Resaca
    - Resaca de la Guerra
    - Resaca del Rancho Viejo
- Ground Water
- Water Quality
- Hydrology and Floodplains
    - Resaca Hydrology
    - Floodplains

Riverine Resources

Wetlands

Biological Resources

Threatened and Endangered Species

Cultural Resources

Land Use

- State parks, conservation areas, and other areas of recreational, ecological, scenic, or aesthetic importance
- Floodplains

Socioeconomics

- Minority and low-income populations (Environmental Justice)

Visual Aesthetics

Noise

Hazardous, Toxic, and Radioactive Waste (HTRW)

Air Quality

Under the Clean Air Act (CAA) of 1967 (as amended), the EPA identified and set limits on how much of particular harmful pollutants can be in the air. The regulated pollutants are called criteria air pollutants. EPA has developed two types of air quality standards: primary standards that protect human health, and secondary standards that prevent environmental and property damage. 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).

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.

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). Model results show future changes in precipitation resulting from climate change is highly variable and has a high level of uncertainty (Schmandt et al., 2011).

Water Resources

Resacas were historically numerous throughout the lower Rio Grande Valley; however, most of the resacas have been heavily altered by agriculture, development, and changes in hydrology. It is estimated that within Cameron and Willacy County there are about 130 square miles of these resaca channels and approximately 190 linear miles of water-filled resaca channels in various stages of degradation. These resacas form an extensive freshwater system in the LRGV.

The City of Brownsville is estimated to have a total of 3,500 acres of resacas (ranging from less than one to over 50 acres in size). In addition to the urban resacas, several higher quality resacas have been set aside, including at the Resaca de la Palma State Park, Southmost Preserve, Palo Alto National Battlefield, and the Lower Rio Grande Valley National Wildlife Refuge complex. The remaining undeveloped resacas are under intense pressure as housing developments target waterfront real estate in the LRGV.

- Surface Water
- Ground Water
    - Water Quality
    - Hydrology and Floodplains

Surface Water

Resacas provide multiuse water services to the LRGV. In addition to providing important habitat for fish and wildlife resources, the resacas serve as conveyance channels through the City of Brownsville. BPUB and the irrigation districts utilize the resaca systems for drinking water, agricultural irrigation, storm water storage, and recreation.

For most of the resacas, property lines extend to the center of the resaca; therefore the beds of resacas are privately owned. Although the land under the resaca is privately owned, the State of Texas retains ownership of the water in the resacas and has authorized various local public agencies, including BPUB, to use the water. Since the water is publicly owned, the general public can use it for boating, fishing, or other activities.

The study area includes three main resaca systems: Resaca de la Guerra, Resaca del Rancho Viejo, and Town Resaca. These areas all eventually drain into Laguna Madre through the Port of Brownsville Ship Channel; however, runoff is sometimes pumped from the resacas to the Rio Grande River when the City of Brownsville operates its drainage pumps. The BPUB controls the water surface elevations of the resacas through a series of water control structures (Figure A-4).

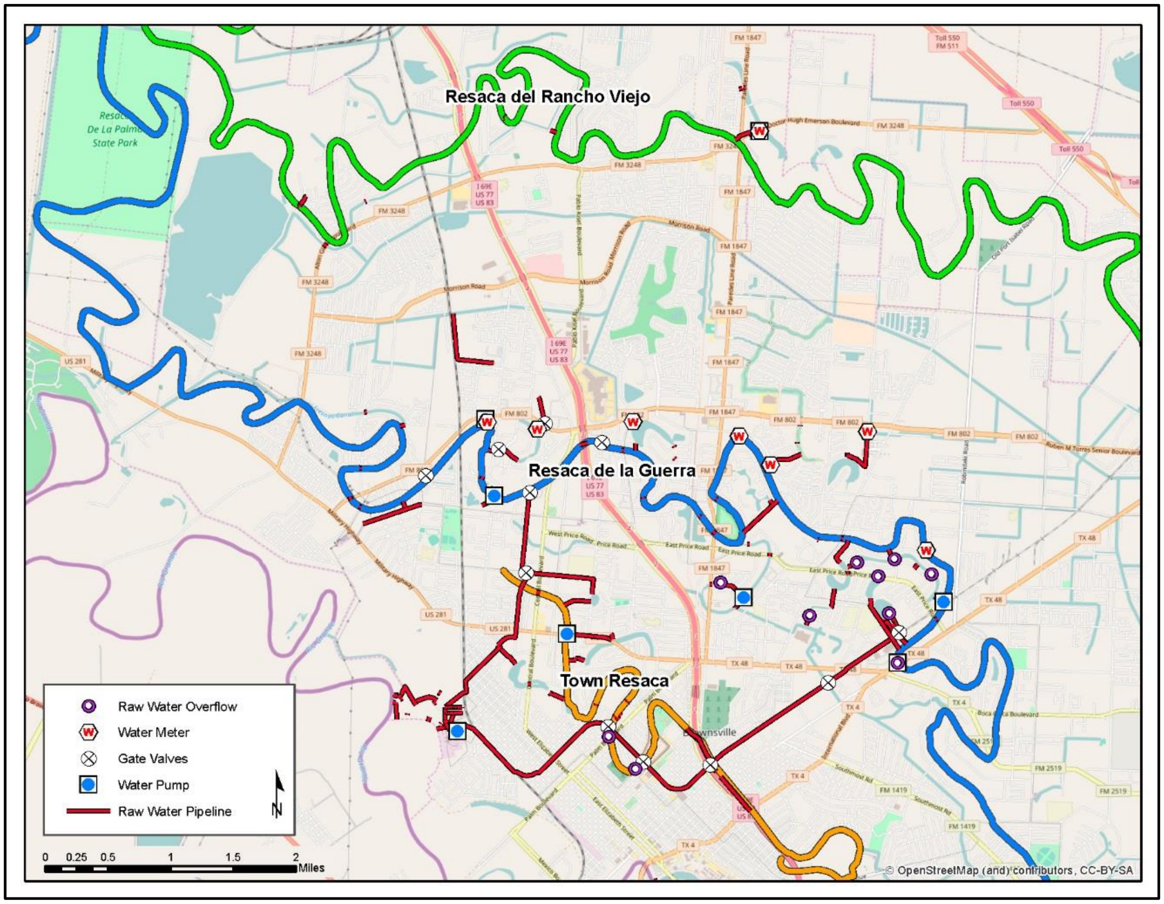


Figure A-4: Water Control Structures for Resaca de la Guerra and Resaca del Rancho Viejo

Resaca de la Guerra

The Resaca de la Guerra is located between Town Resaca and Resaca del Rancho Viejo. Most of the resaca’s water originates from the Rio Grande through the BPUB pumps, and is used for public consumption and irrigation. Water levels in Resaca de la Guerra are maintained by a weir located near 14th Street. Most of the land adjacent to the resaca has been developed for both residential and commercial purposes. This resaca also provides extra drainage capacity during rainfall events with excess runoff routed to the Brownsville Navigation District Ship Channel.

Resaca del Rancho Viejo

The Resaca del Rancho Viejo is the northernmost of the three Brownsville resaca systems. The areas surrounding Resaca del Rancho Viejo are the least developed consisting of low density residential and agricultural uses. Water in the Resaca del Rancho Viejo system is primarily used for the irrigation of row crops and orchards. The resaca and irrigation flow is primarily gravity flow. The areas adjacent to the Resaca del Rancho Viejo system are undergoing rapid change due to urban expansion from the City of Brownsville. Several in-channel water control structures have been constructed in conjunction with residential neighborhood development.

Town Resaca

The Town Resaca system originates approximately 800 feet east of the intersection of Los Ebanos Boulevard and Honeydale Street in Brownsville and extends southeasterly to the intersection of 30th Street and Hortencia Boulevard. The major source of water for the Town Resaca system is the Rio Grande River through the BPUB pipeline. In addition, smaller amounts of water also enter the Town Resaca System through storm sewers and natural surface drainage during rainfall events. The primary use of Town Resaca System is for storm water drainage.

Ground Water

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). This water must be diluted with fresh surface water to be used for municipal uses.

Water Quality

In general, existing water quality data for resacas is relatively limited. The Texas Commission on Environmental Quality (TCEQ) regulates surface water quality within the State of Texas. The resacas of Brownsville are unclassified with respect to Texas water quality standards. General criteria that apply to all surface waters in Texas apply to the resacas; they are found in the Texas Administrative Code (TAC), Title 30, Part 1, Chapter 307. However, the TCEQ is currently investigating pollutant loads and impairments of resaca water quality resulting from nonpoint sources (TCEQ, 2017). Results of the study and designation of the resacas are still pending.

Although no water quality testing has been conducted for Resaca de la Guerra and Resaca del Rancho Viejo, 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, unpublished data).

High pH and dissolved oxygen (percent saturation) 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 resacas 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, 2014) throughout much of the year, oxygen levels decreased significantly during the summer months (Table A-12). Water temperatures ranged from 59° F in January to 70° F in November.

Table A-12: Boulevard Resaca (Section 206 CAP Study Restoration Area) Water Quality

Month	Dissolved Oxygen (mg/L)	Water Temperature (°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) with similar results (Table 10). 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 resaca segments evaluated by McIntosh are considered eutrophic. In addition to collecting standard water quality parameters for the resacas, McIntosh also analyzed the resaca segments 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 A-13: Average Annual Water Quality Parameters for Three Sites on Town Resaca

Water Quality Parameter	Sites (not correlated with Restoration Areas 1,2 and 3)			TCEQ Exceedance Criteria
	1	2	3	
Water Temperature	77.7	79.3	75.3	95
pH	8.1	8.3	7.9	Low 6.5, High 9.0
Dissolved Oxygen	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	-
Total P (mg/L PO43-)	0.656	1.058	0.550	0.69
Nitrite (mg/L NO2--N)	0.007	0.005	0.005	-
Nitrate (mg/L NO3--N)	0.020	0.010	0.013	1.1
Ammonia (mg/L NH3-N)	0.299	0.254	0.264	0.46

A 1976 Brownsville Urban Waterways Study (Balli & Associates and Heningson, Durham & Richardson, Inc. Of Texas, 1976) found high concentrations of fecal coliform in Town Resaca. The contamination was attributed to the Gladys Porter Zoo, storm water runoff, and septic systems along the resacas. The study concluded that the contamination could be attributed to a specific source, since concentrations of most other analytical parameters were not indicative of pollution.

Potential non-point source pollutants account for a significant portion of resaca contamination. Fertilizers and pesticides enter the resacas through runoff from residential and commercial landscapes. In addition, petroleum byproducts, antifreeze, and trash are carried into the resacas from stormwater runoff.

Hydrology and Floodplains

Rivers frequently alter their courses in response to changes in flow characteristics. This is particularly common in the lower reaches of a river in the delta. As described above, the shifting of the Rio Grande has resulted in the creation of cutoff channels (resacas) that are formed during flood events.

Resaca Hydrology

Brownsville relies almost entirely on the Rio Grande for its water supply. Because of poor quality, ground water must be combined with freshwater for municipal use. With the connection to the Rio Grande, resacas play an integral role in Brownsville's water supply and management (Figure A-5). Brownsville diverts water from the Rio Grande and operates two water treatment plants and two wastewater treatment plants. The combined capacity of Water Treatment Plant (WTP) No. 1 and WTP No. 2 totals 40 million gallons per day. The resacas are used as a conveyance to transport river water to WTP No. 2. Of the average 18 million gallons of water per day used by the city of Brownsville, approximately 8 million gallons per day are transported along the Resaca de la Guerra system to WTP No. 2. The resacas also serve as limited reservoirs for water storage, a role that becomes increasingly important during times of drought.

In addition to the municipal water used, two irrigation districts manage the water in the resacas within the study area. Cameron County Irrigation District # 6 and Brownsville Irrigation and Drainage District # 5 are under agreement with BPUB to manage the scarce water supplies in the area. Water demand in the LRGV consists of approximately 90 percent irrigation use and 10 percent municipal use; however as economic growth continues to increase urban development, the percent of water dedicated to municipal uses are increasing.

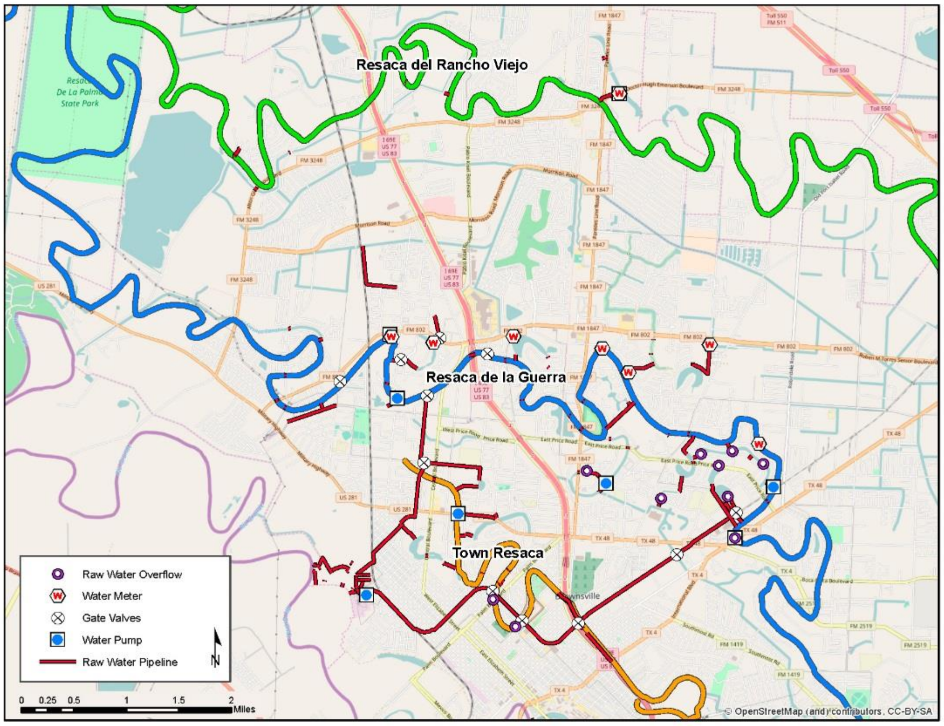


Figure A-5 BPUB Water Management of the Resaca Systems.

Floodplains

The resacas are the aquatic component of the Tamaulipan thornscrub habitats. The aquatic and riparian habitat restoration areas would be located within the 100-year floodplain of the Rio Grande and the resacas. The floodplain connection of the resacas has been altered in the past 100 years as the construction of dams, flood control levees, and water management has significantly minimized the size of the resaca floodplain.

Riverine Resources

The resacas are linear aquatic features over the LRGV landscape that are comprised of old Rio Grande Delta distributaries and paleochannels of the Rio Grande. Currently, flows within the resacas are extremely slow and the resacas functions as a series of pooled segments instead of a flowing system. Many of the resacas have filled with sediments over the last 100-150 years which have negatively affected water temperatures, dissolved oxygen concentrations, and water depths throughout the resaca systems.

Wetlands

Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands generally include swamps, marshes, bogs, and similar areas (USACE, 1987). Ecologically, wetlands are unique and critical habitat for many species of plants and wildlife. The U.S. Army Corps of Engineers performs identification of wetlands, and under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899, permits are required for activities impacting identified wetlands.

Wetlands within the study area are concentrated along the banks of the resacas and in the areas between adjacent restoration areas. Additional wetland areas have also formed along drainage ditches and drains into the resacas. In addition, resacas that have silted in and provide a relatively low sloping shoreline, or are seasonally inundated, may provide the hydrology, soils, and vegetation to support wetland habitats.

The USFWS National Wetland Inventory (NWI) data was used with a 150-foot buffer around the resacas to estimate the spatial extent of wetlands associated with the resacas. Approximately 11 percent of the areas adjacent to the resacas have been classified as wetlands using the NWI methodology. Table 11 lists the percentages and types of NWI wetlands classified within and adjacent to the resacas in Brownsville.

Table A-14: NWI Wetlands in and Adjacent to Resacas in Brownsville, Texas.

NWI Class	System	Subsystem	Class	Subclass	Water Regime	Modifier	Acres	Percent of Wetlands	Percent of Total
L1UBH	Lacustrine	Limnetic	Unconsolidated Bottom		Permanently Flooded		16.4	6.4	0.7
							16.4		
PAB3F	Palustrine		Aquatic Bed	Rooted Vascular			1.6	0.6	0.1
							1.6		
PEM1A	Palustrine		Emergent	Persistent	Temporarily Flooded		4.3	12.8	1.4
PEM1C			Emergent	Persistent	Seasonally Flooded		11.1		
PEM1Ch			Emergent	Persistent	Seasonally Flooded	Diked/ Impounded	2.1		
PEM1F			Emergent	Persistent	Semi-permanently Flooded		15.1		
							32.6		
PSS1A	Palustrine		Scrub-Shrub		Temporarily Flooded		0.5	2.2	0.2
PSS1C			Scrub-Shrub		Seasonally Flooded		4.3		
PSS1Cx			Scrub-Shrub		Seasonally Flooded	Excavated	0.8		
							5.6		
PUBF	Palustrine		Unconsolidated Bottom		Semi-permanently Flooded		5.3	75.9	8.5
PUBH			Unconsolidated Bottom		Seasonally Flooded		151.5		
PUBHh			Unconsolidated Bottom		Seasonally Flooded	Diked/ Impounded	24.5		
PUBHx			Unconsolidated Bottom		Seasonally Flooded	Excavated	12.6		
							194.0		
Total Wetlands							255.4	100.0	11.2
Riparian Acreage							2019.6		88.8
Total Study Area Acreage							2275.0		100.0

Palustrine wetlands (inland, marsh-like areas) comprise the largest percentage of wetland with a large proportion of those classified as semipermanently flooded wetlands with unconsolidated bottoms. The lacustrine wetlands identified in the table are comprised of permanently flooded resacas

Biological Resources (Fish and Wildlife)

The aquatic and riparian vegetation associations being proposed for restoration support an equally rare and diverse fish and wildlife community. Wildlife species found nowhere else in the U.S such as the plain chachalaca, black-spotted newt, white-lipped frog, and South Texas siren occur within the resaca's aquatic and riparian habitats. The following section on rare, threatened, and endangered species highlights the incredible ecological value and significance of resaca habitats.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service threatened and endangered species list for Cameron County identifies 10 endangered, 4 threatened, and 2 candidate species. In addition to these species, TPWD lists additional species as endangered and threatened. The TPWD is 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 species listed in Table A-1 indicate species that utilize resaca habitats in the LRGV.

Cultural Resources

Federal agencies are required under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, to "take into account the effects of their undertakings on historic properties" and consider alternatives "to avoid, minimize or mitigate the undertaking's adverse effects on historic properties" [(36 CFR 800.1(a-c)] in consultation with the State Historic Preservation Officer (SHPO) and appropriate federally recognized Indian Tribes (Tribal Historic Preservation Officers - THPO) [(36 CFR 800.2(c)]. There are other applicable cultural resources laws, rules and regulations that will inform how investigations and evaluations will proceed throughout the study and implementation phases (e.g., Archeological and Historic Preservation Act of 1974, National Environmental Policy Act of 1969, Native American Graves Protection and Repatriation Act, Engineer Regulation 1105-2-100).

The Brownsville study area is located along the southern Texas coast, which has been occupied by humans since the Paleoindian period, dating to around 11,500 BP (Hester, 1995). It is situated in the Lower Rio Grande Valley, on the Texas Gulf Coastal Plain, and is described as a moisture-deficient region with a semiarid, subtropical climate (Blair, 1950; Griffiths and Bryan, 1987).

The resacas, which are abandoned meandering channels of the Rio Grande River, are generally filled with clays and silts, and surrounded by overbank flood deposits. Hundreds of archaeology sites have been recorded in the silty clay dunes surrounding these abandoned river channels (Anderson, 1932; Terneny, 2005).

The Paleoindian Period in this region persists until approximately 8,000 BP, and is not well documented due to rising sea levels, which have left coastal Paleoindian sites submerged on the continental shelf. Tool types recorded at these sites include Clovis, Folsom, and Angostura points, which represent the earliest stone tool technologies in North America.

Archaic Period (8,000-500 BP) sites are more common and contain evidence of increased populations, use of cemeteries for human burial, and intensified plant processing using earth ovens and grinding implements (Hester, 1995). During the Late Prehistoric Period (1,300-500 BP/1500AD), bow and arrow artifacts appear, and the presence of Tancol Polychrome pottery, jade, and obsidian artifacts indicate links with Mexican Gulf Coast cultures (Terneny, 2005).

The Protohistoric Period spans from approximately 500 years before present (1500 AD) to 1750 AD. Traces of European-introduced material culture are evident at Protohistoric Period sites but do not appear to substantially alter local economies or other aspects of culture.

By the Historic Period (early-mid 1700s), conflicting colonial interests had begun to drastically affect the cultural landscape of the Lower Rio Grande Delta. Aggressive Indian removal took place throughout the 1800s, and in May of 1846, the second battle of the Mexican American War was fought at Resaca de la Palma. The site of the battle, which is located within the Resacas Ecosystem Restoration study area, is now a National Historic Landmark managed by the National Park Service (NPS).

Historic documentation and excavations associated with residential construction confirm that Mexican soldiers were buried in mass graves of 50-100 individuals after the decisive loss to American forces (Wescott et al., 2012). Today, the area is known as the city of Brownsville and has over 180,000 residents. The modern landscape is significantly altered by infrastructure, residential, and commercial development, though many historic standing structures remain in the central historic area of the city.

Land Use, Recreation, and Transportation

Land Use

Land use within the study area is reflective of an agricultural environment that has experienced incredible urban growth. The historic natural vegetation has been cleared for intensive winter garden and orchard agricultural uses. The agricultural land use is now transitioning to residential, commercial, and industrial development as the economic growth of the area has increased. As Figure A-6 and Figure A-7 graphically indicate, the urban core of Brownsville gives way distally to open space and agriculture. Table A-15 shows total acreage and percent of land uses immediately around each resaca. The table also shows the expected pattern of development with Town Resaca in the oldest part of Brownsville being more densely developed than the more rural resacas associated with the Resaca del Rancho Viejo system. Under the future project conditions, land use on the outer portions of the study area would continue to transition into residential and commercial development, while the more centralized urban areas would continue to transition to a more dense urban land use.

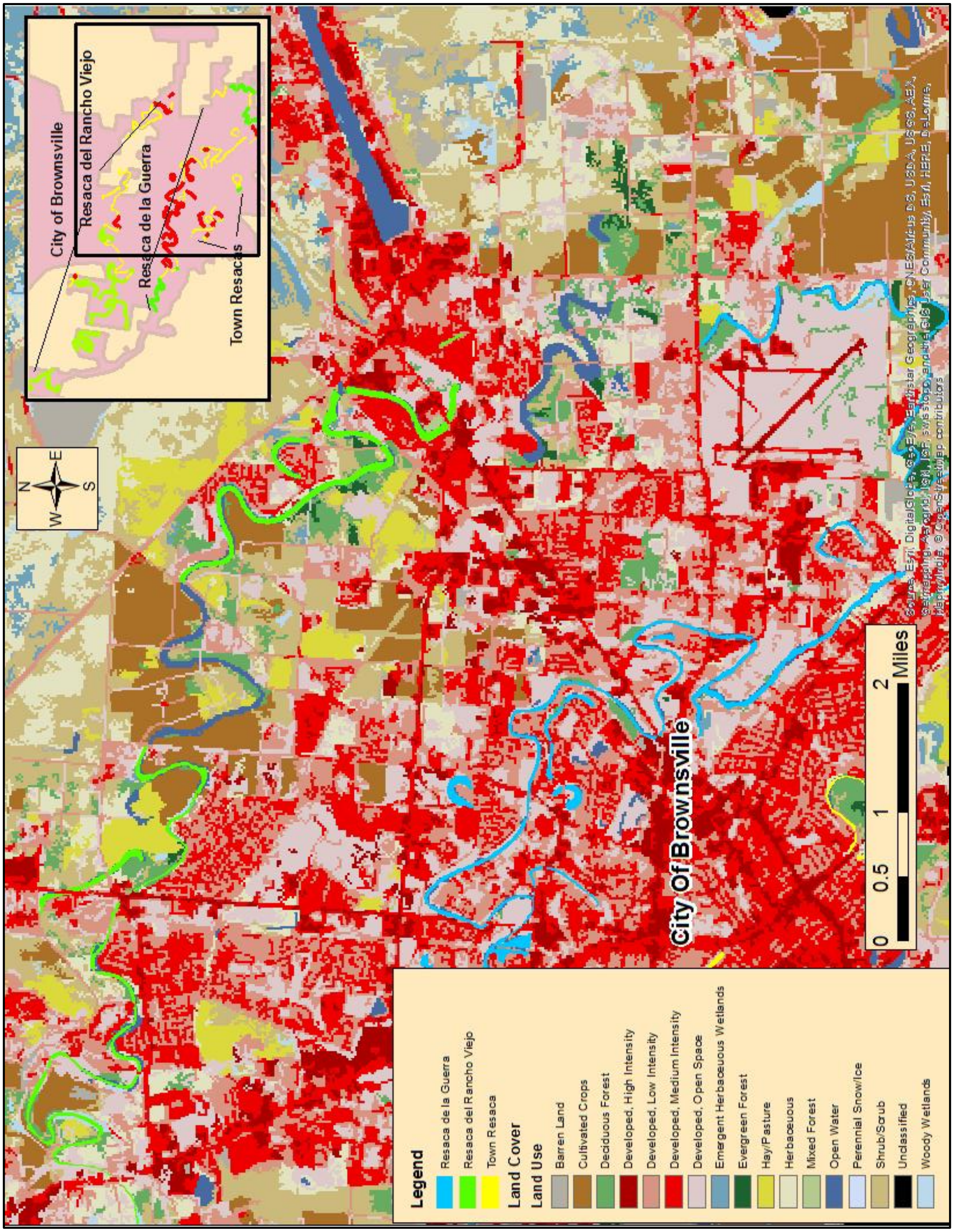


Figure A-6: Land Use Map of Resacas Study Area

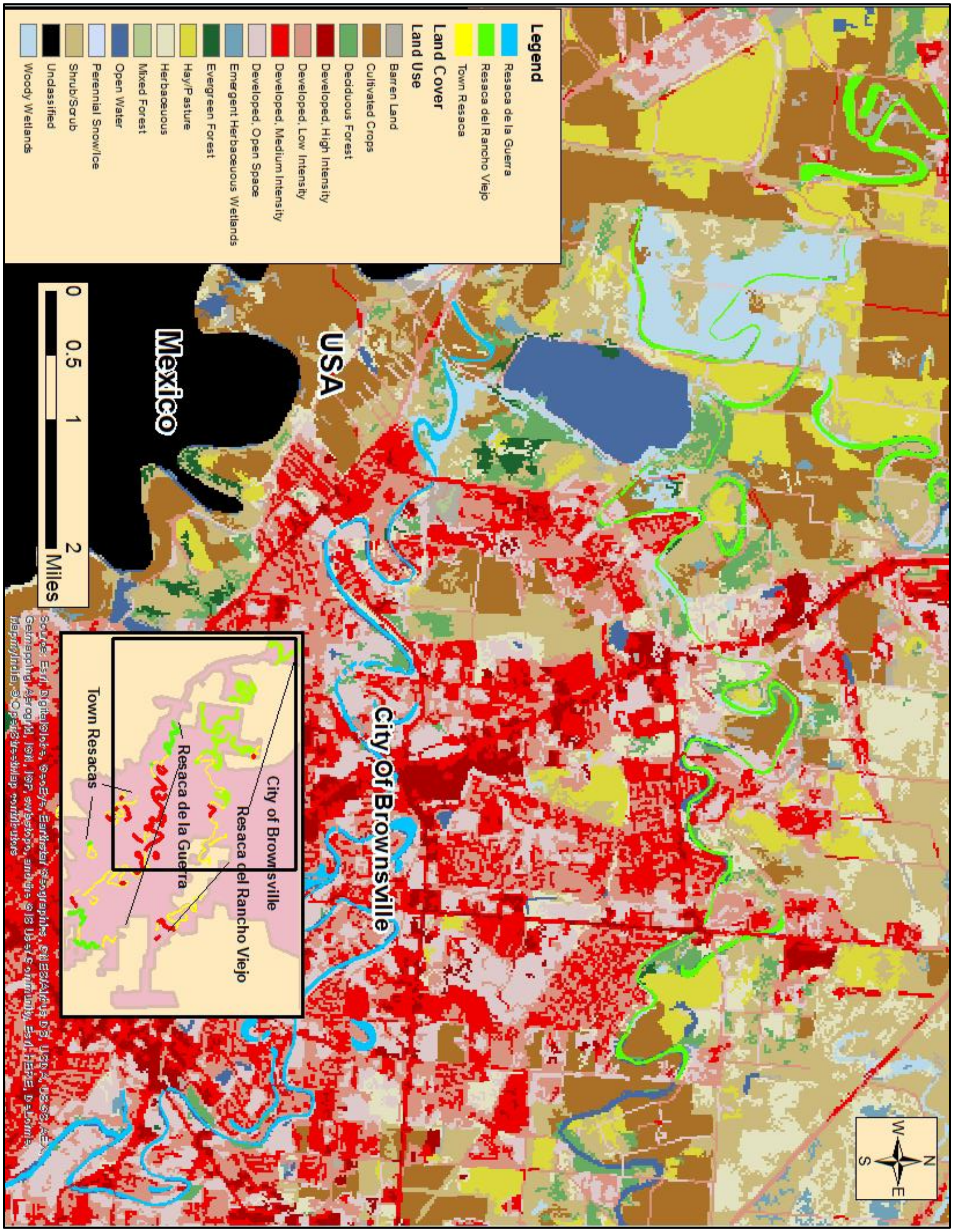


Figure A-7: Land Use Map of Resacas Study Area

Table A-15: Land Use in the Resaca Study Area.

Land Use	Resaca del Rancho Viejo		Resaca de la Guerra		Town Resaca	
	Acres	Percent Area	Acres	Percent Area	Acres	Percent Area
Urban or Built-up Land						
Residential	277.8	5.1	2,171.9	33.7	788.3	63.6
Commercial	127.4	2.3	179.1	2.8	181.0	14.6
Industrial			1.9	0.0	0.8	0.1
Transportation, Communications	102.7	1.9	60.6	0.9	75.0	6.1
Mixed Urban or Built-up Land			13.8	0.2		
Other Urban or Built-up Land	5.4	0.1	364.0	5.6	78.0	6.3
Agriculture Land						
Cropland and Pasture	4,076.9	74.9	2,902.0	45.0	57.7	4.7
Orchards, Groves, Vineyard, Nurseries	463.0	8.5	166.4	2.6	58.1	4.7
Rangeland						
Herbaceous Rangeland	141.0	2.6	78.8	0.0		
Shrub and Brush Rangeland	201.1	3.7	84.2	1.3		
Mixed Rangeland			130.8	2.0		
Forest Land						
Evergreen Forest Land			4.6	0.0		
Water						
Lakes	42.0	0.8				
Reservoirs	8.4	0.2	13.4	0.0		
Barren Land						
Barren Land			281.1	4.4		
Total Acres	5,445.7	100	6,452.7	100	1,238.9	100
Sources: Texas Natural Resources Information System; and G.E.C., Inc.						

Socioeconomic and Visual Aesthetics

Demographics

Brownsville's population is overwhelmingly Hispanic or Latino (90.9 percent) and young. The tables below and in Appendix 3 present information that allows for comparison of the resaca areas in the context of the City of Brownsville, Cameron County and Texas on a number of social and demographic variables. Racial and ethnic breakdown is presented in Table A-16 for Texas, Cameron County and Brownsville. Table A-17, Table A-18Table A-19 show the same detailed racial and ethnic information for selected census tracts surrounding the resacas as well as the number and percent of persons below the poverty level. Location of the census tracts relative to the resacas can be seen on Figure A- 8. Age, gender, racial/cultural, and income characteristics are presented in Attachment 3 for Texas, Cameron County, Brownsville and selected resaca area census tracts.

Table A-16: Population Characteristics for Texas, Cameron County, and Brownsville.

Category	Texas	Percent	Cameron Co.	Percent	Brownsville	Percent
Total:	20,851,820		335,227		165,776	
Not Hispanic or Latino:	14,181,698	68.0%	52,071	15.5%	15,038	9.1%
White alone	10,927,538	52.4%	48,551	14.5%	13,465	8.1%
Black or African American alone	2,349,641	11.3%	1,079	0.3%	308	0.2%
American Indian and Alaska Native alone	71,831	0.3%	260	0.1%	103	0.1%
Asian alone	549,054	2.6%	1,415	0.4%	780	0.5%
Native Hawaiian and Other Pacific Islander	9,810	0.0%	4	0.0%	17	0.0%
Some other race alone	19,264	0.1%	63	0.0%	45	0.0%
Two or more races	254,560	1.2%	699	0.2%	320	0.2%
Hispanic or Latino:	6,670,122	32.0%	283,156	84.5%	150,738	90.9%
White alone	3,870,447	18.6%	220,938	65.9%	122,591	73.9%
Black or African American alone	35,913	0.2%	460	0.1%	348	0.2%
American Indian and Alaska Native alone	41,924	0.2%	1,182	0.4%	564	0.3%
Asian alone	6,874	0.0%	94	0.0%	53	0.0%
Native Hawaiian and Other Pacific Islander	2,654	0.0%	40	0.0%	44	0.0%
Some other race alone	2,436,708	11.7%	53,458	15.9%	23,790	14.4%
Two or more races	275,602	1.3%	6,984	2.1%	3,348	2.0%

Source: U.S. Census, 2000.

Table A-17: Detailed Population Characteristics for Selected Resaca-Area Census Tracts.

Census Tracts	Total	Not Hisp	White	Black or Afr	Indian and	Asian	Native Hawai	Some other	Two or more	Hisp or Latino	White alone	Black or Afr	Indian and	Asian alone	Native Hawai	Some other	Two or more	Persons Below	Percent Below
125.04	5,457	1,112	991	66	0	55	0	0	0	4,345	3,591	0	10	0	0	629	115	1,216	22.3%
125.07	4,210	157	153	0	0	4	0	0	0	4,053	3,556	0	85	0	0	385	27	1,757	32.2%
125.08	1,630	188	174	0	14	0	0	0	0	1,442	708	0	0	0	0	716	18	485	8.9%
126.04	1,024	73	73	0	0	0	0	0	0	951	939	0	0	0	0	12	0	376	6.9%
126.05	967	295	295	0	0	0	0	0	0	672	672	0	0	0	0	0	0	220	4.0%
126.06	1,775	470	460	0	10	0	0	0	0	1,305	1,160	0	0	0	0	137	8	299	5.5%
126.07	2,119	0	0	0	0	0	0	0	0	2,119	1,601	0	0	9	0	509	0	498	9.1%
126.09	5,950	78	78	0	0	0	0	0	0	5,872	5,123	0	0	5	0	733	11	3,609	66.1%
126.1	1,264	10	10	0	0	0	0	0	0	1,254	1,052	0	0	0	0	202	0	886	16.2%
126.11	1,496	279	279	0	0	0	0	0	0	1,217	1,092	0	0	0	0	97	28	519	9.5%
126.12	5,543	488	362	96	0	30	0	0	0	5,055	3,916	21	15	0	0	921	182	715	13.1%
127	4,287	355	341	14	0	0	0	0	0	3,932	3,037	5	0	0	0	861	29	1,708	31.3%
128	4,803	128	123	0	0	5	0	0	0	4,675	3,832	4	0	0	0	781	58	1,604	29.4%
129	3,783	964	952	6	0	0	0	0	6	2,819	2,516	0	6	0	0	297	0	888	16.3%
130.02	4,264	760	680	4	0	45	0	0	31	3,504	2,844	15	61	0	0	459	125	789	14.5%
130.03	2,118	202	149	14	0	39	0	0	0	1,916	1,461	0	0	0	6	426	23	822	15.1%
130.04	3,252	491	424	0	3	40	0	0	24	2,761	2,264	0	0	26	0	434	37	745	13.7%
131.02	2,143	393	367	0	0	12	0	5	9	1,750	1,569	0	0	0	0	170	11	377	6.9%
131.04	3,831	739	668	16	4	51	0	0	0	3,092	2,465	16	32	0	0	482	97	729	13.4%
131.06	4,320	334	293	0	0	41	0	0	0	3,986	3,419	9	30	0	0	407	121	1,820	33.4%
133.03	3,603	364	314	6	0	32	0	0	12	3,239	2,573	0	0	0	0	584	82	662	12.1%
133.04	3,619	278	243	15	0	0	0	11	9	3,341	2,572	0	13	0	0	722	34	1,150	21.1%
133.05	5,428	235	235	0	0	0	0	0	0	5,193	4,028	0	0	0	0	1,125	40	2,090	38.3%
133.07	2,592	0	0	0	0	0	0	0	0	2,592	1,919	0	14	0	0	503	156	1,431	26.2%
133.08	2,690	41	33	8	0	0	0	0	0	2,649	2,030	0	0	0	0	578	41	985	18.1%
133.09	3,049	8	8	0	0	0	0	0	0	3,041	2,309	9	0	0	0	617	106	1,344	24.6%
134.02	2,668	42	42	0	0	0	0	0	0	2,626	2,287	0	13	0	0	318	8	1,285	23.5%
135	2,147	599	599	0	0	0	0	0	0	1,548	1,372	0	0	0	0	138	38	393	7.2%
136	4,007	429	403	14	0	5	0	0	7	3,578	2,838	0	0	0	0	727	13	1,295	23.7%
137	4,387	204	204	0	0	0	0	0	0	4,183	3,316	0	61	0	0	682	124	2,163	39.6%
138.01	3,726	121	108	13	0	0	0	0	0	3,605	3,045	10	18	0	0	395	137	1,922	35.2%
138.02	4,027	33	27	0	0	0	0	6	0	3,994	3,439	5	5	0	0	545	0	2,035	37.3%
139.02	4,611	61	61	0	0	0	0	0	0	4,550	3,746	0	27	0	0	638	139	1,979	36.3%
140.01	2,721	185	180	0	0	0	0	0	5	2,536	2,238	21	0	0	8	255	14	1,566	28.7%

Table A-18: Population by Gender and Age for Texas, Cameron County, and Brownsville Census Tracts.

Census Area	MALES	FEMALES	AGE UNDER 5	AGE 5-17	AGE 18-21	AGE 22-29	AGE 30-39	AGE 40-49	AGE 50-64	AGE 65-UP
Texas	10,352,910	10,498,910	1,624,628	4,262,131	1,288,410	2,501,993	3,259,444	3,049,533	2,793,149	2,072,532
Cameron Co.	159,599	175,628	31,744	81,551	20,935	38,193	44,755	40,280	40,394	37,375
Brownsville	78,553	87,223	16,620	41,978	10,958	20,139	22,510	19,846	18,740	14,985
Tracts										
125.04	2,589	2,868	597	1,461	263	630	884	809	542	271
125.07	2,013	2,197	405	1,117	291	559	538	502	516	282
125.08	795	855	152	366	88	141	250	174	235	244
126.04	501	553	96	247	74	109	149	133	151	95
126.05	511	565	71	285	64	90	139	143	186	98
126.06	867	923	169	486	85	166	332	237	210	105
126.07	948	1,124	281	533	149	360	296	183	187	83
126.09	3,063	3,001	827	1,802	494	867	733	637	478	226
126.1	526	666	184	429	61	185	168	99	42	24
126.11	625	829	143	277	49	167	231	157	201	229
126.12	2,696	2,847	680	1,528	293	653	1,008	815	407	159
127	2,020	2,267	458	1,318	277	469	696	461	404	204
128	2,294	2,509	427	1,056	330	590	555	600	657	588
129	1,744	1,999	260	709	166	374	459	437	536	802
130.02	1,999	2,265	387	815	273	685	662	537	526	379
130.03	962	1,196	254	499	141	265	296	214	240	249
130.04	1,495	1,757	243	591	214	380	388	440	494	502
131.02	1,019	1,107	109	454	134	162	243	341	354	329
131.04	1,755	2,093	357	818	214	518	457	525	499	460
131.06	2,024	2,296	411	1,107	316	490	500	537	538	421
133.03	1,692	1,911	375	942	227	495	559	458	368	179
133.04	1,754	1,991	468	894	231	618	524	407	363	240
133.05	2,571	2,819	600	1,537	409	678	726	664	531	245
133.07	1,270	1,351	276	710	210	352	296	284	342	151
133.08	1,276	1,326	292	776	218	335	323	305	227	126
133.09	1,478	1,592	312	964	256	354	404	416	245	119
134.02	1,183	1,446	251	607	201	315	325	292	293	345
135	995	1,191	156	409	101	173	314	294	368	371
136	1,837	2,170	351	906	213	464	526	428	461	658
137	1,937	2,450	405	1,124	287	469	541	477	522	562
138.01	2,007	1,719	290	732	315	578	572	452	370	417
138.02	1,850	2,177	360	993	262	457	459	456	508	532
139.02	2,130	2,481	432	1,220	328	517	517	569	527	501
	1,302	1,419	289	482	171	286	334	319	340	500

Table A-19: Housing Unit Tenure for Texas, Cameron County, Brownsville, and Resaca-Area Census Tracts.

Texas	8,157,575	764,221	4,716,959	2,676,395
Cameron Co.	119,654	22,387	65,875	31,392
Brownsville	50,340	5,460	28,326	16,554
Tract				
125.04	1,596	77	1,151	368
125.07	1,094	72	831	191
125.08	620	151	427	42
126.04	423	131	235	57
126.05	313	21	233	59
126.06	479	13	434	32
126.07	521	32	336	153
126.09	1,392	99	930	363
126.1	344	37	59	248
126.11	596	21	266	309
126.12	1,535	84	1,259	192
127	1,208	185	787	236
128	1,385	83	876	426
129	1,737	397	866	474
130.02	1,701	141	565	995
130.03	706	63	194	449
130.04	1,113	82	687	344
131.02	834	157	605	72
131.04	1,319	77	622	620
131.06	1,280	51	637	592
133.03	1,044	78	589	377
133.04	1,223	77	410	736
133.05	1,282	73	878	331
133.07	639	41	381	217
133.08	594	53	409	132
133.09	645	38	470	137
134.02	748	50	400	298
135	793	74	546	173
136	1,271	137	453	681
137	1,396	185	596	615
138.01	943	107	319	517
138.02	1,225	99	526	600
139.02	1,228	57	695	476
140.01	1,161	207	297	657

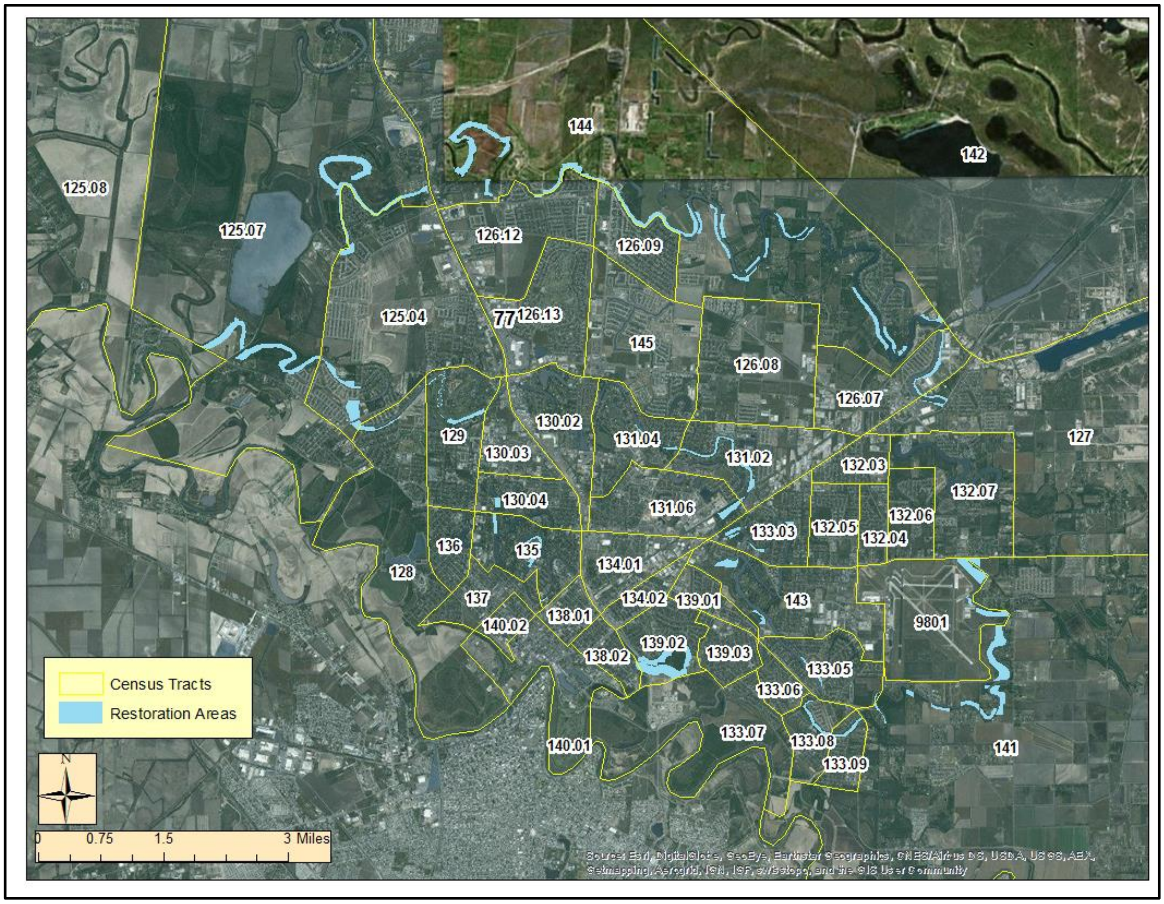


Figure A- 8: Census tracts in relation to resaca restoration areas. Environmental Justice

The study area is comprised of an Hispanic dominated population with non-Hispanic whites the second most populous. Much of the signage in the Brownsville area is either in Spanish or bilingual. Due to the large scale of the restoration study, the racial makeup of study area is representative of the City of Brownsville and the south Texas region.

Visual Aesthetics

Resacas are an important component of the Brownsville community and ecotourism landscape. The resacas provide waterside real estate and recreational opportunities for Brownsville residents. Many residences have structures that indicate provision for this kind of usage, picnic tables, decks or even wharf-like structures built next to or over the water. In addition, many resacas in commercial and residential areas are bulkheaded to reduce erosion and form a neat, straight-lined landscape.

Existing artificial light sources within the 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.

Noise

Noise pollution is the exposure of people or animals to levels of sound that are annoying, stressful, or damaging to the ears. Although loud and frightening sounds are part of nature, urbanization has caused an increase in the level and frequency of noise exposure. Ambient noise pollution comes from machines like automobiles, trucks, construction equipment, farm machines, and aircraft. Home appliances, shop tools, and yard equipment can also be sources of noise pollution, as well as guns, fireworks, and loud music.

Sound intensity is measured in units called decibels (dB). The decibel scale is logarithmic and climbs steeply. Sound levels measured in decibels are commonly weighted to better approximate the way a human ear perceives sound. Sound level values obtained using this weighting network are referred to as "A-weighted" sound levels and are signified by the identifying unit, dBA. Table A-20 lists typical decibel levels of common noise sources. Exposure to excessive noise has been related to hearing loss, stress, high blood pressure, sleep loss, distraction, and lost productivity.

Table A-20: Decibel Levels of Common Noise Sources.

Noise Source	dBA
Normal Breathing	10
Soft Whisper	30
Rainfall	50
Air Conditioner	50 - 75
Normal Conversation	60
Vacuum Cleaner	60 - 85
Power Lawn Mower	65 - 95
Freeway Traffic	70
Ringing Telephone	80
Motorcycle	95 -110
Baby Crying	110
Leafblower	110
Football Game (Stadium)	117
Thunder	120
Jet Engine Taking Off	150
Firecracker	150
Fireworks (At 3 Feet)	150
Handgun	160

The increasing growth in the Brownsville area has brought with it an increase in sources of noise. Primary sources of noise in the Brownsville area include major local and international roadways, railways, and the Brownsville/South Padre Island International Airport. Other common sources of urban noise include lawn and yard equipment, construction projects, and loud music. Because of Brownsville's urban nature, many major sources of noise are located in close proximity to residential and public areas. Brownsville does have a noise restriction ordinance. Noise violations are handled on a case by case basis.

The Brownsville/South Padre Island International Airport is located within the city of Brownsville. The airport serves approximately 140,000 passengers and logs approximately 35,000 landing and takeoffs annually. A Noise Compatibility Plan prepared in accordance with FAA regulations was approved by the FAA and noticed in the Federal Register on January 29, 2003 (Vol. 68, No. 19).

The Port of Brownsville is located approximately two miles northeast of the City of Brownsville. Many activities conducted at the port may contribute to excessive noise, including construction of offshore drilling rigs, ship repairing and dismantling, steel fabrication, boat construction, rail car rehabilitation, liquefied petroleum gas (LPG) storage/distribution, waste oil recovery, bulk terminaling for miscellaneous liquids, and grain handling and storage.

Hazardous, Toxic, and Radioactive Waste

The purpose of this report is to discuss the HTRW investigation for the study area. This report identifies both HTRW and non-HTRW environmental issues, and presents appropriate measures to resolve these issues. The methods used in performing the investigation are described in detail. Conclusions and recommendations regarding potential impacts due to HTRW and non-HTRW issues associated with the project site are provided. The purpose of the evaluation is to identify and avoid hazardous, toxic, or radiological wastes (HTRW) sites during planning or implementation of a USACE project, to the extent practicable.

No sites with recognized environmental conditions, were identified within the footprint of the alternatives evaluated.

Geology and Soils

Geology and Topography

The Brownsville resacas are located on Quaternary alluvial deposits of the LRGV. The specific geologic formations associated with the resacas consist of floodplain deposits dominated by mud (Qam) with the adjacent upland habitats consisting of floodplain deposits dominated by silt and sand (Qas) (USGS, 1987).

The topography of the resaca study area is consistent with the flat topography associated with large river delta areas ranging from an elevation of 40 feet above mean seal level (AMSL) in the northwestern corner of the study area to an elevation of 20 feet AMSL in the southeastern portion. Localized drainage swales, drains, and irrigation canals direct local storm water runoff and water throughout the study area.

Soils, Including Prime Farmlands

Within the resaca study area, historic soils were primarily comprised of Laredo silty clay loam (LAA and LAB). The Laredo soils consist of deep, well-drained, calcareous soils found on old flood plains and delta with nearly level to gentle slope. In addition, pockets of Olmito silty clay (OM) soils are interspersed throughout the resaca areas. These three soil types are still represented within the study area; however, the cut and fill activities often associated with the more urbanized areas have resulted in modifications to the historic soils; therefore, soils within the urbanized areas of the study area are now classified as Laredo-Urban land complex soils (USDA, 1977). The urban soil complex consists of stratified layers of silt loam and silty clay loam extending 72 inches into the soil profile. Because the study area is enclosed within the city limits of Brownsville, soils within the study area are not covered under the Farmland Protection Policy Act. Under the future without project conditions, the conversion of native soil profiles to disturbed urban complex soils will continue as development continues to sprawl.

Habitat Evaluations

Because of the endemic and unique nature of the resaca ecosystem, a Resaca Reference Condition Model (RRCM) was developed in cooperation with USFWS, TPWD, NPS, BPUB, and university biologists, to quantify and assess existing and future habitat conditions for the resaca study area, with and without the study alternatives.

The RRCM utilizes data collected 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. 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.

Resaca Aquatic and Riparian Habitat Assessment

The resaca terminology use below is meant to identify different aspects of the resaca ecosystem. For the purpose of this document, a resaca is a linear aquatic feature across the landscape that was formed as a paleochannel or old distributary of the Rio Grande. The resacas in this study are Resaca del Rancho Viejo, Resaca de la Guerra, and Town Resaca. Resaca segments are smaller portions of the resaca that can be combined to form a group or "stepping stone" along the larger resaca. Resaca segments can be as small as a single area or up to a dozen areas. Restoration areas are defined as the aquatic and riparian habitats surrounding a single resaca pool or segment between pools. Measures and habitat indices were developed at the restoration area scale. For instance, Restoration Areas 65, 66, and 67 are each individual restoration areas, but grouped together would be a resaca segment. This resaca segment is located on Resaca de la Guerra.

Procedures

The RRCM was developed to quantify and assess existing and future habitat conditions for the resaca study area, with and without the study alternatives. 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 emergent and terrestrial 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.

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, with the exception of the presence of water, there is no semblance of the native resaca ecosystem intact.

The Ecosystem Restoration Planning Center of Expertise (EcoPCX) was closely involved regarding the certification or approval of the RRCM. Because the resaca ecosystems are specialized and unique, the EcoPCX recommended keeping two landscape ecologists/botanists associated with the University of Texas at Austin out of the model development process to serve as Agency Technical Review level reviewers of the model. The EcoPCX submitted the RRCM to HQ for approval on 2 Dec. 2016.

Sampling for the reference condition resacas was conducted in mid December, 2015 and data collection for the potential restoration areas was conducted in August 2016. Details of the RRCM calculations and derivation of the indices are described in more detail in Appendix B-1 and B-2.

Existing Habitat Conditions

To quantify the value of the existing habitat conditions, the RRCM was used to quantify the degree to which a potential restoration site mirrored reference conditions. The RRCM utilized habitat-specific features that can be incorporated into measures to improve resaca habitat within the Brownsville Resaca study area. The existing RRCM metrics and the RRCM indices for the potential restoration areas are identified in Table A-21.

Table A-21: RRCM Index Scores for the Brownsville Resacas Existing Conditions

Restoration Area	Slope 1:X	Percent Canopy Cover				Spp Composition	Spp Richness	Water Depth (feet)	RRCM Index
		Bank	Riparian	Aquatic	Invasive				
Town Resaca									
3	2	80	70	0	85	0.16	0.38	3	0.46
4	2	80	70	0	85	0.16	0.38	3	0.46
5	2	80	70	0	85	0.16	0.38	3	0.46
6	2	80	70	0	85	0.16	0.38	3	0.46
7	12	85	75	20	60	0.15	0.33	3	0.63
8	2	80	70	0	85	0.16	0.38	3	0.46
10	2	80	70	0	85	0.16	0.38	3	0.46
13	15	90	85	25	70	0.26	0.71	3	0.67
19	1	90	75	5	5	0.46	0.71	2	0.68
39	2	80	70	0	85	0.16	0.38	3	0.46
Resaca de la Guerra									
40	6	70	80	50	80	0.35	0.46	3	0.58
41	1	80	75	50	70	0.36	0.79	3	0.59
42	20	75	62	0	55	0.22	0.38	6	0.69
43	20	75	62	0	55	0.22	0.38	6	0.69
44	1	65	40	0	50	0.28	0.58	3	0.53
45	15	35	80	0	25	0.26	0.33	6	0.72
46	10	85	90	0	45	0.30	0.46	3	0.66
53	2	90	70	5	80	0.17	0.29	3	0.48
54	2	90	70	5	80	0.17	0.29	3	0.48
59	2	40	1	0	70	0.14	0.25	5	0.43
60	2	40	1	0	70	0.14	0.25	5	0.43
61	1	35	70	2	2	0.28	0.63	4	0.65
62	1	35	70	2	2	0.28	0.63	4	0.65
66	1	35	70	2	2	0.28	0.63	4	0.65
67	8	70	80	0	25	0.19	0.42	4	0.69
71	1	30	60	0	70	0.38	0.54	6	0.48
72	8	70	80	0	25	0.19	0.42	4	0.69
74	0.01	0	0	0	80	0.00	0.00	3	0.25
75	4	20	10	0	99	0.25	0.42	3	0.32
76	4	20	10	0	99	0.25	0.42	3	0.32
77	4	20	10	0	99	0.25	0.42	3	0.32
78	4	20	10	0	99	0.25	0.42	3	0.32
79	4	20	10	0	99	0.25	0.42	3	0.49

Restoration Area	Slope 1:X	Percent Canopy Cover				Spp Composition	Spp Richness	Water Depth (feet)	RRCM Index
		Bank	Riparian	Aquatic	Invasive				
80	1	20	50	0	50	0.15	0.42	5	0.49
81	1	85	87	0	55	0.07	0.13	5	0.57
82	1	75	70	0	60	0.19	0.38	3	0.52
83	0.01	5	25	0	50	0.13	0.21	2	0.35
84	0.5	40	35	0	80	0.15	0.29	2	0.35
93	2	99	99	0	2	0.73	1.00	0	0.56
94	2	0	0	0	80	0.00	0.00	0	0.07
95	2	85	80	0	25	0.21	0.33	0	0.42
96	1.5	75	50	5	18	0.20	0.42	3	0.62
161	15	65	70	0	0	0.15	0.33	0	0.57
Resaca del Rancho Viejo									
98	2	60	50	0	75	0.56	0.96	5	0.56
99	2	60	50	0	75	0.56	0.96	5	0.56
100	2	60	50	0	75	0.56	0.96	5	0.56
101	2	30	30	0	50	0.13	0.29	5	0.49
104	1	80	75	0	80	0.19	0.29	5	0.52
105	2	85	80	0	25	0.21	0.33	2	0.60
108	2	85	85	0	40	0.17	0.33	3	0.59
109	4	65	50	0	20	0.10	0.21	3	0.60
110	0.01	70	60	0	20	0.14	0.25	5	0.64
111	0.01	40	40	0	80	0.13	0.17	3	0.36
112	7	65	60	5	25	0.20	0.29	5	0.68
116/117	12	77	80	30	25	0.17	0.38	3	0.74
142	0.01	5	70	0	40	0.30	0.42	3	0.45
148/167	20	75	62	0	55	0.22	0.38	3	0.64
149	8	80	60	10	28	0.45	0.50	3	0.69
150	0.01	40	40	0	80	0.13	0.17	1	0.31
151	0.01	40	40	0	80	0.13	0.17	1	0.31
165	8	50	50	0	60	0.29	0.46	0	0.33
166	10	13	32	0	40	0.28	0.42	0	0.32
1000	4	70	75	0	28	0.46	1.00	5	0.73
1001	1	50	60	0	60	0.22	0.54	5	0.53

Future without Project Conditions

The benefits of implementing each management measure were forecast by assessing the changes a measure would have on each of the model metrics over time (at year 0, 1, 5, 10, 25, 50 and 75). Some measures such as dredging (water depth) and bank slope sculpting immediately increased benefits at year 0 as the water depth and bank slope metrics were immediately affected. In addition, the percent canopy cover was assumed to be zero as the OMRR&R would require the management of invasive plant species. Because riparian plantings require 40 to 50 years to complete the successional development required by the three target vegetation associations, a 75-year project life was used to bracket the 50-year target in the CE/ICA analysis and capture the full benefits of the project. The species composition and richness metrics were modified over each time interval to reflect the successional changes in the vegetation using interagency guidance. Similarly the aquatic, bank, and riparian were modified over time to reflect changes in the vegetation community. For the future without project conditions, these metrics were negatively impacted over time as the restoration areas would continue to be inundated with invasive species and water depths would continue to decrease.

The future without conditions RRCM indices over the life of the project are presented in Table A-22.

Table A-22: RRCM Indices for the Future without Project Conditions

Restoration Area	Year						
	0	1	5	10	25	50	75
3	0.46	0.46	0.45	0.43	0.40	0.25	0.25
4	0.46	0.46	0.45	0.43	0.40	0.25	0.25
5	0.46	0.46	0.45	0.43	0.40	0.25	0.25
6	0.46	0.46	0.45	0.43	0.40	0.25	0.25
7	0.63	0.63	0.61	0.57	0.51	0.35	0.34
8	0.46	0.46	0.45	0.43	0.40	0.25	0.25
10	0.46	0.46	0.45	0.43	0.40	0.25	0.25
13	0.67	0.67	0.66	0.64	0.57	0.40	0.40
19	0.68	0.68	0.65	0.62	0.42	0.31	0.29
39	0.46	0.46	0.45	0.43	0.40	0.25	0.25
40	0.58	0.58	0.58	0.53	0.48	0.28	0.28
41	0.59	0.59	0.57	0.54	0.47	0.30	0.30
42	0.69	0.69	0.68	0.68	0.61	0.38	0.36
43	0.69	0.69	0.68	0.68	0.61	0.38	0.36
44	0.53	0.53	0.53	0.48	0.41	0.24	0.23
45	0.72	0.72	0.72	0.68	0.63	0.34	0.30
46	0.66	0.66	0.64	0.62	0.54	0.36	0.34
53	0.48	0.48	0.48	0.45	0.41	0.25	0.25
54	0.48	0.48	0.48	0.45	0.41	0.25	0.25
59	0.43	0.43	0.43	0.39	0.35	0.30	0.12
60	0.43	0.43	0.43	0.39	0.35	0.30	0.12
61	0.65	0.65	0.64	0.60	0.50	0.32	0.2
62	0.65	0.65	0.64	0.60	0.50	0.32	0.2
66	0.65	0.65	0.64	0.60	0.50	0.32	0.2
67	0.69	0.69	0.67	0.63	0.56	0.40	0.26
71	0.48	0.48	0.47	0.46	0.42	0.37	0.18
72	0.69	0.69	0.67	0.63	0.56	0.40	0.26
74	0.25	0.25	0.25	0.25	0.24	0.23	0.11
75	0.32	0.32	0.32	0.29	0.27	0.12	0.12
76	0.32	0.32	0.32	0.29	0.27	0.12	0.12
77	0.32	0.32	0.32	0.29	0.27	0.12	0.12
78	0.32	0.32	0.32	0.29	0.27	0.12	0.12
79	0.49	0.49	0.48	0.44	0.36	0.23	0.14
80	0.49	0.49	0.48	0.44	0.36	0.23	0.14
81	0.57	0.57	0.56	0.52	0.47	0.42	0.23
82	0.52	0.52	0.51	0.47	0.43	0.26	0.25
83	0.35	0.35	0.32	0.29	0.21	0.10	0.07
84	0.35	0.35	0.35	0.33	0.25	0.15	0.15
93	0.56	0.56	0.55	0.50	0.44	0.37	0.34
94	0.07	0.07	0.07	0.07	0.07	0.04	0.04
95	0.42	0.42	0.41	0.40	0.36	0.30	0.26
96	0.62	0.62	0.62	0.54	0.46	0.26	0.24
161	0.57	0.57	0.55	0.50	0.42	0.37	0.34
98	0.56	0.56	0.56	0.52	0.50	0.45	0.27
99	0.56	0.56	0.56	0.52	0.50	0.45	0.27
100	0.56	0.56	0.56	0.52	0.50	0.45	0.27
101	0.49	0.49	0.47	0.44	0.38	0.33	0.14
104	0.52	0.52	0.51	0.48	0.46	0.42	0.24
105	0.60	0.60	0.58	0.55	0.42	0.30	0.26
108	0.59	0.59	0.57	0.49	0.44	0.26	0.26
109	0.60	0.60	0.59	0.52	0.45	0.24	0.22
110	0.64	0.64	0.62	0.57	0.51	0.42	0.34
111	0.36	0.36	0.36	0.34	0.24	0.14	0.14

Restoration Area	Year						
	0	1	5	10	25	50	75
112	0.68	0.68	0.67	0.63	0.55	0.47	0.27
116/117	0.74	0.74	0.72	0.66	0.59	0.39	0.37
142	0.45	0.45	0.44	0.40	0.33	0.14	0.13
148/167	0.64	0.64	0.63	0.61	0.48	0.37	0.36
149	0.69	0.69	0.68	0.64	0.56	0.34	0.33
150	0.31	0.31	0.31	0.16	0.15	0.14	0.14
151	0.31	0.31	0.31	0.16	0.15	0.14	0.14
165	0.33	0.33	0.33	0.33	0.30	0.26	0.26
166	0.32	0.32	0.32	0.30	0.26	0.21	0.20
1000	0.73	0.73	0.72	0.68	0.60	0.51	0.32
1001	0.53	0.53	0.52	0.48	0.43	0.38	0.21

Because the Brownsville Resaca would continue to accumulate excessive sediments without improvements to the riparian and emergent habitats proposed by the study, most resacas segments would continue to accumulate sediments from runoff under FWOP conditions. Some resacas would continue to be maintained due to the aesthetic value and public demand for aquatic features adjacent to commercial and residential areas. These areas were not considered for proposed restoration. In addition, invasive species would continue to inundate riparian and emergent habitats, which would decrease the species richness and species composition metrics of the RRCM. These factors are the predominant drivers in the decreasing habitat quality over time

Alternative Development

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 Brownsville Resaca Study was to restore the structure and function of the resaca 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 resaca study uses established, documented, and proven methodologies in an incremental approach.

An array of resacas and measures was identified that would be combined into a suite of alternatives that addresses the degraded ecosystem structure and function problems of the resacas within the vicinity of Brownsville. Resaca ecosystems are dependent on both the frequent and infrequent Rio Grande flooding events for the creation of new resacas and the maintenance of existing resacas. Because the natural flooding functions of the Rio Grande have been essentially eliminated from the watershed, one of the design requirements was a water budget that would sustain the aquatic and riparian habitats of the resacas. Assuring hydrologic functions of these aquatic wetland systems would benefit resaca habitats.

Planning constraints are factors restricting plan formulation resulting in a project alternative that could not be implemented. Planning constraints for this study are limited to the FAA restrictions for restoration areas 42, 43, and 45. For these restoration areas, the bank sculpting and emergent vegetation measures would be eliminated from the area within 1,000 feet of the flight path of the two runways at the South Padre/Brownsville Airport. For these areas, the riparian planting would still be implemented as they would not increase the probability of bird strikes along the flight path.

Initial Measure Identification

The Section 206 Continuing Authorities Project (CAP) Study on the Resaca Boulevard Resaca was used to inform the selection of measures for the Brownsville Resaca Study. The ecosystem restoration measures identified below were developed in coordination with the USFWS, the TPWD, the NPS, and TNC, the BPUB, and the University of Texas-Brownsville. Measures that were eliminated during the alternative formulation phase of the CAP study included the active control of the invasive, nonnative vermiculated sailfin catfish (Pterygoplichthys disjunctivus) and the creation of island habitats in the resacas. Instead a passive control measure resulting from the bank slope measure below was proposed to control the catfish (Hoover et al., 2014). The active catfish control and an island creation measures were screened out of the Brownsville Resaca study. Recreation measures were similarly removed from consideration due to the incompatibility of the restoration measures with recreation. This does not preclude the future construction of recreation features adjacent to the restoration areas.

A focused approach was used to identify restoration measures that would address the ecological structure or function as identified in high quality resacas. In several of the descriptions of measures, the resacas were compared to high quality reference resacas observed in the Brownsville area with the measure addressing a means to return the resaca 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 Appendix B-1 and B-2. A description of each management measure identified in this focused approach is provided below:

- Dredging
- Riparian Soil Supplementation
- Planting Riparian Species

- Bank Slope Restoration
- Bank Stabilization
- Planting Aquatic and Emergent Species
- Water Control Structure/Flow Management
- Invasive Plant Species Management

Dredging

Historically, the long-term sustainability of the resacas dependedon the flushing function of floodwaters to periodically remove accumulated sediments from the resacas. Because the risk of flooding has been essentially eliminated. The flood control projects implemented along the Rio Grande, the flushing function must be artificially accomplished. The dredging measure would mimic the sediment flushing function in the resacas by physically removing accumulated sediments. The dredging would increase the water depth and the volume of the aquatic habitat. Water temperatures and dissolved oxygen concentrations would be improved. The dredging measure was considered for resacas with average depths less than five feet and entails dredging the resaca to a depth of six feet or until the clay layer of the resaca was encountered.

Some resacas have been silted in completely. The silted in resacas would be excavated to a depth of six feet or until the clay layer of the resaca was encountered. The excavation of the sediments in the filled in resacas would increase the aquatic and habitats and improve the adjoining riparian habit.

Riparian Soil Supplementation

Historically, the frequent flooding events of the Rio Grande provided a mechanism to distribute nutrients, sediments, and organic material, throughout the floodplain. The nutrient cycling function has been lost due to the flood control projects implemented along the Rio Grande. The soil supplementation measure would utilize dredged material from the resacas to supplement the soils of riparian habitats. The soil supplementation would restore nutrients that have been leached out over the extended period of flood control. Soil supplementation would promote the establishment and growth of the native vegetation communities. The healthier vegetation would benefit native invertebrate, amphibian, avian, and mammalian communities dependent on healthy resaca environments.

Planting Riparian Species

The resaca's historic riparian vegetation communities are critically imperiled with extinction. This planting measure would include the restoration of a Texas Ebony Resaca Forest, Texas Ebony/Snake-eyes Shrubland, and Subtropical Texas Palmetto Woodland habitats by planting target species representative of these communities within the riparian habitat of the resacas. Because it takes many years for these plant to mature, native south Texas grassland species would also be planted to provide interim habitat. The grass mixture would also help to minimize the spread of non-native invasive species, and stabilize the riparian soils while the target vegetative community becomes established.

Invasive and non-native vegetation first would be removed and managed throughout the life of the project. Early successional native plant species would be included in the grassland seed mix to ensure early establishment of native species listed below:

- Rio Grande clammyweed (Polanisia dodecandra ssp. riograndensis),
- tallow weed (Plantago hookeriana), r
- ed-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)

The following species would be planted to establish a diverse, native grassland habitat while the target vegetation matures:

- 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)

Restoration of the native resaca vegetation would provide valuable habitat for resident and migratory wildlife species, especially rare amphibians associated with the resaca. The canopy of the riparian vegetation in references resacas is incredibly dense. One of the limiting factors for plant growth in these areas 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. The riparian vegetation along the shoreline 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 inclusion and preservation of snags in the revegetation of the resacas is also important. Red-crowned parrots (a candidate for federal listing on the endangered species list) often nest in abandoned nest cavities of 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). Washington fan palms are not a native component of the resaca ecosystems; however, the palms are not invasive and provide habitat structure similar to native palms. In addition to keeping existing snags within the restoration areas, fallen Washington fan and sabal palms from other city properties could be collected and erected on the riparian areas of the resacas for the red-crowned parrots. 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 could then excavate nest cavities into the trunks until the parrots take the nest over. Because the fan palms are not native, a fraction of the 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 aid in sustaining the 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 nest cavities in the more distant future.

Bank Slope Restoration

Natural banks and shorelines are significant features of stable, functioning aquatic systems providing habitat for fish, wildlife, and plant species. The ecosystem benefits from natural banks and shorelines include the improved connection between the aquatic and riparian habitats vital for amphibians as they transition from aquatic to terrestrial forms. Eliminating the steep banks would be a passive method of controlling the invasive sailfin catfish. 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 lower 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 resaca shorelines to reference conditions. In bulkheaded areas, the shoreline will be assessed to determine if additional erosion control measures could be implemented to ensure bank stability with the reference condition slopes. The relaxed banks would also preclude the vermiculated sailfin catfish from burrowing into the banks for nesting. This passive catfish control method eliminates the steep cutbanks needed by the catfish to lay its eggs.

Bank Stabilization

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 would stabilize localized erosion along swales feeding into the resaca and reduce sedimentation into the resaca. The grass mix would provide 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 other appropriate materials should be designed to provide habitat structure for aquatic and riparian species while also providing bank stabilization.

Planting Aquatic and Emergent Species

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 resacas shoreline

Native aquatic and emergent plant species and other species would be planted to establish aquatic habitat in the resacas:

- 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.),

The restored aquatic and emergent vegetation would provide reproductive, foraging, and protective cover habitats for fish and amphibian species and foraging habitat for waterbirds and waterfowl. The vegetation would assist in stabilizing the near shore substrate and improving water quality.

Water Control Structure/Flow Management

The natural hydrologic processes of resacas involve fluctuating water depths. Historically, the resacas were replenished by stormwater runoff and Rio Grande floodwaters. The water depths would decrease between events. Fluctuating water levels benefit the vegetation and fish and wildlife habitat of the resacas.

Allowing the resacas to drawdown to the scale of natural resacas would not be compatible with the multiple uses of the resaca systems including water supply and stormwater management. However, seasonal management of water depths on a smaller scale would provide benefits to riparian and emergent vegetation. The fluctuation of pool elevations provide a dynamic habitat that would benefit fish and wildlife. This measure includes the construction or modification of water control structures to mimic, to the extent practicable, the natural water depth variations of the resacas. Historically, resacas would periodically dry out facilitating the spread and growth of emergent vegetation. With the restored bank slope, a lowered water surface of 6-12 inches would expose an average pf 5 to 10 feet of bank slope and would be modified to maximize ecological benefits. Water control structures would be monitored and managed to ensure seasonal fluctuations are being produced.

Invasive Plant Species Management

Invasive and non-native plant species have proliferated due to urbanization and landscaping around many of the resacas. The removal and the continued management of non-native invasive species from the restoration areas is essential for the resiliency of the resaca ecosystem restoration project. This measure would include the appropriate mechanical, chemical, and/or biological control of invasive and non-native species. The measure includes an invasive species management plan to address the encroachment of non-native invasive species throughout the life of the project.

Measures Summary

Each of the proposed measures would restore components of the resaca ecosystem. A conceptual graphic of the proposed restoration measures is provided in Figure A- 8 .

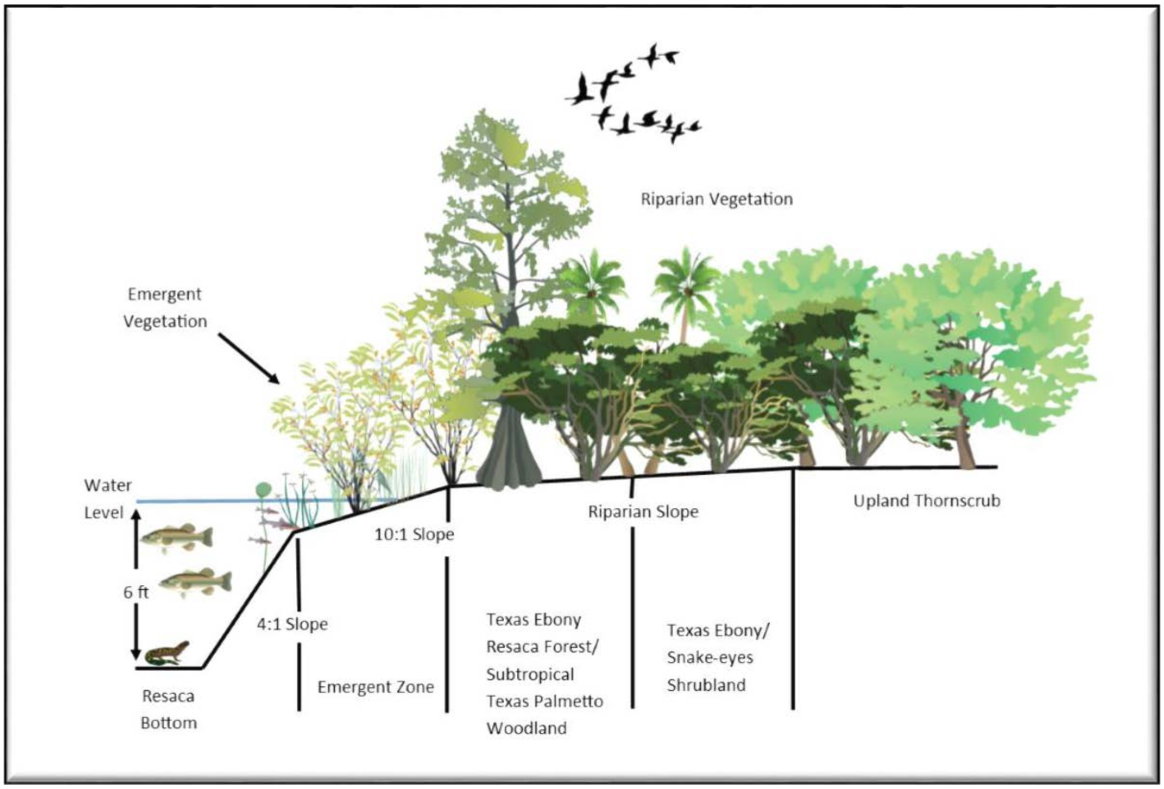


Figure A-9: Conceptual design of the proposed resaca restoration.

Initial Screening of Measures

The RRCM index was used to quantify existing conditions and forecast future conditions. The existing conditions RRCM indices were multiplied by the acreage of habitat restoration for each restoration area to estimate the existing habitat units. The forecast conditions assumed: the water depths of the resacas would be maintained, planted vegetation would mature over a 75-year period, and the spread of non-native species would be minimized. Existing water depth estimates were provided by the BPUB water management supervisor. The forecast rate of sedimentation was assumed to be low. The resulting indices and habitat units for the existing and with project condition are presented in Table A- 23 and Table A- 24.

Table A- 23: RRCM Indices for the Future with Project Conditions

Restoration Area	Year						
	0	1	5	10	25	50	75
3	0.46	0.59	0.59	0.59	0.59	0.59	0.59
4	0.46	0.59	0.59	0.59	0.59	0.59	0.59
5	0.46	0.78	0.85	0.89	0.96	0.99	1.00
6	0.46	0.78	0.85	0.89	0.96	0.99	1.00
7	0.63	0.78	0.85	0.89	0.96	0.99	1.00
8	0.46	0.59	0.59	0.59	0.59	0.59	0.59
10	0.46	0.78	0.85	0.89	0.96	0.99	1.00
13	0.67	0.78	0.85	0.90	0.96	0.99	1.00
19	0.68	0.82	0.87	0.91	0.96	0.99	1.00
39	0.46	0.78	0.85	0.89	0.96	0.99	1.00
40	0.58	0.80	0.85	0.90	0.96	0.99	1.00
41	0.59	0.81	0.85	0.90	0.96	0.99	1.00
42	0.69	0.81	0.87	0.91	0.96	0.99	1.00
43	0.69	0.80	0.86	0.90	0.96	0.99	1.00
44	0.53	0.81	0.87	0.91	0.96	0.99	1.00
45	0.72	0.83	0.86	0.92	0.97	0.99	1.00
46	0.66	0.81	0.86	0.90	0.96	0.99	1.00
53	0.48	0.53	0.53	0.53	0.53	0.53	0.53
54	0.48	0.53	0.53	0.53	0.53	0.53	0.53
59	0.43	0.78	0.85	0.90	0.96	0.99	1.00
60	0.43	0.43	0.43	0.43	0.43	0.43	0.43
61	0.65	0.79	0.86	0.90	0.96	0.99	1.00
62	0.65	0.79	0.86	0.90	0.96	0.99	1.00
66	0.65	0.80	0.88	0.90	0.96	0.99	1.00
67	0.69	0.82	0.87	0.90	0.94	0.96	0.97
71	0.48	0.78	0.84	0.89	0.96	0.99	1.00
72	0.69	0.82	0.87	0.90	0.94	0.96	0.97
74	0.25	0.30	0.30	0.30	0.30	0.30	0.30
75	0.32	0.78	0.85	0.90	0.96	0.99	1.00
76	0.32	0.73	0.80	0.85	0.91	0.94	0.95
77	0.32	0.73	0.80	0.85	0.91	0.94	0.95
78	0.32	0.73	0.80	0.85	0.91	0.94	0.95
79	0.49	0.78	0.85	0.90	0.96	0.99	1.00
80	0.49	0.78	0.85	0.90	0.96	0.99	1.00
81	0.57	0.80	0.85	0.90	0.96	0.99	1.00
82	0.52	0.81	0.86	0.90	0.96	0.99	1.00
83	0.35	0.42	0.42	0.42	0.42	0.42	0.42
84	0.35	0.78	0.85	0.90	0.96	0.99	1.00
93	0.56	0.78	0.85	0.90	0.96	0.99	1.00
94	0.07	0.78	0.85	0.90	0.96	0.99	1.00
95	0.42	0.78	0.85	0.90	0.95	0.99	1.00
96	0.62	0.78	0.84	0.86	0.91	0.94	0.95
161	0.57	0.81	0.87	0.92	0.98	1.00	1.00
98	0.56	0.78	0.85	0.89	0.96	0.99	1.00
99	0.56	0.78	0.85	0.89	0.96	0.99	1.00
100	0.56	0.78	0.85	0.89	0.96	0.99	1.00
101	0.49	0.78	0.85	0.90	0.96	0.99	1.00
104	0.52	0.78	0.85	0.90	0.96	0.99	1.00
105	0.60	0.80	0.85	0.90	0.96	0.99	1.00
108	0.59	0.80	0.85	0.90	0.96	0.99	1.00

Restoration Area	Year						
	0	1	5	10	25	50	75
109	0.60	0.80	0.86	0.90	0.96	0.99	1.00
110	0.64	0.81	0.86	0.90	0.96	0.99	1.00
111	0.36	0.78	0.85	0.90	0.96	0.99	1.00
112	0.68	0.79	0.85	0.90	0.96	0.99	1.00
116/117	0.74	0.79	0.85	0.90	0.96	0.99	1.00
142	0.45	0.79	0.85	0.90	0.96	0.99	1.00
148/167	0.64	0.78	0.85	0.89	0.96	0.99	1.00
149	0.69	0.79	0.85	0.90	0.96	0.99	1.00
150	0.31	0.59	0.59	0.59	0.59	0.59	0.59
151	0.31	0.59	0.59	0.59	0.59	0.59	0.59
165	0.33	0.78	0.85	0.90	0.96	0.99	1.00
166	0.32	0.78	0.85	0.90	0.96	0.99	1.00
1000	0.73	0.82	0.88	0.93	0.98	1.00	1.00
1001	0.53	0.78	0.85	0.90	0.96	0.99	1.00

Table A- 24: List of Restoration Areas with existing and forecast conditions

Restoration Area	Existing Resaca Depth (ft)	FWOP Resaca Depth (ft)	Existing RRCI	FWOP Annualized RRCI	Acres	Existing Habitat Units	FWOP Habitat Units
3	3	0	0.46	0.33	0.69	0.34	0.23
4	3	0	0.46	0.33	1.83	0.84	0.61
5	3	0	0.46	0.33	5.53	2.54	1.85
6,7	3	0	0.51	0.45	24.02	15.13	10.74
8	3	0	0.46	0.33	0.02	0.01	0.01
10	3	0	0.46	0.33	7.11	3.27	2.38
13	3	0	0.67	0.5	8.44	5.65	4.25
17,18,19	2	0	0.68	0.41	96.49	65.61	39.82
39	3	0	0.46	0.33	1.18	0.54	0.39
40	3	0	0.58	0.37	32.71	18.97	11.99
41	3	0	0.59	0.41	21.24	12.53	8.60
42	6	0	0.69	0.51	54.75	37.78	27.83
43	6	0	0.69	0.51	33.99	23.45	17.28
44	3	0	0.53	0.34	19.54	10.36	6.74
45E	6	0	0.72	0.49	5.05	3.64	2.49
45,46	6	0	0.66	0.47	4.96	3.27	2.32
53	3	0	0.48	0.34	1.62	0.78	0.56
54	3	0	0.48	0.34	8.61	4.13	2.95
59	5	0	0.43	0.31	3.62	1.56	1.12
60	5	0	0.43	0.31	1.81	0.78	0.56
61	4	0	0.65	0.42	26.10	16.97	10.90
62	4	0	0.65	0.42	3.22	2.09	1.34
66	4	0	0.65	0.42	20.37	13.24	8.51
67	4	0	0.69	0.48	19.54	13.48	9.34
71	6	0	0.48	0.37	7.77	3.73	2.91
72	4	0	0.69	0.48	8.76	6.04	4.19
74	3	1	0.25	0.22	4.98	1.25	1.08
75	3	0	0.32	0.2	13.46	4.31	2.73

76	3	0	0.32	0.2	0.86	0.28	0.17
77,78	3	0	0.32	0.2	4.11	1.32	0.83
79	5	0	0.49	0.3	3.39	1.66	1.03
81	5	0	0.57	0.43	4.42	2.52	1.90
82	3	0	0.52	0.36	21.43	11.14	7.65
83	2	0	0.35	0.17	12.61	4.41	2.18
84	2	0	0.35	0.22	18.27	6.39	4.03
93	0	0	0.56	0.42	10.49	5.87	4.40
94	0	0	0.07	0.06	10.87	0.76	0.60
95	0	0	0.42	0.33	45.07	18.93	15.06
96	3	0	0.62	0.38	12.89	7.99	4.94
98	5	0	0.56	0.45	19.60	10.98	8.89
99	5	0	0.56	0.45	10.13	5.67	4.60
100	5	0	0.56	0.45	16.90	9.46	4.00
101	5	0	0.49	0.34	47.64	23.34	16.25
104	5	0	0.52	0.42	20.27	10.54	8.47
105	2	0	0.60	0.39	43.95	26.37	17.03
108	3	0	0.59	0.37	5.78	3.41	2.14
109	3	0	0.60	0.37	17.18	10.31	6.28
110	5	0	0.64	0.47	10.94	7.00	5.16
111	3	0	0.36	0.22	13.34	4.80	2.87
112	5	0	0.68	0.5	15.97	10.86	7.98
116/117	3	0	0.74	0.51	30.30	22.42	15.45
142	3	0	0.45	0.25	32.50	14.63	8.25
149	3	0	0.69	0.47	9.82	6.78	4.63
150	1	0	0.31	0.16	2.49	0.77	0.40
151	1	0	0.31	0.16	2.44	0.76	0.40
161	0	0	0.57	0.41	53.16	30.30	22.02
165	0	0	0.33	0.29	4.29	1.42	1.23
166	0	0	0.32	0.24	10.76	3.44	2.63
167,148	3	0	0.64	0.46	81.53	52.18	37.18
1000	5	0	0.73	0.55	51.70	37.74	28.25
1001	5	0	0.53	0.39	17.26	9.15	6.78
Average	3.33	0	0.52	0.36	-	-	-
Total	-	-	-	-	1,099.77	635.89	437.40

Action Alternative Formulation

Restoration plans, consisting of different combinations of restoration segments within each resaca, were evaluated and screened through several iterations using the Cost Effective/Incremental Cost Analysis (CE/ICA) in the USACE Institute of Water Resources (IWR) Planning Suite 2.0.6.1. The IWR Planning Suite is a USACE certified model developed to assist in the identification of a cost effective recommended plan that can be incrementally economically and ecologically justified. The first iterations of the screening evaluation screened the restoration plans within a group of restoration areas and within each resaca segment. The second phase was used to select a final array of alternatives taking in to account the restoration of the three resacas as a system.

Ecological connectivity is a primary need. Addressing connectivity of the resacas habitat occurred in three phases. The first phase of addressing connectivity was the identification of restoration areas that would provide a minimal level of connectivity within each of the resaca systems. This level of connectivity addressed the extent of the gaps of habitat between segments of the resacas (groups of nearby areas). This phase involved a qualitative assessment and the combinations of restoration areas. The connectivity assessment for the first phase dealt with the connectivity of aquatic habitats only.

The second phase of alternative development centered on the connectivity concept and addressed the viability and sustainability of the resaca's aquatic and riparian habitats. The restoration measures segments were applied to each restoration area, as needed, to address the area needs. This phase involved a quantitative assessment of the segments identified in the first phase and was analyzed using the CE/ICA.

A connectivity analysis occurred after the CE/ICA to supplement the incremental cost analysis. The connectivity analysis considered the proximity of restoration areas to high quality thornscrub habitat managed by natural resource agencies. There is an intrinsic value of restoring habitats adjacent to high quality landscapes. The resacas are the aquatic component of the thornscrub habitat and the proximity of high quality uplands provides a direct connectivity between the aquatic and terrestrial habitats. The CE/ICA does not capture the benefits of connectivity.

The first phase screened out the combinations of restoration areas that did not meet the qualitative criteria of aquatic connectivity. The second phase utilized the alternatives identified in phase one and quantitatively assessed alternatives that maximized connectivity among the resacas. The best buy alternatives identified by the CE/ICA were then assessed for terrestrial connectivity.

All of the resacas receive water from the Rio Grande and stormwater runoff, but different segments of the resaca systems are connected via different local systems. For instance, in Resaca de la Guerra, a water control valve is located between Restoration Area 76 and 77 (Figure A- 10). From this valve, water can be pushed up the resaca system to Restoration Areas 77-84 and flow downstream to Restoration Areas 74-76. In other areas, dry resaca segments and roadways separate the restoration areas. This is the case between two restoration areas on Resaca del Rancho Viejo where U.S. Highway 77 separates Restoration Area 165 from Restoration Area 113. An existing irrigation canal provides water to Resaca del Rancho Viejo at Restoration Area 113 and can be managed separately from the upstream resaca segments. Hydrological associated groups of restoration areas were identified within Resaca de la Guerra Resaca del Rancho Viejo, and Town Resaca. Restoration measures were applied to these groups of hydrologically-connected resacas to form functioning units. The measures proposed at certain restoration areas can be implemented without improvements to upstream restoration areas. These restoration areas are typically on the downstream ends of the resacas where the water is typically deeper and more dependable (Restoration Areas 40-46). Each of these restoration areas were incorporated as stand-alone segments in the CE/ICA.

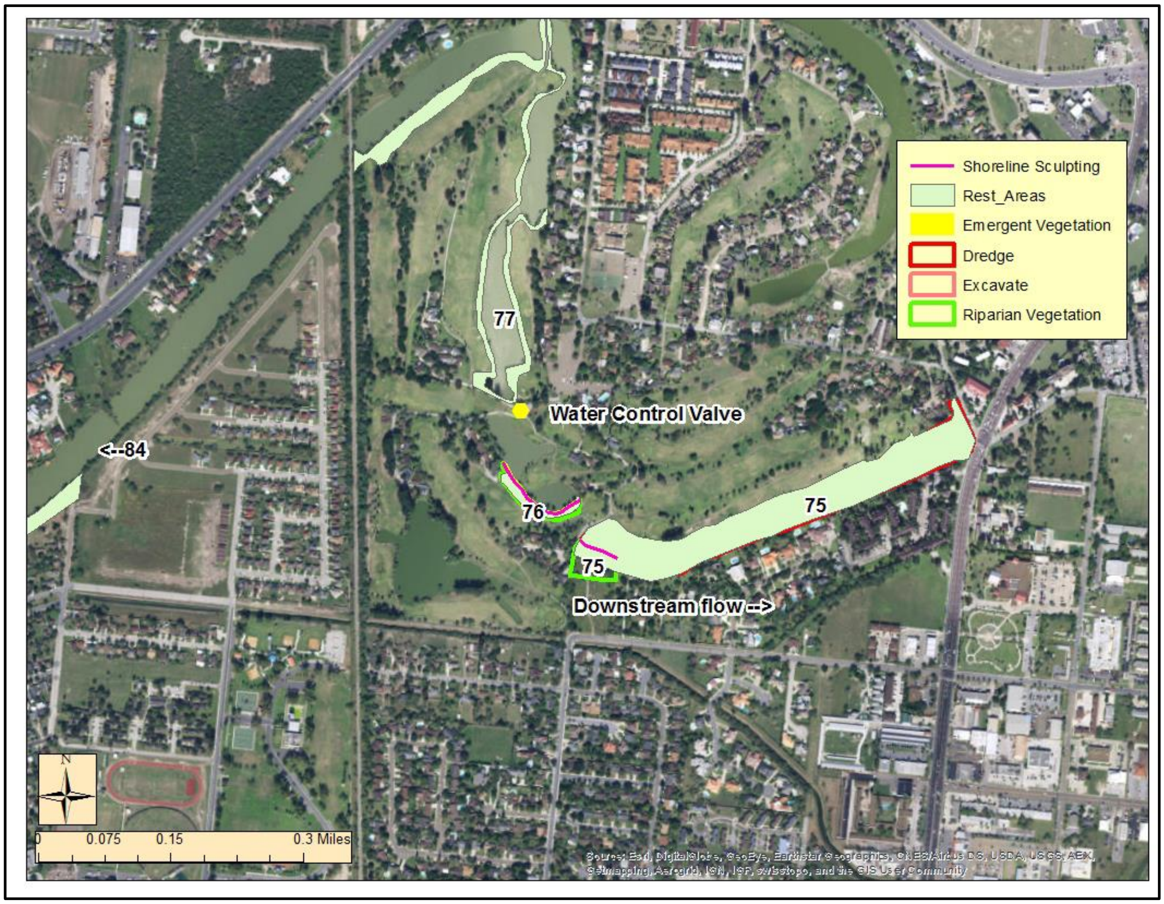


Figure A- 10: Example of water supply control for Resaca de la Guerra at the City of Brownsville Country Club.

FORMULATION

Alternative Comparison for Final Array

The next step in formulation was to compare the final array of alternatives through the CE/ICA tool. This analysis required two criteria: costs criterion and ecological benefit. Details of the cost estimation can be found in Appendix E.

The RRCM index was used to determine the ecological criterion. This index was multiplied by the number of acres over which the measure(s) would be applied to derive the habitat units (HUs). The HUs were annualized over a 75 year period of analysis (2038 to 2113) to derive the associated Average Annual Habitat Units (AAHUs). To obtain the climax condition of the resaca riparian habitats, the habitat must go through several successional stages. The transition between successional stages is relatively slow as newer species are naturally introduced into the community. A 75-year period was selected based on the length of time required for the target vegetation association to reach maturity and provide full benefits. The AAHUs for the future with project condition were subtracted from the future without project to determine the incremental AAHUs for each fully formed plan. The incremental AAHUs the level of ecological lift of a plan over the future without project condition.

Cost Effectiveness and Incremental Cost Analysis (CE/ICA)

The final array of alternatives was evaluated with the CE/ICA tool to compare each alternative. The final array of six alternatives identified the combinations of fully formed plans, for each resaca and with the two resacas combined, and identified the incremental annual benefit for the incremental annual cost. This analysis did not include the benefits of ecological connectivity. Those important benefits were considered in a subsequent analysis.

All alternatives consisted of the same measures (plantings, dredging, shoreline sculpting) and would require similar adaptive management and monitoring activities. It was assumed that total adaptive management and monitoring costs would be similar and would not affect plan selection and were not included in the CE/ICA analysis. Costs associated with operation, maintenance, repair, replacement and rehabilitation (OMRR&R) would be dependent on acreage; therefore these costs were included in the cost inputs for the CE/ICA.

Figure A-11 provides the cost effectiveness of the final array of alternatives and identifies Best Buy plans that were carried forward for the incremental cost analysis.

An initial CE/ICA resulted in an alternative that included Town Resaca as Alternative 3. However, the Town Resaca Alternatives (Alt 3) did not add to the connectivity of the system and was excluded from subsequent CE/ICA analysis. Therefore, the progression of alternatives in the CE/ICA below does not include an Alternative 3.

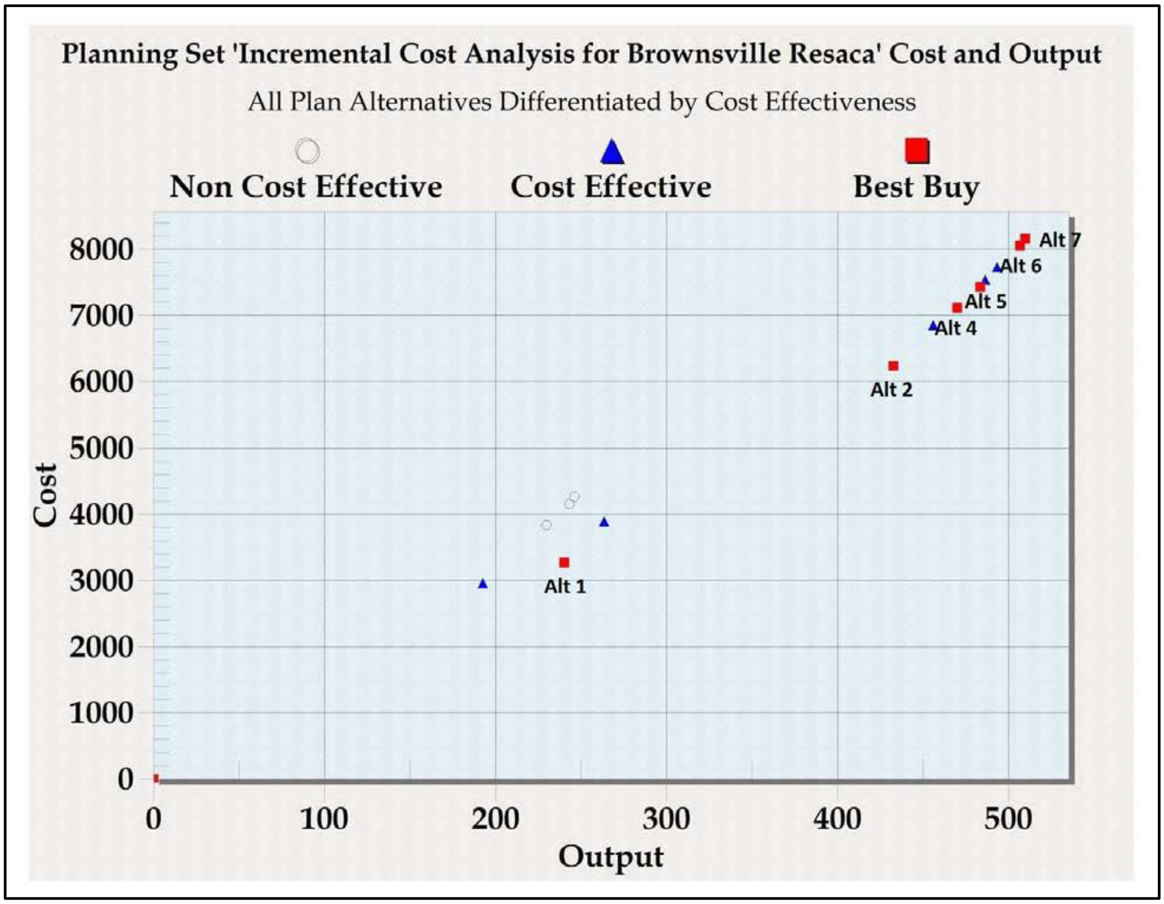


Figure A-11: CE/ICA Cost-effective and Best-buy Alternatives.

CE/ICA Best Buy Array

The final Best Buy array of alternatives represents an incremental ranking of cost effective plans.

Table A-25 shows supporting data and the incremental cost analysis is graphically represented in Figure A-12.

Table A-25: Best-buy Array from CE/ICA

Cost and Benefit Category	Alternative					
	1	2	4	5	6	7
First Cost ($1,000)	90,318	172,198	196,277	205,501	223,542	226,611
AAC ($1,000)	3,273	6,232	7,108	7,428	8,050	8,157
IDC ($1,000)	652	1,258	1,444	1,515	1,654	1,678
OMRR&R ($1,000)	248	506	578	593	618	624
Project Acres	448.7	826.2	884.2	914.5	963.0	968.6
FWP AAHU	393	762	815	846	883	888
FWOP AAHU	153	329	346	362	376	378
Net Benefit (AAHU)	240	433	470	483	507	510
Benefit/Acre (AAHU)	0.53	0.92	0.92	0.93	0.92	0.92
Incremental Benefit (AAHU)	240	193	37	13	23	3
AAC/AAHU ($1,000)	13.6	14.4	15.1	15.4	15.9	16.0
Incremental AAC ($1,000)	13.6	6.8	1.9	0.7	1.2	0.2
Incremental AAC/AAHU ($1,000)	13.6	15.4	23.5	23.7	26.7	37.5
Total Cost./Acre ($1,000)	201.28	208.42	221.98	224.71	232.13	233.96
AAC/Acre ($1,000)	7.29	7.54	8.04	8.12	8.34	8.42

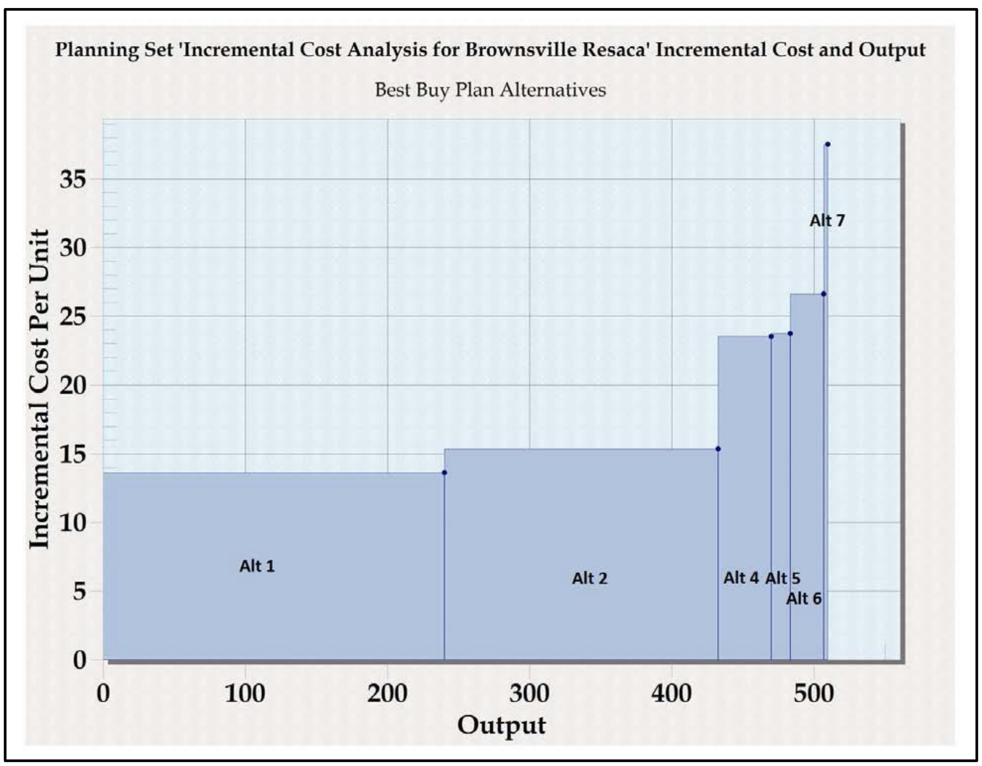


Figure A-12: Best Buy Array from CE/ICA.

PLAN SELECTION

Introduction

Plan selection used the CE/ICA to determine the best plan based on quantified incremental cost per habitat unit derived from the RRCM and qualitative benefits of connectivity. Connectivity is an important ecological concept in fragmented habitats such as the urban and agricultural landscapes of the Brownsville resacas. Travel corridors connecting isolated patches are critical for the dispersal and survival of species.

The connectivity of the resacas was assessed at two scales. At the first scale, the proposed restoration measures would ensure linear connectivity of aquatic habitats along each of the resacas. This would provide direct connectivity for fish and amphibian species that require water for their dispersal. The linear connectivity of proposed riparian habitat restoration area is fragmented with gaps between habitat patches ranging from 20 feet up to approximately 5,000 feet.

These restored habitats would provide connectivity through a “stepping stone” approach. This approach is used by the USFWS and TPWD for the conservation of the ocelot and jaguarundi (USFWS, 2013; USFWS, 2016b). The stepping stone approach would benefit each floral and faunal species differently (Brooker et al., 1999). The ocelot and jaguarundi are known to cross habitat gaps of inhospitable habitat well beyond the 5,000-foot maximum habitat gap in the proposed alternatives. A species like a tree frog may require habitat gaps of less than 20 to 30 feet due to their arboreal nature and the safety that the tree canopy provides. Habitat connectivity is more important to specialist species such as the ocelot, jaguarundi, black-spotted newt and South Texas siren than they are for generalist species (Sverdrup-Thygeson et al., 2017). Connectivity is even more important for resaca habitats because of the high species richness comprised of many habitat specialists that have evolved with the resaca ecosystem. These habitat patches also provide urban reserves for plant conservation in the fragmented urban landscape (Kendal et al., 2017).

Restoration of the amphibian populations would be dependent on the direct connectivity of aquatic habitats. Direct linear connectivity for aquatic species would be achieved by the dredging and excavation of restoration areas to restore quality and quantity of the aquatic habitat.. This measure would ensure direct aquatic connection for fish, amphibian, and reptile species such as the Rio Grande perch, red-eared sunfish, black-spotted newt, and south Texas siren. Two of the species, the newt and siren, are especially significant because they are known to inhabit urban portions of the resacas.

The second scale of connectivity would be the lateral connectivity between the aquatic, riparian, and upland communities. The resacas are the aquatic component of the Tamaulipan thornscrub ecosystem. The restoration of the upland and aquatic components of this ecosystem would provide significantly greater habitat benefits because 1) the width of the habitat corridor is generally wider resulting in a more buffered travel corridor, 2) upland species are provided a water source with continuous habitat across the resaca/upland interface, and 3) high quality upland areas associated adjacent to the resacas within the study area are generally managed by natural resource agencies and NGO's so they are protected from development ((Prugh, L., K. Hodges, A. Sinclair, and Brashares, J., 2008); (Tischendorf, L., and Wissell, C., 1997); (Rail, J., Darveau,M, Desrochers, A., and Huot, J., 1997); (Ruefenacht, B. and R. Knight. 2017. Ruefenacht, B. and R. Knight. 2017. 71:269-274., 2017).

The stepping stone approach for increasing connectivity is used by ecologists when dealing with highly fragmented systems such as the agricultural and urban environments of the resacas (Saura, S., Bodin, O, and Fortin, M. , 2014.); (Saura, S. and L. Rubio. , 2010.); (Bierwagen, B. , 2007.); (Baum, K., Haynes, K., Dillemuth, F., and Cronin, J. , 2004.); (Sondgerath, D. and B Schroder. , 2002.). Stepping stone habitats create long-distance dispersal opportunities for species and facilitate range expansion. The full value of the stepping stones is realized over time and across generations as the species extend their reach across the landscape. Consideration in the stepping stone approach is the size of the habitat patches. This resaca study utilized the many small stepping stone approach, which has been shown to increase species diversity (Tscharntke, T., Steffan-Dewenter, I., Kruess, A., and Thies, C.. , 2002.); (Whittaker, R. , 1998.); (Burkey, T. , 1989.); (Quinn, J., and Harrison, S., 1988.). Through the use of small stepping stones, this connectivity would be increased between the east and west sides of the city. The result would be increased species diversity within the urban resaca habitats.

One of the primary goals of the proposed study was to maximize ecological connectivity from the restored resacas to surrounding high quality resaca habitats. The stepping stone approach would minimize the physical gaps between riparian habitats across the study area and provide a pathway to the surrounding high quality habitats. The ability of fish and wildlife resources to disperse east to west across the study area would be greatly diminished, if not completely eliminated without implementation of restoration measures.

The proposed restoration would increase the number of restored habitats along the resacas which would increase the probability of wildlife, specifically avian species, to cross between Resaca de la Guerra and Resaca del Rancho Viejo. Therefore, the proposed project would increase connectivity by decreasing habitat gaps and using the resacas as stepping stone habitats between two resacas as well as linearly along them.

National Ecosystem Restoration Plan Selection Criteria and Process

The RRCM estimates how well a particular area represents the highest quality reference resaca habitats, specifically the three critically imperiled resaca habitats: Texas Ebony Resaca Forests, Subtropical Texas Palmetto Woodlands, and Texas Ebony/Snake-eyes Shrublands. Restoration of these three vegetation associations supports the national significance of the alternatives.

ALTERNATIVE COMPARISON

"Is It Worth It" Analysis for Final Array of Alternatives (Best Buy Array)

To select a plan the final array of alternatives was evaluated to determine incremental benefits. For each increment, a determination was made to answer the question, "Is it worth it to spend the incremental cost of each larger and higher cost?" Each alternative in the final array builds on the previous alternative by adding one or more restoration areas. For each increment the question "Is it worth it to add the additional restoration areas?" The selected plan is identified when we can no longer make the ecological and economic justification to spend the additional incremental cost for the next larger alternative.

Comparing Alternative 1 to the No Action Plan

The no action alternative plan is the baseline to evaluate the alternatives. For the no action plan, there would be no expenditure of funds. The Brownsville resacas would continue to degrade. Without intervention, the resacas would eventually complete their successional life cycle, dry up, and revert to upland habitats. Many areas would become dominated by invasive and non-native plant species and the fish and wildlife value of the ecosystem would significantly decrease through the loss of the aquatic component of the resacas habitat. The loss of resaca habitats is compounded by the fact that modified floodplain conditions no longer enable additional resacas to form.

Alternative 1 would include the restoration of a significant portion of Resaca del La Guerra. A total of 26 restoration areas would be included in Alternative 1. Graphics for these restoration areas are provided in the drawings at the end of the main report. The restoration measures for each restoration area are in Table A- 26. An overall graphical representation of Alternative 1 is provided with Figure A-13.

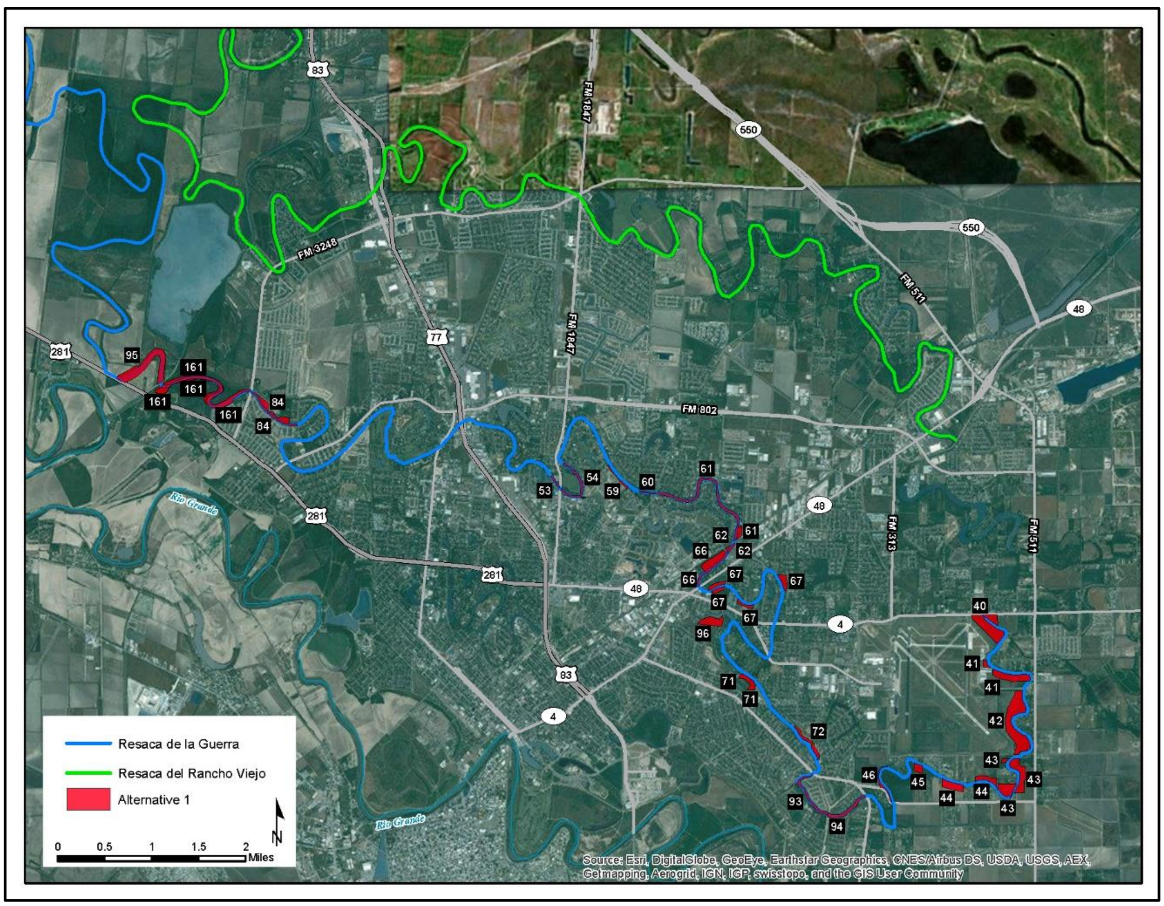


Figure A-13: Alternative 1

Table A- 26: Restoration Areas for Alternative 1.

Restoration Area	Riparian Restoration Acres	Aquatic/Emergent Restoration Acres	Bank Sculpting (lf)	Invasive Species Management Acres	Dredging or Excavation Acres	AAHU
40	32.7	1.2	3,545	33.9	0.0	19
41	21.2	0.9	2,575	22.1	0.0	12
42	54.8	1.7	4,950	56.5	0.0	25
43	34.0	0.0	0	34.0	0.0	15
44	19.5	0.9	2,700	20.4	0.0	12
45E	5.1	0.2	525	5.3	0.0	2
45,46	5.0	0.9	2,525	5.9	0.0	2
53	0.0	0.0	0	0.0	1.6	1
54	0.0	0.0	0	0.0	8.6	2
59	3.6	0.6	1,710	4.2	0.00	2
60	0.0	0.0	0	0.0	1.8	1
61	3.6	0.3	768	3.9	22.5	13
62	1.4	0.2	658	1.6	1.8	2
66	13.8	0.6	1,600	14.4	6.6	11
67	19.5	1.3	3,900	20.8	0.0	9
71	7.8	0.3	989	8.1	0.0	5
72	8.8	0.8	2,336	9.6	0.0	4
75	10.6	1.9	5,540	12.5	9.9	10
76	0.9	0.2	620	1.1	0.0	1
84	10.5	1.1	3,191	11.6	7.8	13
93	6.1	1.8	5,148	7.9	4.4	6
94	6.1	1.3	3,750	7.4	4.8	10
95	24.2	3.3	9,670	27.5	20.9	28
96	12.9	0.5	1,345	13.4	0.0	7
161	23.9	5.1	14,815	29.0	29.2	30
Rounded Total	326.0	25.1	72,860	351.1	119.9	240

The alternative would include planting herbaceous and woody species representative of the target community. (see tables in Appendix H) The alternative includes the removal and management of invasive and non-native, species within the restoration area. This alternative includes dredging of 12 resacas. The dredged materials would be used to supplement soils in the riparian areas. The dredging would ensure the sustainability of the resaca ecosystem by providing the water necessary to support the ecosystem. Alternative 1 includes reshaping the resaca bank slope to better connect the aquatic and riparian habitats, particularly for amphibian species dependent on the two habitat types for successful reproduction and development. Alternative 1 would provide direct linear connectivity along Resaca de la Guerra for fish, amphibian, and aquatic invertebrates.

Alternative 1 would provide 240 Average Annual Habitat Units (AAHUs) of benefit at a first cost of $90,318,000 and an Average Annual Cost (AAC) of $3,273,000. Alternative 1 meets the study objectives by restoring 326.0 acres of globally imperiled Texas Ebony Resaca Forest and 119.9 acres of aquatic and emergent resaca habitat for a total of 445.9 acres of restoration. The incremental cost associated for Alternative 1 is worth the federal and local investment to restore the resaca habitat.

Comparing Alternative 2 to Alternative 1

Alternative 2 would add Resaca del Rancho Viejo with a total of 15 additional restoration areas to the Resaca de la Guerra areas of Alternative 1. Graphics of these individual restoration areas are provided in the drawings section at the end of the main report. The restoration measures that would be added to Alternative 1 to compose Alternative 2 are shown in Table A- 27. An overall graphical representation of Alternative 2 is provided with Figure A- 14.

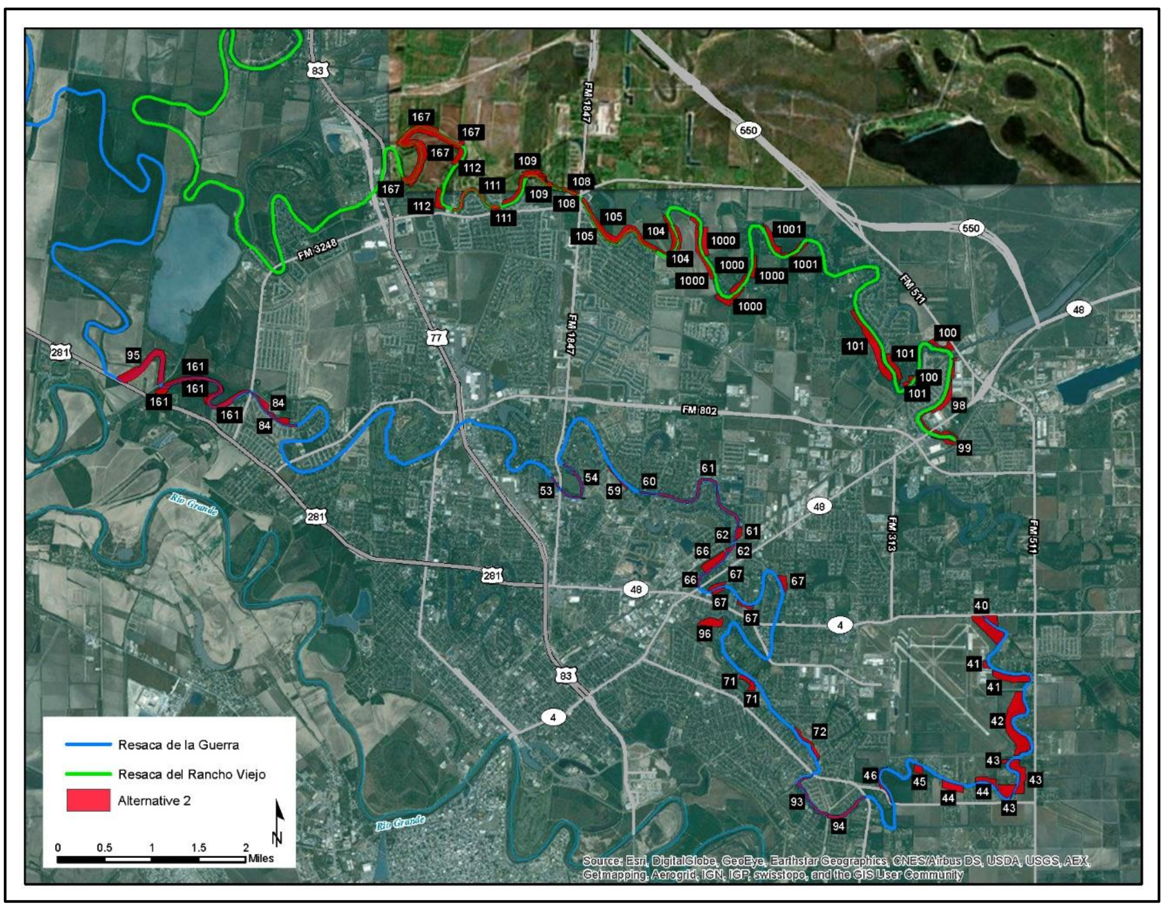


Figure A- 14: Alternative 2.

Table A- 27: Restoration Areas for Alternative 2

Restoration Area	Riparian Restoration Acres	Aquatic/ Emergent Restoration Acres	Bank Sculpting (lf)	Invasive Species Management Acres	Dredging or Excavation (E) Acres	AAHU
98	19.6	1.7	4,887	23.1	0.0	10
99	10.1	1.1	3,118	11.2	0.0	5
100	8.8	0.7	1,930	9.5	0.0	4
101	47.6	2.3	6,762	49.9	0.0	29
104	20.3	1.6	4,727	21.9	0.0	11
105	31.3	2.2	6,409	33.5	12.7	25
108	3.6	0.7	2,053	4.3	2.2	3
109	10.2	1.1	3,171	11.3	7.0	10
110	10.9	0.8	2,345	11.7	0.0	5
111	1.8	0.8	2,201	2.6	11.6	10
112	16.0	0.9	2,465	16.9	0.0	7
167, 148	63.0	6.0	17,321	69.0	(E) 19.0	41
1000	51.7	3.5	10,137	55.2	0.0	22
1001	17.3	1.7	4,790	19.0	0.0	10
Sub Total	312.2	25.1	72,316	337.3	52.5	192
Alt 1 Total	326.0	25.1	72,860	351.1	119.9	240
Alt 2 Total	638.2	50.2	145,176	688.4	172.4	433

Alternative 2 would provide an additional 193 Average Annual Habitat Units (AAHUs) of benefit for a total of 433 AAHUs at a first cost of $172,198,000 and an Average Annual Cost (AAC) of $6,232,000. Alternative 2 meets the study objectives by restoring 638.2 acres of globally imperiled Texas Ebony Resaca Forest and 172.4 acres of aquatic and emergent resaca habitat for a total of 810.6 acres of restored habitat. Alternative 2 adds significant restoration to an additional resaca system providing an incremental annual benefit of 193 AAHUs at an incremental AAC/AAHU of about $6,800. In addition to the connectivity provided in Alternative 1, Alternative 2 would provide linear connectivity along Resaca del Rancho Viejo. The relatively small incremental cost associated with moving from Alternative 1 to Alternative 2, the relatively large incremental benefit, and the fact that Alternative 2 almost doubles restoration by adding a separate, additional resaca system would justify the expenditure of additional funds. The rarity of the habitat, the incredible biodiversity of the resaca ecosystems, and the dependency of numerous resaca-dependent and rare wildlife species on the habitat justify the ecological value of the expenditure of the additional incremental increase in cost. The incremental cost associated for Alternative 2 is worth the federal and local investment.

Comparing Alternative 4 to Alternative 2

Alternative 4 would add five additional restoration areas located in northwest section of Resaca del Rancho Viejo restoration areas to Alternative 2. Graphics of these individual restoration areas are provided in the drawings section at the end of the main report. The restoration measures added to Alternative 2 are shown in Table A- 28. An overall graphical representation of Alternative 4 is provided in Figure A- 15.

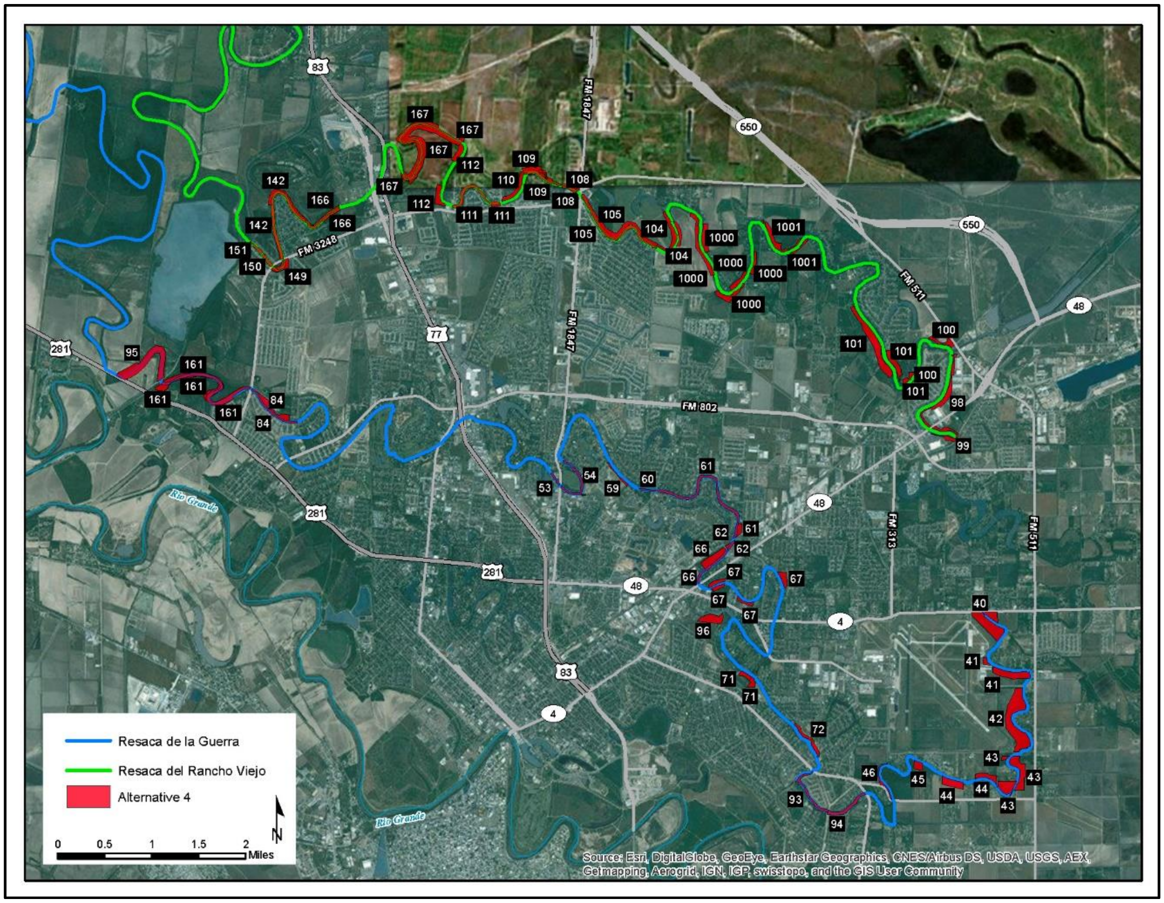


Figure A- 15: Alternative 4.

Table A- 28: Restoration Measures and Benefits for Alternative 4.

Restoration Area	Riparian Restoration Acres	Aquatic/Emergent Restoration Acres	Bank Sculpting (lf)	Invasive Species Management Acres	Dredging Acres	AAHU
142	11.6	1.7	5,047	13.3	20.9	23
149	8.0	1.1	3,229	9.1	1.8	5
150	0.0	0.0	0	0.0	2.5	1
151	0.0	0.0	0	0.0	2.4	1
166	6.5	1.8	5,071	8.3	4.3	8
Sub Total	18.22	4.60	13,347	23.9	31.91	38
Alt 2 Total	638.2	50.2	145,176	688.4	172.4	433
Alt 4 Total	664.3	54.8	158,523	719.1	204.3	470

Alternative 4 provides an additional 37 Average Annual Habitat Units (AAHUs) of benefit for a total of 815 AAHUs at a first cost of $196,277,000 and an Average Annual Cost (AAC) of $7,108,000. Alternative 4 meets the study objectives by restoring 664.3 acres of globally imperiled Texas Ebony Resaca Forest and 204.3 acres of aquatic and emergent resaca habitat for a total of 868.6 acres of restored habitat. Although Alternative 4 adds an incremental annual benefit of 37 AAHUs at an increased incremental AAC/AAHU of $23,500 over Alternative 2, the restoration areas associated with Alternative 4 would restore direct connectivity with high quality resaca habitats currently under federal, state, and NGO resource management.

Alternative 4 is located adjacent to 330 acres of land managed by the USFWs and TPWD (Figure 16). The 330 acres is comprised of high quality upland thornscrub habitat and is one of the high quality areas on the west side of Brownsville that the proposed project is trying to connect. The resaca segments included in Alternative 4 borders the southern end of the 330 acre tract of conservation lands providing direct lateral connectivity between the resacas and upland habitats. The conceptual restoration design illustrated in Figure 8 shows importance of the lateral connectivity of the aquatic and riparian habitats upslope to the upland thornscrub habitat. The continuity of habitat away from the resaca provides synergistic benefits to the surrounding upland habitats not accounted for in the RRCM. Specifically, the restoration associated with Alternative 4 provides aquatic habitat for the adjoining 330 acres of high quality upland thornscrub habitat (Figure A- 16).

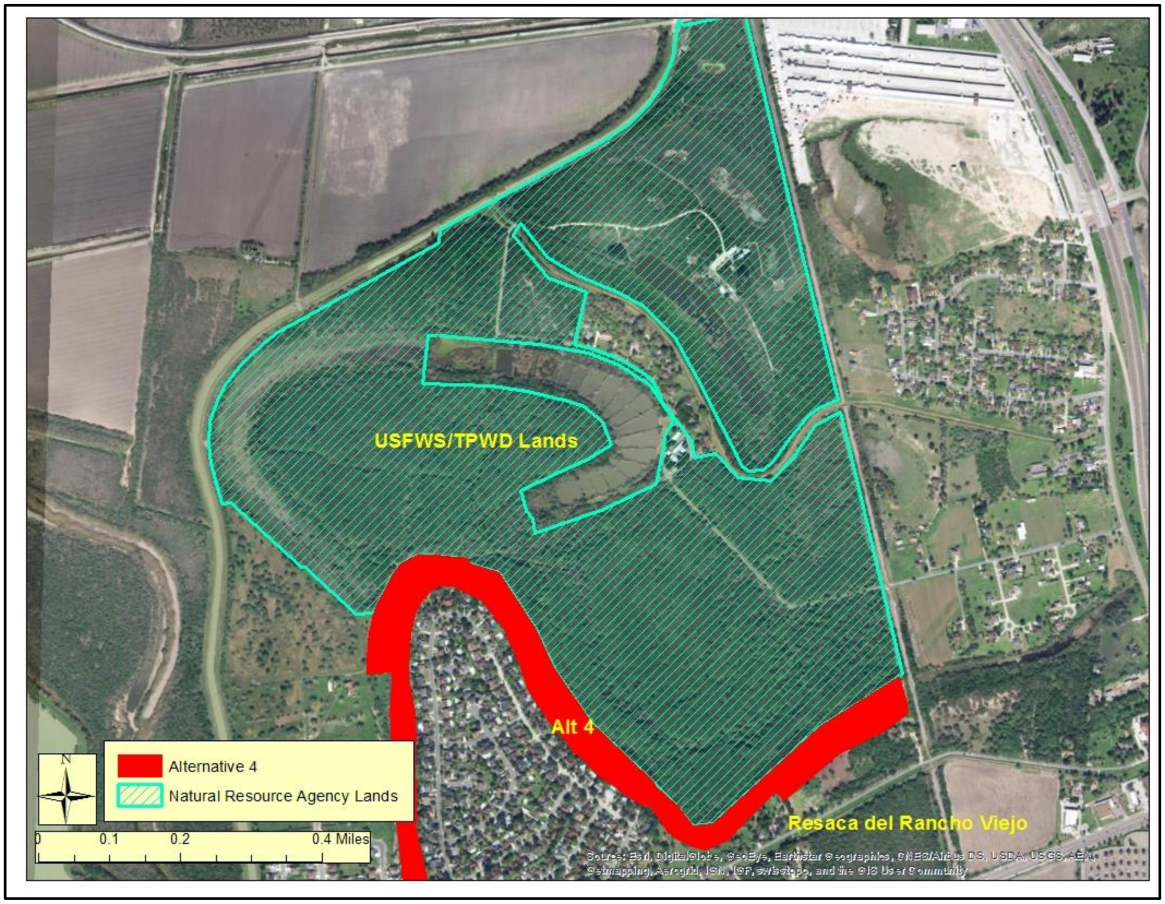


Figure A- 16:Proximity of Alternative 4 resaca segment to high quality upland thornscrub habitat manage by natural resource agencies.

The value of expanding the high quality habitat associated with these natural resource management areas and directly connecting the restoration efforts to these large high quality habitats is not included the CE/ICA analysis. Although the relative incremental costs are greater than the previous alternatives with smaller incremental ecological benefits, the habitat model does not account for the synergistic benefits of connectivity. There is great value in the rarity of the upland habitats, the diversity of the ecosystem, and the ecological value of directly connecting the restoration areas to high quality, managed vegetative and wildlife source populations. The benefits of lateral connectivity with the high quality uplands provides the justification for the expenditure of the incremental costs.

Comparing Alternative 5 to Alternative 4

Alternative 5 would add two restoration areas – consisting of the restoration of an old resaca segment within the TPWD State Fish Hatchery property located in northwest section of Resaca del Rancho Viejo to the restoration provided for in Alternative 4. Graphics of this individual restoration area is provided in the drawings at the end of the main report.The restoration measures for the alternative are shown in Table A- 29. An overall graphical representation of Alternative 5 is bywith Figure A-17.

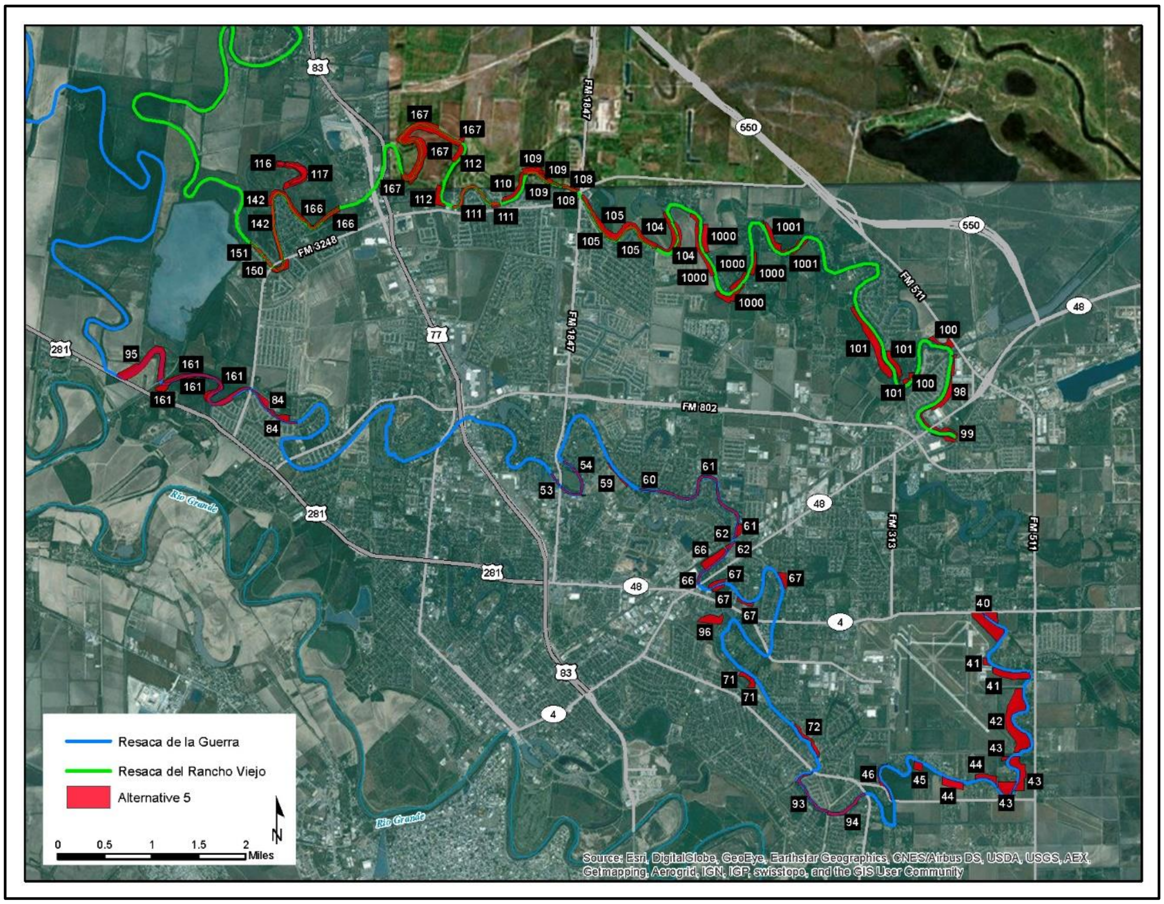


Figure A-17: Alternative 5.

Table A- 29: Restoration Measures and Benefits for Alternative 5.

Restoration Area	Riparian Restoration Acres	Aquatic/Emergent Restoration Acres	Bank Sculpting (lf)	Invasive Species Management Acres	Dredging or Excavation (E) Acres	AAHU
116/117	16.7	2.1	6,070	18.8	13.6	14
Alt 4 Total	664.3	54.8	158,523	719.1	204.3	470
Alt 5 Total	681.0	56.9	164,593	737.9	217.9	483

Alternative 5 provides an additional 13 Average Annual Habitat Units (AAHUs) of benefit for a total of 846 AAHUs at a first cost of $205,501,000 and an Average Annual Cost (AAC) of $7,428,000. Alternative 5 meets the study objectives by restoring 681.0 acres of globally imperiled Texas Ebony Resaca Forest and 217.9 acres of aquatic and emergent resaca habitat for a total of 898.9 acres of restored habitat. Alternative 5 would add relatively significant restoration at an incremental AAC/AAHU of about $700. Alternative 5 restores the habitat located on the State Fish Hatchery lands managed by TPWD. This resaca was modified by TPWD to form fishery ponds for the rearing of sportfish. Although the resaca was portioned off with a series of levees and dams, the adjacent habitat consists of high quality south Texas thornscrub habitat is consistent with the restoration goals of the study.

Similar to Alternative 4, the restoration associated with Alternative 5 would entail the restoration of aquatic and riparian resaca habitats adjacent to high quality upland thornscrub habitats owned and managed by natural resources agencies. However, the resaca segment restoration with Alternative 5 is located in the middle of the high quality upland thornscrub habitat and surrounded on all sides by this habitat (Figure A-18). The resaca to the north was used as a reference resaca for the RRCM to quantify a reference condition. The edge of the resaca habitats provides lateral connectivity with the 330 acres of upland habitats for the entire circumference of the resaca including some of the highest quality resaca habitat in the Lower Rio Grande Valley.

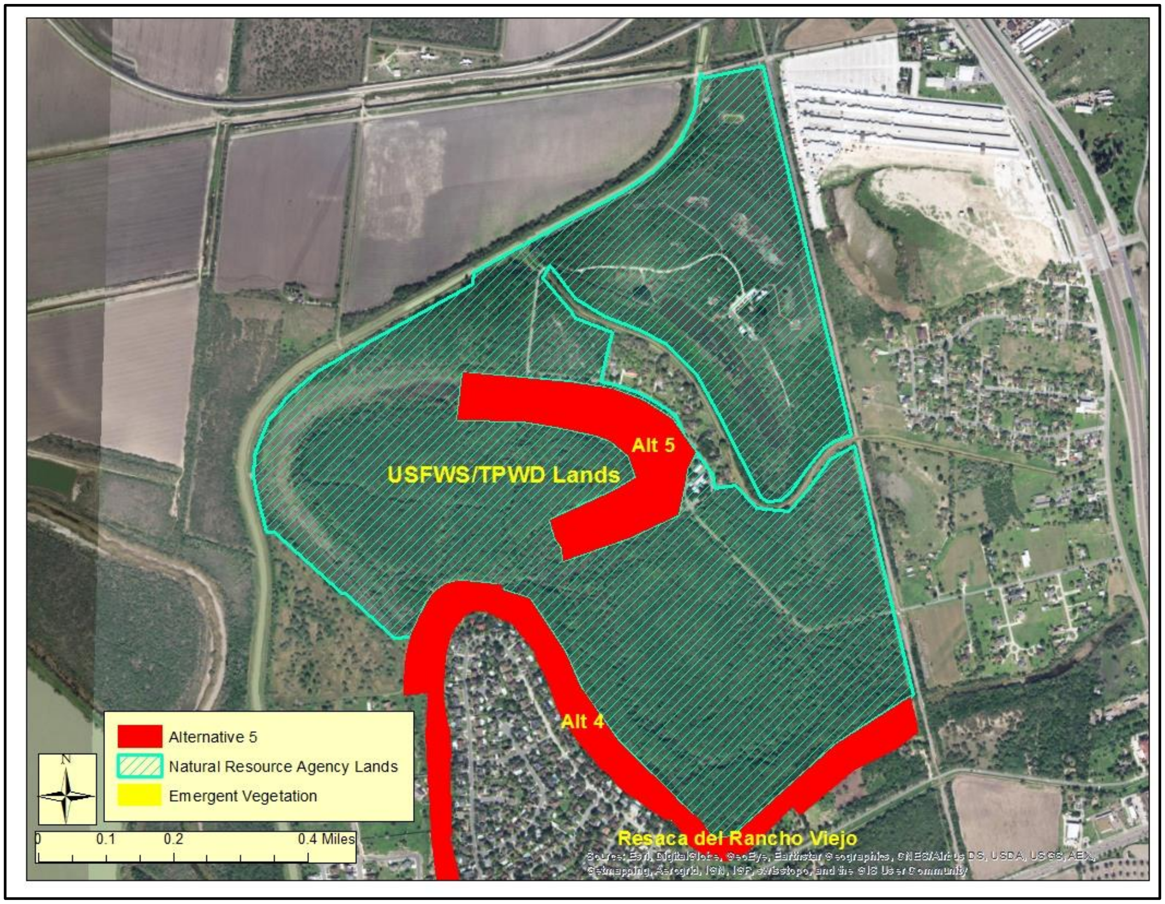


Figure A-18: Proximity of Alternative 5 to high quality upland thornscrub managed by the USFWS and TPWD

As with Alternative 4, the lateral connectivity benefits are not accounted for in the CE/ICA. However, unlike Alternative 4 there is a relatively small incremental cost associated compared with the incremental benefits. Considering the CE/ICA analysis alone, the Alternative 5, would be justified. But, with the addition of the lateral connectivity benefits, this alternative is further justified. The benefits associated with the restoration of the resaca segments included in Alternative 5 fully justify the expenditure of additional funds. Therefore, the incremental cost associated for Alternative 5 is worth the federal and local investment.

Comparing Alternative 6 to Alternative 5

Alternative 6 would complete the proposed restoration of Resaca de la Guerra through the addition of 6 restoration areas. Graphics of the individual restoration areas are provided in the drawings at the end of the main report. The restoration measures for the alternative are shown in Table A-30. An overall graphical representation of Alternative 1 is provided in Figure A-19.

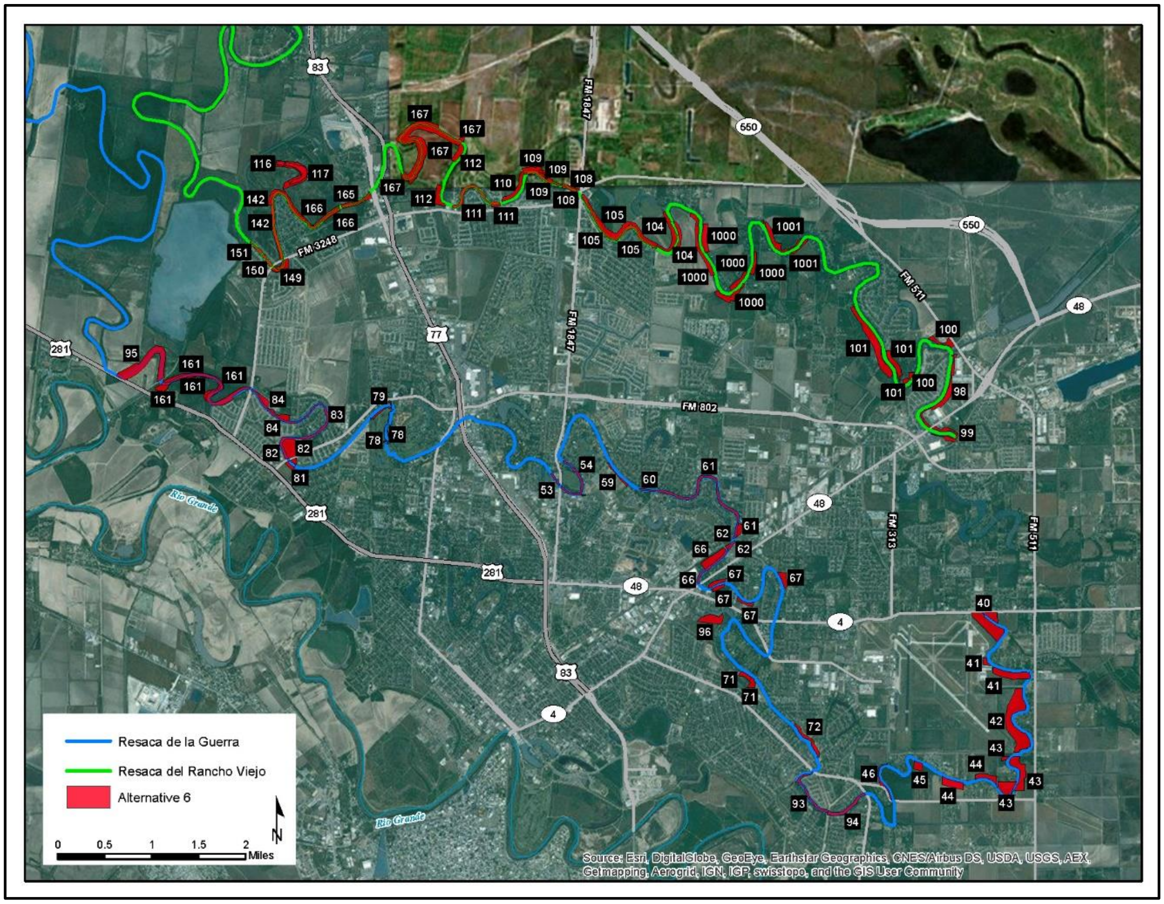


Figure A-19: Alternative 6.

Table A-30; Restoration Measures and Benefits for Alternative 6.

Restoration Area	Riparian Restoration Acres	Aquatic/Emergent Restoration Areas	Bank Sculpting (lf)	Invasive Species Management Acres	Dredging Acres	AAHU
77, 78	4.1	1.5	4,376	2.60	0.0	3
79	3.4	0.6	1,860	2.75	0.0	2
81	4.4	0.4	1,166	4.02	0.0	2
82	15.5	0.9	2,644	14.57	6.0	13
83	0.0	0.0	0.00	0.00	12.6	3
Subtotal	27.4	3.4	10,046	30.8	18.6	23
Alt 5 Total	681.0	56.9	164,593	737.9	217.9	483
Alt 6 Total	708.4	60.5	174,639	768.7	236.5	507

Alternative 6 would provide an additional 23 Average Annual Habitat Units (AAHUs) of benefit for a total of 883 AAHUs at a first cost of $223,542,000 and an Average Annual Cost (AAC) of $8,050,000. Alternative 6 would meet the study objectives by restoring 708.4 acres of globally imperiled Texas Ebony Resaca Forest, add Subtropical and Ebony, and 236.5 acres of aquatic and emergent resaca habitat for a total of 944.9 acres of restored habitat. Alternative 6 would add an incremental annual benefit of 23 AAHUs at an increased incremental AAC/AAHU of $1,200 over Alternative 5. The incremental cost of Alternative 6 is higher than Alternative 5. Although Alternative 6 would provide additional habitat connectivity for Resaca de la Guerra and would increase the extent of restored critically imperiled habitats, the benefits would not warrant the higher incremental costs. The incremental cost of Alternative 6 would not be worth the federal and local investment. Because Alternative 6 would be justified, the incremental cost of Alternative 7 would not be justified.

RECOMMENDED PLAN/NATIONAL ECOSYSTEM RESTORATION PLAN

The Recommended Plan (Alternative 5) would provide for restoration of the aquatic and riparian habitats for Resaca de la Guerra and Resaca del Rancho Viejo. The recommended plan was identified as the NER Plan. The plan would include the planting of more than 681 acres of Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snakeyes Shrubland throughout the two resacas. The plan would also restore more than 217.9 acres of aquatic habitat by the dredging and excavation of resaca segments and the planting of aquatic and emergent vegetation within the restored resaca. The plan includes the shaping of over 33 miles of resaca bank shoreline to reconnect the riparian terrestrial habitats with the aquatic habitats.

This feature specifically benefits native amphibians as the lesser bank slope facilitates their transition from aquatic to terrestrial forms. The plan entails the management and control of non-native invasive plant species throughout the restoration areas. The combined riparian and aquatic restoration encompasses almost 846 acres of resaca habitats along the two resacas.

DESCRIPTION OF THE RECOMMENDED PLAN

The Recommended Plan, Alternative 5, would restore Resaca de la Guerra and Resaca del Rancho Viejo. The following sections describe the plan itself.

Graphics of the individual restoration areas are shown in the drawings at the end of the main report.

Restoration Features

The restoration measures proposed for each restoration area depend on the needs of the individual area. The ecosystem restoration measures available for each area include dredging of sediments to increase the depth of the resaca to historical depth or 6 feet, whichever is less; the beneficial use of dredged material to supplement the riparian soils; the sculpting of the resaca bank slope to reduce the slope to reference conditions; the planting of aquatic and emergent vegetation along the edge of the dredged resacas and modified bank slopes; the planting of native riparian vegetation consistent with the three critically imperiled with extinction vegetation associations; and the management and control of non-native, invasive plant species.

Benefits Gained for Nationally, Regionally, and Locally Significant Resources

The benefits of the proposed Brownsville Resaca Ecosystem Restoration study can be defined by the following criteria: scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

Scarcity

The resaca ecosystems are the aquatic components of the Tamaulipan shrubland ecoregion of south Texas. Over 95 percent of native Tamaulipan shrubland habitats have been lost due to agricultural and urban development. Ninety nine percent of resaca habitat has been lost. Numerous rare species have evolved in the unique ecology of the resacas. A large community of organisms are strictly dependent on the resaca ecosystems. No new resacas will be created because the Rio Grande has been modified through the construction of many structures to reduce flood risk. The remaining resacas will continue convert to upland habitats over time. The proposed action would maintain and restore these increasingly scarce habitats.

Representativeness

The ability of the City of Brownsville resacas ability to exemplify a natural habitat or ecosystem in south Texas can be demonstrated in the reference resacas used in the RRCM development. Resaca de la Palma State Park, Southmost Preserve, and Camp Lula Sams provide high quality resaca habitats in the suburban areas surrounding the City of Brownsville. These areas provide resaca dependent fish and wildlife habitat with resources.

Status and Trends

Urbanization will continue to shift the region from rural to urban areas with an increasing number of people. As a result, the Brownsville resaca ecosystem will decline in quality and quantity. Without restoration, this unique ecosystem will be lost.

Connectivity

One of the project's objectives was to reestablish connectivity between existing high quality resaca habitats using stepping stone habitats. The resacas project would provide direct hydraulic connectivity between each of the restoration areas and would minimize the gaps between riparian habitats across the study area. Without proactive restoration efforts, the potential for fish and wildlife to successfully disperse east to west across the study area would be negligible. The stepping stone habitats would increase the value of habitat for wildlife within the restoration areas and therefore provide connectivity across the urban landscape.

Limiting Habitat

Limiting habitat is defined in ER 1105-2-100 as, "habitat essential for the conservation, survival, or recovery of one or more species". The recommended plan would restore that are habitats critically imperiled with extinction. The wildlife species dependent on those habitats are equally rare. The resaca habitats are a high priority for conservation for the USFWS, TPWD, and TNC. Most remaining resaca habitats are highly altered and fragmented. Stepping stone habitats are the primary need identified for the endangered ocelot, the jaguarundi, and most resaca species. The species recovery plan for them would identify, restore, conserve, and preserve high quality habitats and identify and develop stepping stone habitats across the landscape to promote dispersal and emigration of the species.

Biodiversity

The success of the resaca restoration would be defined by the degree and magnitude of biodiversity attained. Increasing species diversity in the resaca aquatic and riparian communities is a primary component of the RRCM and it supports life across the panorama of the ecosystem. Rich biodiversity would provide resources for species variety among the lower trophic level organisms and that would directly support diversity in the upper level trophic community of mammals, birds, reptiles, and amphibians. This component of the plan would address the resource of significance and measure the degree of biodiversity improvement.

ENVIRONMENTAL CONSEQUENCES

Introduction

Generally, an environmental consequences section would include discussion regarding the impacts of various alternative plans on the natural resources of the study area, allowing the study team to determine whether any potential adverse environmental impacts might preclude the selection of one alternative over another. However, all alternatives included in this study would result in different levels of beneficial ecosystem restoration. This process resulted in a set of alternatives that are additive, meaning that each progressive alternative includes all the restoration elements of the previous alternative and then adds another increment of restoration, until the final alternative, which includes full restoration of all resaca areas to the extent practicable. In the following sections, environmental consequences affect each alternative similarly, the discussion of impacts may be combined into a single description.

Air Quality

No Action Plan

Under the no action plan, there would be no adverse impacts to air quality within the study area.

Alternatives

The construction activities of the alternatives would generate air pollutant emissions as a result of excavation, demolition, grading, compacting, trenching, and construction operations. These emissions would be temporary and would not be not expected to generate offsite effects or exceed state or federal air quality standards.

The construction activities would result in short-term emissions of criteria pollutants as combustion products resulting from construction and transportation equipment, as well as evaporative emissions from asphalt paving operations. Minor short-term increases would also result fromdetours required by temporary rpoad closures other activities.

Construction activities would generate particulate matter emissions, such as fugitive dust. Fugitive dust in particulate matter, solid particles that come primarily from soil, that become suspended in the air by wind and human activities. Fugitive dust emissions would be greatest during initial site preparation activities and would vary daily depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site are generally proportional to the area of land being worked and the level of construction activity. Appropriate fugitive dust control measures would be employed to suppress emissions, such as using mulch, water sprinkling, temporary enclosures, and other appropriate methods as needed.

The alternatives would generate emissions below de minimis levels. Cameron County is classified as an attainment area for all criteria pollutants. Therefore General Conformity Rule requirements would not be applicable. The construction contractor would be required to use low greenhouse gas-emitting vehicles to the extent possible and available, such as clean diesel technologies.

Climate

The USACE policy is to integrate climate change preparedness and resilience planning into all of its activities. This integration enhances the resilience resource infrastructure, the effectiveness of the military support mission, and reduces potential infrastructure and mission climate change vulnerability. The limited scale of the restoration effort would preclude change to climatic conditions.

The Brownsville resacas are located near typical urban greenhouse gas generators. The alternatives would produce de minimis greenhouse gas emissions during construction. The temporary emissions would not reach the reportable threshold. The aquatic and riparian vegetation proposed for restoration would have net benefits in reducing greenhouse gases.

The alternatives would use site-specific native plant species that have evolved with cyclical drought patterns. These species are suited to prolonged periods of extended drought followed by intense flooding. Construction measures would utilize management and irrigation strategies to ensure the successful establishment of vegetation.

The proposed native plant species would be able to adapt to weather extremes anticipated as the result of climate change. The increased depth of the resacas from dredging and the restoration of riparian buffers from plantings would improve the resiliency of the resaca ecosystem.

The effects of climate change on resaca flows are similarly uncertain as prolonged drought periods may affect the aquatic resources of the resaca. Due to the high uncertainty regarding the impacts of climate change on temperature and precipitation patterns in Texas (Schmandt et al, 2011), the impacts of climate change on the success of restoration efforts is unknown.

Water Resources

Implementation of any alternative would restore a level of resaca ecosystem restoration function. The resaca resources encompass ecological elements comprising a healthy, functioning, aquatic ecosystem, including the aquatic, riparian, and adjacent upland environments. Ecosystem restoration would have beneficial affects on resaca resources, including water resources.

Surface Water

No Action Plan

Under the no action plan, the resacas would continue along their successional pathway and continue to silt in, eventually converting the aquatic feature into rich upland thornscrub habitats. The increased urban development would most likely maintain the aquatic component of several resacas due to aesthetic value of the resacas; however, the aquatic and riparian habitats associated with natural resaca systems would be lost as urbanization and development continues throughout the region.

Alternatives

The alternatives would restore the resaca aquatic component. The dredging measure would mimic a natural flood event by mobilizing accumulated sediments and restoring the aquatic capacity of the resaca. The restored resaca depth from dredging would increase the aquatic habitat quantity and quality by providing greater water volume, more cover, lower water temperatures, and increased dissolved oxygen concentrations for fish and amphibian species.

All alternatives would impact surface waters. Alternatives restoring greater areas would have greater beneficial affects.

Ground Water

The Brownsville resacas are not located in an aquifer recharge zone. None of the alternatives would groundwater resources.

Water Quality

The resacas surface water quality is affected by adjacent land use that produces sediments and contaminants (petroleum products, chemicals, fertilizers, etc.). Generally, higher densities of development (i.e. urban areas such as the resacas study area) require more intensive degrees of storm water management because of rapid storm runoff produced by higher proportions of impervious surfaces.

No Action Plan

Under the no action plan, there would be no direct impacts to water quality of the resacas. The resacas would continue to be affected by storm water runoff and contaminants introduced from adjacent properties at similar levels as the existing conditions.

Alternatives

The alternatives would directly impact surface waters through construction activities associated with dredging, excavation, and bank slope reshaping. During construction, dredging and ground disturbing activities would temporarily degrade water quality. Erosion and sedimentation controls would be required during construction, such as silt curtains, silt fencing, and sediment traps, and the application of water sprays. Revegetation of disturbed areas would be prompt to reduce and control siltation or erosion impacts. Every construction alternative 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 to reduce the risk of such contamination. The plan would include best management practices such as, proper storage, handling, and emergency preparedness. Anticipated impacts to surface waters during construction would be temporary and insignificant.

Dredging and excavation of the resacas would increase the acres of surface waters in the study area. Establishment of aquatic plants and revegetation of the resaca banks and riparian areas with native grasses, forbs, and woody species, would act as effective vegetative filters, reducing amounts of sediments and other contaminants. The vegetation would improve water quality over existing conditions. The long-term water quality impacts of constructing any of the proposed alternatives would be beneficial, and would include an increase in water surface area, reduction in water temperature by vegetational influences, improved water chemistry, and increase organic allochthonous materials.

The TCEQ provided a water quality certification on 26 July 2017.

Hydrology and Floodplains

Floodplains

No Action Plan

Under the no action plan, the floodplain of the resacas would remain unchanged.

Alternatives

All of the alternatives are located within the resacas floodplains. Alternatives should not result in a decrease in floodplain capacity or an increase in flood risk.

The 100-year and 500-year flood zones were determined from the FEMA Digital Flood Insurance Rate Map. None of the alternatives would result in a decrease in the floodplain capacity or an increase in flood risk. The proposed action would be in compliance with EO 11988.

Riverine Resources

Wetlands

The Brownsville resacas are U.S. jurisdictional waters and are subject to protection under the CWA, Sections 401 and 404.

No Action Plan

Under the no action plan, there would be no direct impacts to waters of the U.S. Over time, sediments would continue to fill in the resacas eventually converting them into upland systems. Therefore, the long term impacts of the No Action plan would be the loss of wetlands within the study area.

Alternatives

The alternatives would not result in a net loss of wetlands or waters of the U.S. The alternatives would increase the extent of wetlands and waters of the U.S. The proposed alternatives would be in compliance with the CWA.

Biological Resources (Fish, Wildlife, and Vegetation)

No Action Plan

Under the no action plan, there would be no direct impacts to vegetation along the resacas. The existing non-native, invasive plant species would continue to adversely impact fish and wildlife habitats along the resacas. The lower quality habitats provided by the invasive species would limit the diversity and sustainability of fish and wildlife species within the resacas.

Alternatives

The alternatives would improve habitat conditions throughout the resaca system using the measures identified in Chapter 3.

For each of the action alternatives, the proposed riparian vegetation would increase the organic allochthonous material to the aquatic system and provide energy to the lower trophic organisms. Restoration of the native aquatic and riparian habitats would provide additional resources (food, shelter, and reproductive habitats) for mammals, birds, amphibians, reptiles, invertebrates, and fishes.

The restoration would minimize the distances between stepping stone habitats and increase connectivity throughout the resaca systems.

The study area is located within the Mississippi and Central Flyways. The ability of migratory species to find adequate resources along the migratory corridors ultimately determines their ability to arrive at their breeding grounds in a healthy condition to establish territories, find mates, reproduce, and fledge young. Restoration would increase migratory, breeding, and wintering habitats for waterbirds, waterfowl, and neotropical and temperate migrants. The restoration would specifically support breeding birds successful reproduction and fledging. The restoration measures would also provide high quality habitat for amphibian species requiring both aquatic and terrestrial habitats to successfully reproduce.

The application of best management practices, such as erosion control and tree protection, would reduce the risk of temporary impacts. Staging areas would be located in existing project areas or adjacent hardened surfaced areas therefore temporary construction impacts to vegetation would not be anticipated. The establishment of appropriate vegetation would enhance connectivity of the stepping stone habitats and improve the habitat connectivity of the resaca ecosystems.

The restoration of the aquatic, wetland, and riparian habitats would improve habitat for several species such as the black-spotted newt and south Texas siren that are listed by the state of Texas and being considered for listing under the ESA. Many of these species are limited to the south Texas region and the restoration of resaca habitats may be the key to keep these species from being listed in the future. Implementation of any alternative would comply with the Migratory Bird Treaty Act, Migratory Bird Conservation Act, and Executive Order 13186, Migratory Birds.

Threatened and Endangered Species

No Action Plan

Under the no action plan, there would be no added benefits to listed species. The red-crowned parrot, a federal candidate species, was observed within the study area during field surveys and habitat for the parrot would continue to decline within the resaca ecosystems of the study area.

Alternatives

The proposed action would have no effect on federally endangered or threatened species. The USFWS, in their August 10, 2017 Fish and Wildlife Coordination Act Report, concurred with the determination of no effect [Appendix D]. The proposed action would have the potential to positively affect three species listed or proposed for listing under the Federal Endangered Species Act, the red-crowned parrot, ocelot, and jaguarundi.

The red-crowned parrot (a candidate for federal listing on the endangered species list) would benefit from the proposed action. The restoration of native vegetation, including Texas sabal palms, would provide forage and nesting habitat for the parrots.

The ocelot and jaguarundi are species of national significance. The range of the jaguarundi extends about 600 miles along the Rio Grande upstream of Brownsville. The range of the ocelot once extended into Texas, Arizona, Arkansas, and Louisiana, but is now generally restricted in the U.S. to a small areas in Arizona and south Texas, including the nearby Laguna Atascosa National Wildlife Refuge. The alternatives were not formulated to specifically benefit the ocelot or jaguarundi, but the connection provided to the surrounding ecosystems would inherently benefit both.

Restoring habitat along a former Rio Grande corridor would simulate a natural resaca environment and encourage movement of these large cats between areas of preferred habitat on either side of Brownsville and beyond, thereby increasing genetic diversity and population expansion.

While not providing preferred habitat for these cats, the alternatives would create the stepping stone corridors that provide ecological connectivity to their preferred habitat of concealed areas. Both species are secretive in nature and the corridors would be conducive for undetected movement that would protect them from predators and human interactions as they pass through the urban landscape of Brownsville. By minimizing the threat of predation, the proposed action would help sustain the ocelot and jaguarundi population.

These benefits would compliment ocelot and jaguarundi restoration efforts by others. Specifically, the proposed action would support the Endangered Species Act (dated August, 2016 & December 2013, respectively) ocelot and jaguarundi recovery plans

Cultural Resources

No Action Plan

Under the no action plan, there would be no impacts to cultural resources within the study area.

Alternatives

A desktop review and assessment of resources within the study area was conducted using the Texas Historical Commission's ATLAS online database. Two previously recorded archaeology sites are recorded within the proposed area of disturbance; one of these (41CF3) is the Resaca de la Palma National Battlefield and the USACE continues to work closely with the NPS to avoid and minimize potential impacts to associated cultural resources in relation to the undertaking. The second site (41CF188), is a historic debris scatter that has been previously determined ineligible for listing on the National Register of Historic Places (NRHP).

Much of the study area is within the central portion of the City of Brownsville, resulting in a lower potential for inadvertent discovery and significant impacts to cultural resources. Because the proposed action would consist of habitat restoration and would not significantly alter the viewshed, the finding of no potential to have adverse effects to built historic resources is anticipated. Cultural resource investigations were done during the PED phase and the resulting report/determinations provided to the Texas SHPO. The agency concurred that the proposed project would not result in any adverse effects on historic properties and that letter is provided in Appendix D-1-a. There will not be any further concurrence from SHPO until our investigations are conducted in PED and the USACE provides a report/determinations for SHPO concurrence. Additional cultural surveys of standing structures would not be not anticipated. All archaeological investigations, as well as inadvertent discoveries would be treated in accordance with The Native American Graves Protection and Repatriation Act (NAGPRA). Applicability of NAGPRA would be specified in the Corps' final determination. Detailed provisions matching the requirements of NAGPRA are included in the Programmatic Agreement (Appendix D-1-b).

Land Use, Recreation, and Transportation

Ecosystem restoration along the resaca systems is consistent with current land uses and would enhance the existing public use areas and general quality of life for local residents. The alternatives would not alter existing land uses or transportation facilities within the study.

No Action Plan

Most of the study area has been developed with residential, commercial, industrial, and agricultural land uses. Under the no action plan this would not change.

Alternatives

Several public areas are adjacent to a proposed resaca restoration areas including the former State fisheries hatchery and city parks. None of the alternatives would negatively impact the community state parks, conservation areas, and other areas of recreational, ecological, scenic, or aesthetic importance (per 40 CFR 1508.27(b)(3)).

Recreation opportunities may be improved as several restoration areas are located adjacent to public parks and existing recreation areas. The restoration of resaca habitats throughout the resaca systems would also provide improved eco-recreation opportunities such as birding, wildlife viewing, and kayaking that would be developed by the City of Brownsville.

The proposed action would not impact any waterbodies designated as a wild or scenic waterway, in accordance with the Wild and Scenic Rivers Act.

Socioeconomics and Visual Aesthetics

An environmental justice analysis intended to “analyze and address the distributional effects of environmental impacts on certain populations” is included to comply with the requirements of Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The purpose of the EO is to determine if the impacts of an action fall disproportionately on minority or low-income communities. Disproportionate impacts occur when, in order to minimize or avoid impacts to another community or environmental resource, adverse impacts are instead focused on the minority or low-income community.

No Action Plan

Under the no action plan, there would be no adverse impacts to socioeconomic resource within the study area.

Alternatives

The alternatives would not negatively impact minority populations. None of the proposed alternatives would block people from hospitals, schools, shopping or split neighborhoods into smaller segments. The long-term environmental restoration would be a community benefit whereby the Brownsville citizens would have a higher quality natural resources to enjoy.

Noise

No Action plan

Under the no action plan, there would be no increase in noise levels within the study area.

Action Alternatives

The alternatives’ use of heavy equipment, such as dredging equipment, backhoes, front-end loaders, and dump trucks, would be associated with short-term, localized increases in noise levels. These short-term increases would not be expected to substantially affect adjacent noise sensitive receptors or wildlife areas. Construction noise levels would be attenuated by distance, topography, and vegetation.

Construction would occur during daylight hours, thus reducing day-night average sound levels. The use of best management practices, such as keeping equipment in good operating condition, proper training, and providing appropriate health and safety equipment would minimize potential noise impacts. Construction would be conducted in accordance with City noise ordinances.

Hazardous or Toxic Substances

No Action Plan

The no action alternative would have no effect on HTRW sites within the study area.

Alternatives

None of the alternatives would be expected to affect HTRW sites within the City of Brownsville. The footprint of the resacas would not be expanded beyond what already exists, so distances between the resacas and known HTRW sites would not change. An abbreviated Phase 1 Environmental Assessment (see Appendix A) did not identify any major sites near the resacas, that could potentially affect the proposed action.

Geology, Seismicity, and Soils

No Action Plan

Since the no action plan would leave the resaca systems in its existing condition, no adverse impact to the geology, seismicity, or soils would result.

Alternatives

Alternatives would include dredging and excavation along shoreline and riparian areas. Maximum depth of excavation would be about 6 feet within the resacas, and 1 to 3 feet along the shorelines and riparian areas. Excavation would not impact sensitive or significant geological features.

The study area is located within the city limits of Brownsville and the Brownsville Extraterritorial Jurisdiction. The requirements of Section 1541(b) of the Farmland

Protection Policy Act of 1980 and 1995, 7 U.S.C. 4202(b), would not apply to prime farmland soil types within the project footprint.

Alternative implementation activities during construction would have the potential to expose soils to increased wind and water erosion because of vegetation removal. Activities would include, dredging, excavation of dry resacas, shaping the resaca bank slopes, and soil preparation for planting the riparian habitats.

The upper six inches of soil within the riparian areas 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. The affected area would be revegetated with site-specific native vegetation to stabilize the soils and restore ecological functions. Potential impacts would be minimized the application of best management practices, such as controlling runoff, erosion, and sedimentation.

Soils along the resacas would stabilize because of the presence of plantings of native riparian vegetation. Additionally, the soils would be from dredged material, thus nutrient-rich, and would improve the establishment of native trees and shrubs.

The location of active hard mineral leases (minerals other than oil and gas) was determined from data from the Texas State General Land Office. While there were active hard mineral leases within the Brownsville area, there were none located within the project footprint.

Irreversible and Irretrievable Commitment of Resources

The proposed action would not entail any significant irretrievable or irreversible commitments of resources. Construction of the 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.

Indirect Effects

Indirect effects, as defined by the CEQ 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 ecosystem” (40 CFR 1508.8). Indirect effects differ from effects caused by an action or actions that have an established relationship or connection to the proposed project. 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 Brownsville resacas and the associated vegetation and wildlife. In addition, the proposed resaca ecosystem restoration measures would result in benefits that extend farther outside the study area for several notable environmental resources. These benefits would increase over time as the resaca habitats develop and mature.

The establishment of wildlife corridors through the development of stepping stone habitats has been documented in this report. The indirect effects of this study are directly linked to these wildlife corridors as the proposed action would facilitate the emigration and dispersion of wildlife across an urban/suburban interface, thereby connecting habitats currently disconnected. In addition, the improved resaca habitats would improve water quality downstream as aquatic, wetland, and riparian vegetation would filter pollutants and sediments.

Cumulative Impacts

The 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 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. 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. The CEQ guidance recommends narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, cumulative impact analysis for the Brownsville resacas was focused on those resources that were substantially impacted, either directly or indirectly, 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 the cumulative impacts analysis include the riparian vegetation and the associated wildlife. Each of these resources would be substantially directly and/or indirectly impacted by the resacas study. For the purposes of this cumulative analysis, the resource study area for the riparian vegetation and wildlife is the historical extent of the resaca habitats.

Past, Present, and Reasonably Foreseeable Projects with-in the Resaca Study Area

The resaca aquatic and riparian habitats have been in critical decline in quantity and quality over the last 100 years. This trend is expected to continue even in the light of conservation efforts initiated in the last 20 years by the USFWS and the TPWD. Although the proposed ecosystem restoration study would result in the restoration of a small proportion of historical habitat, it represents a substantial proportion of the remaining habitat. The USFWS, the TPWD, TNC, and other land trusts are actively trying to preserve and restore the remaining patches of Tamaulipan scrubland and USACE has the opportunity to take part and participate in the restoration of the aquatic component of this system. The USACE completed the feasibility study of a Continuing Authority Program Section (CAP) 206 project on the Resaca Boulevard resaca segment on Town Resaca. This CAP study will inform the restoration efforts proposed for this feasibility study. The BPUB has initiated ecosystem restoration projects at Dean Porter and Cemetery Resacas located in the Town Resaca system.

ENVIRONMENTAL COMPLIANCE

This integrated report has been prepared to satisfy the requirements of all applicable environmental laws and regulations using the CEQ NEPA regulations (40 CFR Part 1500–1508) and the USACE ER 200-2-2 - Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230. In implementing the Recommended Plan, the USACE would follow provisions of all applicable laws, regulations, and policies related to the proposed actions. The following sections present summaries of federal environmental laws, regulations, and coordination requirements applicable to this study.

Clean Water Act

Section 404(b)1

The USACE under the direction of Congress regulates the discharge of dredged and fill materials into waters of the U.S., including wetlands. The USACE does not issue itself permits for construction activities affecting waters of the U.S., but must meet the legal requirement of the Act. As directed in Wetlands and Waters of the U.S., a 404(b)(1) analysis was conducted for the Brownsville resacas study and reviewed by the Galveston District (Appendix D-3). Although not used, the proposed project would meet the qualifications for a Nationwide Permit 27. Before construction, the USACE or its contractors will obtain a National Pollutant Discharge Elimination System (NPDES) construction activities permit from the TCEQ. The Section 404(b)1 analysis was provided to the TCEQ and the agency provided the water quality certification for the study in accordance with Section 401 of the CWA.

Section 402

The construction activities that disturb upland areas (land above Section 404 jurisdictional waters) are subject to the NPDES requirements of Section 402(p) of the CWA. Within Texas, the 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 the TPDES requirements. Operators of construction activities that disturb five or more 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 ensure 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.

Clean Air Act of 1970

Federal agencies are required by this Act to review all air emissions resulting from federal funded projects or permits to insure conformity with the SIPs in non-attainment areas. The Brownsville metropolitan area is currently in attainment for all air emissions; therefore, the proposed study would be in accordance with the Clean Air Act.

National Historic Preservation Act of 1966

Federal agencies are required under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, to “take into account the effects of their undertakings on historic properties” and consider alternatives “to avoid, minimize or mitigate the undertaking’s adverse effects on historic properties” [(36 CFR 800.1(a-c)] in consultation with the State Historic Preservation Officer (SHPO) and appropriate federally recognized Indian Tribes (Tribal Historic Preservation Officers - THPO) [(36 CFR 800.2(c)]. There are other applicable cultural resources laws, rules, and regulations that will inform how investigations and evaluations will proceed throughout the study and implementation phases (e.g., Archeological and Historic Preservation Act of 1974, National Environmental Policy Act of 1969, Native American Graves Protection and Repatriation Act, Engineer Regulation 1105-2-100).

In accordance with Section 106 of the NHPA, USACE has consulted with the Texas SHPO, as well as all federally recognized Native American Tribes with an interest in the project area, regarding the potential to impact historic properties from the proposed undertaking (Appendix D-1-a). Based on background research and correspondence with the SHPO, the finding of no potential to have adverse effects to built historic resources is anticipated. The SHPO and the USACE concur that the landforms adjacent to resacas generally display a high probability for containing buried archaeological resources. The potential for undisturbed archaeological resources remains and additional cultural resource surveys may be required in areas of significant ground disturbance.

A Programmatic Agreement (PA)(Appendix D-1-b) with all consulting parties was executed per 36 CFR 800.14(b)(1)(ii) as required when effects on historic properties cannot be fully determined prior to approval of an undertaking. The PA stipulates that outlining efforts (surveys, testing, evaluation, effects determination, mitigation) shall to be completed during PED and before construction (also see ER 1105-2-100, page C-30).

Endangered Species Act

Informal consultation was conducted with the USFWS. No federally listed threatened and endangered species are expected to occur in the study area as identified by the USFWS; therefore a Biological Assessment (BA) was not prepared for this study.

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 water body 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 Brownsville resaca study, the USFWS and the TPWD have participated in the planning process, data collection efforts, and provided input and comment throughout the process. The USFWS and the TPWD will continue to be involved throughout the Brownsville resaca study. The USFWS Planning Aid Letter/Coordination Act Report is located in Appendix D-2.

Executive Order 13112, Invasive Species

The EO 13112 recognizes the significant contribution native species make to the well-being of the nation's natural environment and directs federal agencies to take preventative and responsive action to the threat of the invasion of non-native plants and wildlife species in the U.S. 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.”

The degradation of the Brownsville resacas has resulted in the loss of habitat quality to support native fish and wildlife resources. Linked to the habitat degradation is the loss of native aquatic and riparian plant species, which is vital to the aquatic and riparian environment. The measures included in the Brownsville 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 resacas study area by the non-federal sponsor during long-term management of that area would keep the negative influence of nonnative 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 habitat.

Executive Order 13690 (Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input) (Amendment to Executive Order 11988, Floodplain Management)

The EO 13690 was enacted on January 30, 2015 to amend EO 11988 , enacted May 24, 1977, in furtherance of the NEPA of 1969, as amended (42 U.S.C. 4321 et seq.), the National Flood Insurance Act of 1968, as amended (42 U.S.C. 4001 et seq.), and the Flood Disaster Protection Act of 1973 (Public Law 93-234, 87 Star.975). The purpose of the EO 11988 was to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. The EO 13690 builds on EO 11988 by adding climate change criteria into the analysis.

These orders state that each agency shall provide and shall take action to reduce the risk of flood loss, to minimize the impacts of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. The FEMA Digital Flood Insurance Rate Map (DFIRM) of the study area was analyzed to establish the locations of the 100-year and 500-year flood zones. All alternatives were designed to ensure that the combination of all ecosystem restoration measures proposed would not result in a decrease in the floodplain capacity and an increase in flood risk to the study area. The Proposed Action would remain in compliance with EO 11988 and EO 13690.

Migratory Bird Treaty Act, Migratory Bird Conservation Act, and Executive Order 13186, Migratory Birds

The importance of migratory non-game birds to the nation is embodied in numerous laws, executive orders, and partnerships. The Migratory Bird Treaty 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. The EO 13186 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 the primary goal of the USFWS to conserve avian diversity in North America. 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 USFWS Migratory Bird Program goals to protect, conserve, and restore migratory bird habitats to ensure long-term sustainability of all migratory bird populations.

Executive Order 12898, Environmental Justice

The 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 effects 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 and the low-income population is above the national averages, 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 individuals in the Brownsville resacas 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 English and Spanish. No environmental justice concerns are anticipated and the Proposed Action would be consistent with EO 12898.

Executive Order 13045, Protection of Children

The 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, dredgers, graders, and dump trucks, and other large construction equipment would be used throughout the duration of the construction of the proposed action. Because construction sites and equipment can be enticing to children, activity could create an increased safety risk. The risk to children would be greatest in construction areas near densely populated 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.

Advisory Circular 150/5200-33A – Hazardous Wildlife Attractants on Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife to, or 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 U.S. Army as well as other federal agencies, signed a Memorandum of Agreement (MOA) with the FAA to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the U.S.

The project area is located adjacent to the Brownsville-South Padre Island International Airport. In accordance with the advisory circular, the USACE coordinated with the FAA to address potential hazardous wildlife attractants near the airport with respect to the proposed action. The coordination letter with the FAA is included in Appendix D-4.

REPORTING

The Project is expected to be constructed as a phased project over a period of sixteen years. Evaluation of the success of the Project would assessed annually until all performance standards are met for each phase of the study. Site assessment would conducted annually by the MAMT and an annual report would be submitted to the U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department, and USACE by January 30 following each monitoring year for up to ten years after the last phase is constructed.

Permanent locations for photographic documentation would be established to provide a visual record of habitat development over time. The locations of photo points would be identified in the pre-construction monitoring report. Photographs taken at each photo point would be included in monitoring reports.

ADAPTIVE MANAGEMENT AND MONITORING PLAN

Monitoring and if necessary, adaptive management will occur for a period of up to ten 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 by BPUB and USACE personnel. See Appendix C for the Monitoring and Adaptive Management Plan.

Costs to be incurred during PED and construction phases include the drafting of the detailed monitoring and adaptive management plan. Cost calculations for post-construction monitoring are displayed for a ten year monitoring period for each construction phase.

A centralized data management system would be used for storage, analysis, and reporting. All data collection activities would follow consistent and standardized processes established in the detailed monitoring and adaptive management plan.

Cost estimates include monitoring equipment, photo point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements (Table A 31). Unless noted, preconstruction monitoring costs would begin at the onset of the preconstruction, engineering and design of the first construction phase. Monitoring would be budgeted as construction costs.

Table A 31:Preliminary Cost Estimates for Implementation of the Monitoring and Adaptive Management Plan for the Brownsville Resacas Ecosystem Restoration Project

Category	Activities	PED Set-up & Data Acquisition	Construction	10-year Post Construction	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures	$25,000			$25,000
Monitoring: Data Collection	Data collection		$50,000	$450,000	$500,000
Data Analysis	Assessment of monitoring data and performance standards		$25,000	$75,000	$100,000
Adaptive Management Program	Detailed adaptive management plan and program	$25,000			$25,000
	Establishment of adaptive management program			$600,000	$600,000
Database Management	Database development, management, and maintenance		$10,000	$30,000	$40,000
Total		$50,000	$85,000	$1,155,000	$1,290,000

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APPENDIX B

Ecosystem Model

Contents:

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APPENDIX B-1

Resaca Reference Model Description

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RESACA REFERENCE CONDITION MODEL

Model Certification Plan

Brownsville Resaca Ecosystem Restoration Study

Background

Purpose of Model

The Resaca Reference Condition Model (RRCM) was designed to quantify the habitat quality of potential resaca restoration sites by comparing the existing habitat against reference conditions of high quality resacas and their associated riparian habitats.

Model Description and Depiction

The RRCM used high quality reference condition sites as a habitat quality target. Three modules are included in the RRCM, one for each vegetation community that may be encountered in the study area: Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony-Snake Eyes Shrubland.

The RRCM was composed of five suitability index (SI) categories: invasive species, aquatic habitat, bank habitat, riparian habitat, and water regime/depth. The metrics and indices incorporated into each category are described in the following section. The indices for invasive species, aquatic habitat, bank habitat and water regime/depth were the same across the three modules. The riparian habitat component was dependent on the vegetation community target for restoration. The reference conditions were based on data from 10 sampling locations: four at Resaca de la Palma State Park, three at The Nature Conservancy's Southmost Preserve, and two at Camp Lula Sams.

Contribution to Planning Effort

The RRCM was used to establish existing conditions and to forecast future with and without project conditions. The data outputs were incorporated in a Cost Effective/Incremental Cost Analysis tool within the IWR Planning Suite 2.0.6.1.

Description of Input Data

The RRCM was composed of four suitability index (SI) categories: invasive species, bank habitat, vegetative habitat, and water regime/depth. The invasive species index was comprised of a single metric, the percent of the vegetative community of a site that is comprised of invasive species. The bank habitat suitability index was comprised of two metrics, the percent vegetative canopy cover of the shoreline and the slope of the terrestrial/aquatic interface of the resaca.

The vegetative habitat index was comprised four metrics: riparian species composition, riparian species richness, percent riparian canopy cover, and percent aquatic canopy cover. The riparian species composition metric was a community specific metric based on one of the three vegetation communities identified above. A species function curve was constructed for each of the three vegetation communities and the species composition metric was a measure of the closeness of fit to these curves (see model documentation). The species richness metric was the total number of plant species identified on the site. The remaining two metrics were a measure of the percent canopy cover of the riparian and aquatic vegetation.

The final index was comprised of two metrics: the water regime of the resaca and the mean depth of the resaca. The water regime was a categorical metric describing the resaca as permanently connected, semi permanently flooded yet disconnected, or a dry resaca.

Description of Output Data

The data output of the RRCM was an index between 0.0 and 1.0 that reflects the degree that a site reflects high quality resaca sites as represented by the 10 sampling sites reference resacas.

Capabilities and limitations of the model

The RRCM was to be used only in Cameron County, Texas, for resacas that would have historically supported the three vegetation associations identified in the model documentation (Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland). Resacas associated with more saline soils closer to the coast or differently vegetated resacas were not evaluated due to their rarity in the study area. Because accurate plant species identification was critical for the quantification of habitat quality, botanical expertise of the flora of the resacas was essential for the collection of field data inputs.

Due to the uniqueness of the resaca habitats and the incredible density of the lower, mid, and upper canopy vegetation layers, the model is applicable to riparian corridors as narrow as 25-30 feet. The field data collection team included at least one person with the expertise to identify resaca ecosystems plant species.

Model development process

Key ecosystem metrics were identified utilizing a resaca conceptual model developed in cooperation with biologists from the U.S. Fish and Wildlife Service (USFWS) Santa Ana Wildlife Refuge, USFWS Alamo Ecological Field Office, Palo Alto Battlefield National Historical Park, Texas Parks and Wildlife (TPWD) Wildlife Division, TPWD Parks Division, TPWD Inland Fisheries Division, The Nature Conservancy's Southmost Preserve, University of Texas Rio Grande Valley, Brownsville Public Utilities Board, and USACE Regional Planning and Environmental Center. The riparian species composition index curves (Appendix B-2) were developed in consultation with botanists with the USFWS, TPWD, and the Nature Conservancy. The functionality of the resulting model was tested in the Resaca Boulevard Resaca Section 206 Continuing Authority Program study.

Model development team

The team consisted of Jason Singhurst, the Texas Parks & Wildlife Department, Chris Hathcock, the U.S. Fish and Wildlife Service, Rolando Garza, the U.S. National Park Service, Max Pons, The Nature Conservancy, and Danny Allen, the USACE.

Technical Quality

Theory

The RRCM was based on an understanding that the more closely a potential site reflects the structural and species diversity of relatively high quality resacas, the more closely it will function as a high quality resaca, assuming other environmental prerequisites are met, such as a suitable water budget.

Description of system being represented by the model

Resacas are defined as paleochannels of the Rio Grande delta that have long been cut off from the Rio Grande. These aquatic and riparian habitats are becoming increasingly rare as approximately 99 percent of resaca habitats have been lost to agriculture and urban development. Historically, the resacas were maintained by the periodic flooding of the Rio Grande. The floodwaters would reconnect the resacas within the floodplain and the resacas would retain the isolated floodwater well into the dry season serving as a refuge for fish and wildlife species dependent on the diverse aquatic and riparian habitats. Over time, the floodplain connectivity of the resacas and the river has been lost due to the construction of dams along the Rio Grande, irrigation canals diverting water from the river, and flood control projects within the basin. The ecosystem restoration study would restore the ecological function of the system by artificially reconnecting the resacas with the river and the floodplain.

Analytical requirements

The RRCM is a spreadsheet model developed in Excel.

Assumptions

The primary assumption of the RRCM is that the model development team has identified the highest quality remnant resaca sites in the study area and that these sites are reflective of the natural resaca ecosystem. The motives used in the model were reflective and representative of high quality resacas in the Lower Rio Grande Valley. It was assumed that the inherent variability of the vegetation and structural components of the resacas would be effectively captured and reflected in the RRCM metrics.

Conformance with Corps policies and procedures

The RRCM is compliant with Engineering Circular 1105-2-412: Assuring Quality of Planning Models, dated 31 March 2011.

Formula identification and computational accuracy

The formulas incorporated in the RRCM were developed by the multiagency model development team.

Invasive Species

The invasive species component of the RRCM was simply an index between 0.0 and 1.0 and was measured as the percent of the vegetative community comprised of non-native and non-native invasive species. The index was calculated as follows:

$$I_{SI} = 1 - \left(\frac{I_i}{100}\right)$$

Where I_{SI} = Invasive Species Suitability Index and

I_i = The percent of the vegetative community of site *i* comprised of invasive species.

The resulting invasive species index would approach zero as the percent of cover of invasive species approaches 100 percent, thereby penalizing a site with a higher proportion of invasive and non-native species.

Bank Habitat

The Bank Habitat Suitability Index is comprised of two components, the percent canopy cover of vegetation along the shoreline and the slope of the bank measured across the terrestrial/shoreline/aquatic continuum. The percent canopy cover of shoreline vegetation across the 10 reference sites averaged approximately 75 percent. Therefore, the canopy cover index for the shoreline is assumed to be 1.0 for canopies greater than or equal to 75 percent. For canopy covers between 0 and 75 percent, a linear relationship between 0 and 75 was assumed:

$$BC_i < 75, BC_{SI} = \frac{BC_i}{75};\ BC_i \geq 75, BC_{SI} = 1.0$$

Where BC_{SI} = Bank Canopy Cover Index and

BC_i = Percent bank canopy cover for site *i.*

The bank slopes of the reference resacas were flat and ranged from 1:15 to 1:30. For slopes less than 1:15, the bank slope index was 1.0. For slopes greater than 1:15, a linear relationship was assumed with vertical or bulkheaded banks resulting in a 0.0 bank slope index and a 1:15 slope resulting in a 1.0 index:

$$BS_i > 1{:}15, BS_{SI} = 0.0667 \times BS_i;\ BS_i \leq 1{:}15, BS_{SI} = 1.0$$

Where BS_{SI} = Bank Slope Suitability Index and

BS_i = Bank slope at site *i.*

The Bank Habitat Suitability Index (B_{SI}) was the mean of the bank canopy cover index and the bank slope index and calculated as follows:

$$B_{SI} = \frac{BC_{SI} + BS_{SI}}{2}$$

Vegetation Metric

Riparian Habitat

The Riparian Habitat Suitability Index was comprised of three components: species composition, species richness, and percent canopy cover. The species composition index was dependent on the target vegetation association that is being proposed for a specific restoration site. This metric was calculated separately for the Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and the Texas Ebony/Snake-eyes Shrubland vegetation associations.

For each vegetation association, the respective reference site was evaluated to develop a plant list of native species inhabiting each association. Sampling sites were located within a patch of relatively homogenous habitat to minimize the effect of edge habitats. The RRCM development team determined the range of a species' abundance within a 0.1-acre sampling plot for each site. The abundance ranges (Figures B-2 [I-3])) were used as the reference standard for species composition for each vegetation association.

For potential restoration sites, species abundance falling within the range identified on the reference condition sites would result in a species abundance index of 1.0. The abundance of a specific species outside of the reference condition range was calculated as a linear function around the bounds of the range. Specific ranges and Abundance Suitability Index curves for each species is located in the "TERF Species SI", "STPW Species SI", and "TESES Species SI" tabs of the model spreadsheet for the Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland respectively. The Species Composition Suitability Index was then calculated as the mean of all the species abundance metrics for the site:

$$SC_{SI} = {\sum_{i=1}^{n} f(SC_i)}/{n}$$

Where SC_{SI} = Species Composition Suitability Index of a site,

$F(SC_i)$ = The species composition index as calculated by the species abundance curve function for species *i,* and

n = the number of species identified at the sampling location.

The species richness component of the riparian habitat suitability index was the number of plant species identified at the potential restoration site. For the reference sites, the mean species richness for the three vegetation associations was 24 (Texas Ebony Resaca Forest), 18 (Subtropical Texas Palmetto Woodland), and 20, (Texas Ebony/Snake-eyes Shrubland). The species richness suitability index was calculated as follows:

$$RR_i < RR_{RC}, RR_{SI} = \frac{RR_i}{RR_{RC}};\ RR_i \geq RR_{RC}, RR_{SI} = 1.0$$

Where RR_{SI} = Riparian Species Richness Suitability Index of the sampling location,

RR_i = Species richness of the sampling location, and

RR_{RC} = Species richness for the corresponding reference vegetative association.

The final component of the Riparian Suitability Index was the percent canopy cover of riparian vegetation. The mean percent canopy cover of riparian species for the 10 reference condition resacas was 80-percent; therefore, the riparian canopy index attains a value of 1.0 from 80-percent to 100-percent canopy cover. For canopy covers between 0 and 80 percent, a linear relationship between 0 and 80 was assumed and calculated as follows:

$$RC_i < 80, R_{SI} = \frac{RC_i}{80};\ RC_i \geq 80, RC_{SI} = 1.0$$

Where, RC_{SI} = Riparian Canopy Cover Suitability Index and

R_i = The percent canopy cover of riparian vegetation at site *i.*

Aquatic Habitat

The aquatic habitat component of the RRCM was based on the percent canopy cover of emergent and aquatic vegetation within the resaca. The mean percent canopy cover of emergent and aquatic species for the 10 reference condition resacas was 60-percent; therefore, the aquatic habitat index attains a value of 1.0 from 60-percent to 100-percent canopy cover. For canopy covers between 0 and 60 percent, a linear relationship between 0 and 60 was assumed and calculated as follows:

$$A_i < 60, A_{SI} = \frac{A_i}{60}; \; A_i \geq 60, A_{SI} = 1.0$$

Where, A_{SI} = Aquatic Habitat Suitability Index and

A_i = The percent canopy cover of emergent and aquatic vegetation at site *i.*

The vegetation metric (V_{SI}) was then calculated as the average of the aquatic and three riparian indices:

$$V_{SI} = \frac{SC_{SI} \times RR_{SI} \times RC_{SI} \times A_{SI}}{4}$$

Water Regime and Mean Maximum Resaca Depth

The final RRCM were a water regime metric and a water depth metric. The water regime metric (W_{SI}) was a discrete index where a resaca with a permanent water supply and active connectivity to the resaca system would result in an index of 1.0. Resacas with a semi-permanent, yet disconnected water regime results in an SI of 0.5, while resacas that have been sedimented in or remain dry through much of the year are assigned a value of 0.0.

The mean maximum resaca depth SI was a linear index function where the index maximizes at mean maximum depths greater than five feet. This metric was based on historic resacas and measures the water quality and habitat benefits due to deeper waters such as water temperature, dissolved oxygen, and habitat variability

RRCM Index Calculation

The final Resaca Reference Condition Index was calculated as the product of the invasive species, aquatic, bank, and riparian habitat suitability indices:

$$RRCI = B_{SI} \times I_{SI} \times V_{SI} \times W_{SI} \times D_{SI}$$

System Quality

Description and rationale for selection of supporting software tool/programming language and hardware platform.

The RRCM was an Excel spreadsheet based model. The software was utilized due to the ubiquitous application of Excel within the USACE and natural resource agency field. The spreadsheet and RRCM can be run on any PC based system.

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Appendix B-2

Resaca Reference Condition Model Application

Resaca Reference Condition Model Application

The Resaca Reference Condition Model (RRCM) utilized reference condition metrics collected at high quality resaca sites within Resaca de la Palma State Park, The Nature Conservancy's Southmost Preserve, and Camp Lula Sams near the City of Brownsville, Texas. Three rare vegetation associations: Texas Ebony Resaca Forest (n=4), Subtropical Texas Palmetto Woodland (n=3), and Texas Ebony/Snake-eyes Shrubland (n=1). The Texas Ebony Resaca Forest is ranked as a critically imperiled with extinction on a global and state scale (G1S1). The Subtropical Texas Palmetto Woodland and Texas Ebony/Snake-eyes Shrubland are ranked as imperiled with extinction on a global and state scale (G2S2). The three rare vegetation associations are dependent on the floodplains and resaca habitats associated with the lower Rio Grande and provide habitat for a unique community of fish and wildlife resources. The RRCM model was comprised of three components to quantify the habitat quality of each vegetation association.

RRCM Vegetation Component

The vegetation composition metric was comprised of three indices quantifying species composition, diversity, and canopy cover of the vegetation. The vegetation component was the mean of the three indices.

Species Composition Index

The species composition index utilized both the historical description of each vegetation association as defined by Diamond (1993) and the native species composition identified on the reference resaca sites (Figure B-2-1 and Figure B-2-2). Although, Diamond does not include estimates on the percent composition for each species, data collected at the reference sites included estimated ranges for each species observed (Attachments 1-3). Suitability indices were created for the percent composition of each native species by using the reference site's estimates as the boundaries of the composition range. A value contained within the composition range was assigned a SI of 1.0 and values outside of the range were assigned SIs assuming a 5-10 percent linear relationship buffer with values between 0.0 and 1.0. The sum of each species SI was then averaged by the total number of species identified for the respective vegetation association.

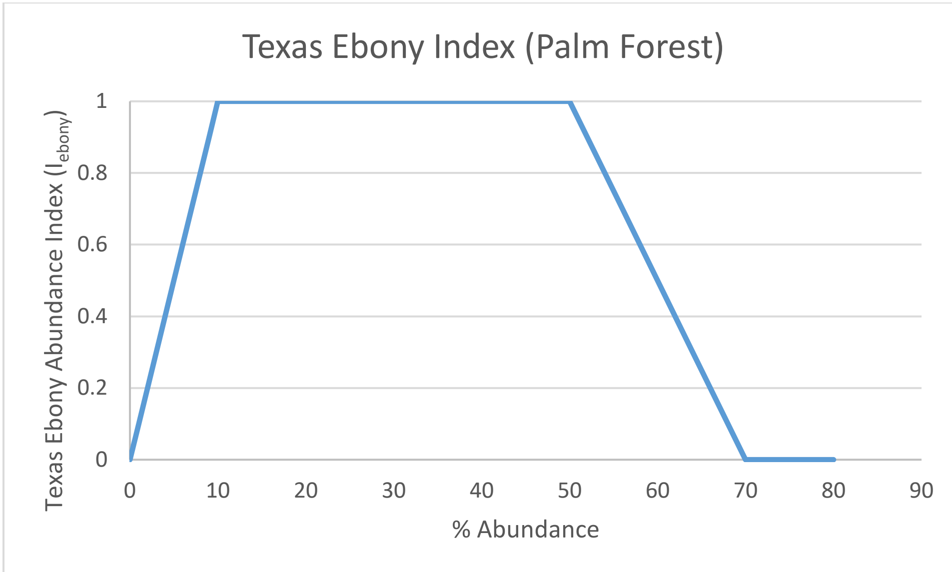

Figure B-2-1: Chart depicting the Texas Ebony Abundance Index

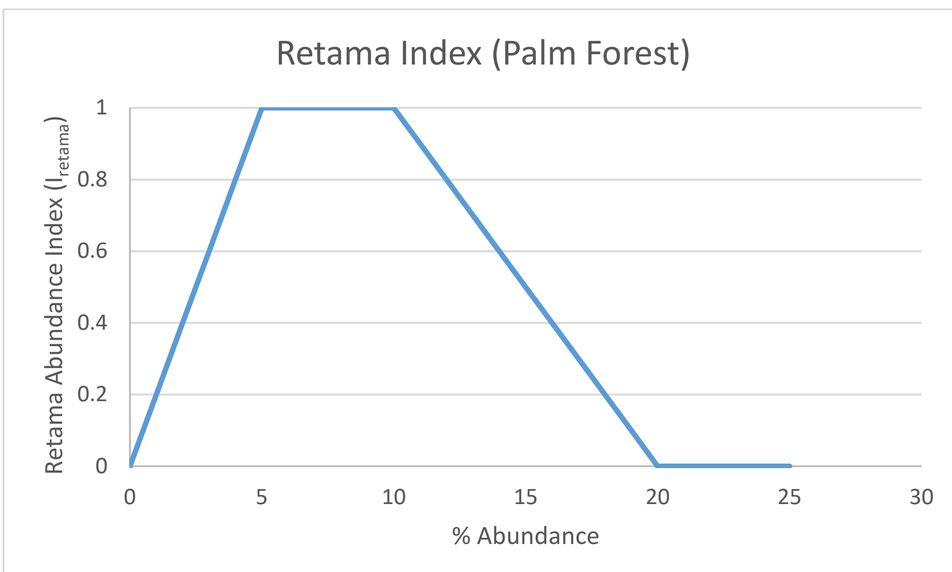

Figure B-2-2: Chart depicting the Retama Abundance Index

Equation 1:

$$C_x = \frac{\sum f\ (I_s)}{n_v}$$

Where Cv = Species Composition Index for site x, f(Is) = the SI of species s as a function of the reference site conditions, and nv = the total number of species identified by Diamond (1993) and/or observed on the reference sites for vegetation type v.

Species Diversity Index

The species diversity index captures the unique diversity of each vegetation association. Species richness was calculated for each reference site and the reference site with the highest species richness for each vegetation association was used as the richness benchmark: Texas Ebony Resaca Forest S_b=49, Subtropical Texas Palmetto Woodland S_b=35, Texas Ebony/Snake-eyes Shrubland S_b=28. The Species Diversity SI was then calculated as the species richness of the site divided by the richness benchmark for respective vegetation association.

Equation 2

$$D_x = \frac{S_x}{S_b}$$

Where Dx = Species Diversity Index for site x, Sx = Species richness for site x, and Sb= Richness benchmark for the appropriate vegetation association.

Canopy Cover Index

The canopy cover index incorporates a measure of vegetative structure for both the riparian and aquatic habitats of the three vegetation associations of interest. The percent canopy cover of the riparian overstory and shrub species within the reference sites was substantial averaging approximately 85 percent canopy closure. The percent canopy cover of nearshore emergent and aquatic vegetation of the reference sites averages approximately 60 percent. These two metrics were used as the baseline to compare against existing and future project conditions.

Equation 3

$$V_x = \frac{R_x}{0.85} \times \frac{E_x}{0.6}$$

Where Vx = Canopy Cover Index for site x, Rx = Percent riparian canopy cover for site x, Ex = Percent emergent/aquatic canopy cover for site x.

Resaca Bank Component

The resaca bank component of the RRCM was comprised of a geomorphic index capturing the slope of the shoreline along the riparian/aquatic gradient and the percent canopy cover of shrub and overstory vegetation extending over the resaca edge (Figure B-2-3). The bank slopes of the reference resacas ranged from 1:10 to 1:30; therefore, an index of 1.0 was assigned to sites with bank slopes less than 1:10 and decreased linearly to 0.0 at a 1:1 slope ().

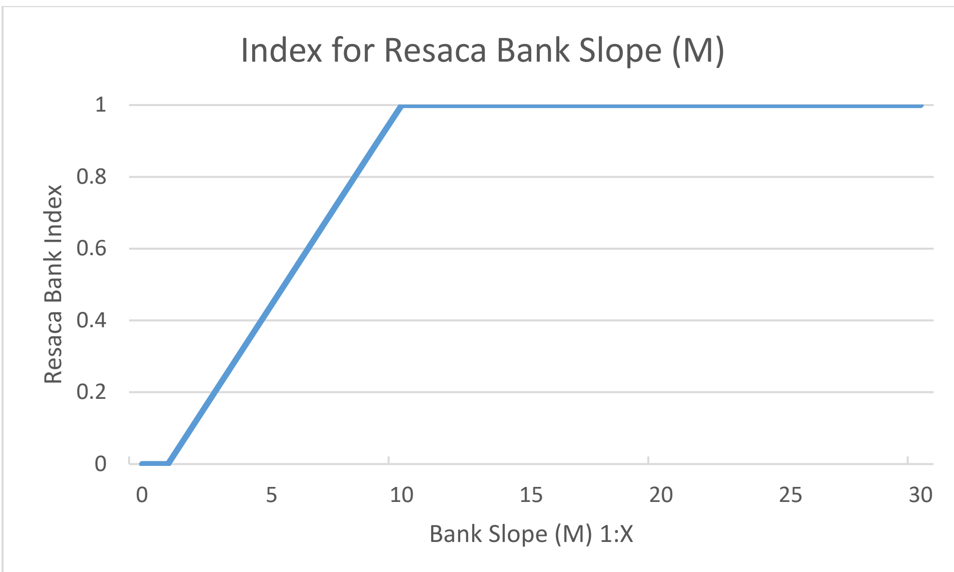

Figure B-2-3: Chart depicting the Resaca Bank Slope

The second index of the resaca bank component incorporates the percent canopy cover of the bank overstory, herbaceous, and emergent vegetation along the shoreline. The percent bank canopy cover of the reference resacas averaged 75 percent; therefore the bank canopy cover index was calculated as the quotient of the bank canopy cover and the average reference bank canopy coverage (0.75).

Equation 4

$$B_x \frac{M \times \frac{K_x}{0.75}}{2} =$$

Invasive Species Component

The invasive species component of the RRCM is simply an index between 0.0 and 1.0 and is measured as the percent of the vegetative community comprised of non-native and non-native invasive species. The index is calculated as follows:

$$I_{SI} = 1 - \left(\frac{Ii}{100}\right)$$

Where I_{SI}=Invasive Species Suitability Index and

I_i= The percent of the vegetative community of site *I* comprised of invasive species.

The resulting invasive species index approaches zero as the percent cover of invasive species approaches 100 percent, thereby penalizing a site with a higher proportion of non-native, invasive species.

References

Diamond, D.D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin, TX. 25 pp.

APPENDIX C

Monitoring and Adaptive Management Plan

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APPENDIX C

Monitoring and Adaptive Management Plan

INTRODUCTION

This document outlines the feasibility level Monitoring and Adaptive Management Plan (MAMP) for the Brownsville Resacas Ecosystem Restoration Project in Brownsville, Texas. The U.S. Army Corps of Engineers, Galveston District (USACE) in partnership with the City of Brownsville (City) and the Brownsville Public Utilities Board (BPUB), has developed feasibility level plans to restore 220 acres of aquatic habitat and 625 acres of riparian habitat along the Resaca del la Guerra and Resaca del Rancho Viejo resaca systems. This plan identifies and describes the monitoring and adaptive management activities proposed and estimates their cost and duration.

The general purpose of the MAMP is to provide a systematic approach for improving resource management outcomes and a structured process for recommending decisions, with an emphasis on uncertainty about resources response to management actions and the value of reducing that uncertainty to improve management.

More specifically, the MAMP will:

- Establish a framework for effective monitoring, assessment of monitoring data, and decision making for implementation of adaptive management activities in the project area.
- Provide the process for identifying adaptive management action in the project area.
- Establish decision criteria for vegetation and wildlife evaluation and modification of adaptive management activities.

This plan will be reviewed and revised as needed during the Preconstruction, Engineering, and Design (PED) phase as specific design details are made available.

Statutory Basis for Monitoring and Adaptive Management

Section 2039 of the Water Resources Development Act (WRDA) 2007, as amended, directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration.

Section 2039 of WRDA 2007 requires that the monitoring plan include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring, and specifies that monitoring will be performed until restoration success is achieved.

The USACE implementation guidance for Section 2039, in the form of a memo dated 31 August 2009, also requires that an adaptive management plan (i.e., contingency plan) be developed for all ecosystem restoration projects. This MAMP includes all elements required by the WRDA 2007 implementation guidance for Section 2039, including:

- the rationale for monitoring (Section 2.2), including:
    - key project specific parameters to be measured (Section 2.3.2),
    - how the parameters relate to achieving the desired outcomes or making a decision about the next phase of the project (Sections 2.3.2, 6.1),
- the intended use(s) of information obtained (Section 2.3.4),
- the nature of the monitoring including duration and/or periodicity (Sections 2.3.2, 2.3.3),
- the disposition of the information and analysis (Sections 2.3, 5.0),
- the cost of the monitoring plan (Section 7.0),
- the party responsible for carrying out the monitoring plan (Section 1.2),
- the project closeout plan (Section 6.3).

Adaptive Management Team

The MAMP provides the framework and guidance for an Adaptive Management Team (AMT) to review and assess monitoring results and consider and recommend adaptive management actions when ecological success is not achieved and decision criteria are triggered. The AMT members shall work together to make recommendations relevant to implementing the MAMP. The AMT is comprised of an interagency team of biologists with specific knowledge of resaca ecosystem's form and function.

Although USACE, the City, and BPUB have coordinated with the entities that will comprise the AMT in development of this Integrated Ecosystem Restoration Feasibility Report and Environmental Assessment, the AMT will be officially established during PED. The AMT focuses on the ecological function of the aquatic and riparian habitats through related management actions to maintain and provide functional resaca habitat for general species, and special status species (threatened and endangered species, migratory bird species) within the project area.

INTRODUCTION

This MAMP provides a monitoring plan and identifies triggers upon which an adaptive management action may be implemented. The AMT shall review the monitoring results and advise on and recommend actions that are consistent with the project goals and reflect the current and future needs of the habitat and the species they support within the project area. USACE shall have final determination on all adaptive management actions recommended.

USACE is responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. If USACE determines that adaptive management actions are needed, it will coordinate with the AMT on implementation of those actions. USACE is also responsible for project documentation, reporting, and external communication.

The AMT shall meet a minimum of once per year, as scheduled by USACE during the monitoring period, to review the results of monitoring and assess whether project objectives are being met. If objectives are not being met, the AMT may recommend that adaptive management actions be taken in response to monitoring results as compared to decision-making triggers.

The AMT may also consider other past and current related restoration efforts of resaca and South Texas brushland habitats conducted by the USFWS, TPWD, NPS and TNC in determining adaptive management actions, and may consult with other recognized experts or stakeholders as appropriate, to achieve project goals.

Recommendations for adaptive management should be based on:

- monitoring data from previous years,
- consideration of current habitat conditions,
- consideration of current and potential threats to habitat establishment success,
- past and predicted response by target species.

Team Structure

The Management Team shall include representatives from USACE and the non-federal sponsors, the City and BPUB.

<u>U.S. Army Corps of Engineers</u>

The USACE may be represented by the Project Ecologist and a representative from the Lewisville Aquatic Research Facility, as well as the Project Hydrology and Hydraulics (H&H) representative and Civil Engineer representative as needed. Other USACE attendees may include the Project Manager, Project Environmental Coordinator, and/or Operations and Maintenance designees, as needed.

Non-federal Sponsors

The City and BPUB, as the non-federal sponsors for the project, will ultimately be responsible for all Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) activities for each restoration segment once USACE notifies the non-federal sponsors of each phase's completion. Prior to final project completion, USACE will transfer responsibility of resaca segments of the project to the non-federal sponsors as they are completed. The City Manager, City Engineer, Director of Parks & Recreation, Director of Planning and Development Services, Director of Public Works, or their designees may represent the City. The Water Resource Manager, or their designees may represent the BPUB.

The AMT shall also include representatives from resource agencies who would serve in an advisory capacity, to assist in evaluation of monitoring data and assessment of adaptive management needs. The agencies shall include, upon their acceptance:

- U.S. Fish and Wildlife Service (USFWS)
    - Ecological Services, Corpus Christi
    - Ecological Services, South Texas Sub-Office
    - Lower Rio Grande and Santa Ana National Wildlife Refuges
- Texas Parks and Wildlife Department (TPWD)
    - Habitat Assessment Program
    - State Parks Division
    - Wildlife Diversity Program
    - Inland Fisheries Division
- The Nature Conservancy (TNC)
- World Birding Center (WBC)
- University of Texas – Rio Grande Valley (UT-RGV)

Additional expertise may be provided by other entities and stakeholders with knowledge of resaca ecosystems at the discretion of the primary AMT participants.

MONITORING

An effective monitoring program will be required to determine if the project outcomes are consistent with original project goals and objectives. The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management. A carefully designed monitoring program is the central component of the project adaptive management program as it supplies the information to assess whether the project is functioning as planned.

Project Objectives

The specific restoration objectives of the Brownsville Ecosystem Restoration Project are to:

- Restore impacted resaca aquatic and riparian complexes to functional and self-regulating systems that mirror reference resaca to the extent practicable. Target vegetation associations include Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland.
- Restore connectivity within the Brownsville resacas and to the high quality thornscrub and resaca habitats of the surrounding ecosystem. This includes habitat connectivity along the resaca systems, between the resaca's aquatic and riparian habitats, and between patches of restored habitats managed by the USFWS, TPWD, TNC, or other environmental non-governmental organizations.
- Reduction or elimination of aquatic invasive species, particularly the sailfin catfish, and invasive and non-native riparian plant species including Brazilian pepper (*Schinus terebinthifolia*) and giant cane (*Arundo donax*).

Rationale for Monitoring

Monitoring must be closely integrated with the adaptive management components because it is the key to the evaluation of adaptive management needs. Objectives must be considered to determine appropriate indicators to monitor. In order to be effective, monitoring must be able to distinguish between ecosystem responses that result from project implementation (i.e., management actions) and natural ecosystem variability.

Achieving objectives will require monitoring that focuses on the target habitats and the ecological processes that support them.

Monitoring Plan

According to the USACE implementation guidance memo for WRDA 2039, dated 31 August 2009, "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits."

The following discussion outlines a monitoring plan that will support the Brownsville Resacas Ecosystem Restoration Adaptive Management Program. The plan identifies performance measures along the desired outcomes and monitoring design in relation to specific objectives. A performance measure includes specific feature(s) to be monitored to determine project performance. Additional monitoring is identified as supporting information needs that will help to further understand the interrelationships of restoration features and external environmental variability and to corroborate project effects.

Success criteria, or decision-making triggers, are related to each performance measure and desired outcome and identify the need to discuss potential implementation of adaptive management actions with the AMT. These criteria/triggers are identified in Section 6.1.

Overall, monitoring results will be used to evaluate the progress of habitat restoration toward meeting project objectives and to inform the need for adaptive management actions to ensure successful restoration is achieved.

Monitoring Period

Upon completion of construction of each Resaca segment of the Brownsville Resaca Ecosystem Restoration Project, cost-shared monitoring for ecological success and adaptive management will be initiated and will continue for no longer than ten years. Concurrent monitoring of one or more nearby reference site with similar conditions to the desired habitat, such as Resaca de la Palma State Park or TNC's Southmost Preserve, is recommended to differentiate changes at the restoration site that are attributable to the restoration activity versus normal environmental variability affecting the region. Generally, ecological success is considered achieved when aquatic and riparian complexes are functioning, self-regulating and mirror the aforementioned reference sites.

This monitoring plan includes the minimum monitoring actions to evaluate success and to determine adaptive management needs. Assuming that multiple contracts over a period of 16 years will be required to implement all of the resaca restoration segments associated with the recommended plan, monitoring and adaptive management will be initiated at the completion of each construction segment and early results will be available to improve the design and implementation of later segments.

WRDA 2007 allows for up to ten years of cost-shared monitoring when necessary. Because of the relatively slow successional development and growth of the target woody species, up to ten years of monitoring is proposed for the restoration areas to ensure the habitats are self-sustaining and meet the performance criteria for project objectives. Once USACE determines that ecological success for a resaca restoration segment has been fully achieved, even if this occurs in less than ten years, no further monitoring will be performed. If success cannot be determined within the ten-year period of cost-shared monitoring allowed by law, any additional monitoring and management will be a non-Federal responsibility. Cost-shared monitoring shall not continue beyond ten years. Per USACE policy in the Planning Guidance Notebook, cost-shared monitoring would not continue if additional monitoring would result in the monitoring costs of the ecosystem restoration exceeding one percent of the total ecosystem restoration costs minus the costs for monitoring and adaptive management of the ecosystem restoration.

Performance Measures and Design

Objective 1: Restore impacted resaca aquatic and riparian complexes to functional and self-regulating systems that mirror reference resaca to the extent practicable. Target vegetation associations include Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland.

Performance Measure 1a: Vegetative diversity, cover, and structure

Desired Outcome: Increase species diversity of riparian, emergent, and submerged vegetation to be consistent with the appropriate target vegetation association.

Desired Outcome: Increase percent cover of native riparian, emergent and submerged plant species to be consistent with the appropriate target vegetation association.

Desired Outcome: Increase structural diversity of the vegetative community to be consistent with the appropriate target vegetation association.

Desired Outcome: Increase percent cover of riparian and emergent vegetation over the water to reduce water temperatures and increase dissolved oxygen to support native fish.

Monitoring Design and Rationale: Permanent vegetation monitoring stations will be established for assessing project area vegetation communities. These stations will be sampled annually for up to ten years post construction.

Monitoring of vegetation, including species diversity, percent cover, structural diversity, and cover over water will indicate if target habitats have been successfully restored. Results of vegetation monitoring would indicate whether habitat components necessary to provide habitat for fish and wildlife species have been successfully established.

Decision-making triggers can be found in Section 6.1.1.

Performance Measure 1b: Resaca bank slope

Desired Outcome: Maintain designed bank slope of the resaca.

Monitoring Design and Rationale: Permanent monitoring stations will be established in areas where bank slope modifications were implemented. These stations will be sampled annually for up to ten years post construction.

Monitoring of the bank slope is necessary to determine the successful connection of transition habitats for amphibians between their aquatic and riparian habitats. Amphibian species of significance include the state listed black-spotted newt and South Texas siren. Severe bank slopes also provide nesting habitat for the invasive armored catfish. The bank slope monitoring will allow the AMT assess the sustainability of the restoration measure and assess the control and management of the armored catfish.

Decision-making triggers can be found in Section 6.1.2.

Performance Measure 1c: Resaca depth

Desired Outcome: Increase depth of the resacas.

Desired Outcome: Increase structural diversity of submerged shoreline.

Monitoring Design and Rationale: Permanent monitoring stations will be established for assessing the resaca depths. These stations will be sampled annually for up to ten years post construction. Water depth will be standardized using the control depth of the respective resaca water control structure.

Monitoring the resaca depths is necessary to determine the successful establishment of aquatic habitats and water quality required for aquatic species. The depth of the resaca affects water temperatures and dissolved oxygen concentrations. Increasing the structural diversity of the submerged shoreline increases the habitat quality for aquatic and amphibian resaca species.

Decision-making triggers can be found in Section 6.1.3.

Objective 2: I Restore connectivity within the Brownsville resacas and to the high quality thornscrub and resaca habitats of the surrounding ecosystem.

Performance Measure 2: Wildlife diversity

Desired Outcome: Increase wildlife species diversity

Monitoring Design and Rationale: Inventories of general wildlife (native and non-native) would be documented during the annual vegetation monitoring effort.

Monitoring of wildlife will indicate if target habitats result in an increase in wildlife species diversity likely caused by increased connectivity with high quality habitat areas and an increase in habitat suitability for wildlife typical of the associated vegetation coverage. Results of this monitoring will inform whether adaptive management actions related to native wildlife species are needed.

Supporting Information Need: Wildlife surveys also serve to provide supplemental information on restoration success, and will indicate whether target habitats and connectivity have been successfully restored. If vegetative diversity, cover, and structure criteria are not being met, wildlife species presence, distribution, and diversity may provide supplemental information on habitat elements and underlying ecosystem functions that have not been achieved in target habitats.

Consequently, if vegetation has met requirements in terms of diversity, cover, and structure based on prescribed triggers, but common obligate wildlife use or use by extirpated wildlife has not improved, then additional studies may be warranted to understand if the habitat is lacking critical elements and functions to support species use and movement. Presence of resaca obligate and facultative species that use the habitat for all or portions of their life requirements is an indicator of successful habitat establishment, as well as the successful establishment of a functional, self-sustaining ecosystem.

In addition to general wildlife surveys, bird surveys will be performed bi-annually for up to ten years post construction to quantify wildlife species diversity of the restored habitats.

Decision-making triggers can be found in Section 6.1.4.

Objective 3: Reduction or elimination of aquatic invasive species, particularly the sailfin catfish, and invasive and non-native riparian plant species including Brazilian pepper (*Schinus terebinthifolia*) and giant cane (*Arundo donax*).

Desired Outcome: Decrease percent cover of non-native invasive plant species

Monitoring Design and Rationale: Randomly selected monitoring stations will be used to assess the extent of non-native invasive species in the project area. The restoration areas will be sampled annually for up to ten years post construction.

Invasive species typically form monocultures and their presence in the community displaces native plant species. Results of the monitoring of invasive species will indicate if target habitats have been successfully restored.

Decision-making triggers can be found in Section 6.1.5.

Monitoring Procedures

The following monitoring procedures will provide the information necessary to evaluate the previously identified project objectives for the Brownsville Resacas Ecosystem Restoration Project:

Vegetation: Vegetation sampling will occur annually at two to ten tenth-acre sites per Resaca segment, depending on the size of the restoration area. Reference vegetation data will also be collected at high quality resaca habitats for the three target vegetation associations on natural resource managed lands. Sampling will occur during the spring months and will occur at permanent field monitoring station points. Each sampling point will be randomly located within each restoration area ensuring that both aquatic, emergent, and riparian vegetation will be sampled. For small, homogeneous restoration areas, a minimum of two sampling locations (one aquatic and one terrestrial) will be established. As the area of the restoration area increases and the habitat increases in variability, the number of sampling locations for each restoration area should also increase. Monitoring metrics include plant species diversity; percent canopy cover of the herbaceous, shrub, and overstory canopy; and percent riparian and emergent vegetation over the water. Photograph stations are also important for documenting vegetation conditions. Photographs will be taken in the four cardinal directions at each sampling location and georeferenced to ensure subsequent monitoring efforts.

General observations, such as fitness and health of plantings, native plant species recruitment, and signs of drought stress would be noted during the surveys.

Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified.

A general inventory of all wildlife species observed and detected using the project area would be documented. Nesting sites, roosting sites, animal burrows, and other signs of wildlife use of the newly created habitat would be recorded. These notes would be important for early identification of species colonization patterns.

<u>Resaca Shoreline:</u> To assess the structural and ecological habitat of the resaca shoreline, a survey of the shoreline will be completed annually to assess the bank slope and areas of erosion. Survey methods would utilize a transect placed perpendicular to the shoreline extending ten feet on each side of the water's edge to measure the slope of the land/water interface of the resaca. The location and extent of excessive erosion would georeferenced and recorded.

<u>Wildlife:</u> A general inventory of all wildlife species observed and detected in the project Area would be documented during the vegetation monitoring. Indications of herbivory and disturbance of the plantings would also be documented during the vegetation surveys.

This draft plan includes monitoring bird species diversity as a surrogate for wildlife diversity. Bird diversity serves as a robust measure of wildlife diversity due to the wide range of habitats required for different species. Bird communities occupy most all niches within the ecosystem and can be characterized as belonging to numerous ecological guilds based on diet, nesting habitat, and foraging habitat. The habitats required for these guilds can be correlated with other vertebrate and invertebrate communities. The absence of a guild would provide an indication of a gap in habitat structure or quality within the restored ecosystem. Avian surveys would be conducted using point count survey methodology described in Hamel et al, 1996 would occur during the spring between 1 March and 15 May annually post construction. A minimum of two point count stations per restoration area would be established within the restored habitat.

The AMT will utilize the general inventory of wildlife species and the avian surveys to determine whether objective 2 is achieved. This MAMP will be discussed in greater detail with the AMT during the PED phase. The AMT will evaluate whether bird species diversity monitoring should be augmented or replaced by terrestrial species diversity monitoring.

Use of Monitoring Results and Analysis

Results of the monitoring will be assessed in comparison to project objectives and decision-making triggers to evaluate whether the project is functioning as planned and whether adaptive management actions are needed to achieve project objectives. The results of the monitoring will be provided to the AMT who will evaluate and compare data to project objectives and decision-making triggers. The AMT will use the monitoring results to assess habitat responses to management, evaluate overall project performance, and make recommendations for adaptive management actions as appropriate. If monitoring results, as compared to desired outcomes and decision-making triggers, show that project objectives are not being met, the AMT will evaluate causes of failure and recommend adaptive management actions to remedy the underlying problems.

As data is gathered through monitoring, more information will also be available to address uncertainties and fill information gaps. Uncertainties such as effective urban restoration design needs and benefits realized by the restored features can be evaluated to inform adaptive management actions and future restoration needs.

PROJECT ADAPTIVE MANAGEMENT PLANNING

The MAMP outlines how the results of the project-specific monitoring program would be used to adaptively manage the project, including specification of conditions that will define project success.

The MAMP reflects a level of detail consistent with the feasibility study phase. The primary intent was to develop monitoring and adaptive management actions appropriate to assess and achieve the project's restoration goals and objectives. The specified management actions, as well as expected timelines for achieving successful establishment and self-sustaining maturity of restored habitat features, were used to develop an estimation of the adaptive management costs and duration for the project.

The following section outlines restoration actions that will be undertaken to achieve the project objectives and lists sources of uncertainty that may impact the need for adaptive management actions. Subsequent sections describe assessment of monitoring results, data management, and decision-making on the implementation of adaptive management.

The level of detail in this plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Uncertainties may remain concerning the exact project features, monitoring elements, and adaptive management opportunities. Components of the MAMP, including costs, were similarly estimated using currently available information. Uncertainties will be addressed in the preconstruction, engineering, and design (PED) phase, and the MAMP may be amended to incorporate additional detail as part of the design phase.

Management and Restoration Actions

The PDT performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Many alternatives were considered, evaluated, and screened in producing a final array of alternatives. USACE subsequently identified a Recommended Plan.

The Recommended Plan is referred to as Alternative 5 and encompasses portions of Resaca de la Guerra and Resaca del Rancho Viejo. The restoration actions have been divided into 46 distinct restoration areas as each restoration area incorporates a distinct segment, or “pool”, of the resaca system. The construction schedule entails the restoration of one to six restoration areas per year over the course of 16 years.

The proposed action includes the restoration of the 46 restoration areas that restores critically imperiled aquatic and riparian habitats and increases the connectivity of the resacas by creating a corridor of “stepping stone” habitats across the system. The Recommended Plan would restore aquatic, wetland, and riparian habitats and functions and would provide 846 average annual habitat units (AAHU).

The restoration would increase the acreage of critically imperiled riparian vegetation communities such as the Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and the Texas Ebony/Snake-eyes Shrubland vegetation associations. The restoration areas would provide direct and stepping stone connections to an array of conservation areas that support these communities and are managed by the Lower Rio Grande National Wildlife Refuge, Resaca de la Palma State Park, the Nature Conservancy, and the Audubon Society. The Recommended Plan is described in detail in Chapter 6 of the feasibility report.

Sources of Uncertainty

Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any large-scale ecosystem restoration project. Below is a list of uncertainties associated with the restoration of the aquatic and riparian habitats associated with the resacas.

- Correct engineering and design to fully address project alternatives
- Correct operational regime to fully achieve project objectives
- Ability of the Resaca Reference Condition Model method to predict project benefits
- Imprecise relationships between management actions and corresponding outcomes
- Future availability of water for restored habitats due to extreme drought or other climate change issues
- Other factors which are not completely within USACE or the Sponsors control or ability to predict

RATIONALE FOR ADAPTIVE MANAGEMENT

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties listed above.

Given these uncertainties, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. The adaptive management program for the Resacas Ecosystem Restoration Project will use the results of continued project monitoring to manage restoration actions in order to achieve the previously stated project objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

Implementation of the MAMP will provide flexibility to account for changing environmental conditions and new information and will allow project success to be measured, though it will not alleviate all uncertainty. The MAMP provides a mechanism to evaluate the effectiveness of the restoration measures implemented in this project and to implement adaptive changes, if required, to realize project objectives.

ASSESSMENT

The assessment phase of the adaptive management framework describes the process by which the results of the monitoring efforts will be compared to the project performance measures, which reflect the objectives of the restoration action.

The results of the Resaca Ecosystem Restoration Project monitoring program will be assessed annually through the AMT. Monitoring results will be compared to the desired project outcomes as set forth by the project performance measures. This assessment process will measure the progress of the project in relation to the stated project objectives.

The AMT will compare monitoring results to decision-making triggers to evaluate project effectiveness and consider if adaptive management actions are needed.

The assessments will indicate if the habitat responses to management actions are undesirable (e.g., are moving away from restoration goals) or if the responses have met or are moving towards the success criteria for the project. Assessments will also inform the AMT if other factors are influencing the response that may warrant further research.

Database Management

Database management is an important component of the monitoring plan and the overall adaptive management program. As part of the AMT, individuals with responsibility for data management activities (data managers) in support of an adaptive management program will be identified from USACE. The data managers should collaborate with the AMT in developing a data management plan to support the adaptive management program. The data management plan should describe how and where data will be archived, data standards, data upload process and format, quality assurance and quality control procedures, metadata standards, and public data release. Storage of all data will be handled by USACE.

Data analysis and reporting will be the responsibility of USACE, who will provide reports for the AMT to facilitate evaluation of adaptive management needs.

Documentation and Reporting

USACE will document the monitoring results, assessments, and results of the AMT deliberations. USACE will produce annual reports that will measure progress towards meeting project objectives as characterized by the performance measures. Results of assessments will be used to evaluate adaptive management needs and inform decision-making.

DECISION-MAKING

Decisions on the implementation of adaptive management actions are informed by the assessment of monitoring results. The information generated by the monitoring plan will be used by USACE and the non-federal sponsors in consultation with the other AMT members to guide decisions on adaptive management that may be needed to ensure that the ecosystem restoration project achieves success. Final decisions on implementation of adaptive management actions are made by USACE.

Decision Criteria

Decision criteria, also referred to as adaptive management triggers, are used to determine if and when adaptive management opportunities should be implemented. They can be qualitative or quantitative based on the nature of the performance measure and the level of information necessary to make a decision. Desired outcomes can be based on reference sites, predicted values, or comparison to historic conditions. Several potential decision criteria are identified below, based on the project objectives and performance measures. More specific decision criteria, possibly based on other parameters such as hydrology and vegetation dynamics may be developed during the PED phase of the project.

If assessments show that any of these triggers are met, USACE would consult with the AMT to discuss whether an adaptive management action is warranted, and if so, what that action should be. Investigations may be required to determine the cause of failure in order to inform the type of adaptive management actions that should be implemented, if needed.

Vegetative Diversity, Cover, and Structure Triggers

1) Desired Outcome: Increase species diversity of riparian, emergent, and submerged vegetation to be consistent with the appropriate target vegetation association.

   Trigger: 75% species diversity of native aquatic, emergent, and riparian habitats is not achieved compared to reference sites within three years.

2) Desired Outcome: Increase percent cover of native riparian, emergent and submerged plant species to be consistent with the appropriate target vegetation association.

   Trigger: 75% herbaceous canopy cover is not achieved within three years.

   Trigger: 25% shrub canopy cover is not achieved within six years.

3) Desired Outcome: Increase structural diversity of the vegetative community to be consistent with the appropriate target vegetation association.

   Trigger: 80% survival of planted woody species is not achieved after the one year contract nurturing period has expired.

4) Desired Outcome: Increase percent cover of riparian and emergent vegetation over the water to reduce water temperatures and increase dissolved oxygen to support native fish.

   Trigger: Percent cover over water does not achieve 25% within 3 years and 40% within five years.

Riparian, emergent, and submerged vegetation may not achieve the target percent cover, structure, or plant composition due to improper geomorphic conditions. Such conditions may include altered drainage patterns, sedimentation, and erosion. Additional factors that may influence vegetation success criteria are urban soil conditions, drought, water management of the resacas, predation, and vandalism. These conditions may be created naturally or may be the consequence of design.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlines in Section 6.2.

Resaca Bank Slope

1) Desired Outcome: Decrease above and below water bank slope on the resaca edge.

   Trigger: A slope shallower than 1:8 is not maintained for at least 80% the resaca banks that were modified within three years of restoration.

Desirable bank slope conditions were identified using reference sites to determine quantitative thresholds for bank slopes. Bank slope conditions may not achieve target slopes due to improper geomorphic conditions caused by natural events or design. Bank erosion could develop due to sheet erosion from the riparian areas, fetch across the resacas, or sailfin catfish disturbances.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlined in Section 6.2.

Resaca Depth

1) Desired Outcome: Increase depth of resacas.

   Trigger: Based on depths standardized by the associated water control structure for each resaca, depth of resaca is less than four feet (if the depth of the impervious clay layer does not restrict depth) is maintained beyond the first year.

2) Desired Outcome: Increase structural diversity of submerged shoreline.

   Trigger: The creation of a shallow submerged shelf that supports emergent vegetation extends at least six feet from the shoreline is achieved within three years.

The target depth of the resacas may not be achieved if excessive sedimentation occurs upstream and within the resaca. These conditions may occur naturally as the source water from the Rio Grande may contain sediments or may occur due to excessive local erosion adjacent to the resacas.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlined in Section 6.2.

Wildlife Diversity

1) Desired Outcome: Increase wildlife species diversity.

   Trigger: Wildlife monitoring and avian surveys shows decreasing or no change in species diversity.

The restored habitats would increase the diversity of the vegetative community and structure which opens up niches for an increasing diversity of fish and wildlife species. The creation of a novel resaca ecosystem would also support the reintroduction a special status species such as the black-spotted newt and South Texas siren. Bird species diversity will be used as a surrogate for wildlife diversity.

Reduce Invasive Species

1) Desired Outcome: Decrease percent cover of non-native invasive plant species.

   Trigger: Percent cover of non-native invasive plant species exceeds 20% after three years. Percent cover of non-native invasive plant species exceeds 10 percent after six year.

The infestation of invasive plant species may occur from upstream or adjacent seed sources. This may be especially prevalent for resacas adjacent to residential areas. Depending on the species, invasives may be resistant to specific treatment methods and may require an integrated management strategy.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlined in Section 6.2.

Potential Adaptive Management Measures

The results of monitoring will be used by the AMT to evaluate project status and adaptive management needs. Some potential adaptive management actions for this project are described below. Prior to implementing adaptive management measures, USACE and the non-federal sponsors shall assess whether supplemental environmental analysis is required. The AMT may develop other measures as ecological monitoring is performed.

Irrigation/Supplemental Water: Irrigation and/or supplemental water may be needed if triggers for vegetative cover are met. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and successful restoration of target vegetation communities.

Replanting: Replanting may be needed if triggers for vegetative cover, structure, and/or diversity are met. Monitoring results should be used to assess the underlying cause of inadequate cover, structure, and/or diversity, which may require that additional adaptive management actions be implemented to support successful replanting. For instance, monitoring results may show low survival of a specific plant species. Adaptive management would include actions to remedy the low survival which may include soil supplementation with fertilizers or biopolymers, changing the source of seed/plant material, or changing the species of the plant to another species consistent with the target vegetative community. Restoration techniques and methodologies developed for thornscrub shrubland restoration over the last 30 years will be incorporated into the study design to minimize uncertainties in the habitat restoration. Because the construction schedule would be staggered over a period of 16 years, lessons learned would also be incorporated and implemented into subsequent restoration efforts.

Invasive Plant Species Control: Changes in invasive species management may be needed if triggers for invasive species percent cover are met. Monitoring results should be used to determine if existing invasive species control is ineffective or if the project area has been infested with a new invasive plant species. Adaptive management actions would include modifying the herbicide and/or surfactant, the application method, mechanical control, or introducing biological control agents if available.

Erosion Control: Erosion control may be needed if triggers for vegetative cover and/or bank slope are met. Monitoring may show that vegetative cover is inadequate due to slope erosion issues and bank slopes may increase outside of the target tolerances. Adaptive management actions would include erosion control measures such as the installation of straw wattles, erosion mats, or energy dissipating features. Additional information may be required to determine the cause of erosion, and additional adaptive management design measures may be required to be implemented.

Response to predation, vandalism and other urban disturbances: If the AMT finds any of these disturbances are having an impact on ecological success, the AMT can implement adaptive management measures such as fencing, signage, etc. to correct the issue to the extent practicable.

Conclusion of Monitoring for Project Features

Once ecological success has been documented by the District Engineer in consultation with the Federal and State resource agencies, and a determination has been made by the Division Commander that ecological success has been achieved, no further monitoring will be required. Ecological success will be documented through an evaluation of the predicted outcomes as measured against actual results.

COSTS FOR IMPLEMENTATION OF MONITORING AND ADAPTIVE MANAGEMENT PROGRAMS

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data, methods, and comparable projects. The potential adaptive management actions as described in Section 6.2 and potential expected frequency of need were used as a basis for cost estimating. Costs were estimated based on the overall area of monitoring the 46 restoration areas spread out over a 16-year construction schedule. The extended construction schedule would result in a 26-year monitoring program as the Year 1 restoration area would complete the monitoring period the same year as the Year 11 restoration area started. However, as subsequent restoration areas are constructed, adaptive management lessons learned would be implemented and need and costs for the later restoration areas would be anticipated to decrease.

Because uncertainties remain as to detailed designs and adaptive management needs and opportunities, the costs estimated in Table 1 may be refined in PED during the development of the detailed monitoring and adaptive management plans for each restoration area.

Costs for Implementation of Monitoring Program

Cost calculations for monitoring are displayed as a ten-year total. If ecological success is achieved earlier, the monitoring program will cease and costs will decrease accordingly.

The current total estimate for implementing the monitoring plan is approximately $1.22 million for the Recommended Plan.

Costs for Implementation of Adaptive Management Program

Costs for the adaptive management program were based on estimated level of effort and potential frequency of need, and include participation in the AMT and reporting. The current estimate for implementing the adaptive management program is approximately $2.9 million for the Recommended Plan.

Total MAMP Costs

The total cost for the MAMP includes the monitoring, the adaptive management, and the reporting costs. As discussed above, the monitoring cost is $1.2 million, the adaptive management cost is $2.9 million. Adding in $325 thousand for the cost of MAMP reporting, the total MAMP cost is $4.4 million.

References

Hamel, P.B., W.P Smith, D.J. Twedt, J.R. Woehr, E. Morris, R.B. Hamilton, and R.J. Cooper. 1996. A land manager's guide to point counts of birds in the southeast. General Technical Report SO-I 20. United States Department of Agriculture, Forest Service, Southern Research Station. 39 pp.

Table 1: Monitoring and Adaptive Management Costs

Task	Assumed Task for Recommended Plan	Frequency	Cost Assumptions for Recommended Plan	Total Cost
Monitoring				
Vegetation/Bank Slope Monitoring	Assume monitoring of each restoration area and three reference sites. Each monitoring site will consist of a tenth acre plot to estimate percent cover of native, non-native, and invasive plant species, plant species composition/diversity, structural diversity, and percent canopy cover over water. Bank slope will be monitored concurrently with vegetation monitoring.	Annually for 10 years	Assume 2 biologists for 1.5 hours/restoration area. Assume an average of 4 plots/restoration area. As the construction of the project will occur over 16 years, the number of restoration areas monitored will vary over the course of the project. The number of restoration areas monitored per year is presented in Table 2.	$717,000
Bird Species Diversity Monitoring	Assume monitoring of each restoration site and three reference areas. Point count bird surveys will be conducted for 5 minutes at each site to estimate population density and diversity.	Annually for 10 years	Assume 2 teams of 2 biologists for one hour/restoration area. Assume an average of 3-point count stations/restoration area sampled on two separate days. As the construction of the project will occur over 16 years, the number of restoration areas monitored will vary over the course of the project. The number of restoration areas monitored per year is presented in Table 2.	$502,000
Total Monitoring Costs				***$1,219,000***
Adaptive Management Actions				
Irrigation/Supplemental Water	Due to the drought tolerant habit of the target species, assume supplemental water would only be needed to in extreme circumstances for a short period of time.		Assume $30,000 per year as a rough estimate	$750,000
Re-planting	Assume that 10% of vegetation may require replanting over 25 years		Assume $12,000 per planted acre based off of project costs.	$1,014,000

Task	Assumed Task for Recommended Plan	Frequency	Cost Assumptions for Recommended Plan	Total Cost
Invasive Plant Species Control	Assume that up to 50% of acreage may require retreatment or alternative control methods (above spot treatments associated with original treatment)		Assume $1,500 per acre based off of project costs	$633,000
Erosion Control	Assume bank slopes may require re-sculpting and/or design/construction of erosion control structures if excessive erosion occurs.		Assume $20,000 per year based off project costs	$500,000
Total Adaptive Management Costs				***$2,897,000***
Adaptive Management Team & Reporting				
Team Meetings	Assume one meeting/year over 25 years (25 years accounts for the phased construction and 10 year monitoring timeframe)	Annually over 25 years	Assume $3K per meeting	$75,000
Investigations (studies/surveys to determine cause of problems)	As needed, assume over 25 years (25 years accounts for the phased construction and 10 year monitoring timeframe)		Assume $10K per year	$250,000
Annual Report	Assume a comprehensive annual report accounting for all actively monitored restoration sites for that year.	Annually over 25 years	Assume $30,000 per report annually for 25 years	$750,000
Total Reporting Costs				*$325,000*
Total Monitoring and Adaptive Management Costs				***$4,441,000***

Table 2: Restoration Area Monitoring Efforts per Year

Year	Number of Restoration Areas Monitored	Annual Cost (Vegetation Monitoring)	Annual Cost (Bird Monitoring)
2022	6	$9,000	$6,000
2023	8	$12,000	$8,000
2024	9	$13,500	$9,000
2025	10	$15,000	$10,000
2026	15	$22,500	$15,000
2027	17	$25,500	$17,000
2028	23	$34,500	$23,000
2029	24	$36,000	$24,000
2030	26	$39,000	$26,000
2031	30	$45,000	$30,000
2032	28	$42,000	$28,000
2033	32	$48,000	$32,000
2034	33	$49,500	$33,000
2035	34	$51,000	$34,000
2036	34	$51,000	$34,000
2037	32	$48,000	$32,000
2038	26	$39,000	$26,000
2039	25	$37,500	$25,000
2040	23	$34,500	$23,000
2041	19	$28,500	$19,000
2042	18	$27,000	$18,000
2043	12	$18,000	$12,000
2044	10	$15,000	$10,000
2045	8	$12,000	$8,000
Total	-	$753,000	$502,000

APPENDIX D

Compliance and Coordination

Contents:

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APPENDIX D-1-a

Tribal Nation and Cultural Coordination

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Kiowa Tribe of Oklahoma
Office of Historic Preservation
P.O. Box 50
100 Kiowa Way
Carnegie, OK 73015

July 21, 2016

Douglas Sims, RPA
Chief, Environmental Compliance Branch
Fort Worth District COE
PO Box 17300
Fort Worth, TX 76102-0300

RE: Section 106 Consultation and Review for Resacas Feasibility Study (RFS) in Brownsville, Cameron County, TX

Dear Mr Sims,

The Kiowa Tribe Office of Historic Preservation has received the information and materials requested for our Section 106 Review and Consultation. Section 106 of the National Historic Preservation Act of 1966 (NHPA), and 36 CFR Part 800 requires consultation with the Kiowa Tribe.

Given the information provided, you are hereby notified that the proposal project location should have minimal potential to adversely affect any known Archaeological, Historical, or Sacred Kiowa sites. Therefore, in accordance with 36 CFR 800.4(d) (1), you may proceed with your proposed project. However, please be advised undiscovered properties may be encountered and must be immediately reported to the Kiowa Tribe Office of Historic Preservation under both the NHPA and NAGPRA regulations.

This information is provided to assist you in complying with 36 CFR Part 800 for Section 106 Consultation procedures. Please retain this correspondence to show compliance. Should you have any questions, please do not hesitate to contact me at kellie@tribaladminservices.org. Thank you for your time and consideration.

Sincerely,

Kellie J. Poolaw,
Acting Tribal Historic Preservation Officer (THPO)

Kellie J. Poolaw
Acting Tribal Historic Preservation Officer (THPO)
Phone: (405) 435-1650 ***kellie@tribaladminservices.org*** ***Complex: (580) 654-2300***

TONKAWA TRIBE OF OKLAHOMA
NATIVE AMERICAN GRAVES PROTECTION
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1 RUSH BUFFALO ROAD • PHONE (580) 628-2561 • FAX (580) 628-9903
WEB SITE: www.tonkawatribe.com
TONKAWA, OKLAHOMA 74653

July 11, 2016

Dear Sir or Madam,

Regarding the Resacas Feasibility Study (RFS) in Brownsville, Cameron County Texas. The Tonkawa Tribe of Indians of Oklahoma submits the following:

The Tonkawa Tribe has no specifically designated historical or cultural sites identified in the above listed project area. However if any human remains, funerary objects, or other evidence of historical or cultural significance is inadvertently discovered then the Tonkawa Tribe would certainly be interested in proper disposition thereof.

We appreciate notification by your office of the many projects on-going, and as always the Tonkawa Tribe is willing to work with your representatives in any manner to uphold the provisions of NAGPRA to the extent of our capability.

Respectfully,

Miranda "Nax'ce" Myer

NAGPRA Representative

TEXAS HISTORICAL COMMISSION
real places telling real stories

July 7, 2016

Douglas Sims, RPA
Chief, Environmental Compliance Branch
Department of the Army
Fort Worth District, Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Re: Project review under Section 106 of the National Historic Preservation Act of 1966 and the Antiquities Code of Texas: Resacas Feasibility Study

Dear Mr. Sims:

Thank you for your correspondence describing the above referenced project. This letter serves as comment on the proposed federal undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission which is also the state agency responsible for administering the Antiquities Code of Texas.

The Archaeology Division (AD) review staff, led by Casey Hanson, has completed its review of the proposed project and concurs that there are six recorded archeological sites immediately adjacent to the resacas and numerous recorded archeological sites in the vicinity of the resacas. Furthermore, although the resacas are situated in urban settings, the landforms adjacent to the resacas generally display a high probability for containing buried archeological resources. Due to the limited and shallow impacts associated with the proposed restoration activities, the THC recommends that the archeological Area of Potential Effect (APE) include areas of significant ground disturbance including the construction of nesting structures, modification of bank slopes and excavation of accumulated sediments, or any hydrologic restoration efforts that have the potential to affect archeological resources. Please note that if any of the proposed APE requiring archeological survey is located on land owned or controlled by an entity of the state including the City of Brownsville, an Antiquities Permit must be secured from our office before fieldwork may begin.

The History Programs Division (HPD) staff, led by Justin Kockritz, has completed its review of the preliminary project proposal and concurs that Brownsville City Cemetery, Fort Brown, and the Resaca de la Palma Battlefield are located adjacent to the project areas and are each listed in the National Register of Historic Places. To adequately identify any additional historic properties, and to assess the potential effect of the project on historic properties, THC recommends that the APE include any areas of ground disturbance and enough of a buffer to account for potential visual and indirect effects. Given the limited scope of work, this APE may not need to extend more than 200 feet from the project limits, although any areas of work that are particularly visible, especially at the Cemetery or Battlefield, should be taken into account.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Casey Hanson at 512.463.5915.**

Sincerely,

William A. Martin

for
Mark Wolfe, State Historic Preservation Officer

MW/ch, jk

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102-0300

June 24, 2016

Sue Masica, Regional Director
National Park Service
12795 Alameda Parkway
Denver, CO 80225

Dear Ms Masica,

The U.S. Army Corps of Engineers (USACE) is currently conducting a Resacas Feasibility Study (RFS) in Brownsville, Cameron County, Texas. Resacas are rare ecosystems comprised of water bodies that were once part of the Rio Grande River system. Approximately 1,500 acres of resacas occur within the City of Brownsville varying in size from 5 - 200 acres, with widths between 100 to 350 feet. The resacas have become disconnected from one another due to urbanization (roadway crossings, development, utility lines) and would dry out for extended time periods without effective water management.

The RFS identifies and evaluates alternatives that provide improvements in the interest of flood control, watershed management, environmental restoration and protection, water quality and other allied purposes. The RFS will result in a decision document recommending a solution for resacas ecosystem restoration within the study area.

The study area consists of three resacas systems within the Rio Grande watershed – Town Resaca, Resaca de la Guerra and Resaca del Rancho Viejo. Although urban and residential development has occurred along many of the resacas, a narrow 50- to 300-foot remnant band of riparian habitat occurs along resacas interspersed throughout the study area (Enclosure).

The RFS will reevaluate opportunities for aquatic ecosystem restoration within the resaca systems of the Brownsville by restoring the native aquatic and riparian habitat to sustainably support native fish and wildlife species over the next 50 years. Structural and nonstructural measures will be considered to restore degraded resaca habitat where feasible and to control and/or minimize the siltation and improve the hydrology distribution within the system. These measures may include the following:

- Plantings to restore natural native riparian, aquatic, and emergent resaca vegetation community structure and function
- Establishment of nesting structures for birds, including rare species that utilize the resacas
- Modification of bank slopes and excavation of accumulated sediment to restore natural resaca geomorphology

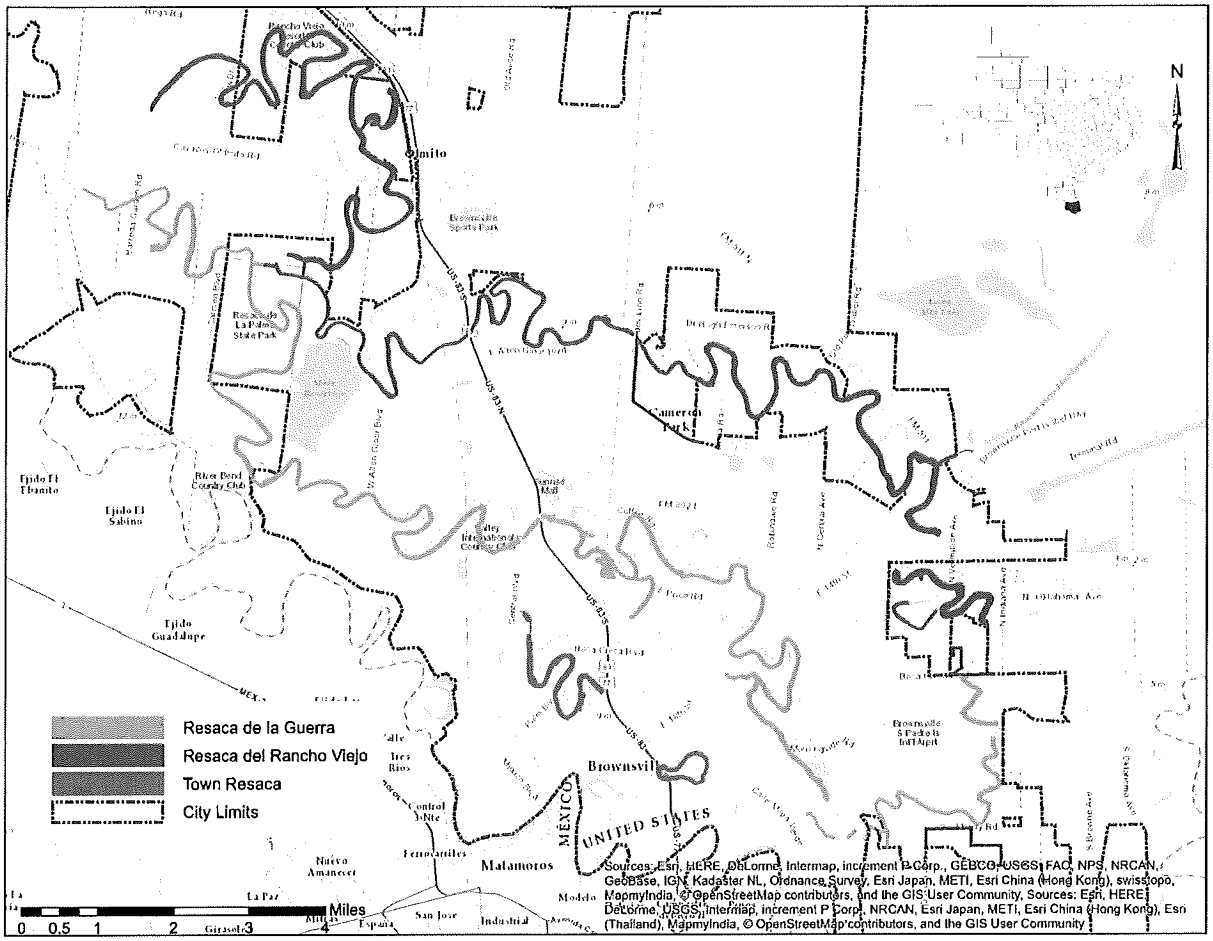
- Hydrologic restoration and management
- Invasive species management (plants and animals)

A preliminary review of the Texas Archeological Sites Atlas shows numerous resources; archeological sites, National Register Properties and National Register Districts within the study area, which is much larger than the anticipated Area of Potential Effect (APE). Approximately six known archeological sites and three National Register Districts (Resaca de la Palma Battlefield, Brownsville City Cemetery/Hebrew Cemetery and Fort Brown) are immediately adjacent to resacas and have a high probability of being within the project's APE. Impacts to cultural resources are expected to be minimal due to the scarcity of built resources within the anticipated APE and the shallow impacts of the proposed restoration activities in areas that have been repeatedly disturbed by riverbank erosion.

We welcome your input regarding defining the APE and the presence of cultural resources within the APE to assist USACE in making an informed decision regarding potential impacts early in the study phase. We look forward to working with your office throughout this process. If you have questions or comments on the RFS or information on historic properties present within the study area, please contact Joseph Murphey, Historic Architect, 817-229-1956, or via email at joseph.s.murphey@usace.army.mil.

Douglas Sims, RPA
Chief, Environmental Compliance Branch

Enclosure



Resacas Feasibility Study Project Area, Brownsville, Cameron County, Texas.

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON, TEXAS 77553-1229

August 17, 2017

Mr. Mark Wolfe
State Historic Preservation Officer
Texas Historical Commission
P.O. Box 12276
Austin, TX 78711-2276

Dear Mr. Wolfe:

The U.S. Army Corps of Engineers, Galveston District (USACE) and the Brownsville Public Utilities Board (BPUB) are continuing the Resacas Feasibility Study (RFS) in Brownsville, Cameron County, Texas. Because effects on historic properties cannot be fully determined prior to approval of the undertaking, it is necessary to address identification and evaluation of historic properties programmatically pursuant to 36 CFR 800.14 in the design phase of the study to meet the agency's Section 106 obligations.

The enclosed draft Programmatic Agreement (PA) (Enclosure 1) provides the study authorization, purpose, a description of proposed restoration measures including aerial imagery, and a description of the area of potential effect (APE), which will be finalized in consultation with the signatories of the PA. Previously recorded historic properties and cultural resource surveys within the study area are also discussed in the draft PA, as well as your comment letter dated 7 July 2016 (Enclosure 2).

We request your review and comment on the enclosed draft PA. We are also inviting the Advisory Council on Historic Preservation and the non-Federal sponsor, the Brownsville Public Utilities Board, to consult as signatories to the PA.

We look forward to continuing to work with your office throughout this process. If you have any questions concerning or comments regarding this project or the attached PA, please contact Leslie Crippen, Archeologist, at 817-886-1470, or via email at Leslie.Crippen@usace.army.mil.

Sincerely,

Douglas C. Sims, RPA
Chief, Environmental Compliance Branch
Regional Planning and Environmental Center

Enclosures

APPENDIX D-1-b

Tribal Nation and Cultural Coordination

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PROGRAMMATIC AGREEMENT
REGARDING COMPLIANCE WITH SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT FOR
THE RESACAS AT BROWNSVILLE ECOSYSTEM RESTORATION PROJECT
IN
CAMERON COUNTY, TEXAS
AMONG
THE U.S. ARMY CORPS OF ENGINEERS, GALVESTON DISTRICT,
THE TEXAS STATE HISTORIC PRESERVATION OFFICER,
THE CITY OF BROWNSVILLE
AND
THE BROWNSVILLE PUBLIC UTILITIES BOARD

WHEREAS, the Resacas at Brownsville, Texas Ecosystem Restoration Study was authorized by resolution by the Committee of Transportation and Infrastructure of the United States House of Representatives dated November 10, 1999, in accordance with Section 110 of the Rivers and Harbors Act of 1962 requesting the Secretary of the Army to review the feasibility of providing improvements to the resacas in the vicinity of the City of Brownsville, Texas in the interest of flood control, watershed management, environmental restoration and protection, water quality, and other allied purposes; and

WHEREAS, the Brownsville Public Utilities Board (BPUB) and the City of Brownsville are the non-Federal sponsor (NFS) with the U.S. Army Corps of Engineers, Galveston District (USACE) for construction and maintenance of this undertaking, and is providing the necessary lands, easements, relocations and rights-of-way; and

WHEREAS, the Area of Potential Effects (APE) includes the footprint of all areas of direct impacts and a 200-foot buffer for indirect impacts; and

WHEREAS, the USACE, has determined that ecosystem restoration proposed for resacas within the city of Brownsville, Texas (hereinafter, "undertaking") may have an effect on historic properties eligible for listing in the National Register of Historic Places (NRHP) (hereinafter, "historic properties") pursuant to Section 106 of the National Historic Preservation Act (54 U.S.C. § 306108) (NHPA), as amended, and its implementing regulations (36 CFR 800); and

WHEREAS, this Programmatic Agreement (PA) is being executed to describe the process the USACE and NFS will utilize to identify and evaluate potential effects on historic properties related to the undertaking; and

WHEREAS, the USACE, the Texas State Historic Preservation Officer (SHPO), and the NFS have agreed that it is advisable to execute this PA for the purposes stated above in accordance with 36 CFR 800.6 and 36 CFR 800.14(b)(1)(ii); and

WHEREAS, the USACE has invited the Advisory Council on Historic Preservation (Council) to participate and the Council has declined to enter into the Section 106 process; and

WHEREAS, in accordance with 36 C.F.R. § 800.14(b), the USACE has notified the following Federally recognized Indian Tribes of Cameron County, Texas of the proposed undertaking: the Tonkawa Tribe of Oklahoma, the Mescalero Apache Tribe, the Comanche Nation of Oklahoma, the Kiowa Tribe of Oklahoma, the Alabama-Coushatta Tribe of Texas, the San Carlos Apache Tribe, and the Kikapoo Traditional Tribe of Texas and;

WHEREAS, the two responding tribes, the Tonkawa Tribe of Oklahoma and the Kiowa Tribe of Oklahoma, stated there were no known historic properties in the APE and no further tribal consultation is warranted, provided that any inadvertent discoveries be treated in accordance with the NHPA and the Native American Graves Protection and Repatriation Act (NAGPRA).

NOW, THEREFORE, the USACE, the SHPO, and NFS agree that the proposed undertaking shall be implemented and administered in accordance with the following stipulations in order to take into account for the effects of the undertaking on historic properties and to satisfy the USACE's Section 106 responsibilities for all individual aspects of the undertaking.

STIPULATIONS

I. Identification, Evaluation, Effect Determination, and Resolution

A. Scope of Undertaking. This PA shall be applicable to all excavation, bank modification, planting areas, and any other ground disturbing activities related to the proposed Resacas at Brownsville, Texas Ecosystem Restoration project. The APE shall be established by the USACE in consultation with the SHPO and shall include all areas to be directly and indirectly affected by the undertaking.

B. Qualifications and Standards. The USACE shall ensure that all work conducted in conjunction with this PA is performed in a manner consistent with the Secretary of Interior's "Standards and Guidelines for Archeology and Historic Preservation" (48 FR 44716-44740; September 23, 1983), as amended, or the Secretary of the Interior's "Standards for the Treatment of Historic Properties" (36 CFR 68), as appropriate.

C. Definitions. The definitions set forth in 36 CFR 800.16 are incorporated herein by reference and apply throughout this PA.

D. Identification of Historic Properties. During the pre-construction, engineering and design phase (PED), and prior to the initiation of construction, the USACE shall identify historic properties located within the APE. These steps may include, but are not limited to, background research, consultation, oral history interviews, sample field investigations, and field survey. The level of effort for these activities shall be determined in consultation with the SHPO and any Native American Indian Tribe or Tribes (Tribes) that attach religious and cultural significance to identified properties. All draft reports of survey or site testing investigations shall be submitted to the SHPO for review and comment. If the SHPO comments are not received by the USACE within thirty (30) days of receipt, the reports and their recommendations shall be considered adequate and the reports may be finalized. Comments received by the USACE from the SHPO or Tribes shall be addressed in the final reports, which shall be provided to all consulting parties. If no historic properties are identified in the APE, the USACE shall document this finding pursuant to 36 CFR 800.11(d), and provide this documentation to the SHPO.

E. Evaluation of National Register Eligibility. If historic properties are identified within the APE, the USACE shall determine their eligibility for the NRHP in accordance with the process described in 36 CFR 800.4(c) and criteria established in 36 CFR 60. All draft reports of NRHP site testing or other NRHP investigations shall be submitted to the SHPO and Tribes for review and comment. If SHPO comments are not received by the USACE within 30 days of receipt, the reports or investigations and their recommendations shall be considered adequate and the reports may be finalized. Comments received by the USACE from the SHPO or Tribes shall be addressed in the final report, which shall be provided to all consulting parties. The determinations of significance shall be conducted in consultation with the SHPO and Tribes. Should the USACE and the SHPO agree that a property is or is not eligible, then such consensus shall be deemed conclusive for the purpose of this PA. Should the USACE and the SHPO not agree regarding the eligibility of a property, the USACE shall obtain a determination of eligibility from the Keeper of the National Register pursuant to 36 CFR 63. For historic properties found not eligible for the NRHP, no further protection or consideration of the site will be afforded for compliance purposes.

F. Other applicable laws and regulations. This PA does not obviate any requirements for a party to otherwise comply with applicable state and/or Federal laws and regulations.

G. Assessment of Adverse Effects.

   1. No Historic Properties Affected. The USACE shall evaluate the effect of each undertaking on historic properties in the APE. The USACE may conclude that no historic properties are affected by an undertaking if no historic properties are present in the APE, or the undertaking will have no effect as defined in 36 CFR 800.16(i). This finding shall be documented in compliance with 36 CFR 800.11(d) and the documentation shall be provided to the SHPO and retained by the USACE for at least seven (7) years. The USACE shall provide

information on the finding to the public upon request, consistent with the confidentiality requirements or 36 CFR 800.11(c).

2. Finding of No Adverse Effect. The USACE, in consultation with the SHPO, and Tribes shall apply the criteria of adverse effect to historic properties within the APE in accordance with 36 CFR 800.5. The USACE may propose a finding of no adverse effect if the undertaking's effects do not meet the criteria of 36 CFR 800.5(a)(1) or the undertaking is modified to avoid adverse effects in accordance with 36 CFR 68. The USACE shall provide to the SHPO documentation of this finding meeting the requirements of 36 CFR 800.11(e). The SHPO shall have 30 days in which to review the findings and provide a written response to the USACE. The USACE may proceed upon receipt of written concurrence from the SHPO. Failure of the SHPO to respond with 30 calendar days of receipt of the finding shall be considered agreement with the finding. The USACE shall maintain a record of the finding and provide information on the finding to the public upon request, consistent with the confidentiality requirements of 36 CFR 800.11(c).

3. Resolution of Adverse Effect. If the USACE determines that the undertaking will have an adverse effect on historic properties as measured by criteria in 36 CFR 800.5(a)(1), the USACE shall consult with the SHPO and Tribes to resolve adverse effects in accordance with 36 CFR 800.6.

   a) For historic properties that the USACE and the SHPO agree will be adversely affected, the USACE shall:

      (1) Consult with the SHPO to identify other individuals or organizations to be invited to become consulting parties. If additional consulting parties are identified, the USACE shall provide them copies of documentation specified in 36 CFR 800.11(e) subject to confidentiality provisions of 36 CFR 800.11(c).

      (2) Afford the public an opportunity to express their views on resolving adverse effects in a manner appropriate to the magnitude of the project and its likely effects on historic properties.

      (3) Consult with the SHPO, Tribes, and any additional consulting parties to seek ways to avoid, minimize or mitigate adverse effects.

      (4) Prepare an historic property plan (Plan) which describes mitigation measures the USACE proposes to resolve the undertaking's adverse effects and provide this Plan for review and comment to all consulting parties. All parties have thirty (30) days in which to provide a written response to the USACE.

b) If the USACE and the SHPO fail to agree on how adverse effects will be resolved, the USACE shall request that the Council join the consultation and provide the Council and all consulting parties with documentation pursuant to 36 CFR 800.11(g).

c) If the Council agrees to join the consultation, the USACE shall proceed in accordance with 36 CFR 800.9.

d) If, after consulting to resolve adverse effects, the Council, the USACE, or the SHPO determines that further consultation will not be productive, then any party may terminate consultation in accordance with the notification requirements and processes prescribed in 36 CFR 800.7.

II. Post Review Changes and Discoveries

A. Changes in the Undertaking. If construction on the undertaking has not commenced and the USACE determines that it will not conduct the undertaking as originally coordinated, the USACE shall reopen consultation pursuant to Stipulation I. D-F.

B. Unanticipated Discoveries or Effects. Pursuant to 36 CFR 800.13(b)(3), if historic properties are discovered or unanticipated effects on historic properties are found after construction on an undertaking has commenced, the USACE shall develop a treatment plan to resolve adverse effects and notify the SHPO and Tribes within 48 hours of the discovery. The notification shall include the USACE assessment of the NRHP eligibility of affected properties and proposed actions to resolve the adverse effects. Comments received from the SHPO and Tribes within 48 hours of the notification shall be taken into account by the USACE in carrying out the proposed treatment plan. The USACE may assume SHPO concurrence in its eligibility assessment and treatment plan unless otherwise notified by the SHPO within 48 hours of notification. USACE shall provide the SHPO and Tribes a report of the USACE actions when they are completed.

III. Curation and Disposition of Recovered Materials, Records, and Reports

A. Curation. The USACE shall ensure that all archeological materials and associated records owned by the State of Texas or NFS, which result from identification, evaluation, and treatment efforts conducted under this PA, are accessioned into a curation facility in accordance with the standards of 36 CFR 79, the Antiquities Code of Texas (Texas Natural Resource Code, Chapter 191), the Texas Administrative Code 13 TAC §29.5, and the Council of Texas Archeologists Guidelines and Standards for Curation, except as specified in Stipulation IV for human remains. The curation of items owned by the State of Texas or the NFS shall be maintained in perpetuity by the NFS. Archeological items and materials from privately owned lands shall be returned to their owners upon completion of analyses required for Section 106 compliance under this PA.

B. Reports. The USACE shall provide copies of final technical reports of investigations and mitigation to the consulting parties and the SHPO, as well as additional copies for public distribution. All consulting parties shall withhold site location information or other data that may be of a confidential or sensitive nature pursuant to 36 CFR 800.11(c).

IV. Treatment of Native American Human Remains

A. Prior Consultation. If the USACE's investigations, conducted pursuant to Stipulation I of this PA, indicate a high likelihood that Native American Indian human remains may be encountered, the USACE shall develop a treatment plan for these remains in consultation with the SHPO and Tribes. The USACE shall ensure that Tribes indicating an interest in the undertaking are afforded a reasonable opportunity to identify concerns, provide advice on identification and evaluation, and participation in the resolution of adverse effects in compliance with the terms of this PA.

B. Inadvertent Discovery. Immediately upon the inadvertent discovery of human remains during historic properties investigations or construction activities conducted pursuant to this PA, the USACE shall ensure that all ground disturbing activities cease in the vicinity of the human remains and any associated grave goods and that the site is secured from further disturbance or vandalism. The USACE shall be responsible for immediately notifying local law enforcement officials, and within 48 hours of the discovery, shall initiate consultation with the SHPO and Tribes to develop a plan for resolving the adverse effects.

C. Dispute Resolution. If, during consultation conducted under paragraphs A and B of Stipulation IV, all consulting parties cannot agree upon a consensus plan for resolving adverse effects, the matter shall be referred to the Council for resolution in accordance with the procedures outlines in 36 CFR 800.9.

V. PA Amendments, Disputes and Termination

A. Amendments. Any party to the PA may propose to the other parties that it be amended, whereupon the parties will consult in accordance with 36 CFR 800.6(c)(7) to consider such an amendment.

B. Disputes. Disputes regarding the completion of the terms of this agreement shall be resolved by the signatories. If the signatories cannot agree regarding a dispute, any one of the signatories may request the participation of the Council in resolving the dispute in accordance with the procedures outlined in 36 CFR 800.9. The USACE shall forward to the Council and all consulting parties within fifteen (15) days of such a request all documentation relevant to the dispute, including the USACE's proposed resolution of the dispute. The Council will respond to the request within thirty (30) days of receiving all documentation. The USACE will take any recommendations or comments from the Council into account in resolving the dispute. In the event that the Council fails to respond to the request within thirty (30) days of receiving all documentation, the USACE may assume the Council's concurrence with its proposed resolution and proceed with resolving the dispute.

C. Termination of PA. Any party to this PA may terminate it by providing a sixty (60) day notice to the other parties, provided that the parties will consult during the period prior to the termination to seek agreement on amendments or other actions that will avoid termination. In the event of termination of this PA the USACE shall comply with the provisions of 36 CFR 800, Subpart B.

VI. Term of this Agreement

A. This PA remains in force for a period of ten (10) years from the date of its execution by all signatories, unless terminated pursuant to Stipulation V.C. Sixty (60) days prior to the conclusion of the ten (10) year period, the USACE shall notify all parties in writing of the end of the ten year period to determine if they have any objections to extending the term of this PA. If there are no objections received prior to expiration, the PA will continue to remain in force for one (1) new ten (10) year period.

Execution of this PA and implementation of its terms evidences that the USACE has afforded the Council an opportunity to comment on the undertaking and its effects on historic properties, and that the USACE has taken into account those effects and fulfilled Section 106 responsibilities regarding the undertaking.

Signature Page for U.S. Army Corps of Engineers District Engineer

**PROGRAMMATIC AGREEMENT
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THE RESACAS AT BROWNSVILLE ECOSYSTEM RESTORATION PROJECT
IN
CAMERON COUNTY, TEXAS
AMONG
THE U.S. ARMY CORPS OF ENGINEERS, REGIONAL PLANNING AND
ENVIRONMENTAL CENTER,
THE TEXAS STATE HISTORIC PRESERVATION OFFICER,
THE CITY OF BROWNSVILLE,
AND
THE BROWNSVILLE PUBLIC UTILITIES BOARD**

1 MAR 18

Colonel Lars N. Zetterstrom, District Engineer | **Date**

Signature Page for State Historic Preservation Officer

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THE CITY OF BROWNSVILLE,
AND
THE BROWNSVILLE PUBLIC UTILITIES BOARD

Mark Wolfe — 10/4/17

Mark Wolfe, Texas State Historic Preservation Officer — **Date**

Signature Page for the City of Brownsville, Texas

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THE CITY OF BROWNSVILLE,
AND
THE BROWNSVILLE PUBLIC UTILITIES BOARD**

10-18-17

Pete Gonzalez, Deputy City Manager — **Date**
City of Brownsville, Texas

"Approved as to Form and Legality
This 18 day of OCT 2017
T SAMECK
Title ASST CITY ATTY
Office of the Brownsville City Attorney"

Signature Page for Brownsville Public Utilities Board, Texas

**PROGRAMMATIC AGREEMENT
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THE CITY OF BROWNSVILLE,
AND
THE BROWNSVILLE PUBLIC UTILITIES BOARD**

1/12/18

John Bruciak, General Manager and CEO
Brownsville Public Utilities Board, Texas

Date

The Resacas at Brownsville Ecosystem Restoration Project
Cameron County, Texas

Cultural Resources and Project Summary for the Programmatic Agreement
U.S. Army Corps of Engineers, Galveston District

Study Purpose and Authorization

The U.S. Army Corps of Engineers (USACE) has prepared an Integrated Feasibility Report and Environmental Impact Statement (IFR_EIS) that presents the results of a feasibility study, which was authorized by the resolution by the Committee of Transportation and Infrastructure of the United States House of Representatives dated November 10, 1999, requesting the Secretary of the Army to review the feasibility of providing improvements to the resacas in the vicinity of the City of Brownsville, Texas in the interest of flood control, watershed management, environmental restoration and protection, water quality, and other allied purposes. Under the authority provided, 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.

Under natural processes, resacas are formed during extreme flooding events when the Rio Grande diverts from its course and forms a new connection with the Gulf of Mexico. The rerouted river leaves behind a disconnected waterbody up to 40 miles long. Sediments deposited between these extreme floods, and during more frequent minor floods, segmented the relict channel into a series of ponded areas referred to as resacas. In terms of National significance, Resaca ecosystems are found nowhere else on earth. The loss of resacas due to natural sedimentation was historically mitigated by the formation of new resacas in other areas of the floodplain as the active Rio Grande channel formed new pathways. However, the construction of Falcon (1954) and Amistad Dams (1968), the construction of Anzalduas (1960) and Retamal (1975) water diversion dams, and the construction of approximately 102 miles of levees altered the hydrology of the Rio Grande.

The purpose of the Resacas at Brownsville, Texas Ecosystem Restoration Study is to restore, at a landscape level, the resacas within the study area to sustainably support native fish and wildlife species in perpetuity. Specifically, the goal of the study is to identify degraded areas for potential habitat restoration that would facilitate the creation of valuable yet limited wildlife transportation corridors through the City of Brownsville.

Existing Project

The Brownsville Resacas Ecosystem Restoration study area is located along the southern Texas coast, which has been occupied by humans since the Paleoindian period, dating to around 11,500 BP (Hester, 1995). It is situated in the Lower Rio Grande Valley, on the

Texas Gulf Coastal Plain, and is described as a moisture-deficient region with a semiarid, subtropical climate (Blair, 1950; Griffiths and Bryan, 1987). The resacas, which are abandoned meandering channels of the Rio Grande River, are generally filled with clays and silts, and surrounded by overbank flood deposits. Throughout the lower Rio Grande River Basin, hundreds of archaeology sites have been recorded in the silty clay dunes surrounding these abandoned river channels (Anderson, 1932; Terneny, 2005). Because of the dynamic nature of the Rio Grande Delta and the abundance of karst topography, these sites occur anywhere between 10 and 30 feet amsl. They are identifiable by their unique artifact assemblages, including a vast array of shell tools and ornaments, trade goods, and ceramic styles, many of which indicate interaction with people of the Huastec peoples of Mexico (Terneny, 2005).

Conflicting colonial interests and aggressive Indian removal by settlers and agents of the United States dramatically impacted the cultural landscape of Brownsville in the Historic Period. The first and second battles of the Mexican American War were fought at Palo Alto Battlefield and at Resaca de la Palma in May of 1846. Although the area has had extensive residential development, one of the resacas proposed for restoration borders the National Historic District of the Battle at Resaca de la Palma. Records indicate Mexican soldiers were buried in graves of 50-100 men after the battle. One of these graves was discovered and excavated in 1967, during the construction of a nearby reservoir (Wescott et al. 2012). During the Civil War, Union and Confederate troops fought in the Battle of Brownsville in 1863, as well as the final battle of the Civil War, the Battle of Palmito Ranch in May of 1865, more than a month after the official surrender of the Confederacy. Existing earthworks from the Mexican American War were reinforced by enslaved laborers, while rock piles, sunken vessels, chains, and other means were used to block Union troops from coming upriver (Barr 1961).

Recommended Plan

The restoration measures proposed for each restoration area depend on the needs of the individual area. The ecosystem restoration measures available for each area include dredging of sediments to increase the depth of the resaca to historical depth or 6 feet, whichever is less; the sculpting of the resaca bank slope to reduce the slope to reference conditions; the planting of aquatic and emergent vegetation along the edge of the dredged resacas and modified bank slopes; the planting of native riparian vegetation consistent with the three critically imperiled with extinction vegetation associations; and the management and control of non-native, invasive plant species. The map set provided herein indicates the restoration activities proposed for each segment of the project.

In order to maintain aquatic connectivity, modifications to existing water control features may be required. The existing features are within Brownsville Irrigation District 5 and Cameron County Irrigation District 6, which have been determined not eligible for listing in the NRHP as a historic district. Individual features are unlikely to be eligible for listing in the NRHP, but will be evaluated by USACE in consultation with the SHPO, as water control measures are finalized in the planning, engineering, and design phase.

Previous Archaeological Investigations

Numerous surveys have been conducted across the central area of Brownsville. Two of the linear projects that overlap the project area did not include any survey; these were conducted by the Texas Department of Transportation (TXDOT) in 1982 and the Farmer's Home Administration in 1994. A third linear project, conducted by Hicks & Company on behalf of the City of Brownsville in 2006, surveyed the route of the proposed Texas Historic Battlefield Trails Southern Pacific Linear Park. Survey methods included intensive pedestrian survey, shovel testing, and backhoe trenching. No historic properties were recorded during the survey and the report is on file at the Texas Archaeological Research Laboratory. Finally, a 2004 survey conducted on behalf of the Federal Highway Administration and TXDOT at the Brownsville Airport also crosses the proposed project area. One historic debris scatter was recorded and recommended as ineligible for the NRHP during the investigation.

A report detailing the excavation of the Resaca de la Palma Battlefield grave in 1967 was never published (R. Garza, personal communication, July 13, 2017). However, reports on the analyses of the excavated skeletal remains were published in 1978, 1983, 1993, and 2012 (Wescott, et al. 2012). Archaeological survey conducted at the Battlefield site in 2004 identified cultural modifications to the site since the 1846 battle, including fill placement and other land alterations associated with the 1960s construction of a polo field and horse corrals, dumping of highway construction debris, and the structural remains of the ca. 1940s Wells family residence.

Previously Recorded Historic Properties

Two historic properties have been recorded in areas where proposed restoration activities would occur. Site 41CF3 is the Resaca de la Palma Battlefield, which is part of the Palo Alto Battlefield National Historic Landmark and is managed by the National Park Service. In addition to the historic construction and fill activities described above, the site has been more recently disturbed by extensive residential development. Dredging of recently deposited silts, which will occur at least 15 feet away from either shoreline, is proposed for the resaca bordering the publicly accessible battlefield site. Shoreline sculpting and planting of riparian and emergent vegetation are proposed for the Resaca bordering Hanna High School. The northeast corner of the property falls within the Resaca de la Palma Battlefield site boundary. Site 41CF188 is a scatter of fragmentary historic debris, located in the vicinity of the Brownsville airport, and has been recommended as ineligible for listing in the NRHP. Riparian vegetation planting is proposed for this location. Numerous above-ground historic properties occur within the study area, but will not be impacted by the proposed restoration measures. The determination of no impacts to standing historic structures is discussed below.

Recommendations

Based on the current information for the ecosystem restoration measures proposed for the Brownsville resacas, there is a potential to affect historic properties. These effects consist of direct impacts from earth moving and excavation activities associated with bank slope modification, invasive plant species removal, and planting of emergent and riparian vegetation. The USACE recommends cultural resource investigations as described in Stipulation I(D) of this agreement to identify and evaluate any historic properties within proposed construction areas. Proposed ecosystem restoration activities will restore the visual character of the resacas to that which existed before the lower Rio Grande delta became urbanized and the resacas were isolated from the migrating river. As such, there are no impacts to the historic viewshed and the USACE does not recommend cultural resource investigations of surrounding historic structures and cemeteries.

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APPENDIX D-2a

USFWS Fish and Wildlife Planning Aid Letter/Coordination Act Report

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Texas Coastal Ecological Services Field Office
4444 Corona, Suite 215
Corpus Christi, Texas 78418
361/994-9005/ (Fax) 361/994-8262

August 10, 2017

Douglas C. Sims, RPA, Acting Chief
Attention: Danny Allen
U.S. Army Corps of Engineers
Regional Planning & Environmental Center, Coastal Section
819 Taylor St., Room 3A12
Fort Worth, Texas 76102

Dear Mr. Sims:

The purpose of this joint planning aid letter and Fish and Wildlife Coordination Act report is to describe the existing fish and wildlife resources within the Brownsville Resaca Ecosystem Restoration Study area (study area); describe currently proposed alternatives; identify potentially significant impacts; identify modifications or alternatives that address fish and wildlife related problems, opportunities, or planning objectives; and recommend preliminary measures for resource protection. This planning assistance is provided to the U.S. Army Corps of Engineers (USACE), pursuant to the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 et seq). This information does not represent a final report of the Secretary of the Interior within the meaning of Section 2(b) of the Act. A complete FWCA report will be prepared by the U.S. Fish and Wildlife Service (Service) to accompany the feasibility report after all pertinent information, including review comments from the Texas Parks and Wildlife Department (TPWD) and proposed project alternatives, has been received and reviewed. To streamline the FWCA process, this letter serves as both the Planning Aid Letter (PAL) and the Coordination Act Report (CAR).

Service involvement with the Brownsville Resaca Ecosystem Restoration Study (study) has occurred regularly and throughout the study's lifespan. Important dates of past Service involvement are summarized below. The USACE met with the Service and TPWD staff on 15-18 December 2015 to develop an ecological conceptual model and identify potential measures and model metrics, and the data collection reference areas for the development of a reference condition model. Ongoing discussions with the resource agencies continued during model development, refinement, and QA/QC of the resulting habitat model prior to data sampling of the restoration areas. Data sampling of the study area occurred 25 July and 1 August 2016.

Description of the Project Area

The environmental study area within the Brownsville Resaca Ecosystem Restoration Study is the city of Brownsville, located at the southern tip of Texas within Cameron County, Texas. The study area includes three separate resaca systems: Resaca del Ranch Viejo stretching west to east across the northern portion of the city of Brownsville, Resaca de la Guerra transecting the middle portion of the city, and the Town Resaca system located at the southern end of the city. The study area encompasses the portions of the resaca systems located within the city limits of Brownsville.

The topography of the resaca study area is consistent with the flat topography associated with large river delta areas ranging from an elevation of 40 feet above mean seal level (amsl) in the northwestern corner of the study area to an elevation of 20 feet amsl in the southeastern portion. Localized drainage swales, drains, and irrigation canals direct local storm water runoff and water throughout the study area.

The vegetation communities that have evolved in the Lower Rio Grande Valley (LRGV) and around the resaca ecosystems are unique, representing a distinctive transition between temperate and tropical conditions. These areas exhibit high biodiversity of plants and animals, some of which are found in few other places, if any, and are restricted to the LRGV of Texas (Cameron, Hidalgo, and Willacy counties) and Mexico. Since the early 1870s and the introduction of irrigation, the loss of native desert thorn-scrub vegetation, including resaca habitats, to cultivated agriculture uses has resulted in the loss of 95% of thorn-scrub habitat in the LRGV and 99% of riparian resaca habitats. Over the last 25 years, agricultural lands and remaining thorn-scrub habitat has also been lost to urbanization with Cameron County populations increased over 60% from 1990 to 2014. The agricultural history and rapid urbanization of the area has resulted in the loss of 99% 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, threat of extinction due to the loss of hydrologic function, and the very steep decline in the extent of the vegetation are major factors in the NatureServe rankings. The Rio Grande Delta physiographic zone, where the resacas are found, faces the greatest future conservation challenges because it has the highest human densities and growth within the LRGV.

Migratory Birds and Other Wildlife Resources

The migratory bird and other wildlife use of resacas are as diverse as the high biodiversity found in the vegetation communities described above. Because of the loss of so much natural habitat in the LRGV, the remaining resacas provide crucial habitat resources for numerous species, including species of conservation concern and state and federally listed threatened and endangered species. Specifically, resacas provide loafing, breeding, and refuge habitat for a variety of resident and migratory birds. There are 50 species of migratory birds of conservation concern found within Cameron County. The Service's *Birds of Conservation Concern* (2008) lists 27 avian species that may utilize Tamaulipan brushlands and may be found within the resacas. The LRGV is considered one of the most species-rich butterfly areas in the United States (Wauer 2004) with >50% of observed species considered LRGV specialists or rarely found elsewhere (Leslie 2016). Remnant resacas also provide stepping stones of quality habitat for wildlife within the urban conditions of Cameron County, thus connecting remaining habitat parcels in the LRGV. Fragmentation is a major cause of decline in many native species from different Orders, making restoration and connectivity more critical to conserving wildlife.

Threatened and Endangered Species

The following species are listed as threatened (T), endangered (E), or delisted (D) for Cameron County (w/CH = with critical habitat in Texas; w/CHI = with critical habitat outside of Texas):

Brown pelican	(D)	*Pelecanus occidentalis*
Piping plover	(T w/CH)	*Charadrius melodus*
Red-crowned parrot	(C)	*Amazona viridigenalis*
Red knot	(T)	*Calidris canutus rufa*
Northern aplomado falcon	(E)	*Falco femoralis septentrionalis*
Gulf Coast jaguarundi	(E)	*Herpailurus yagouaroundi cacomitli*
Ocelot	(E)	*Leopardus pardalis*
West Indian manatee	(T)	*Trichechus manatus*
Green sea turtle	(T)	*Chelonia mydas*
Hawksbill sea turtle	(E w/CHI)	*Eretmochelys imbricata*
Kemp's Ridley sea turtle	(E)	*Lepidochelys kempii*
Leatherback sea turtle	(E w/CHI)	*Dermochelys coriacea*
Loggerhead sea turtle	(T)	*Caretta caretta*
South Texas ambrosia	(E)	*Ambrosia cheiranthifolia*
Texas ayenia	(E)	*Ayenia limitaris*

Alternatives Under Consideration

Seven alternatives, including the no action alternative were considered and are described in detail in the *City of Brownsville Resaca Ecosystem Restoration Study, Feasibility Report/Environmental Assessment.* Ecosystem restoration for consideration included dredging, riparian soil supplementation with thin layer dredge material, planting riparian vegetation consistent with the three rare vegetation associations, relaxing the bank slope, bank stabilization, planting of aquatic and emergent vegetation, modification/construction of water control structures, and invasive plant species management.

Because each alternative is cost effective and economically justified, USACE utilized the Institute of Water Resource's Planning Suite cost effective/incremental cost analysis methodology to identify the national ecosystem restoration (NER) plan. Based on this analysis, Alternative 5 was identified as the federally justified Alternative for the NER plan.

Future Without Project (FWOP)

This Alternative presumes that there would be no Proposed Action for the study area. The Brownsville resaca study area includes urban, suburban, and rural areas and future conditions would include the continued development of undeveloped areas over time. The existing habitat would continue to be maintained as a park-like landscape dominated by non-native and invasive species. The non-native plant species would continue to overtake the remaining native vegetation in the study area. For a while, the study area would continue to provide marginal habitat for a small number of generalist fish and wildlife species that are tolerant of low quality habitats, including non-natives. Under the FWOP, the resacas would continue to accumulate sediments and eventually would be incapable of impounding water.

Proposed Action Alternative

This Alternative restores 523 acres of resaca riparian habitat consisting of vegetation representative of Texas Ebony Forest, Subtropical Texas Palmetto Woodland, or Texas Ebony/Snake-eyes vegetation associations; 57 acres of native aquatic and emergent vegetation within the resacas; and invasive species control for 619 acres for a total of 780 acres of resaca restoration. In addition, the project would include the bank shaping along 33 miles of resacas shoreline. 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 discourage colonization of the non-native, invasive vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*), which prefers 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 galbina*) require Texas Ebony (*Ebenopsis ebano*) and Brasil (*Condalia hookeri*), 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.

The recovery plans for the ocelot and Gulf Coast jaguarondi, both endangered species, identify the importance of stepping stone habitats that serve as transportation corridors for dispersing animals. Although the study area would not serve as permanent habitat for these species, should the Service, TPWD, or other NGO restore cat habitat near the eastern and western city limits, the study area could provide a transportation corridor for dispersing cats to move east/west across the city.

In Year 0, 914.5 acres of existing marginal and moderate quality habitat will be temporarily impacted by dredging, grading, and soil bed preparation activities for the implementation of the restoration measures of the proposed action. The immediate loss of habitat quality would then increase gradually over time as the restored habitats begin developing. Habitat quality would increase the quickest over the first 10 to 15 years as the woody vegetation matured in size and canopy coverage; however, habitat benefits would not maximize until the development of later successional climax vegetation such as Sierra Madre torchwood (*Amyris madrensis*), Texas torchwood (*A. texana*), guayacan (*Guaiacum angustifolium*), and other climax species.

Summary and Recommendations

While the Service recognizes that the bank slope restoration should negatively affect the non-native, invasive vermiculated sailfin catfish within the resacas, please consider whether the described benefit to amphibians will be long-term without implementing additional actions to controlling the invasive fish population. This fish species consumes algae and detritus and most certainly impacts the food base for both vertebrates and invertebrates within the resacas. We see that the Average Annual Cost for the Proposed Action Selected is substantially less than the Alternative including the same benefits plus fish control. However, if all of the Alternatives are cost effective and economically justified, please justify utilizing bank restoration without fish control.

The Service recommends installing artificial nest cavities for the candidate red-crowned parrot and managing trees present within the study area for the benefit of this species. The red-crowned parrot depends upon existing cavities in trees for nest sites; therefore, woodpecker holes in dead palm trees are often used by the parrots. If the non-native Washingtonia palm (*Washingtonia robusta*) is present, consider leaving the palms in place and incorporating them into the restoration plans for future red-crowned parrot habitat needs. Live, existing Washingtonia palms could be killed to speed the development of red-crowned parrot cavities in the restoration areas.

The Texas ayenia, an endangered plant, should be included in the restoration plan wherever possible. Texas ayenia has a restricted range in the U.S., only occurring in isolated fragments of Texas Ebony/Anacua/Brasil Shrubland and Texas Ebony/Snake-eyes Shrubland in the Rio Grande Delta in Cameron, Hidalgo, and Willacy counties.

Given the Proposed Action Alternative, the following specific measures could be beneficial for the restoration of the aquatic and riparian habitats of the Brownsville resacas.

1. Widen the riparian corridors along the resacas as much as possible by planting native plant species consistent with the rare vegetation associated with the resacas (Texas Ebony Riparian Forest, Texas Ebony/Anacua Shrubland, and Subtropical Texas Palmetto Woodland vegetation associations). The riparian buffer zones provide several benefits for terrestrial and aquatic resources:
    a. First, riparian zones stabilize eroding banks by absorbing the erosive force of flowing water and fetch along the resacas while roots hold the soil in place.
    b. Second, riparian zones filter sediment, nutrients, pesticides, and animal waste runoff.
    c. Third, riparian zones provide shade, shelter, and food for wildlife and aquatic organisms.
    d. Finally, the connection of riparian zones along the resaca provides habitat connectivity to facilitate the dispersal of organisms and genetic material along these "travel corridors".

    Native plant species should be utilized in the expanded portion of the riparian habitats to improve canopy cover and wildlife food base.

2. Mimic floodplain processes by beneficially utilizing dredge material to augment soils in the riparian habitat planting areas with nutrients.

3. Plant native aquatic and emergent plant species along the resaca edges, including woody emergent vegetation such as giant sensitive tree (*Mimosa pigra*), retama (*Parkinsonia aculeata*), bald cypress (*Taxodium distichum*), and willow (*Salix* sp.). Consider planting other native trees such as sugarberry (*Celtis laevigata*) and Mexican elm (*Ulmus mexicana*), as needed.

4. The Service requests that you develop a written monitoring and management plan to track the progress of restoration over time, with monitoring at specific intervals. The plan should provide for invasive species control over time and opportunities for implementation of adaptive management as needed.

We appreciate the opportunity to participate in the planning of this project and look forward to working with your staff on this and future federal projects. If you have any questions or comments concerning this report, please contact staff biologist Gretchen Nareff at (361) 994-9005, extension 242.

Sincerely,

E. Dawn Gardiner

for Charles Ardizzone
Project Leader

APPENDIX D-2-b

The USACE Response to USFWS Recommendations Provided in the Fish and Wildlife Coordination Act Report

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Appendix D-2-b

The USACE Response to USFWS Recommendations Provided in the Fish and Wildlife Coordination Act Report

The U.S. Fish and Wildlife Service (USFWS) provided recommendations for the Resacas Ecosystem Restoration study in the Fish and Wildlife Coordination Act Report dated 10 August 2017. These recommendations identify measures that would increase the ecological benefits, both captured and uncaptured, of the proposed restoration project. The following is a list of the USFWS recommendations and a description of how the USACE addressed them in the Feasibility/EA report. All responses were considered for effectiveness, efficiency, completeness, and acceptability. Most recommendations reflect the measures and ecosystem processes identified by the USACE and proposed for restoration implementation

Recommendation 1 – The USFWS requested justification for utilizing the bank slope measure without further control of the invasive vermiculated sailfin catfish.

The USACE Response – The bank slope measure discussed in the feasibility report identifies the laying back of the banks as a passive catfish control measure. Although the physical or chemical control of catfish would further provide ecological benefits, including benefits to amphibian species, the higher cost of additional catfish control did not result in alternatives that were cost effective and economically justified. This analysis was conducted during the Section 206 Resaca Boulevard Resaca Ecosystem Restoration study and used to inform the Interim Ecosystem Restoration feasibility study.

Recommendation 2 – The USFWS recommended that the study include the installation of artificial nesting structures for the Red-crowned parrot, a candidate species. The USFWS also recommended creating standing snags by killing non-native Washington palms and leaving the trunks for cavity nesters, including the Red-crowned parrot.

The USACE Response – The use of artificial nest boxes for Red-crowned parrots has not been successful although research in this area continues. The implementation plan includes leaving existing palm snags in place for cavity nesters and incorporates killing selected Washington palms in the riparian planting measure to serve as cavity nesting structures for the red-crowned parrot.

Recommendation 3 – The USFWS recommended the inclusion of Texas ayenia, an endangered plant, in the restoration plan wherever possible.

The USACE Response – The Texas ayenia is included in the riparian planting measure by incorporating Texas ayenia in the plant species mix of the restoration plan.

Recommendation 4 – The USFWS recommended that the riparian corridors along the resacas be widened as much as possible to serve as habitat and buffer zones to the resacas.

The USACE Response – The USACE restoration strategy for the identification of restoration areas was based on the concept of widening the resaca’s riparian habitats as much as feasible and to maximize the connectivity between restoration areas as much as possible based on reference resaca habitat conditions.

Recommendation 5 –The USFWS recommends the mimicking of floodplain processes by beneficially utilizing dredge material to augment soils in the riparian habitat planting areas with nutrients.

The USACE Response – The beneficial use of dredged materials to augment riparian planting areas was proposed as a measure in the development of alternatives, and coordinated with the USFWS for their review.

Recommendation 6 – The USFWS recommends planting native aquatic and emergent plant species along the resaca edges, including woody emergent vegetation.

The USACE Response – The planting of native aquatic and emergent plant species was proposed as a measure in the development of alternatives and was coordinated with the USFWS for their review. The aquatic planting measure is incorporated in the recommended plan.

Recommendation 7 – The USFWS requested that a written monitoring and adaptive management plan be developed to track restoration progress over time. The plan should include provisions for the control of invasive species.

The USACE Response – The feasibility report contains a draft monitoring and adaptive management plan that would be further developed during the PED phase of the project. Measures dealing with the monitoring and control of invasive species are incorporated into this plan.

APPENDIX D-3

Clean Water Act Section 404(b)1 Guidelines – Short Form

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EVALUATION OF SECTION 404(b)(1) GUIDELINES
(SHORT FORM)

PROPOSED PROJECT: Brownsville Resacas Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment

	Yes	No*
1. Review of Compliance (230.10(a)-(d))		
A review of the proposed project indicates that:		
a. The placement represents the least environmentally damaging practicable alternative and, if in a special aquatic site, the activity associated with the placement must have direct access or proximity to, or be located in the aquatic ecosystem, to fulfill its basic purpose (if no, see section 2 and information gathered for EA alternative).	X	
b. The activity does not appear to:		
1) Violate applicable state water quality standards or effluent standards prohibited under Section 307 of the Clean Water Act;	X	
2) Jeopardize the existence of Federally-listed endangered or threatened species or their habitat; and	X	
3) Violate requirements of any Federally-designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies).	X	
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, an economic values (if no, see values, Section 2)	X	
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see Section 5)	X	

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
1) Substrate impacts		X	
2) Suspended particulates/turbidity impacts		X	
3) Water column impacts		X	
4) Alteration of current patterns and water circulation		X	
5) Alteration of normal water fluctuation/hydroperiod		X	
6) Alteration of salinity gradients		X	
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
1) Effect on threatened/endangered species and their habitat		X	
2) Effect on the aquatic food web		X	
3) Effect on other wildlife (mammals, birds, reptiles and amphibians)		X	

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
c. Special Aquatic Sites (Subpart E)			
1) Sanctuaries and refuges	X		
2) Wetlands	X		
3) Mud flats	X		
4) Vegetated shallows	X		
5) Coral reefs	X		
6) Riffle and pool complexes	X		
d. Human Use Characteristics (Subpart F)			
1) Effects on municipal and private water supplies		X	
2) Recreational and Commercial fisheries impacts		X	
3) Effects on water-related recreation		X	
4) Aesthetic impacts		X	
5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves		X	

List appropriate references:
Interim Ecosystem Restoration Feasibility Study and Environmental Assessment for the resacas in the vicinity of the City of Brownsville, Texas. Appendix A, Environmental Consequences Section.

	Yes
3. Evaluation of Dredged or Fill Material (Subpart G)	
a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material (check only those appropriate)	
1) Physical characteristics	X
2) Hydrography in relation to known or anticipated sources of contaminants	X
3) Results from previous testing of the material or similar material in the vicinity of the project	X
4) Known, significant sources of persistent pesticides from land runoff or percolation	
5) Spill records for petroleum products or designated (Section 311 of Clean Water Act) hazardous substances	X
6) Other public records of significant introduction of contaminants from industries, municipalities or other sources	X
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities	

	Yes	No
b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredged or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and placement sites and not likely to degrade the placement sites, or the material meets the testing exclusion criteria.	X	

List appropriate references:
Interim Ecosystem Restoration Feasibility Study and Environmental Assessment for the resacas in the vicinity of the City of Brownsville, Texas. Appendix A, Environmental Consequences Section, HTRW Subsection.

	Yes
4. Placement Site Delineation (230.11(f))	
a. The following factors as appropriate, have been considered in evaluating the placement site:	
1) Depth of water at placement site	N/A
2) Current velocity, direction, and variability at placement site	N/A
3) Degree of turbulence	N/A
4) Water column stratification	N/A
5) Discharge vessel speed and direction	N/A
6) Rate of discharge	N/A
7) Fill material characteristics (constituents, amount, and type of material, settling velocities)	N/A
8) Number of discharges per unit of time	N/A
9) Other factors affecting rates and patterns of mixing (specify)	N/A

List appropriate references: The dredged material will be treated at a mobile onsite dewatering/flocculation facility and the dredged material hauled to the landfill by truck. The placement area is an existing landfill in the City of Brownsville. The dredge material will be used as cover for the landfill facility. As stated in the "Interim Ecosystem Restoration Feasibility Study and Environmental Assessment for the resacas in the vicinity of the City of Brownsville, Texas. Appendix A, Environmental Consequences Section", some of the dredged material will be used as a soil supplement for the riparian planting areas.

	Yes	No
b. An evaluation of the appropriate factors in 4a above indicates that the placement site and/or size of mixing zone are acceptable.	N/A	

	Yes	No
5. Actions to Minimize Adverse Effects (Subpart H)		
All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77 to ensure minimal adverse effects of the proposed discharge.	X	

List actions taken:

1) **Impacts to the physical substrate from discharge of dredged material were minimized through a treatment facility that flocculates sediments from discharge waters and disposes the sediments to an existing upland disposal area. Some of the dredged material will be used as soil supplements for the riparian planting areas of the project area, see Interim Ecosystem Restoration Feasibility Study and Environmental Assessment for the resacas in the vicinity of the City of Brownsville, Texas. Appendix A, Environmental Consequences Section**

	Yes	No*
6. Factual Determination (230.11)		
A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:		
a. Physical substrate at the placement site (review Sections 2a. 3, 4, and 5 above)	X	
b. Water circulation, fluctuation and salinity (review Sections 2a. 3, 4, and 5)	X	
c. Suspended particulates/turbidity (review Sections 2a. 3, 4, and 5)	X	
d. Contaminant availability (review Sections 2a. 3, and 4)	X	
e. Aquatic ecosystem structure and function (review Sections 2b and c, 3, and 5)	X	
f. Placement site (review Sections 2, 4, and 5)	X	
g. Cumulative impacts on the aquatic ecosystem	X	
h. Secondary impacts on the aquatic ecosystem	X	

7. Evaluation Responsibility	
a. This evaluation was prepared by: Position:	**Daniel Allen** **Regional Technical Specialist, Coastal Section, CESWF-PEC-CC**

8. Findings	Yes
a. The proposed placement site for discharge of or fill material complies with the Section 404(b)(1) Guidelines.	X
b. The proposed placement site for discharge of dredged or fill material complies with the Section 404(b)(1) Guidelines with the inclusion of the following conditions:	

List of conditions:

c. The proposed placement site for discharge of dredged or fill material does not comply with the Section 404(b)(1) Guidelines for the following reason(s):	
1) There is a less damaging practicable alternative	
2) The proposed discharge will result in significant degradation of the aquatic ecosystem	

3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem	

2/7/18 Date	Douglas C. Sims Chief, Environmental Compliance Branch, Regional Planning and Environmental Center

NOTES:

* A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

Negative responses to three or more of the compliance criteria at the preliminary stage indicate that the proposed projects may not be evaluated using this "short form" procedure. Care should be used in assessing pertinent portions of the technical information of items 2a-e before completing the final review of compliance.

Negative response to one of the compliance criteria at the final stage indicates that the proposed project does not comply with the Guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form" evaluation process is inappropriate.

APPENDIX D-4

Federal Aviation Administration Coordination

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U.S. Department
of Transportation
**Federal Aviation
Administration**

Federal Aviation Administration
Southwest Region, Airports Division
Texas Airports Development Office

FAA-ASW-650
10101 Hillwood Parkway
Fort Worth, Texas 76177

September 5, 2017

Douglas C. Sims, RPA
Chief, Environmental Compliance Branch
Regional Planning and Environmental Center
P.O. Box 17300
Fort Worth, TX 76102-0300

VIA EMAIL

Subject: Brownsville Resacas Ecosystem Restoration Study Feasibility Report/ Environmental Assessment Wildlife Hazard Mitigation

Per your letter dated August 22, 2017, the U.S. Army Corps of Engineers, Galveston District (USACE) and the Brownsville Public Utilities Board are requesting FAA concurrence on the following mitigation measures for the Brownsville Resacas Restoration Project:

1. The bank restoration and emergent planting measures will be removed from a 1,000-foot buffer from the flight paths of runways 13/31 and 18/36. Restoration measures in this area will consist of invasive plant management and native riparian shrub plantings only.

2. The Feasibility Report/Environmental Assessment (FR/EA) for the Brownsville resaca ecosystem restoration study will address the commitment to conduct bird surveys during the initial Preconstruction Engineering and Design (PED) phase of the project. USACE will coordinate the results of the bird surveys with the FAA, and if possible, coordinate the surveys to coincide with the development of the wildlife hazard report update for the Brownsville airport.

3. A conditional Finding of No Significant Impact will be drafted to include the two requirements listed above.

4. USACE will coordinate the changes to the Draft FR/EA and the conditional FONSI with the FAA prior to the publication of the Final FR/EA.

If the project incorporates the measures above, the FAA concurs that the project will be in compliance with FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports.

Thank you for your cooperation in this matter. If you need any additional assistance, feel free to contact this office.

Sincerely,

John MacFarlane
Environmental Protection Specialist
Texas Airports District Office

cc: Richard Middleton
Daniel Allen, USACE

APPENDIX D-5

Texas Coastal Management Program Coordination

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

July 26, 2017

CERTIFIED MAIL

Mr. Douglas Sims
Chief, Environmental Compliance Branch
Fort Worth District
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76012-0300

Re: Draft Feasibility Report and Integrated Environmental Assessment for the Resacas at Brownsville Ecosystem Restoration Study (EA)

Dear Mr. Sims:

This letter is in response to the EA dated June 7, 2017, and the U.S. Army Corps of Engineers' (Corps) request for certification received July 20, 2017, on the Brownsville Public Utilities Board proposed Brownsville Resacas Ecosystem Restoration project. The project is located in Brownsville, Cameron County, Texas.

The Texas Commission on Environmental Quality (TCEQ) has reviewed the EA. On behalf of the Executive Director and based on our evaluation of the information contained in these documents, the TCEQ certifies that there is reasonable assurance that the project will be conducted in a way that will not violate water quality standards.

The purpose of the Resacas at Brownsville, Texas Ecosystem Restoration Study is to restore, at a landscape level, the resacas within the study area to sustainably support native fish and wildlife species in perpetuity. Specifically, the goal of the study is to identify degraded areas for potential habitat restoration that would facilitate the creation of valuable yet limited wildlife transportation corridors through the City of Brownsville. The study area includes three separate Resaca systems: Resaca del Rancho Viejo stretching west to east across the northern portion of the city of Brownsville, Resaca de la Guerra transecting the middle portion of the city, and the Town Resaca system located at the southern end of the city. The study area encompasses the portions of the resaca systems from the edge of the western Brownsville city limit to the eastern city limit boundary, inclusive of Cameron County inholdings.

The TCEQ has reviewed this proposed action for consistency with the Texas Coastal Management Program (CMP) goals and policies in accordance with the CMP regulations (Title 31, Texas Administrative Code (TAC), Section (§)505.30) and has determined that the action is consistent with the applicable CMP goals and policies.

This certification was reviewed for consistency with the CMP's development in critical areas policy (31 TAC §501.23) and dredging and dredged material disposal and placement policy (31 TAC §501.25). This certification complies with the CMP goals (31 TAC §501.12(1, 2, 3, 5)) applicable to these policies.

No review of property rights, location of property lines, nor the distinction between public and private ownership has been made, and this certification may not be used in any way with regard to questions of ownership.

If you require additional information or further assistance, please contact Ms. Jenna R. Lueg, Water Quality Assessment Section, Water Quality Division (MC-150), at (512) 239-4590 or by email at jenna.lueg@tceq.texas.gov.

Sincerely,

Jocalyn Mullins for

David W. Galindo
Water Quality Division Director
Texas Commission on Environmental Quality

DWG/JRL/sh

cc: Mr. Daniel Allen, Fort Worth District U.S. Army Corps of Engineers, P.O. Box 17300, Fort Worth, Texas 76012-0300

APPENDIX D-6

Hazardous, Toxic, and Radioactive Waste

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Hazardous, Toxic, and Radioactive Waste

Introduction

The purpose of this report is to discuss the HTRW investigation for the Resacas in the Vicinity of Brownsville, Texas, Interim Ecosystem Restoration Study. This report identifies both HTRW and non-HTRW environmental issues, and presents appropriate measures to resolve these issues. The methods used in performing the investigation are described in detail. Conclusions and recommendations regarding potential impacts due to HTRW and non-HTRW issues associated with the project site are provided. The purpose of the evaluation is to identify and avoid hazardous, toxic, or radiological wastes (HTRW) sites during planning or implementation of a USACE project, to the extent practicable.

Records Review

A records review gathers and analyzes existing information to identify potential HTRW sites within or near a project area. The records review correlated the standard ASTM environmental record sources and search distances to the proposed footprint of the study alternatives. The recognized environmental conditions (RECs) are discussed below.

Authority

Engineer Regulation (ER) 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works projects, requires that a site investigation be conducted as early as possible to identify and evaluate potential HTRW problems. According to ER 1165-2-132, non-HTRW issues that do not comply with the federal, state, and local regulations should be discussed in the HTRW investigation along with HTRW issues.

The HTRW investigation presented in this report was conducted during the feasibility phase of the project. This report was performed at the level of detail required and relies on existing information, observations made through database research, and aerial photograph, topographic map, and historical document review, a site visit, and information provided by the local sponsor.

Hazardous, Toxic, and Radioactive Waste

The objective of ER 1165-2-132 is to outline procedure to facilitate early identification and appropriate consideration of HTRW. This investigation, therefore, identifies potential HTRW and discusses resolutions and/or provides recommendations regarding the HTRW identified.

Non-Hazardous, Toxic, and Radioactive Waste

According to ER 1165-2-132, non-HTRW environmental issues that do not comply with federal, state, and local regulations should be discussed in the HTRW investigation along with HTRW. For example, solid waste is a non-HTRW issue considered. Petroleum releases from leaking underground storage tanks (LUSTs) are not considered HTRW but are regulated under state law. These sites have the potential to impose environmental hazards. Non-HTRW issues identified during the investigation are also discussed in this report, along with resolutions and/or recommendations for resolution.

GUIDANCE

Supplemental guidance was provided by the Standard Practice for Environmental Assessments: Phase I Environmental Site Assessment Process (Designation: E 1527-13) prepared by the American Society for Testing of Materials (ASTM). See Table D-6-1. The purpose of this guidance is to define good commercial and customary practice in the United State of America for conducting an environmental site assessment of a parcel of commercial real estate with respect to the range of contaminants within the scope of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 U.S.C. § 9601) and petroleum products. These standards recommend that an environmental assessment include a records review, site visit, and interviews.

The goal of the environmental site assessment process is to identify RECs on a property. The term recognized environmental conditions means the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment. De minimis conditions are not recognized environmental conditions; background concentrations of anthropogenic compounds are de minimis.

LAWS AND REGULATIONS

Federal

The definition of HTRW according to ER 1165-2-132, page 1, paragraph 4(a) is as follows: *"Except for dredged material and sediments beneath navigable waters proposed for dredging, for purposes of this guidance, HTRW includes any material listed as 'hazardous substance' under the Comprehensive Environmental Response, Compensation and liability Act, 42 U.S.C. 9601 et seq (CERCLA). (See 42 U.S.C. 9601 (14).) Hazardous substances regulated under CERCLA include 'hazardous wastes' under Sec. 3001 of the Resource Conservation and Recovery Act, 42 U.S.C. 6921 et seq; 'hazardous substances' identified under Section 311 of the Clean Air Act, 33 U.S.C. 1321, 'toxic pollutants' designated under Section 307 of the Clean Water Act, 33 U.S.C. 1317, 'hazardous air pollutants' designated under Section 112 of the Clean Air Act 42, U.S.C. 7412; and 'imminently hazardous chemical substances or mixtures' on which EPA has taken action under Section 7 of the Toxic Substance Contol Act, 15 U.S.C. 2606; these do not include petroleum or natural gas unless already included in the above categories. (See 42 U.S.C. 9601(14).)"*

As noted in 42 U.S.C. 9601(14), the term "hazardous substance" does not include crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance, nor does the term include natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel. Underground storage tanks (USTs) are federally regulated under 40 CFR Part 280, which includes technical standards and corrective action requirements for owners and operators of USTs.

Table D-6-1: Standard ASTM Search Distances, Records Review Results, and Sources

ASTM Source	ASTM Distance (miles)	Number of Results	Source Name
Federal National Priorities List (NPL) site list	1.0	0	Environmental Protection Agency (EPA) Cleanups In My Community
Federal Delisted NPL site list	0.5	0	EPA Cleanups In My Community
Federal Comprehensive Environmental Response, Compensation, and Liability, Information System (CERCLIS) (SEMS) list	0.5	0	EPA EnviroFacts
Federal No Further Remedial Action Planned (NFRAP) (SEMS archive) site list	0.5	0	EPA EnviroFacts
Federal Resource Conservation and Recovery Act (RCRA) Corrective Action facilities list	1.0	0	EPA Cleanups In My Community
Federal RCRA TSD facilities list	0.5	0	EPA EnviroFacts
Federal RCRA generators list	Property and adjacent properties only	3	EPA EnviroFacts
Federal ICs/Engineering Control registry	Property only	0	Source not found*
Federal Emergency Response Notification System (ERNS) list	Property only	594*	Right To Know database (rtk.net)
State and tribal equivalent National Priority List (NPL) list	1.0	0	Texas Commission on Environmental Quality (TCEQ) Central Registry
State and tribal equivalent CERCLIS	0.5	0	TCEQ Central Registry
State and tribal landfill and/or solid waste disposal sites	0.5	1	TCEQ Central Registry
State and tribal leaking AST/UST sites	0.5	4	TCEQ Central Registry
State and tribal registered storage tank list	Property and adjacent properties only	326*	TCEQ Central Registry
State and tribal ICs/Engineering Control registry	Property only	0	Source could not be accessed*
State and tribal voluntary cleanup sites	0.5	0	TCEQ Central Registry
Federal, State and tribal Brownfields site list	0.5	1	EPA Cleanups In My Community

** Denotes a data failure*

Federal Resource Conservation and Recovery Act (RCRA) Generators List

The Resource Conservation and Recovery Act (RCRA) generators list identifies sites that generate quantities of waste classified as hazardous under RCRA. Three sites adjacent to resacas to be restored under Alternative 5 were classified as conditionally exempt. The first was classified as a conditionally exempt small quantity generator, the second as a small quantity generator, and the third as unknown. Even with their proximity to the resacas to be restored, no impact is expected to the proposed project from these sites. Their generator status is not sufficient to expect an impact. The site with the unknown generator status is located at 3501 N Vermillion rd., Brownsville, Texas, immediately adjacent to the resaca. The facility is used as an auto parts manufacturer’s warehouse, and is not expected to interact with the proposed project.

Site Name	Location	RCRA Status	Latitude	Longitude
Express Cleaners	1601 E. Alton Gloor Blvd.	CESQG	25.98192	-97.48584
Walmart # 5493	7480 Padre Island Blvd.	SQG	25.94492	-97.42556
Inteva Products LLC Warehouse	3501 N. Vermillion Rd.	Unknown	25.95292	-97.41927

Federal Emergency Response Notification System (ERNS) List

The Federal Emergency Response Notification System (ERNS) records and stores information on reported releases of oil and hazardous substances. A search of available ERNS records show that 594 release incidents have been reported to the National Response Center (NRC) from 1982-2016. However, due to the quality of the data, it is impossible to discern whether these releases occurred in any of the resacas being considered for restoration. A review of specific 2016 data showed that all reported releases for that year occurred in the Brownsville Ship Channel, well away from the proposed project. It is reasonable to believe that some of the releases from 1982-2016 occurred in the resacas; however, without specific data showing this, it is impossible to determine the risk to the proposed project.

The failure of this data set to provide enough information is called a data failure.

Federal Institutional Controls/Engineering Controls Database

This search is designed to look for sites where institutional or engineering controls are in place to prevent exposure to contaminants that are left on the site. These controls are typically implemented as part of response or remediation efforts at cleanups sites where the remedy keeps contaminants onsite, such as a capping or groundwater containment and extraction system. No database was found on this topic, and no data could be found for this search. However, the proposed project takes place in areas where no remediation has occurred in the past. Therefore it’s reasonable to deduce that no institutional or engineering controls are in place at the proposed project properties.

State and Tribal Solid Waste Facilities/Landfill Sites

This search is designed to check any state or tribal databases for solid waste handling facilities or landfills in the project vicinity. A site was identified, located at the intersection of W Alton Gloor Blvd. and State Highway 281. The site is referred to as the Flor De Mayo pit, and appears to have an active municipal solid waste permit. However, no other information about this site could be found, including exact location, waste accepted, or contact information. This site is about 0.5 miles from a potential restoration area, but no impact is expected.

State and Tribal Leaking Above Ground Storage Tank (AST) Underground Storage Tank (UST) Sites

This database is a list of leaking petroleum storage tank incidents, maintained by the State of Texas. A search of this database identified 4 sites where active remediation is underway for leaking petroleum storage tanks within a half mile of any of the resacas. None of the sites are expected to impact the proposed project.

Site Name	Location
City Stop 22	5405 South Padre Island Hwy
Dan’s Quick Stop	7878 Boca Chica Blvd.
Magic Mart	2100 E Price Rd.
Four Corners Texaco	3375 Boca Chica Blvd.

State and Tribal Registered Storage Tanks

This list is a combination of the State of Texas registered UST and AST databases, representing sites with storage tanks registered with the State of Texas. 326 registered underground storage tanks (USTs) and/or aboveground storage tanks (ASTs) sites were identified within the City of Brownsville.The existence of a registered storage tank (UST or AST) is not sufficient to believe that contamination is likely to be generated, and therefore none of these sites will be carried forward as RECs.

State and Tribal ICs/Engineering Control registry

The State of Texas maintains a database called the Activity Use Limitations (AUL) List, which functions as the state’s IC list. This database is proprietary and could not be accessed. Similar to the federal IC database, sites on this list would likely be areas where remediation had been completed and contamination was left in place. No documentation of cleanup sites was found within the proposed action area. Therefore, no ICs or engineering controls are expected.

Brownfields List

The Brownfields database is a list of sites where information has been reported back to EPA Brownfields Assessment office. This does not mean these sites were selected as Brownfields for redevelopment, or that. A site was found in the search area, located at 5800 Stagecoach Trail, which currently houses a church. EPA documentation shows that the site was investigated, but no further action was taken. This site is not expected to impact the proposed project.

3.0 Site Visit

The site visit in environmental investigations is designed to identify environmental conditions that would otherwise not be identified in the records search. The site visit also is used to look at indoor areas and area usages on the subject property. A site visit was not conducted for this phase of the investigation.

4.0 Interviews

The objective of the interviews is to discover environmental conditions that could not be obtained in the records search, as well as to determine past uses of the subject property. Due to time constraints, no interviews were conducted. If necessary, for further investigation potential interviewees can be identified in the future.

5.0 Conclusion

No sites with recognized environmental condition, were identified within the footprint of the alternatives evaluated.

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APPENDIX D-7

Public Review Comments and USACE Responses

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The Resacas at Brownsville, Texas

Ecosystem Restoration Study

Draft Report and Integrated Environmental Assessment

- Public Comments, and
- District Responses

The public comments that follow are in response to the June 2017 joint notice of availability (Figure D-7-1) and public meeting held 14 June 2017. The notice indicated comments could be provided by email or letter. Three comments were received by email and one by letter.

Attachment A provides the comments.

Attachment B provides the USACE responses to comment.

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DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON, TEXAS 77553-1229

JOINT NOTICE OF AVAILABILITY
DRAFT FEASIBILITY STUDY AND INTEGRATED ENVIRONMENTAL ASSESSMENT
FOR THE PROPOSED U.S. ARMY CORPS OF ENGINEERS
RESACAS AT BROWNSVILLE ECOSYSTEM RESOTRATION
CAMERON COUNTY, TEXAS
June 2017

The public is hereby notified of the draft Integrated Feasibility Report and Environmental Assessment (EA) for the Resacas at Brownsville Ecosystem Restoration Study (Cameron County, Texas), prepared by the U.S. Army Corps of Engineers, Galveston District (USACE), in partnership with Brownsville Public Utilities Board (BPUB). Authorized by Congress in a resolution from the House Committee on Transportation and Infrastructure dated November 10, 1999, the study is a vital tool produced and used by the U.S. Army Corps of Engineers (USACE) to guide the responsible stewardship of USACE administered resources for the benefit of present and future generations. The report is also available for download at the following URL address:

http://www.swg.usace.army.mil/BusinessWithUs/PlanningEnvironmentalBranch/DocumentsforPublicReview.aspx

Compact disc (CD) copies of the report can be requested from Mr. Harmon Brown at the address above. In addition, CDs of the report are available for viewing at the following libraries:

- Brownsville Public Library (Main Branch), 2600 Central Blvd., Brownsville, TX 78520
- Brownsville Public Library (Southmost Branch), 4320 Southmost Blvd., Brownsville, TX 78521

A public information meeting will be held in the Brownsville area during the public comment period. Please refer to the Galveston District website at http://www.swg.usace.army.mil/ for the upcoming announcement of a meeting date and location.

The USACE will accept written public comments on the integrated report for a 30-day period starting on June 12, 2017 and continuing through July 12, 2017. Comments on the report must be postmarked by July 12, 2017. You may send written comments or questions to the USACE, Galveston District, Attn: Harmon Brown, P.O. Box 1229, Galveston, TX 77553-1229, or you may email comments or questions to Harmon.Brown@usace.army.mil.

This public notice is also issued for the purpose of advising all known interested persons that there is pending before the TCEQ a decision on water quality certification. Any comments concerning this application may be submitted to the TCEQ, 401 Coordinator, MSC-150, P.O. Box 13087, Austin, Texas 78711-3087. A copy of the public notice, with a description of work, has been made available for review in the TCEQ's Austin office.

07 June 2017
Date

Brian Harper
Chief, Civil Planning Branch

Figure D-7-1: Joint Notice of Availability

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Attachment A – Public Comments

Comment provided at the public meeting.

June 14, 2017

Dear U.S. Army Corp. of Engineers and Brownsville PUB,

My name is Melissa Landin, and I am an executive board member for Hooked for Life, Kids Gone Fish'n. We organize an annual event held at one of Brownsville's beautiful resacas. This year marked our 8th annual event.

Each year, more than 5,000 people attend our event where many learn to fish for the first time. It is an all-free, community event. Each child -- ages 0-16 -- goes home with a free fishing rod, bait, lunch, a goodie bag and more. But more importantly, they begin to develop a love for fishing.

The Brownsville Public Utilities Board has been a tremendous partner with helping us to provide this quality-of-life event for our City. And, with the event being held at one of Brownsville's beautiful resacas, Hooked for Life fully supports the city's efforts to restore and improve upon our resaca system.

Brownsville's resacas are a jewel in the community – from kayak use to fishing.

Oftentimes, I see children and families enjoying some fishing on our resacas. And oftentimes, you'll see a group of kiddoes balancing their bicycles' handles with one hand as they hold a rod in the other. Where are they going? Fishing with friends at one of our many resacas. We have a saying: "Trade in that Xbox for a Tackle Box." And, it is because our resacas are plentiful and accessible that Brownsville's children can enjoy this virtually free pastime. Restoring and improving our resacas will allow more families to enjoy some quality time fishing.

Hooked for Life fully and wholeheartedly supports the Brownsville Public Utilities Board and the U.S. Army Corp. of Engineers in all efforts to restore and improve our resacas.

Sincerely,

Melissa Landin

Melissa Landin

From: Elizabeth Caro
Sent: Thursday, July 13, 2017 1:58 PM
To: Brown, Harmon III CIV USARMY CESWF (US)
Subject: Resaca Restoration Brownsville, Texas

To whom my concern:

Hello to all, my name is Elizabeth Caro I'm an activist, I 'm doing a project to protect the wildlife in the Resacas in Brownsville, Texas.

In the past, I contact many people working in different Agencies and areas, PUB, CITY OF BROWNSVILLE, WILDLIFE, US ARMY expressing my concerns about the Resacas, my biggest concern is all the Wildlife around the Resacas, ducks, birds, turtles, nutrias fishes etc.....

I'm really concern regarding the ducks and bird's because the population is shrinking, to the point in some resacas you don't see any ducks anymore.

The quality of water is very important too, contamination and all kinds of garbage is a serious problem, in the past after conversation with different people with PUB, CITY OF BROWNSVILLE, WILDLIFE, WAS NOT CLEAR WHAT HAPPEN WITH THE FISHES AND TURTLES, WHEN PEOPLE IS WORKING IN THE RESACAS, BUT SAME TIME ABOUT THE TRIMMING WITH NOT SUPERVISION AND CONTROL, I ASK SOME PEOPLE AND EACH TELL ME THAT THEY ARE NOT RESPONSABLE.

FOR PRESERVATION WE NEED TO WORK TOGETHER WITH PROTECTING THE NATIVE, GRASS, PLANTS BUSHES AND TREES, THEY ARE TRIMING WITH NO CONTROL AND SUPERVISION AND IT'S DESTROYING THE WILDLIFE HABITAT.

CONSERVATION IS VERY IMPORTANT TOO AND HELP THE HABITAT FOR ALL DIFFERENT SPECIES CREATING THE NATURAL HABITAT AND HELPING THEM WITH THE FOOD SOURCES.

In 2016, I send an email to several people expressing my concerns with no answer from the city of Brownsville, sad very sad.

I'M REQUESTING THE FOLLOWING:

1-Short time projects, long time projects affect the wildlife habitat.

2-Please do by parts, no all in the same time, because do a lot damage to the animals. Ducks and birds turtles are walking in the street looking for food and people are running over them.

3-Protect natural grass, plants, trees and bushes, THIS IS SO IMPORTANTAS A FOOD SOURCE AND FOR SHELTER.

4-CREATING SMALL ISLANDS IN THE RESACAS THIS CAN HELP A LOT TO PROTECT THE EGS AND THE NEST, FOR THE DUCKS AND BIRDS AND HELPING THEM IN THE SAME TIME for a place to rest and protect themselves from people, predators, street dogs etc...

5-Keep bushes and plants in the surrounding areas, somebody working for the city of Pub, in the past they trim and they cut a lot of plants and trees leaving some of the resacas with few or nothing and this resacas you don't see ducks or big birds any more.

6-SUPER IMPORTANT ALEGATORS; The local news make a report from alligators in the resacas. I'm requesting to remove them and placed in one place to have a control of them, before is a social problem with out of control, this is very important to help for preservation, for the local ducks birds, turtles and all the wildlife around. Also this can cause a lot of problems for family's who own a house with a Resaca property, other places remove the alligators or crocodiles to keep track of them. The City of Brownsville need to take action before is too late.

7-Garbage, sample Resaca cemetery is done and It's so sad the amount of garbage around for months I don't' see any agency cleaning inside the Resaca, I go every day is how I know this is happening. I'm requesting a plan to maintain clean with out of garbage, the contamination is a serious problem.

8-Fishing: I see people fishing with a fishing net in the resacas and taken the fish in trucks, in the weekends in some places people do that, putting the fish population in risk and to other wildlife depending in fish, like pelicans, ducks etc. I'm requesting a plan to help the wildlife in the resacas with laws about fishing, but also ducks and birds kill from people intentionally with no mercy. REQUESTING SIGNS IN ENGLISH AND SPANISH WITH RULES AND PENALITIES ALSO IS GOOD TO TECH PEOPLE, WHAT NOT TO DO IN THE RESACAS.

9-THE DUCKS POPULATION AND BIRDS HAVE BEEN DECLINING NOW FOR MANY REASONS AND WE NEED TO DO SOMETHING TO HELP THE POPULATION GROW...THIS IS WHAT I'M DOING BY MY SELF FOR YEARS IN SOME RESACAS, BUT WE NEED TO WORK TOGETHER TO HELP THE HABITAT. NOTE: Sometimes people forget the animals and birds, like us, they need food sources, shelter, place for rest, in hot or cold weather, plants, trees and bushes for shade, places to have the eggs protected, clean water, the Ducks are always looking for clean fresh water.

This is a sample and I tell Rene with PUB and Ellie with the army, the Resaca in Bernard is one of my biggest concern.

10-TRAFIC Some streets have a busy traffic but others no, the sad thing some people speed and run over ducks or turtles, some areas need signs from duck crossing and turtle crossing too. Requesting the police, check very close to resacas the people speed when they driving, near Resacas.

I'm ready to help. I love to do my part of this project with the resacas, because I love our Resacas and the Wildlife, but the Ducks and birds are my number one concern.

Thanks to all for taken the time reading this email, so let's do something together.

Any question please call me at 956-204-1930 <tel:(956)%20204-1930> or send me an email to, thanks so much, to hope you have a great day!!

Sincerely,

Elizabeth Caro.

From: Kenneth Teague
Sent: Wednesday, June 28, 2017 2:42 PM
To: Brown, Harmon III CIV USARMY CESWF (US)

Subject: Fw: DRAFT FEASIBILITY STUDY AND INTEGRATED ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED U.S. ARMY CORPS OF ENGINEERS RESACAS AT BROWNSVILLE ECOSYSTEM RESOTRATION CAMERON COUNTY, TEXAS

Dear Mr. Brown: I reviewed the DRAFT FEASIBILITY STUDY AND INTEGRATED ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED U.S. ARMY CORPS OF ENGINEERS RESACAS AT BROWNSVILLE ECOSYSTEM RESOTRATION CAMERON COUNTY, TEXAS, and I have the following comments:

* While it seems reasonably likely the proposed project will have significantly positive impacts, if the sediments proposed to be dredged and disposed are not contaminated, apparently nobody has appropriately evaluated this latter critical question.

* The resacas have received decades of runoff from urban, residential, and agricultural landscapes. It is reasonably likely that some of the sediments are excessively contaminated with metals, PAHs, and /or pesticides. This analysis did not address these risks.

* I recommend a revised EA or EIS, including the results of a high quality sediment contaminant study conducted as per the requirements of the Inland Testing Manual and/or the Upland Testing Manual. Potential effects of dredged material disposal on water quality and sediment quality should be evaluated.

* In addition, depending on the proposed dredged material disposal location and management, the potential for upland soil contamination should be evaluated.

* If such evaluations are not conducted prior to finalization of NEPA compliance documents for this project, the Corps will not be in compliance with the National Environmental Policy Act.

I hope the Corps and the local sponsor have the wisdom, ethical compass, and technical strength to see that the absence of a robust evaluation of resaca sediment quality is a very unfortunate oversight that must be corrected prior to making a determination that the proposed project will not have a significant impact on the human environment.

Sincerely,

Kenneth G. Teague, PWS, Certified Senior Ecologist

From: Jude Benavides
Sent: Wednesday, July 12, 2017 5:01 PM
To: Brown, Harmon III CIV USARMY CESWF
Subject: comments - Brownsville Resacas

Where to start – hmmmmmm. I've been working on and off on resacas since 1990 and have been through several rounds of USACE involvement.   I realized too late the deadline for submitting comments is today.

There are too many details and issues to go into to discuss in one comment entry, but I will attempt to briefly summarize one major point here.

Any attempt to study and/or restore ecosystems of Brownsville area resacas must be conducted via a carefully planned out and agreed upon SYSTEM-wide level that appreciates the many roles they played historically and presently.

Resacas are poorly understood by many, including the majority of those who have worked on them or studied them at the state and federal level.

I applaud the write-up and work done to date through this effort by the Corps. I also applaud the attempt made to address them in a combined and holistic approach that appreciates their various functions.

However, I'm deeply concerned that the final proposed outcome of this effort relies far too heavily (or even demands) an upfront disconnect between ecosystem function and their hydrology.

Specifically:

1. I see very little acknowledgement of what can or should really be considered a baseline to which to restore. Furthermore, there should be multiple baselines and goals as some Resaca systems or portions of a connected system may best be reallocated to a new use or ecosystem.

2. I do not believe there is sufficient emphasis on how riparian ecosystem both relies on and connects with the changed hydrology of the resacas and how multiple uses of the existing systems might benefit. If the goal can only be "riparian plant habitat" or "aquatic plant habitat" in a vacuum, separate from hydrology, storm water contributing area land use, etc. we are really wasting out time.

3. Requiring local stakeholder (partner) to acquire and apparently maintain miles of extremely narrow, restored riparian ecosystem on once private property is not only a near political impossibility, but will result in very little acreage that is truly sustainable. This is particularly true for the majority of the sections for which local stormwater is conveyed to the resacas via underground storm drains and not through overland flow.

4. I encourage the Corps to truly work with local experts and stakeholders on how we can continue to move forward on the good work done (great write-up, decent maps, relevance of specific flora to ecosystem function) and start on a truly system-wide, holistic approach toward ecosystem function of the resacas. This will require hydrologic modifications (all of which that are currently proposed are feasible and possible – ie flow augmentation from scalped river water), considering water quality improvements (working with the EPA), and creating agreed upon baselines and alternatives to strict / broad restoration.

Thanks,

Jude A. Benavides, Ph.D.

Associate Professor of Hydrology and Environmental Sciences

School of Earth, Environmental, and Marine Sciences

UTRGV – Brownsville Campus

Attachment B – Responses to Public Comments

1. Response to comment card by Melissa Landin: Comment Noted.

2. Responses to email comments by Elizabeth Caro. The proposed project would be implemented in stages over a 16 year period. Existing native vegetation would be incorporated where feasible. The proposed project goal is to restore the vegetation to one of three critically imperiled vegetation associations: Texas Ebony Resaca Forest, Subtropical Texas Palmetto Woodland, and Texas Ebony/Snake-eyes Shrubland. Existing vegetation that is a component of these species may be incorporated. The creation of islands to increase habitat benefits were screened out of the initial array of alternatives due to the relatively high cost associated with island construction and comparison to the resulting habitat benefits. The Operation and Maintenance (O&M) for the ecosystem restoration does not allow for pruning of native species. Non-native and invasive species would be controlled and managed by the BPUB. The proposed ecosystem restoration is designed to create native habitats for all native fish and wildlife species. Although the proposed project does not create habitat specific to alligators, the project would create habitat that alligators could use. Restored native riparian vegetation would filter trash, excessive nutrients, and contaminants from the Resacas. The proposed restoration project would not restrict fishing beyond TPWD and City of Brownsville fishing regulations. The restored aquatic and riparian habitats would increase the water quality for fish, amphibians, and other wildlife. The proposed ecosystem restoration project would improve habitat (including food, nesting cover, and shelter) for all native wildlife inhabiting the Resacas. The regulation of traffic adjacent to the study area is beyond the scope of this project.

3. Response to email comments by Kenneth G. Teague, PWS, Certified Senior Ecologist. We share your concern for the potential for contaminants in the sediments to be dredged from the Resacas. We are currently basing our plan of action on the testing conducted by the BPUB on a limited number of Resacas. That analysis indicates no contaminants have been found in concentrations greater than guided by EPA standards. We will precede to the next phase of investigation at which time additional sediment sampling and testing will occur for all construction areas. If contaminated sediments are identified, dredging plans will be reassessed and a subsequent plan of action will be developed based on the type(s) and scope of contamination that may be found. In addition, it is our standard operating procedure to have contingency plans that the dredging contractor would follow if they encounter any materials they suspect are contaminated. The first action of those plans is to stop work and notify the construction inspector.

4. Response to Jude A. Benavides, Ph.D. Comment noted.

APPENDIX D-8

USFWS Letter of Support for Comprehensive Implementation

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United States Department of the Interior
FISH AND WILDLIFE SERVICE
South Texas Refuge Complex HQ
3325 Green Jay Road
Alamo, Texas 78516
Lower Rio Grande Valley National Wildlife Refuge
Laguna Atascosa National Wildlife Refuge
Santa Ana National Wildlife Refuge

October 18, 2017

Mr. Danny Allen
U.S. Army Corps of Engineers
Regional Planning and Environmental Center, Environmental Compliance Branch
819 Taylor St, Room 3A12
Fort Worth, TX 76102

You requested a letter of support from our agency regarding a comprehensive wetland (resacas) restoration effort previously initiated in the Brownsville, Texas area. Currently, your agency is conducting a feasibility study that is evaluating additional wetland improvements and adjacent upland habitat restoration actions.

A former staff member of mine, Chris Hathcock, Wildlife Refuge Specialist, previously participated in initial meetings and discussions as well as participated in some of the restoration efforts for the network of resacas that surround the greater Brownsville area. My understanding is that this effort is in part an initiative by the City of Brownsville to modify resacas for increasing their freshwater storage capability, but also for purposes of protecting and enhancing the adjacent resaca habitat to benefit local wildlife species. The resaca and adjacent upland habitat protection is an effort our agency strongly supports.

U.S. Fish & Wildlife Service finds that the habitat restoration and wetland protection efforts being planned by the City of Brownsville and the U.S. Army Corps of Engineers for their area resacas is consistent with our own agencies land and wetland management practices. In addition, it is my understanding that the Lower Rio Grande Valley National Wildlife Refuge has properties included in the current Feasibility Study which is evaluating further improvements to resacas. The specific properties under evaluation include the Fish Hatchery Tract and Villanueva Tract—both of which could benefit from additional wetland/upland habitat improvements (see Attachments). We support including these properties in your evaluation.

Following finalization of the Feasibility Study, we look forward to future collaboration with you and the City of Brownsville implementation team to insure the habitat restoration efforts on-refuge and City-wide meet the needs of the local community and resident wildlife.

Please let me know if there is anything else you need from me to support this effort. I look forward to working with you more in the future as the study reaches the implementation phases.

Sincerely,

Bryan R. Winton

Bryan R. Winton
Refuge Manager
Lower Rio Grande Valley NWR

cc: Robert D. Jess, Project Leader, South Texas Refuge Complex
Ernesto Reyes, Wildlife Biologist, Corpus Christi Ecological Services Field Office (Alamo Station)


0 0.125 0.25Miles
Fish Hatchery (249 ac.)
N
W
E
S
FISH HATCHERY


0 0.25 0.5Miles
Villanueva (405 ac.)
N
W
E
S
VILLA NUEVA

APPENDIX E

Engineering Appendix

Contents:

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APPENDIX E-1

ENGINEERING APPENDIX

ENGINEERING DESIGN

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Table of Contents

I. Engineering Scope

Various engineering services were provided in support of the feasibility study for the Resacas at Brownsville, Texas Ecosystem Restoration project. Those services were generally geared toward evaluating hydraulic models produced as part of a previous study, evaluating previously collected survey data, assessing the existing conditions of the resaca systems and calculating estimated construction quantities and costs associated with implementation of the various restoration measures under consideration. Feasibility level designs were also conducted for providing a method of controlling the water surface elevations in resaca segments where a vegetation restoration measure was being considered and for supplying water to hydraulically disconnected resaca segments included in the study.

II. Existing Data Sources

Every effort was made to obtain and use the most recent existing survey data and hydraulic models for the study area. The large footprint of the study area would have made gathering all new survey information extremely costly and time consuming. Therefore, survey information from various sources was utilized to establish the existing conditions for the study. A brief description of each source is described in the paragraphs below.

A. Field Survey

Limited survey data of various resaca segments was obtained in 2003 and 2004 by the Brownsville Public Utilities Board (BPUB) to determine available water depths and thickness of sedimentation throughout their resaca system. The surveys consisted of taking various measurements, but the primary data used in this study were cross sections taken across selected resaca segments. The cross sections included survey points located of the top of sediment, top of clay layer beneath the sediment and water surface elevation at the cross section location. While the age of the survey data was of some concern, it was decided that it was suitable for use in the feasibility study. An entry was made in the risk register to account for any variation that may have occurred over time at the locations of the surveyed cross sections.

B. LiDAR Survey

For areas where no ground based survey data was available, LiDAR survey data was used. The LiDAR data consisted of a single band, 10 meter resolution survey of Cameron, Willacy, and Kenedy Counties published by the NOAA Coastal Services Center and the US Geological Survey in 2012. The portion of the data in Cameron

County, in which this study is situated, was said to have originated from LiDAR data sets collected for the Texas Water Development Board (TWDB) in 2005 and 2006.

C. HEC-RAS Model

The BPUB provided HEC-RAS (Hydrologic Engineering Center's River Analysis System) models of Town Resaca, Resaca de la Guerra and Resaca del Rancho Viejo for use in this feasibility study. The models were originally developed by Ambiotec Group in cooperation with Rice University in 2003/2004 and later updated in 2011 to add Resaca del Rancho Viejo. The models were produced as part of a March 2006 Flood Protection Plan developed for the City of Brownsville and the Texas Water Development Board. Additional information on the HEC-RAS model is provided in the Hydrology and Hydraulics Appendix E-4.

III. Field Investigation

During a site visit July 25-29, 2016, BPUB personnel led a tour of the resaca systems and explained how they were connected and operated both for irrigation water supply during dry periods and for drainage during rainfall events. Measurements were taken of hydraulic structures, ecosystem surveys of potential restoration sites were conducted, to assess the possibility of linking multiple resaca segments into continuous corridors.

During the field investigation some resaca culverts were found to be different sizes than those coded in the HEC-RAS model. The culverts observed in the field were larger diameter pipes than those in the model. The discrepancy was discussed and it was decided to continue using the HEC-RAS model for the following reasons:

1. It was not anticipated that the larger culvert sizes would have an impact on any of the restoration measures being considered. This is because the resacas would be in a low flow condition for the vast majority of the proposed project life. Any high water events caused by storms would be of a short enough duration and include low enough velocities that restoration measures would not be negatively impacted.
2. A detailed model of the irrigation water delivery system would be required in order to establish water surface elevations during various operational conditions and to design a method of fluctuating those water surface elevations to mimic historical seasonal variations. Developing such a detailed model is beyond the scope of this General Investigation. An entry has been made into the risk register to account for risks associated with making feasibility level decisions without having a detailed model. Development of the detailed model will be performed during PED activities.

IV. Construction Quantity Estimation

A. Earthwork Quantities

Once the PDT had identified the initial array of restoration areas and associated measures, earthwork quantities were estimated using the surveyed cross sections, where available. The surveyed cross sections were plotted using MicroStation and InRoads CAD software packages. The bank sculpting and dredging measures were superimposed onto the plotted cross sections and associated cross sectional areas of dredge and fill were measured. These cross sectional areas were multiplied by the length of the proposed measure to estimate the total volume of earthwork associated with each measure for that area. A typical cross section showing the dredging and bank sculpting measures is presented in Figure E-1-1. Additional cross sections used in calculating earthwork quantities are shown in Figure E-1-2 through Figure E-1-9.

For areas where dredging or bank sculpting was proposed but no surveyed cross sections were available, average values from similar resaca segments were used. Dredge volumes were approximated by multiplying the area to be dredged by the depth of dredging required. Where dry resaca segments were to be excavated and provided with a source of water, the earthwork volumes were approximated in the same manner as for dredge volumes and water supply components were designed using available survey and LiDAR data. A summary of calculated quantities is provided in Table E-1-1. The Natural Resources Appendix A describes the restoration measures. Ecosystem restoration, design and real estate drawings of the resaca measures are located at the end of the main report.

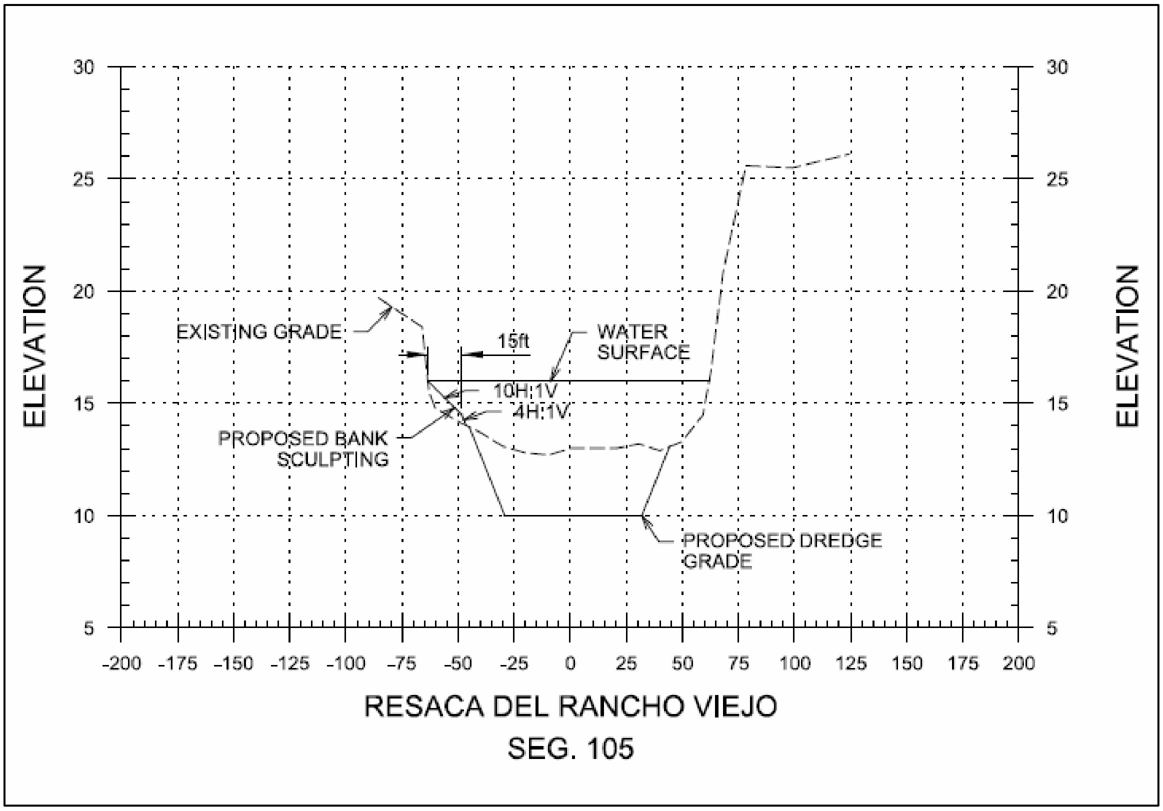

Figure E-1-1: Typical section with dredging and bank sculpting

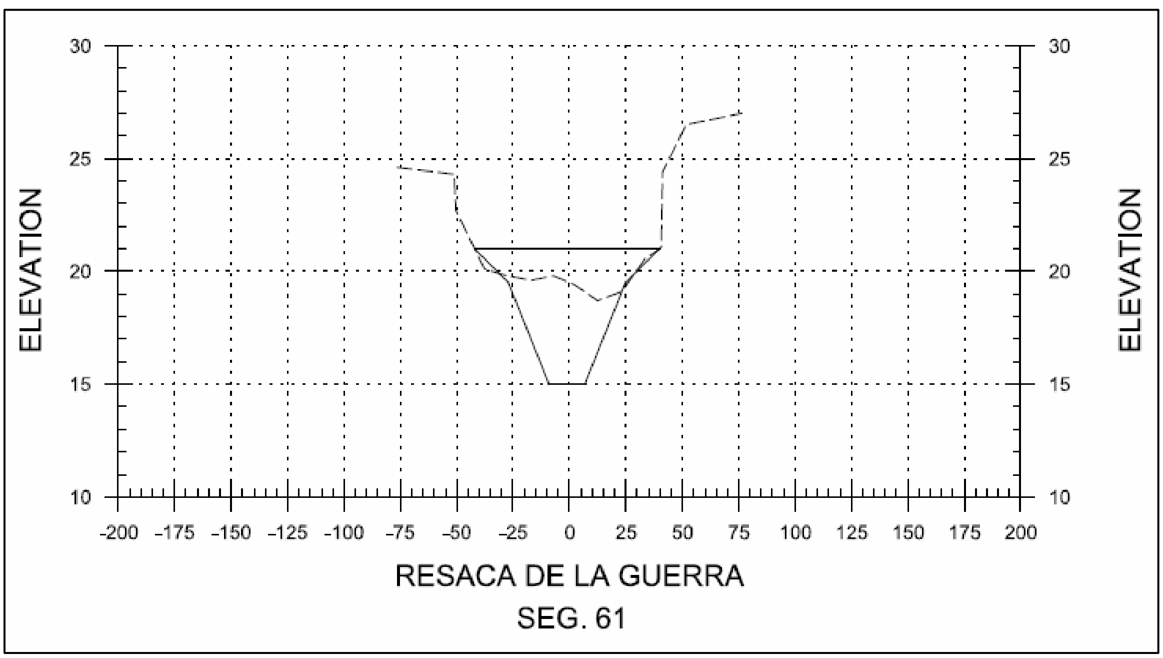

Figure E-1-2: Surveyed cross section of Segment 61

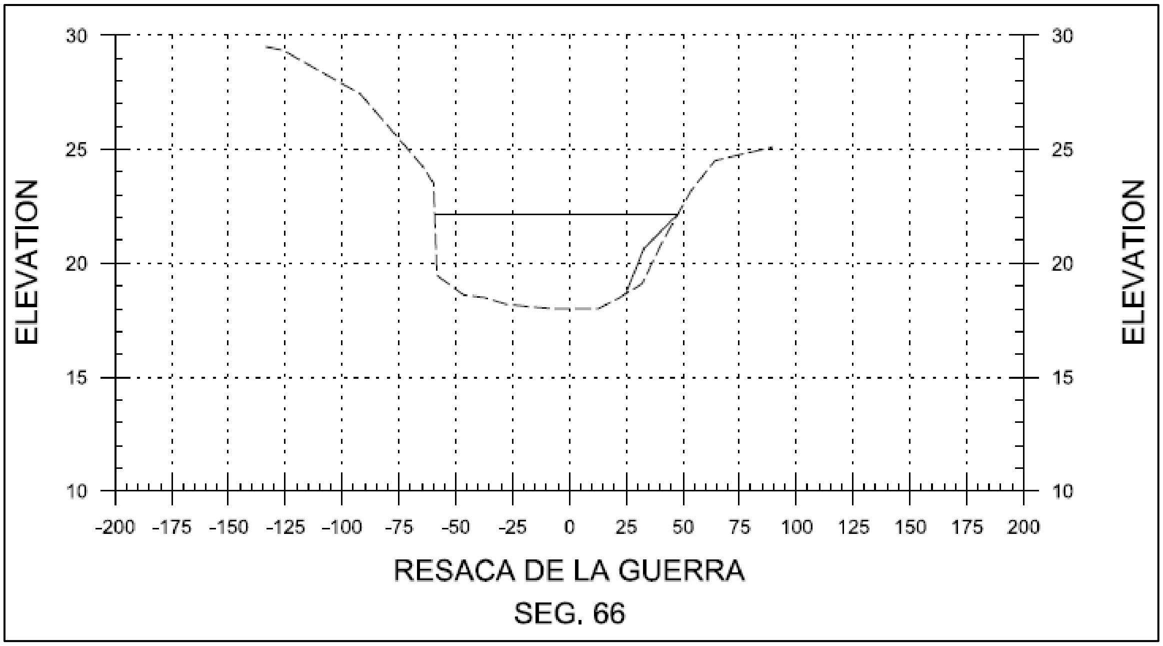

Figure E-1-3: Surveyed cross section of Segment 66

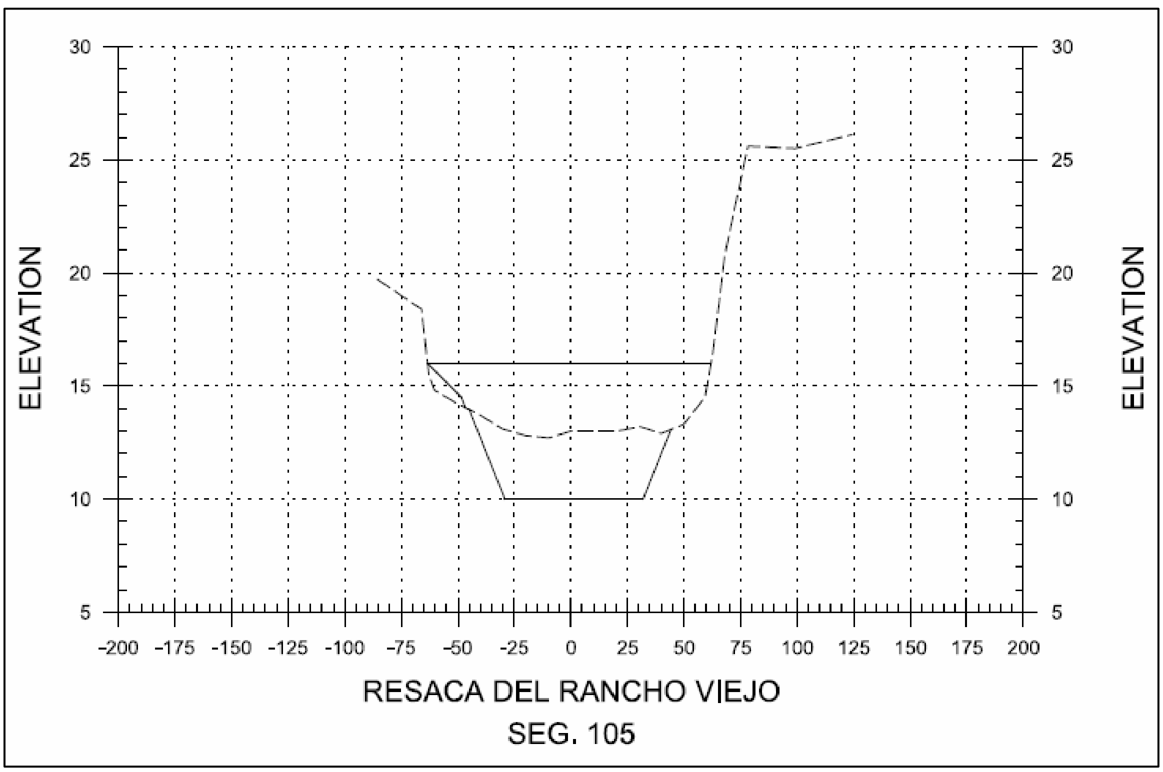

Figure E-1-4: Surveyed cross section of Segment 105

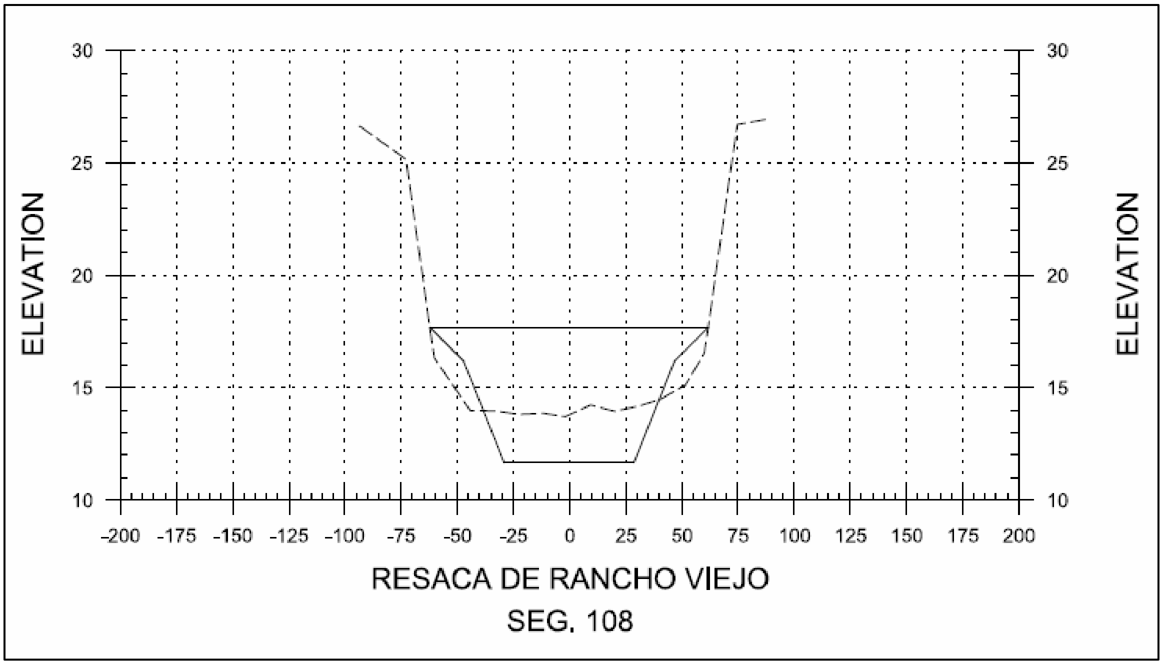

Figure E-1-5: Surveyed cross section of Segment 108

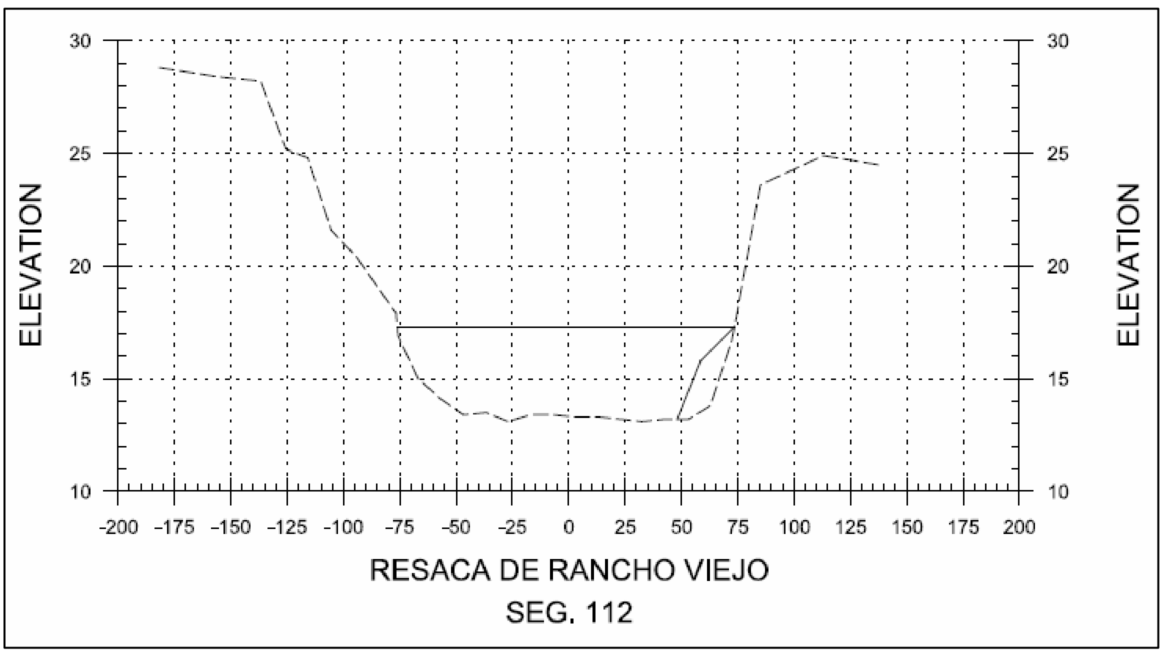

Figure E-1-6: Surveyed cross section of Segment 112

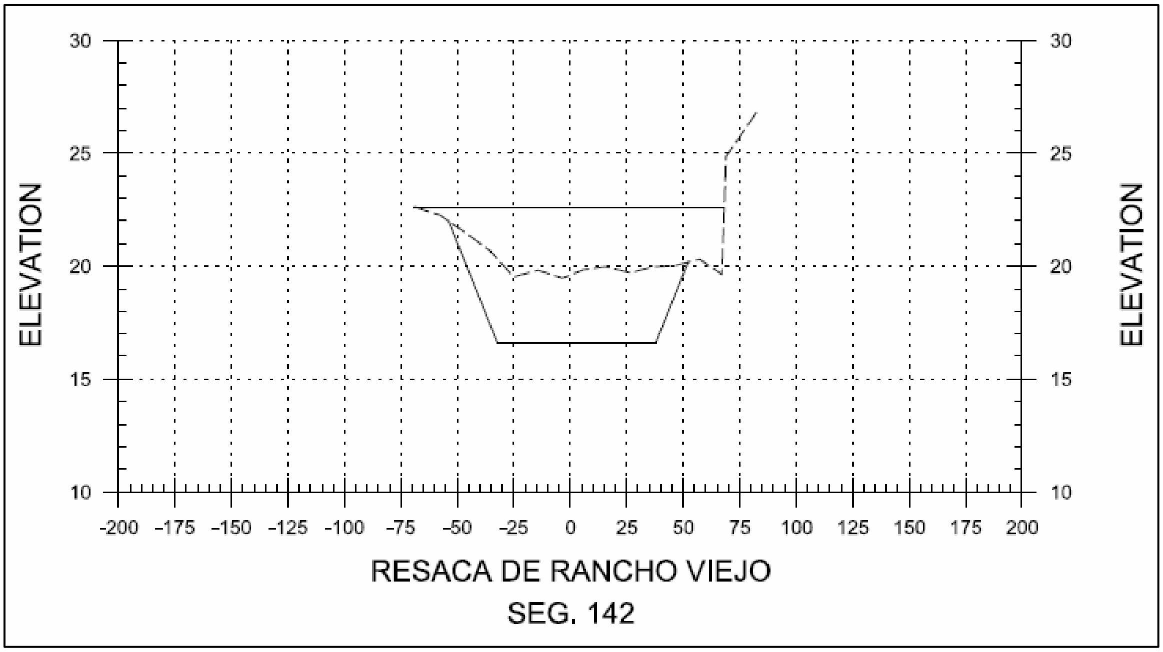

Figure E-1-7: Surveyed cross section of Segment 142

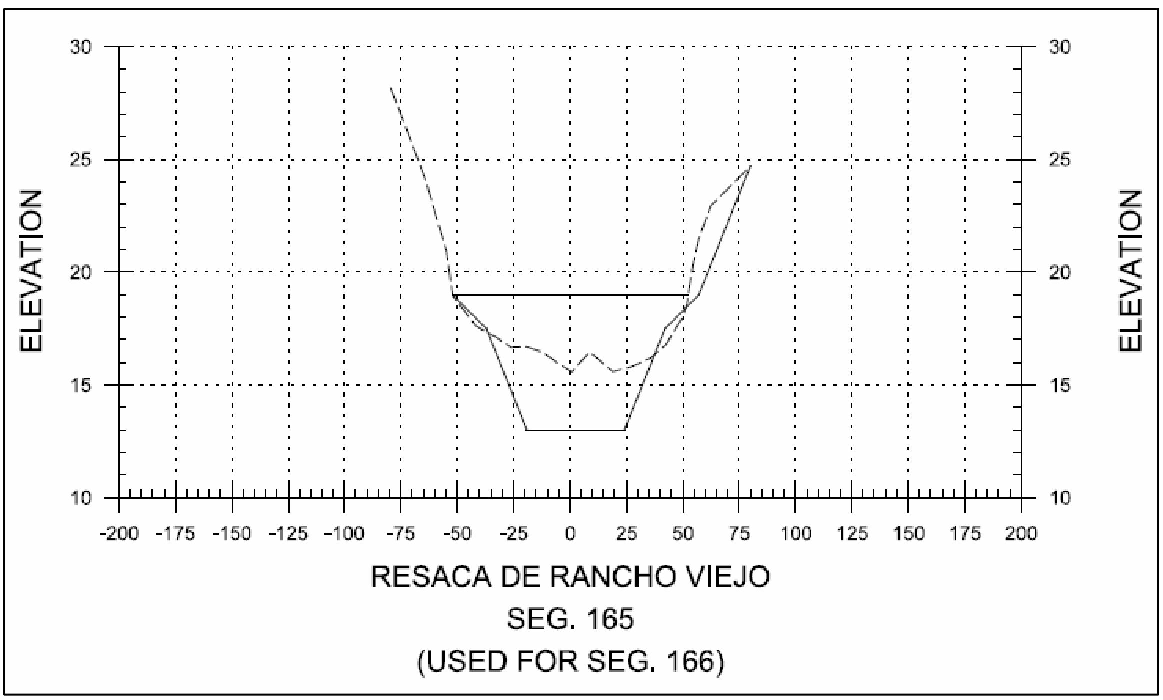

Figure E-1-8: Surveyed cross section of Segment 165

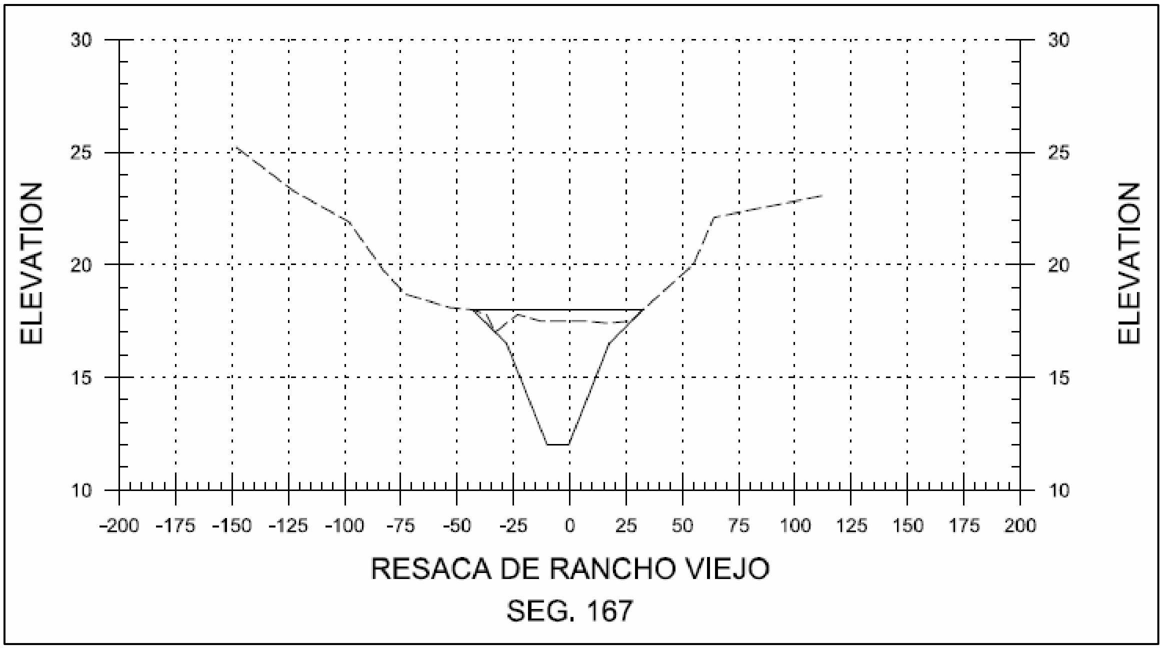

Figure E-1-9: Surveyed cross section of Segment 167

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Table E-1-1: Quantity Calculations for All Restoration Alternatives

Resaca Segment	Resaca System	Connection Required	Excavate			Dredge			Bank Grade			Riparian Grass/Forbe	Riparian Woody Veg.	Emergent Aquatic Veg.	Invasive Species Control
		Material/Equipment	Area	Depth	Volume	Area	Depth	Volume	Length	Fill/LF	Volume	Area	Area	Area	Area
			(ft^2)	(ft)	(yd^3)	(ft^2)	(ft)	(yd^3)	(ft)	(ft^2/LF)	(yd^3)	(ac)	(ac)	(ac)	(ac)
3	Town					30,121	3	3,347							
4	Town					79,814	3	8,868							
5	Town					139,781	3	15,531	735	30	817	2.07	2.07	0.25	2.07
6/7	Town					668,619	3	74,291	3,771	24	3,352	7.37	7.37	1.30	7.37
8	Town					132,066	5	24,457							
10	Town					220,020	4	32,596	2,268	55	4,620	1.64	1.64	0.42	1.64
13	Town					233,877	4	34,648	1,260	22	1,027	2.64	2.64	0.43	2.64
17/18/19	Town					1,102,145	5	204,101	18,208	10	6,744	21.39	21.39	6.27	64.82
39	Town					15,588	3	1,732	635	22	517	0.51	0.51	0.31	0.51
40	de la Guerra								3,545	22	2,889	28.34	28.34	1.22	31.49
41	de la Guerra								2,575	22	2,098	20.35	20.35	0.89	20.35
42	de la Guerra								4,950	22	4,033	47.75	47.75	1.70	53.05
43	de la Guerra											30.59	30.59		33.99
44 East	de la Guerra								1,420	22	1,157	7.53	7.53	0.49	7.53
44 West	de la Guerra								1,280	22	1,043	11.08	11.08	0.44	11.08
45	de la Guerra								525	22	428	4.87	4.87	0.18	4.87
46	de la Guerra								2,525	22	2,057	2.05	2.05	0.87	4.09
53	de la Guerra					70,769	3	7,863							
54	de la Guerra					374,988	3	41,665							
59	de la Guerra								1,710	22	1,393	2.03	2.03	0.59	3.03
60	de la Guerra					78,686	5	14,571							
61	de la Guerra					981,628	2	72,713	768	5	142	1.65	1.65	0.26	3.30
62	de la Guerra					77,441	5	14,341	658	14	341	0.61	0.61	0.23	1.21
66	de la Guerra					286,169	2	21,198	1,600	14	830	6.63	6.63	0.55	13.25
67 East	de la Guerra								1,015	22	827	5.83	5.83	0.35	6.48
67 Central	de la Guerra								1,015	22	827	3.11	3.11	0.35	3.46
67 West	de la Guerra								1,870	22	1,524	7.43	7.43	0.64	8.26
71 East	de la Guerra								669	22	545	3.29	3.29	0.23	3.65
71 West	de la Guerra								320	22	261	3.40	3.40	0.11	3.78
72	de la Guerra								2,336	22	1,903	7.16	7.16	0.80	7.96
74	de la Guerra					216,996	3	24,111							
75	de la Guerra					431,283	3	47,920	5,540	22	4,514	0.96	0.96	1.91	1.07
76	de la Guerra								620	22	505	0.65	0.65	0.21	0.65
78	de la Guerra								4,376	22	3,566	2.60	2.60	1.51	2.60

Resaca Segment	Resaca System	Connection Required	Excavate			Dredge			Bank Grade			Riparian Grass/Forbe	Riparian Woody Veg.	Emergent Aquatic Veg.	Invasive Species Control
		Material/Equipment	Area	Depth	Volume	Area	Depth	Volume	Length	Fill/LF	Volume	Area	Area	Area	Area
			(ft^2)	(ft)	(yd^3)	(ft^2)	(ft)	(yd^3)	(ft)	(ft^2/LF)	(yd^3)	(ac)	(ac)	(ac)	(ac)
79	de la Guerra								1,860	22	1,516	2.75	2.75	0.64	2.75
81	de la Guerra								1,166	22	950	4.02	4.02	0.40	4.02
82	de la Guerra					259,151	4	38,393	2,644	22	2,154	14.57	14.57	0.91	14.57
83	de la Guerra					549,508	4	81,409							
84	de la Guerra					338,179	4	50,101	3,191	22	2,600	9.41	9.41	1.10	9.41
93	de la Guerra	1500 LF 12" PVC w/ 1 HP Pump	190,058	6	42,235				5,148	0	0	1.08	1.08	1.77	4.36
94	de la Guerra	80 LF 24" RCP w/ Overflow Box & HW	208,578	6	46,351				3,750	0	0	1.19	1.19	1.29	4.79
95	de la Guerra	120 LF 18" PVC w/ Gate Valve	909,158	6	202,035				9,670	0	0	18.78	18.78	3.33	20.87
96	de la Guerra								1,345	22	1,096	12.43	12.43	0.46	12.43
161	de la Guerra	130 LF 18" PVC w/ Gate Valve	1,273,136	3	141,460				14,815	0	0	18.83	18.83	5.10	18.83
98	del Rancho Viejo								4,887	22	3,982	16.13	16.13	1.68	17.92
99	del Rancho Viejo								3,118	22	2,541	8.15	8.15	1.07	9.06
100 North	del Rancho Viejo								1,475	22	1,202	5.63	5.63	0.51	6.26
100 South	del Rancho Viejo								455	22	371	1.69	1.69	0.16	1.88
101	del Rancho Viejo								6,762	22	5,510	45.31	45.31	2.33	45.31
104	del Rancho Viejo								4,727	22	3,852	18.64	18.64	1.63	18.64
105	del Rancho Viejo					553,399	4	81,985	6,409	10	2,374	29.04	29.04	2.21	29.04
108	del Rancho Viejo					94,192	3	10,466	2,053	26	1,977	2.91	2.91	0.71	2.91
109	del Rancho Viejo					305,559	3	33,951	3,171	22	2,584	9.08	9.08	1.09	9.08
110	del Rancho Viejo								2,345	22	1,911	7.60	7.60	0.81	10.13
111	del Rancho Viejo					504,508	3	56,056	2,201	22	1,793	1.33	1.33	0.76	1.33
112 South	del Rancho Viejo								1,210	37	1,658	7.49	7.49	0.42	8.32
112 North	del Rancho Viejo								1,255	37	1,720	6.12	6.12	0.43	6.80
116/117	del Rancho Viejo	600 LF 18" PVC w/ Gate Valve				593,740	3	65,971	6,070	22	4,946	9.76	9.76	2.09	14.58
142	del Rancho Viejo					910,196	4	134,844	5,047	22	4,112	6.61	6.61	1.74	9.86
149	del Rancho Viejo					79,300	4	11,748	3,229	22	2,631	5.17	5.17	1.11	6.89
150	del Rancho Viejo					108,287	5	20,053							
151	del Rancho Viejo					106,462	5	19,715							
165	del Rancho Viejo	600 LF 18" RCP w/ Gate Valve & HW	186,657	3	20,740				3,855	0	0	4.65	4.65	1.33	5.17
166	del Rancho Viejo	300 LF 18" RCP w/ Gate Valve & HW	185,444	3	20,605				5,071	0	0	6.44	6.44	1.75	7.15
167/148	del Rancho Viejo					826,230	4	122,404	17,321	0	0	50.94	50.94	5.96	56.60
1000	del Rancho Viejo								10,137	22	8,260	12.05	12.05	3.49	48.21
1001	del Rancho Viejo								4,790	22	3,903	15.61	15.61	1.65	15.61
				Totals:	**473,425**			**1,371,050**			**99,438**	**559.28**	**559.28**	**65.30**	**663.16**

B. Water Level Control Quantities

Water levels in the existing resacas were already being maintained by the local sponsor through the use of overflow boxes, gated culverts, and weirs to maintain minimum pool levels in resaca segments. Some of the existing weir structures included slots for the installation of flash boards, which would allow the upstream pool levels to be adjusted by adding or removing boards. In locations with gated culverts, the pool levels were maintained by opening or closing the gates as needed. Some gates were equipped with Supervisory Control And Data Acquisition (SCADA) systems that would automatically adjust the gate based on pool levels. Other structures, such as fixed weirs and overflow boxes, did not allow for any manipulation of the upstream water surface elevations.

Changes to the existing system would be required to provide for adequate water level control to support the ecosystem restoration effort. Specifically, pool levels where vegetative measures were proposed would need to be lowered during certain periods of the year to simulate natural conditions. The existing control structures were evaluated to determine their ability to lower normal pool levels. Modifications were proposed for those structures which would not allow for this control and which included vegetative restoration measures within their upstream pool limits. Table E-1- 2 is a summary of the proposed control structure modifications and additions.

Water control structures are shows on the 12 figures at the end of Appendix E. Each figure includes a symbol indicating the locations and type of control structure, and the resaca segments that would benefit. The table shows the figure page number.

Table E-1- 2: Water Control Structure Modifications

System	Segment	Benefit Segments	Structure Name	Proposed Modifications	Figure Sheet Number
de la Guerra	41	40, 41	Outlet to North Main Drain	Add adjustable weir to existing overflow box	Sheet 1
de la Guerra	42	42, 43, 44, 45, 46	Outlet to North Main Drain	Add adjustable weir to existing overflow box	Sheet 2
de la Guerra	94	94	New Southmost Rd. Weir	Install sheet pile wall with adjustable weir	Sheet 3
de la Guerra	93	94	Fonsi Dr. Overflow Rd.	Add adjustable weir to existing overflow box	Sheet 3
de la Guerra	59	59, 54, 53	Hackberry Weir	Demo existing weir, install sheet pile wall with adjustable weir	Sheet 4
de la Guerra	95	95	(New Connection)	120 LF 18” PVC w/ Gate Valve	Sheet 5
de la Guerra	161	161	(New Connection)	130 LF 18” PVC w/ Gate Valve	Sheet 5
del Rancho Viejo	99	99, 98	Drainage District #1 Ditch	Add adjustable weir to existing overflow box	Sheet 6
del Rancho Viejo	100	100, 101, 1001, 1000, 104	Heron Cv. Gate Valve/Overflow Structure	Add SCADA control to existing gate valve or replace gate valve with adjustable weir	Sheet 7
del Rancho Viejo	105	105	Cameron Park Berm “Sandbag” Weir	Demo existing weir, install sheet pile wall with adjustable weir	Sheet 8
del Rancho Viejo	109	109, 110, 111, 112, 167	Sleepy Hollow Overflow Box	Add adjustable weir to existing overflow box	Sheet 9
del Rancho Viejo	116	116, 117	(New Connection)	600 LF 18” PVC w/ Gate Valve	Sheet 12
del Rancho Viejo	142	142, 149, 150, 151	Lakeway Overflow Box	Add adjustable weir to existing overflow box	Sheet 11
del Rancho Viejo	166	166	(New Connection)	300 LF 18” RCP w/ Gate Valve and HW	Sheet 10

Two versions of a U.S. Bureau of Reclamation (USBR) adjustable weir were selected for use where modifications to existing structures were required. The first, USBR 103-D-1239, is a 2 or 3 foot wide weir that can be raised or lowered 14 or 16 inches, respectively and is bolted to an existing concrete structure. The 3 foot wide version of this weir was proposed for installation on existing overflow box structures. The second weir version, USBR 103-D-1242, is a 3 foot wide movable weir that can be raised up to 18.5 inches and is self-contained with its own frame assembly. This weir was proposed for use where the existing structures would have to be removed and replaced with new sheet pile weirs. A drawing of each weir configuration is provided in Figure and Figure E-1-11.

The amount of adjustability of the proposed weirs was confirmed to be sufficient to mimic the desired seasonal variations in water levels. 14 to 18.5 inches of adjustment would be capable of drawing the water down enough to expose the 15-foot shelf planted with aquatic emergent vegetation as desired. Furthermore, since the adjustable weirs will be designed such that the weir crest will be no higher than the existing control structure invert, the addition of these control structures will not induce flooding or otherwise reduce the capability of the resaca system to convey high flows. They will only be able to lower the upstream water surface elevations.

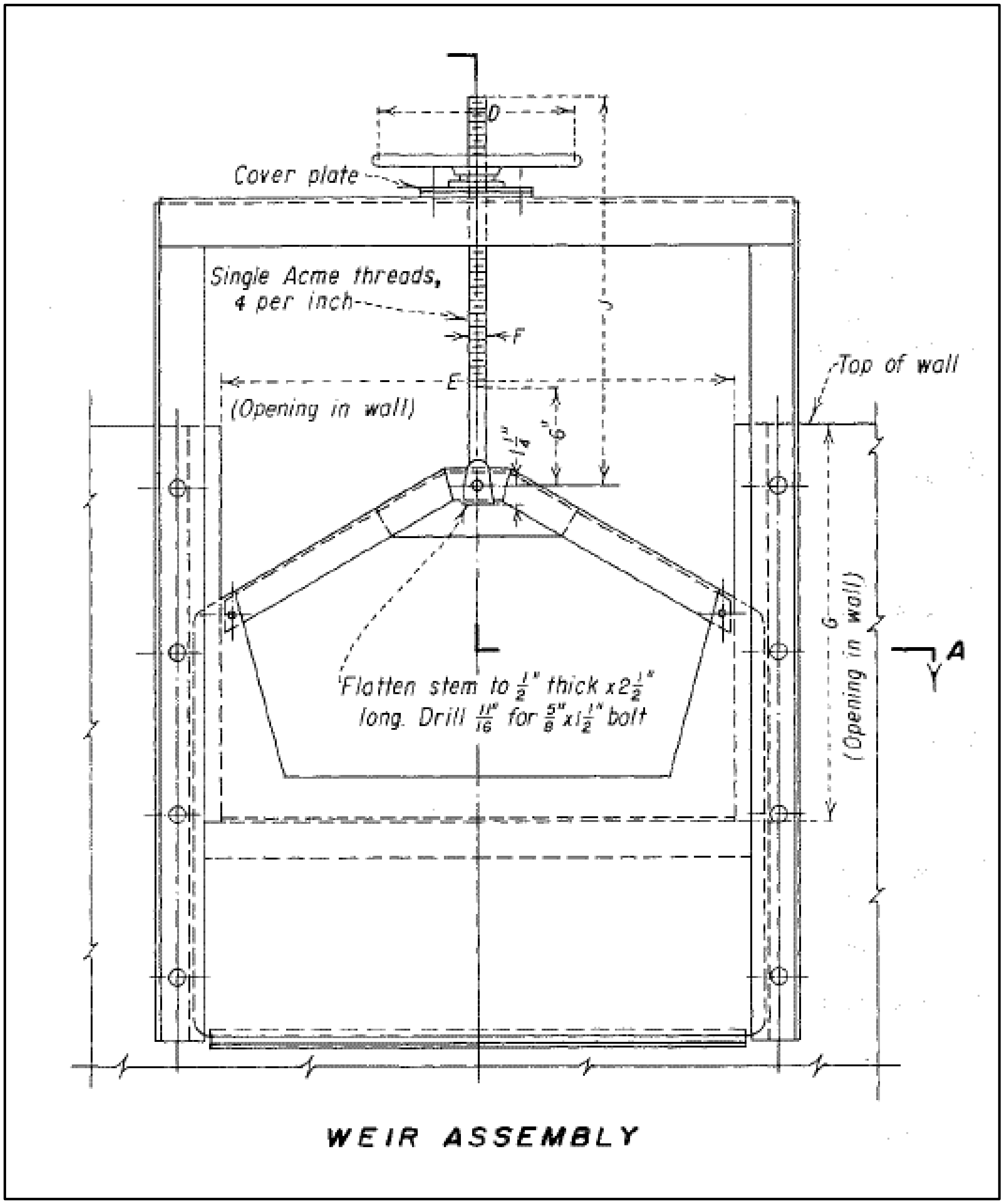

Figure E1-10 : U.S.Bureau of Reclamation Adjustable Weir, 103-D-1239

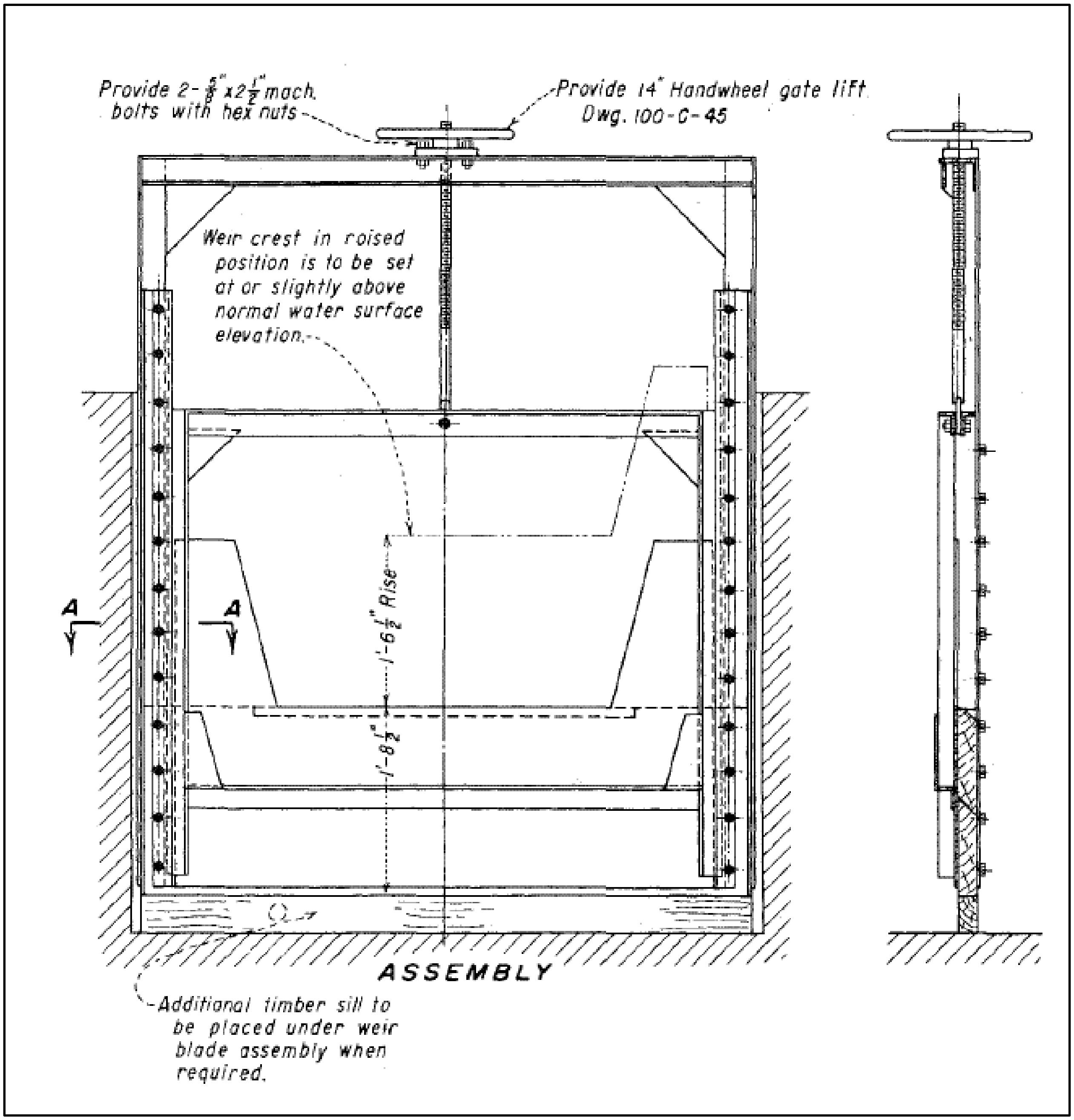

Figure E-1-11: U.S. Bureau of Reclamation Movable Weir, 103-D-1242

C. Disconnected Resaca Segments

Some of the resaca segments included in the study were no longer hydraulically connected to either resaca system, resulting in them remaining dry for most of the year. To utilize those disconnected resacas in the project, provisions were made to supply them with water through artificial means. Maps depicting these artificial connections are provided in the Water Control Structure Map section. The connections are also shown in the Design Drawings provided in the Drawings section of the main report.

In most cases, the disconnected resacas in question were situated such that they could be serviced through a gated culvert pipe flowing by gravity from either another resaca segment or from an irrigation canal. In one location, resaca segment 93, a pumped pipeline would be required to convey flow from the nearest resaca system. Pipe and pump sizing for each artificial connection were estimated based on similar configurations already being used by BPUB for other resaca segments. Detailed design for each connection would be developed during PED.

V. Water Control Structure Maps

The following pages present the Water Control Structure Maps

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 41

RESACAS AT BROWNSVILLE, TEXAS ECOSYSTEM RESTORATION AND FEASIBILITY STUDY

0 550 1,100 Feet

N S E W

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 1 of 12

US Army Corps of Engineers® Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE

PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 42
RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 850 1,700 Feet

N W E S

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 2 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 93 & 94

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 405 810 Feet

N W E S

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 3 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 59

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 550 1,100 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 4 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 95 & 161

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 500 1,000 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 5 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE

PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 99

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 700 1,400 Feet

N W E S

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 6 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 100

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 1,250 2,500 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 7 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 105
RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 362.5 725 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 8 of 12

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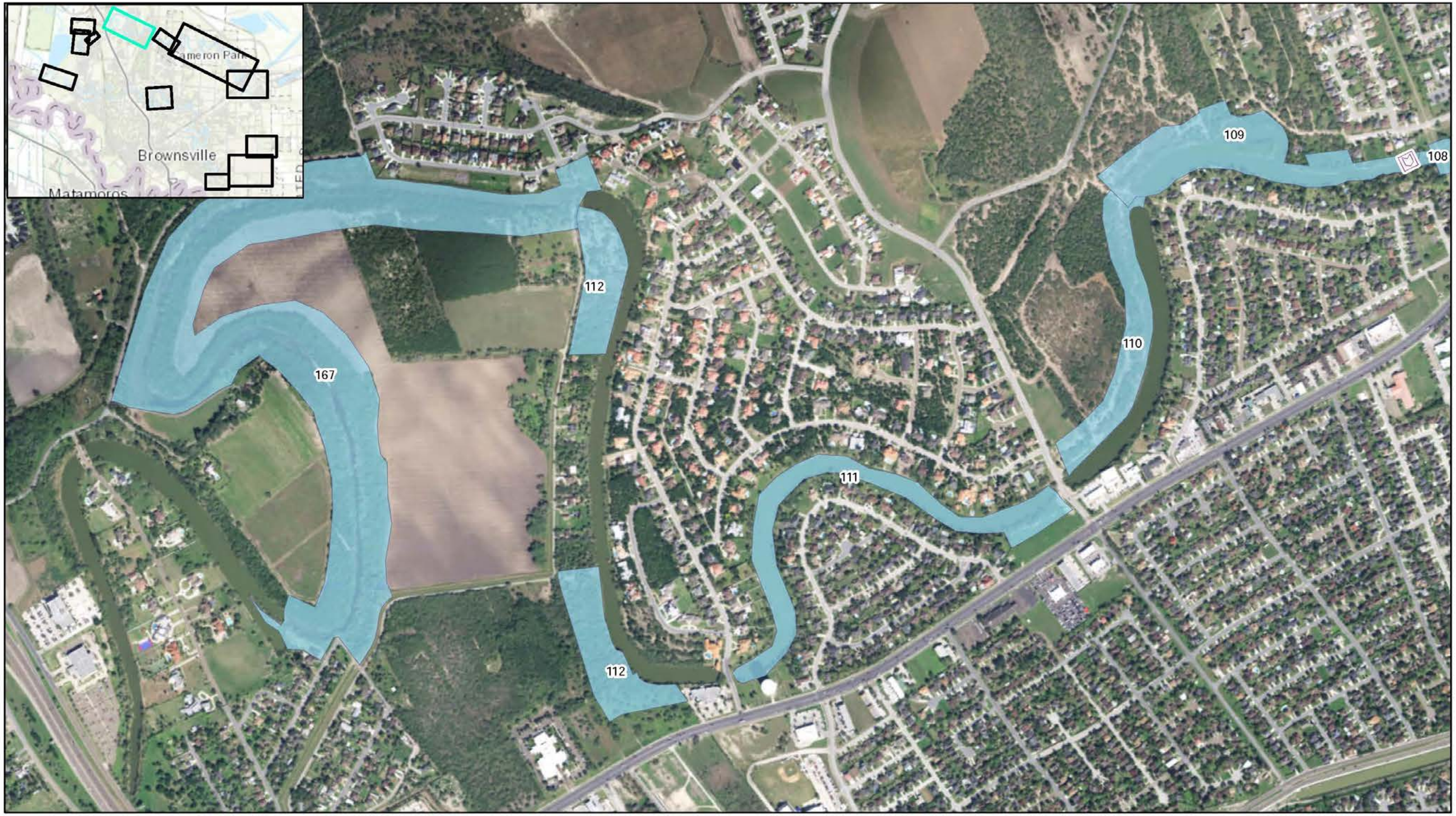


PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE

PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

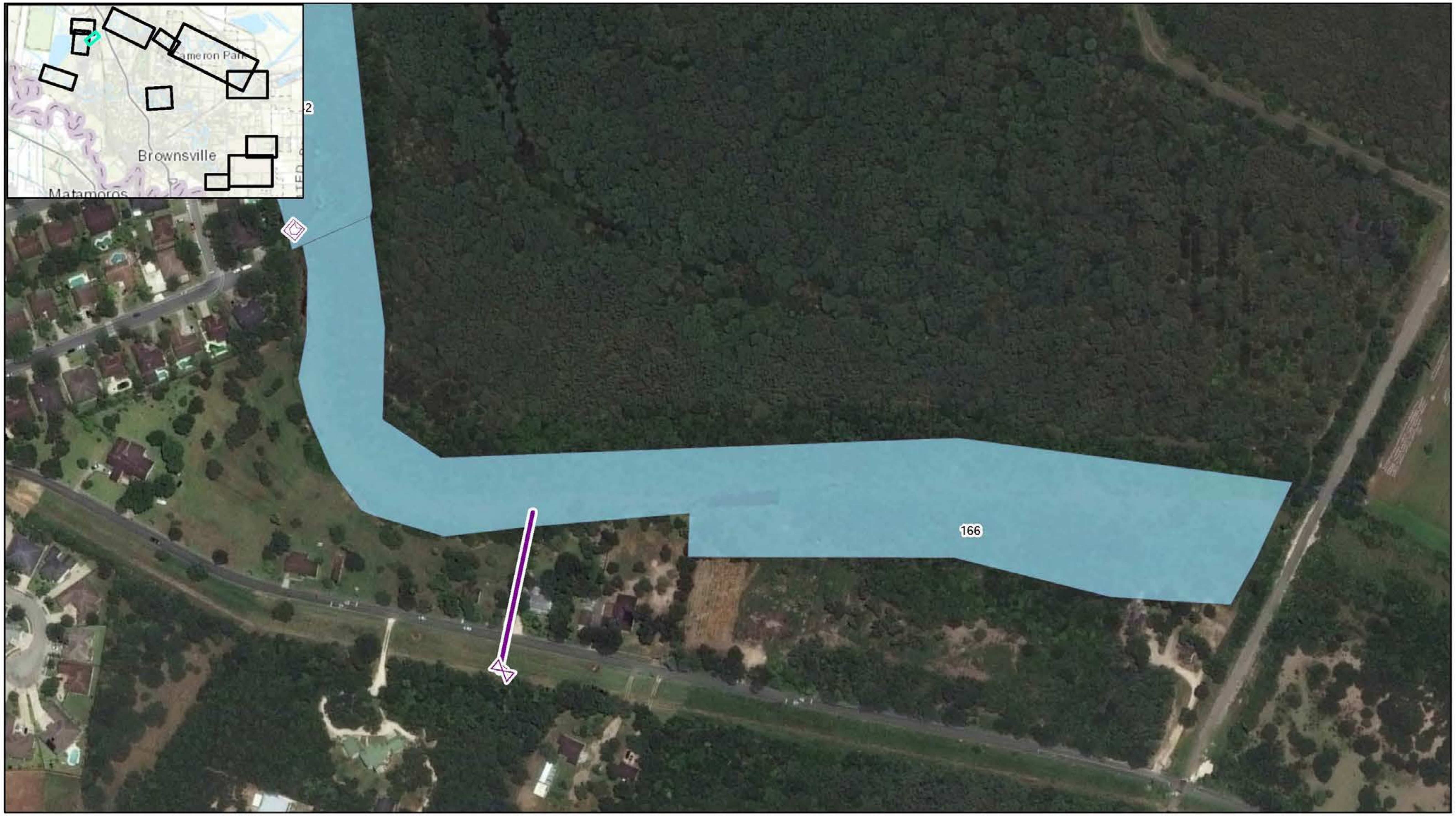
WATER CONTROL SEGMENT 109
RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 700 1,400 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 9 of 12

US Army Corps of Engineers®
Memphis District



PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 166

RESACAS AT BROWNSVILLE, TEXAS ECOSYSTEM RESTORATION AND FEASIBILITY STUDY

0 205 410 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 10 of 12

US Army Corps of Engineers® Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 142

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 425 850 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 11 of 12

US Army Corps of Engineers®
Memphis District

PUMP
SLUICE GATE
WEIR
WEIR IN EXISTING STRUCTURE
PIPE
ALT. 5 MEASURES
99 SEGMENT NO.

WATER CONTROL SEGMENT 116

RESACAS AT BROWNSVILLE, TEXAS
ECOSYSTEM RESTORATION AND
FEASIBILITY STUDY

0 395 790 Feet

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: 4205 TEXAS SOUTH

Sheet 12 of 12

US Army Corps of Engineers®
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VI. Project Implementation

A. Pre-Construction Engineering and Design (PED)

Prior to initiating pre-construction engineering and design phase, the design team must develop a Project Management Plan (PMP) defining the PED scope, work breakdown structure, schedule, and budget. Additional items in the PMP are related to value management and engineering, quality control, communication, change management, and acquisition strategy. The team must develop, negotiate, and agree upon the draft PMP prior to initiation of the PED phase. The team also has to prepare a Design Documentation Report (DDR), plans and specifications (P&S), execute a Project Partnership Agreement (PPA), and complete contract awards.

The DDR would include the final design of project features. The team would complete needed ground surveys, utility surveys, and drilling and testing for subsurface (geotechnical) conditions as necessary to complete the final design. The PED would define the resaca dredging, water control structures, and erosion protection locations based on surveys, hydraulic analysis, and testing. Design parameters for all project features would be defined for development of the plans and specifications. The project archeologist would continue their coordination with the State Historic Preservation Office to ensure archeological resource investigations and mitigation requirements continue to be met with a qualified archeologist on site during construction for monitoring, identification, and proper documentation/preservation of any cultural resources that might be uncovered during construction.

The P&S would include the development of project construction drawings and specifications, estimation of final quantities, and completion of the government cost estimate. The PED team would make available the drawings and specifications to contractors interested in bidding on the construction of the proposed project. The PED would develop as many as 4 sets of P&S for the dredging, aquatic features, bank slope, and riparian vegetation. 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.

Post-Implementation OMRR&R Management Plan

An operations management plan would be developed during PED.

1. 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 Brownsville resaca ecosystem restoration project. Following the Execution of the PPA, a right of way map would be provided to the non-Federal sponsor. The maps would delineate the real estate necessary for construction, operation, and maintenance of the proposed project. The Galveston District's real estate office would coordinate all real estate activities with the Brownsville Public Utilities Board Real Estate Office. 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 prior to any solicitation of construction contracts for Brownsville resaca project.

2. Contract Advertisement and Award

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

3. Project Construction

After award of the construction contract, the Government would manage project construction. About 15 contracts may be awarded. Inherent with contracts would be a warranty period specified for actual construction items and plantings. Construction of the dredging, water control structures, and bank sculpting is estimated to take 6 to 12 months to complete for each restoration area. Planting of riparian habitats would begin in areas where the bank slope work is complete. Planting would occur over at least two seasons within the same restoration area. There would be a 2 year contract period beyond each specific planting period to ensure the aquatic and riparian vegetation is alive and thriving. This activity includes removing any non-native or 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 would be refined during PED. During construction, an archeologist will monitor excavation. Should any significant cultural resources be identified, mitigation procedures would take place prior to further excavation. Total implementation time is expected to be 9 to 12 months per restoration area.

System	Segment	Benefit Segments	Structure Name	Proposed Modification
de la Guerra	41	40, 41	Outlet to North Main Drain	Add adjustable weir to existing overflow box
de la Guerra	42	42, 43, 44, 45, 46	Outlet to North Main Drain	Add adjustable weir to existing overflow box
de la Guerra	94	94	New Southmost Rd. Weir	Install sheet pile wall with adjustable weir
de la Guerra	93	93	Fonsi Dr. Overflow Box	Add adjustable weir to existing overflow box
de la Guerra	59	59, 54, 53	Hackberry Weir	Demo existing weir, install sheet pile wall with adjustable weir
de la Guerra	95	95	(New Connection)	120 LF 18" PVC w/ Gate Valve
de la Guerra	161	161	(New Connection)	130 LF 18" PVC w/ Gate Valve
del Rancho Viejo	99	99, 98	Drainage District #1 Ditch	Add adjustable weir to existing overflow box
del Rancho Viejo	100	100, 101, 1001, 1000, 104	Heron Cv. Gate Valve / Overflow Structure	Add SCADA control to existing gate valve or replace gate valve with adjustable weir
del Rancho Viejo	105	105	Cameron Park Berm "Sandbag" Weir	Demo existing weir, install sheet pile wall with adjustable weir
del Rancho Viejo	109	109, 110, 111, 112, 167	Sleepy Hollow Overflow Box	Add adjustable weir to existing overflow box
del Rancho Viejo	116	116, 117	(New Connection)	600 LF 18" PVC w/ Gate Valve
del Rancho Viejo	142	142, 149, 150, 151	Lakeway Overflow Box	Add adjustable weir to existing overflow box
del Rancho Viejo	166	166	(New Connection)	300 LF 18" RCP w/ Gate Valve & HW

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APPENDIX E-2

ENGINEERING APPENDIX

COST ENGINEERING

Introduction

This project consists of environmental restoration along former water courses (resaca) of the Rio Grande in Brownsville, Texas located in Cameron County. There are three resacas in Brownsville; two would be included in this project. They are Resaca De La Guerra and Resaca Del Rancho Viejo. The resaca excluded from this project is the Town Resaca. The project would consist of eight environmental restoration measures including:

- Dredging
- Riparian Soil Supplementation with Dredged Material
- Planting Riparian Species
- Bank Slope Restoration
- Bank Stabilization
- Plant Aquatic and Emergent Vegetation
- Water Control Structure/Flow Management
- Invasive Plant Species Management

The goal is to provide connectivity between the resaca meanders for wildlife habitat.

Design Information

To restore habitat for the measures would be implemented in varying degrees at each resaca area to provide connectivity and restore the damaged and destroyed habitat. The quantities for the restoration measures are shown below in Table E-2-1.

Acquisition Assumptions

The estimator assumed that the project would be constructed over a 16-year period with about $15-16 million to be awarded each year. The primary type of contract would be a competitive bid process.

Cost Analysis

Alternatives were evaluated using cost effectiveness and increment cost analysis. The estimated project costs associated with each plan reflect the cost side of the benefit cost ratio. Preliminary costs were developed for formulation screening. More detailed costs were developed for the recommended plan.

Alternatives were identified for evaluation. A preliminary design for each was prepared, and design quantities were estimated. A construction cost was then estimated based on the quantities.

The quantities for the recommended plan, Alternative 5, are shown in Table E-2-1. Material quantities were provided by the U.S. Army Corps of Engineers (USACE) Memphis District Design Branch.

The only deviation from these quantities was associated with the various plant habitat on the project. The design engineer provided plant quantities in acres. The Galveston District biologist provided additional application rates for the various plant species as follows:

- Riparian Planting – 300 plants per acre
- Emergent Habitat Planting – 40 feet c-c spacing
- Emergent Habitat Planting (Herbaceous) – 3 feet center-to-center spacing

Using the plant space calculator available at http://wwwusers.math.umn.edu/~white004/personal/plantcalc.html, the cost estimator populated plant quantities for the three species as shown in Table E-2-1.

Restoration areas were identified at 64 locations across Resaca de La Guerra, Resaca Del Rancho Viejo, and Town Resaca. Because there was an opportunity to compose alternatives from any combination of the 64 locations, costs were estimated for each. Costs were formulated for each restoration measure and element of work. The different elements of work are shown in Table E-2-1. Costs were prepared using a detailed cost estimate format, including the use of USACE MII software.

Within the software a bid schedule of quantities was constructed based upon design and used as a basis to formulate costs. There are four subgroups to the direct cost formulation for each bid item. They include labor, equipment, materials, and subcontracting. The software breaks down the costs into these subgroups and distributes indirect overheads and profit to the various cost elements.

Restoration plans within each resaca were initially screened through several iterations using the Cost Effective/Incremental Cost Analysis (CE/ICA) in the USACE Institute of Water Resources (IWR) Planning Suite 2.0.6.1. The Planning Suite is a USACE certified model used to assist in the identification of a cost effective recommended plan that can be incrementally justified both economically and ecologically.

The CE/ICA analysis uses annualized implementation costs. The annualized costs for the formulation level analysis for each restoration area is shown in Table E-2-2.

Labor

Labor rates were reviewed from Davis Bacon wage rates provided at http://www.wdol.gov/dba.aspx. The labor rates in these estimates were provided in the MII 2015 cost book consistent with the USACE Galveston District standard operating practice.

Equipment

Equipment was selected based on historic experience, preference, and crew makeup. Within the MII software there is an RSMeans Database from which equipment can be selected. Every few years these databases for labor and equipment are re-evaluated and indexed to the current year. The equipment manual is divided based on region with Brownsville, located in Region VI. The software fuel prices were adjusted to local costs using the AAA fuel gage report website (http://gasprices.aaa.com). Because Brownsville is not found in the database, the fuel prices for the next closest city in proximity (Corpus Christi, Texas) were used. Because fuel prices have remained stable for the last five years, current rates were presumed to be adequate as escalation would be captured in future re-pricing of the estimate. Standard practice at the Memphis District has been to deduct 0.40 cents per gallon from on road fuel to arrive at a close cost for off-road fuel based upon market research.

Material

Material prices were obtained from local suppliers within the Brownsville area. Quotes were obtained for pervious backfill and topsoil including delivery. Riparian shrubs, riparian turfing, emergent habitat planting, emergent habitat planting (herbaceous), and general turfing quotes were provided by The Nature Conservancy in Brownsville.

Subcontracting

To populate direct costs within the project, labor and equipment were combined into crews. Production rates were applied to the crews based on the knowledge and experience of the estimator. Once the materials and crews are tied to the quantities and production rates, they produce the direct costs for that item of work. The estimator assumed the landscaping and environmental controls portion of the work would be subcontracted. The prime contractor was assumed to construct the remaining items including the dredging work.

Table E-2-1: Alternative 5 - Scheduled Quantity Values

Segment	Silt Fence	A.	B.	C.	D.	*E.*	F.	G.	H.	I.	J.	K.	L.	M.
No.	LF	EA	EA	EA	Acres	CY	EA	Acres	EA	Acres	EA	CY	EA	CY
40	3,545	2		1	31.49	*2889*	9441	31.47	38	31.49	6,818			944
41	2,575	2		1	15.80	*2098*	6105	20.35	27	20.35	4,973		1	861
42	4,950	1		1	35.18	*4033*	15913	53.04	53	53.05	9,500		1	1,319
43	4,800	3		1	33.99		10194	33.98		33.99				
44	2,700	2		1	5.55	*2200*	5583	18.61	29	18.61	5,197			718
45	525	1		1	4.87	*428*	1461	4.87	5	4.87	1,005			139
46	2,525	2		1	4.09	*2057*	1224	4.08	27	4.09	4,862			667
53		1	1	1								7,863		
54		1	1	1								41,665		
59	1,710	1		1	1.68	*1,393*	909	3.03	18	3.03	3,297		1	472
60		1	1	1								14,571		
61	768	1	1	1	3.81	*142*	999	3.33	8	3.3	1,453	72,713		236
62	658	1	1	1	1.38	*341*	357	1.19	7	1.21	1,285	14,341		194
66	1,600	1	1	1	14.02	*830*	3990	13.30	17	13.25	3,073	21,198		1,111
67	3,900	3		1	10.46	*3,178*	5460	18.20	42	18.2	7,488			1,051
71	989	2		1	5.45	*806*	2226	7.42	10	7.43	1,900			278
72	2,336	1		1	4.37	*1,903*	1548	5.16	25	7.96	4,471			694
75	5,540	1	1	1	0.25	*4,514*	513	1.71	60	1.07	10,674	47,920		764
84	3,191	2	1	1	5.58	*2,600*	2814	9.38	34	9.41	6,147	50,101		833
93	5,148	2		1	13.25		1296	4.32	55	4.36	9,892	*42,235	1	958
94	3,750	2		1	9.67		1431	4.77	40	4.79	7,209	*46,351	1	694
95	9,670	2		1	20.87		6246	20.82	104	20.87	18,610	*202,035	1	2,778
96	1,345	2		1	12.43	*1,096*	3729	12.43	14	12.43	2,570			431
161	14,815	2		1	18.83		5700	19.00	160	18.83	28,502	*141,460	1	4,444
98	4,887	1		1	7.88	*3,982*	5376	17.92	52	17.92	9,389			1,417
99	3,118	1		1	5.95	*2,541*	2718	9.06	33	9.06	5,979		1	861
100	1,930	2		1	7.72	*1,573*	2442	8.14	21	8.14	3,744		1	500
101	6,762	1		1	21	*5,510*	13053	43.51	73	45.31	13,021			1,833
104	4,727	1		1	5.71	*3,852*	5589	18.63	51	18.64	9,109			1,278
105	6,409	1	1	1	11.72	*2,374*	8067	28.89	69	29.04	12,351	81,985	1	1,750
108	2,053	1	1	1	1.91	*1,977*	789	2.63	22	2.91	3,968	10,466		236
109	3,171	1	1	1	8.17	*2,584*	2421	8.07	34	9.08	6,091	33,951	1	1,333

Segment	Silt Fence	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.
No.	**LF**	**EA.**	**EA.**	**EA.**	**Acres**	**CY**	**EA**	**Acres**	**EA**	**Acres**	**EA**	**CY**	**EA**	**CY**
110	2,345	1		1	8.68	*1,911*	2940	9.80	25	10.13	4,526			639
111	2,201	1	1	1	0.38	*1,793*	477	1.59	23	1.33	4,247	56,056		139
112	2,465	2		1	15.47	*3,378*	4536	15.12	26	15.12	4,750			667
117	6,070	3	1	1	15.17	*4,946*	4383	14.61	65	14.58	11,680	65,971	1	944
142	5,047	1	1	1	8.79	*4,112*	7059	23.53	54	9.86	9,724	134,844	1	1,333
149	3,229	3	1	1	8.73	*2,631*	2073	6.91	34	6.89	6,203	11,748		556
150		1	1	1								20,053		
151		1	1	1								19,715		
166	5,071	1		1	11.29		2109	7.03	55	7.15	9,780	*20,605	1	1,306
167	17,321	1	1	1	60.62		16440	54.80	187	56.60	33,308	122,404		4,028
201	10,137	1		1	29.47	*8,260*	14448	48.16	109	48.21	19,504			2,736
202	4,790	3		1	9.71	*3,903*	4683	15.61	51	15.61	9,221			1,361
Total	**168,773.00**	**67**	**18**	**44**	**491.39**	***85,835***	**186,742**	**624.47**	**1,757**	**618.17**	**315,521**	**1,280,251**	**14**	**41,867**

***** *Items with this denotation indicate the Resaca is dry therefore land based equipment was used in lieu of dredging equipment.***

- A. – Construction Entrance and Exit (ea)
- B. – Turbidity Curtain (ea)
- C. – Environmental Protection (ea)
- D. – Clearing and Grubbing (acres)
- E. – Pervious Backfill (cy)
- F. – Riparian Planting (Shrubs) (ea)
- G. – Riparian Turfing (acres)
- H. – Emergent Habitat Planting (ea)
- I. – Removal of Invasive Species (acres)
- J. - Emergent Habitat Planting (Herbaceous) (ea)
- K. – Dredging (cy)
- L. – Control Structure Modifications (ea)
- M. – Top Soil (cy)

Table E-2-2: Restoration Area Project First Costs, IDC and Annual Cost (Oct. 2015 Prices, 3.125 percent Discount Rate, 75 Year Period of Analysis, 6 Month Construction Period

Restoration Area	Project First Cost	Interest During Construction	Investment Cost	Annualized Investment Cost	Annualized OMRRR	Annual Cost
R3-4-5	$3,200,000	$25,000	$3,225,000	$112,000	$2,000	$114,000
R6-7	9,346,000	72,000	9,419,000	327,000	8,000	335,000
R8	2,456,000	19,000	2,475,000	86,000	0	86,000
R10-13	7,267,000	56,000	7,323,000	254,000	5,000	259,000
R17-18--39	29,954,000	232,000	30,186,000	1,047,000	66,000	1,113,000
R40	5,372,000	42,000	5,413,000	188,000	29,000	217,000
R41	5,604,000	43,000	5,647,000	196,000	19,000	215,000
R42	3,295,000	25,000	3,320,000	115,000	49,000	164,000
R43	1,969,000	15,000	1,984,000	69,000	30,000	99,000
R44	2,834,000	22,000	2,856,000	99,000	17,000	116,000
R45E	597,000	5,000	601,000	21,000	4,000	25,000
R45-46	1,200,000	9,000	1,209,000	42,000	4,000	46,000
R53	1,342,000	10,000	1,352,000	47,000	0	47,000
R54	3,835,000	30,000	3,864,000	134,000	0	134,000
R59	1,381,000	11,000	1,391,000	48,000	3,000	51,000
R60	1,669,000	13,000	1,682,000	58,000	0	58,000
R61	9,765,000	76,000	9,841,000	342,000	3,000	345,000
R62	1,972,000	15,000	1,987,000	69,000	1,000	70,000
R66	3,878,000	30,000	3,908,000	136,000	12,000	148,000
R67	3,017,000	23,000	3,040,000	105,000	17,000	123,000
R71	1,702,000	13,000	1,715,000	60,000	7,000	66,000
R72	917,000	7,000	924,000	32,000	8,000	40,000
R74	2,552,000	20,000	2,571,000	89,000	0	89,000
R75	5,700,000	44,000	5,744,000	199,000	3,000	202,000
R76	466,000	4,000	469,000	16,000	1,000	17,000
R77-78	1,234,000	10,000	1,243,000	43,000	4,000	47,000
R79	940,000	7,000	947,000	33,000	3,000	36,000
R81	1,096,000	8,000	1,105,000	38,000	4,000	42,000
R82	6,367,000	49,000	6,416,000	223,000	14,000	236,000
R83	8,404,000	65,000	8,469,000	294,000	0	294,000
R84	7,131,000	55,000	7,187,000	249,000	9,000	259,000
R93	3,155,000	24,000	3,179,000	110,000	5,000	116,000
R94	3,041,000	24,000	3,064,000	106,000	5,000	112,000
R95	9,889,000	76,000	9,966,000	346,000	21,000	367,000
R96	2,350,000	18,000	2,368,000	82,000	11,000	94,000
R161	8,240,000	64,000	8,304,000	288,000	21,000	309,000
R98	3,838,000	30,000	3,868,000	134,000	17,000	152,000
R99	2,384,000	18,000	2,402,000	83,000	9,000	92,000
R100	2,121,000	16,000	2,137,000	74,000	8,000	82,000

Restoration Area	Project First Cost	Interest During Construction	Investment Cost	Annualized Investment Cost	Annualized OMRRR	Annual Cost
R101	7,737,000	60,000	7,797,000	271,000	42,000	313,000
R104	3,218,000	25,000	3,243,000	113,000	18,000	131,000
R105	14,295,000	111,000	14,405,000	500,000	18,000	518,000
R108	2,270,000	18,000	2,287,000	79,000	3,000	83,000
R109	5,803,000	45,000	5,848,000	203,000	9,000	212,000
R110	2,020,000	16,000	2,035,000	71,000	10,000	80,000
R111	880,000	7,000	887,000	31,000	2,000	32,000
R112	2,998,000	23,000	3,021,000	105,000	14,000	119,000
R116-117	9,225,000	71,000	9,296,000	323,000	15,000	337,000
R142	14,626,000	113,000	14,739,000	511,000	10,000	522,000
R149	3,001,000	23,000	3,024,000	105,000	7,000	112,000
R150	2,245,000	17,000	2,262,000	78,000	0	78,000
R151	2,298,000	18,000	2,316,000	80,000	0	80,000
R165	3,069,000	24,000	3,092,000	107,000	6,000	113,000
R166	1,908,000	15,000	1,923,000	67,000	55,000	122,000
R167-148	19,543,000	151,000	19,694,000	683,000	46,000	729,000
R1000	7,866,000	61,000	7,927,000	275,000	46,000	321,000
R1001	3,271,000	25,000	3,296,000	114,000	15,000	130,000

Indirect Costs

All direct costs had indirect costs applied. Indirect costs are the costs that are not specifically associated with any one item of work but with multiple items of work. Indirect costs applied include job office overhead, home office overhead, profit, and bond. These items are distributed as a percentage over the construction items. Job office overhead is generally found to range between 5-10 percent in the U.S. but it can be more based on the project itself. Home office generally ranges between 7-15 percent but can also be more based upon government allowed expenses and accounting practices. Profit generally ranges from 3-12 percent based upon competition and type of work. Bond generally ranges from 1-2 percent and is based on the contractors past history of performance.

Segment Evaluation – Indirect Costs

When estimating costs for each segment of work, a project schedule was forecast for that segment and the corresponding days were used to calculate the job office overhead costs. The Home office percentage used was 8 percent and profit percentage used was 10 percent. This was based upon historical rates seen for similar projects of this type. Bond rates were determined based on the Class B surety rates within the MII software. The abbreviated risk analysis was used to calculate risks for each item of work and then applied to each segment accordingly. A copy of the risk analysis used in the segment evaluation is shown in the cost appendix. (See Engineering Appendix E, Cost and Schedule Risk Assessment E-3.) The rates above were used for the prime contractor. For the subcontractor's costs, the estimator used the following rates:

- subJOOH – 5 percent
- subHOOH – 5 percent
- Profit – 10 percent
- Bond – Bond Table calculated using Class B.

The Recommended Plan Evaluation – Indirect Costs

The recommended plan was Alternative 5. The subcontractor rates for Alternative 5 were not adjusted. The following rates were used for the prime contractor:

- JOOH – 10 (%)
- HOOH – 10 (%)
- Profit - 10 (%)
- Bond – Bond Table calculated using Class B.

The alternatives were composed of the (64) restoration areas among the three resacas.

Table E-2-3: Final Array Costs

Alternative Composition					
1	**2**	**4**	**5**	**6**	**7**
40, 41, 42, 43, 44, 45E, 45, 46, 53, 54, 59, 60, 61, 62, 66, 67, 71, 72, 75, 84, 93, 94, 95, 96, 161	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 1
	98, 99, 100, 101, 104, 105, 108, 109, 110, 111, 112, 167, 148, 1000, 1001	Alternative 2	Alternative 2	Alternative 2	Alternative 2
		142, 149, 150, 151, 166	Alternative 4	Alternative 4	Alternative 4
			116, 117	Alternative 5	Alternative 5
				77, 78, 79, 81, 82, 83	Alternative 6
					165

See Table E-2-4 for the cost evaluation of the six alternatives.

*(*Dollars in* Table E-2-4 *are based October 2015 prices and a federal discount rate of 3.125 percent. Final costs of Alternatives reflect minor adjustments made in response to Risk Analysis and agency technical review evaluations. Final values for Alternative 5 are shown in the Certified Cost Estimate,* Exhibit E-2-1).

Table E-2-4: Derivation of Annual Costs for the Recommended Plan
($1,000, October 2017 Prices, 2.75 Percent Discount Rate)

Cost and Benefit Category	Alternative					
	1	2	4	5	6	7
First Cost ($1,000)	90,318	172,198	196,277	205,501	223,542	226,611
AAC ($1,000)	3,273	6,232	7,108	7,428	8,050	8,157
IDC	652	1,258	1,444	1,515	1,654	1,678
OMRR&R	248	506	578	593	618	624
Project Acres	448.7	826.2	884.2	914.5	963.0	968.6
FWP AAHU	393	762	815	846	883	888
FWOP AAHU	153	329	346	362	376	378
Net Benefit	240	433	470	483	507	510
Benefit/Acre	0.53	0.92	0.92	0.93	0.92	0.92
Incremental Benefit	240	193	37	13	23	3
AAC/AAHU ($1,000)	13.6	14.4	15.1	15.4	15.9	16.0
Incremental AAC	13.6	6.8	1.9	0.7	1.2	0.2
Incremental AAC/AAHU ($1,000)	13.6	15.4	23.5	23.7	26.7	37.5
Total Cost./Acre ($1,000)	201.28	208.42	221.98	224.71	232.13	233.96
AAC/Acre ($1,000)	7.29	7.54	8.04	8.12	8.34	8.42

Table E-2-5 shows the annualized costs, for the recommended project, Alternative 5, at October 2017 prices, 2.75 percent interest for a 75 year period of analysis.

Table E-2-5: Projected Project Contract Award Schedule for the Brownsville CityWide Project

Investment		
	Estimated First Cost	$202,492
	Annual Interest Rate	2.750%
	Period of Analysis (years)	75
	Construction Period (months)	12
	Compound Interest Factor	12.15
	Capital Recovery Factor	0.0316356
	Interest During Construction	$2,772
	Investment Costs	$205,264
Annual Charges		
	Interest	$5,645
	Amortization	$849
	OMRRR ($/yr)	$624
	Total Annual Charges	$7,118

Total Project Cost Summary (TPCS)

The total project cost summary (TPCS) includes all the costs that would be incurred for implementation of the project. It is important to note that the study costs are not included in the Planning account of the TPCS. The Lands and Damages estimate was provided by the Galveston District Real Estate Division, Mr. David Mairs, Realty Specialist. The percentages for E&D and S&A were provided by the Galveston District Project Management Team.

The chart of accounts is as follows:

01 – Lands and Damages
02 - Relocations
06 – Fish and Wildlife Facilities (construction costs for ecosystem restoration)
30 – Planning, E&D
31 – Supervision and Administration

Schedule

During the course of the study, an overall project award schedule was prepared with the help of the PDT and is as shown in Table E-2-6. The PDT felt the recommended plan would be executed in one contract per year with a duration spanning several years. Once this was known, it made it easier for the estimator to develop costs for mobilization and demobilization for the overall project.

Table E-2-6: Projected Project Contract Award Schedule

Construction Year Start	Resaca Areas
2021	149, 150, 151
2022	116, 117, 142
2023	166
2024	148, 167
2025	108, 109, 110, 111, 112
2026	104, 105
2027	98, 99, 100, 101, 1000, 1001
2028	161
2029	84
2030	75, 95
2031	53, 54, 59, 60
2032	61
2033	62, 66, 67, 71, 72, 96
2034	93, 94
2035	45, 46
2036	40, 41, 42, 43, 44

WALLA WALLA COST ENGINEERING
MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

SWG - PN 444605 Resacas at Brownsville Ecosystem Restoration Study

The Resacas at Brownsville Ecosystem Restoration Study cost, as presented by the Galveston District, has undergone a successful Cost Agency Technical Review (Cost ATR) performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

Certification Date: 12 February 2018

FY18 Project First Cost:	$202,492,000
Fully Funded Costs:	$255,597,000

Note: It remains the responsibility of the District to correctly reflect these cost values and to implement effective project management controls and implementation procedures including risk management through the period of Federal participation.

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FOR: Michael P. Jacobs, PE, CCE
Chief, Cost Engineering MCX
Walla Walla District

Exhibit E-2-1: Certified Cost Estimate

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Brownsville Resacas Feasibility Eco Restoration ALT 5
PROJECT N P2# 444605
LOCATION: Brownsville, TX

DISTRICT: Galveston District **PREPARED: 12/13/2017**
POC: Welch, Jerry, Chief Cost Engineering, Memphis District

This Estimate reflects the scope and schedule in report; Feasibility Study - Recommended Plan

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2018									
						Effective Price Level Date: 1 OCT 17									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: 1-Oct-16 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
02	RELOCATIONS (USACE)	$4,131	$826	20%	$4,957	0.0%	$4,131	$826	$4,957	$0	$4,957	22.0%	$5,038	$1,008	$6,045
02	RELOCATIONS (USFWS)	$546	$109	20%	$656	0.0%	$546	$109	$656	$0	$656	22.0%	$666	$133	$800
06	FISH & WILDLIFE FACILITIES - USACE	$82,614	$16,523	20%	$99,137	0.0%	$82,614	$16,523	$99,137	$0	$99,137	22.0%	$100,758	$20,152	$120,909
06	FISH & WILDLIFE FACILITIES - USFWS	$10,928	$2,186	20%	$13,114	0.0%	$10,928	$2,186	$13,114	$0	$13,114	22.0%	$13,328	$2,666	$15,994
	CONSTRUCTION ESTIMATE TOTALS (USACE):	$86,745	$17,349		$104,093	0.0%	$86,745	$17,349	$104,093	$0	$104,093	22.0%	$105,796	$21,159	**$126,955**
	CONSTRUCTION ESTIMATE TOTALS (USFWS):	$11,475	$2,295		$13,770	0.0%	$11,475	$2,295	$13,770	$0	$13,770	22.0%	$13,995	$2,799	**$16,794**
01	LANDS AND DAMAGES (USACE)	$37,995	$7,599	20%	$45,595	0.0%	$37,995	$7,599	$45,595	$0	$45,595	19.6%	$45,431	$9,086	$54,517
01	LANDS AND DAMAGES (USFWS)	$434	$87	20%	$521	0.0%	$434	$87	$521		$521	19.6%	$519	$104	$623
30	PLANNING, E & D (USACE)	$15,237	$3,047	20%	$18,284	0.0%	$15,237	$3,047	$18,284	$0	$18,284	45.5%	$22,175	$4,435	$26,610
30	PLANNING, E & D (USFWS)	$1,981	$396	20%	$2,377	0.0%	$2,058	$412	$2,470	$0	$2,470	45.5%	$2,860	$572	$3,432
31	CONSTR. MANAGEMENT (USACE)	$13,012	$2,602	20%	$15,614	0.0%	$13,012	$2,602	$15,614	$0	$15,614	50.8%	$19,626	$3,925	$23,551
31	CONSTR MANAGEMENT (USFWS)	$1,721	$344	20%	$2,065	0.0%	$1,788	$358	$2,146		$2,146	50.8%	$2,596	$519	$3,115
	PROJECT COST TOTALS:	$168,599	$33,720	20%	$202,319		$168,743	$33,749	**$202,492**	$0	**$202,492**	26.2%	$212,997	$42,599	$255,597

________________ **Welch, Jerry, Chief Cost Engineering, Memphis District**

________________ **Shakhar, Misir, Project Management Galveston District**

________________ **Nelson, Timothy J., Chief Real Estate, G**

________________ **Harper, Brian K., Chief Planning, Regional Planning Env. Center**

________________ **Callahan, Shane, Chief Design Branch, Memphis District**

________________ **Hrametz, Josheph, Chief Operations, Galveston District**

________________ **Carelock, Don, Chief Construction, Galveston District**

________________ **Williams, Byron D., Chief PM-PB, Galveston District**

________________ **Miller, Valerie, Chief DPM, Galveston District**

ESTIMATED TOTAL PROJECT COST: $255,597
ESTIMATED TOTAL USACE PROJECT COST: $231,634
ESTIMATED TOTAL USFWS PROJECT COST: $23,963

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TPCS

Printed:2/12/2018

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Brownsville Resacas Feasibility Eco Restoration ALT 5
LOCATION: Brownsville, TX
This Estimate reflects the scope and schedule in report; Feasibility Study - Recommended Plan

DISTRICT: Galveston District PREPARED: 12/13/2017
POC: Welch, Jerry, Chief Cost Engineering, Memphis District

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: Effective Price Level:			13-Dec-17 1-Oct-17	Program Year (Budget EC): Effective Price Level Date:			2018 1 OCT 17	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	PHASE 10 or CONTRACT 10													
02	RELOCATOINS (USACE)	$4,131	$826	20.0%	$4,957	0.0%	$4,131	$826	$4,957	2028Q1	22.0%	$5,038	$1,008	$6,045
02	RELOCATIONS (USFWS)	$546	$109	20.0%	$656	0.0%	$546	$109	$656	2028Q1	22.0%	$666	$133	$800
06	FISH & WILDLIFE FACILITIES - USACE	$82,614	$16,523	20.0%	$99,137	0.0%	$82,614	$16,523	$99,137	2028Q1	22.0%	$100,758	$20,152	$120,909
06	FISH & WILDLIFE FACILITIES - USFWS	$10,928	$2,186	20.0%	$13,114	0.0%	$10,928	$2,186	$13,114	2028Q1	22.0%	$13,328	$2,666	$15,994
	CONSTRUCTION ESTIMATE TOTALS (USACE):	$86,745	$17,349	20.0%	$104,093		$86,745	$17,349	$104,093			$105,796	$21,159	$126,955
	CONSTRUCTION ESTIMATE TOTALS (USFWS):	$11,475	$2,295	20.0%	$13,770		$11,475	$2,295	$13,770			$13,995	$2,799	$16,794
01	LANDS AND DAMAGES (USACE)	$37,995	$7,599	20.0%	$45,595	0.0%	$37,995	$7,599	$45,595	2027Q1	19.6%	$45,431	$9,086	$54,517
01	LANDS AND DAMAGES (USFWS)	$434	$87	20.0%	$521	0.0%	$434	$87	$521	2027Q1	19.6%	$519	$104	$623
30	PLANNING, ENGINEERING & DESIGN													
2.2%	Project Management	$1,908	$382	20.0%	$2,290	0.0%	$1,908	$382	$2,290	2027Q1	44.4%	$2,755	$551	$3,306
2.0%	Planning & Environmental Compliance	$1,735	$347	20.0%	$2,082	0.0%	$1,735	$347	$2,082	2027Q1	44.4%	$2,505	$501	$3,006
3.6%	Engineering & Design	$3,149	$630	20.0%	$3,779	0.0%	$3,149	$630	$3,779	2027Q1	44.4%	$4,546	$909	$5,455
1.0%	Reviews, ATRs, IEPRs, VE	$867	$173	20.0%	$1,041	0.0%	$867	$173	$1,041	2027Q1	44.4%	$1,252	$250	$1,503
1.0%	Life Cycle Updates (cost, schedule, risks)	$935	$187	20.0%	$1,122	0.0%	$935	$187	$1,122	2027Q1	44.4%	$1,350	$270	$1,620
1.0%	Contracting & Reprographics	$867	$173	20.0%	$1,041	0.0%	$867	$173	$1,041	2027Q1	44.4%	$1,252	$250	$1,503
1.5%	Engineering During Construction	$1,301	$260	20.0%	$1,561	0.0%	$1,301	$260	$1,561	2028Q1	50.8%	$1,963	$393	$2,355
1.7%	Planning During Construction	$1,449	$290	20.0%	$1,738	0.0%	$1,449	$290	$1,738	2028Q1	50.8%	$2,185	$437	$2,622
1.3%	Adaptive Management & Monitoring	$1,290	$258	20.0%	$1,548	0.0%	$1,290	$258	$1,548	2027Q1	44.4%	$1,862	$372	$2,235
2.0%	Project Operations	$1,735	$347	20.0%	$2,082	0.0%	$1,735	$347	$2,082	2027Q1	44.4%	$2,505	$501	$3,006
30	PLANNING, ENGINEERING & DESIGN	$1,981	$396	20.0%	$2,377	3.9%	$2,058	$412	$2,470	2027Q1	39.0%	$2,860	$572	$3,432
31	CONSTRUCTION MANAGEMENT (USACE)													
10.5%	Construction Management	$9,108	$1,822	20.0%	$10,930	0.0%	$9,108	$1,822	$10,930	2028Q1	50.8%	$13,738	$2,748	$16,486
2.0%	Project Operation:	$1,735	$347	20.0%	$2,082	0.0%	$1,735	$347	$2,082	2028Q1	50.8%	$2,617	$523	$3,140
2.5%	Project Management	$2,169	$434	20.0%	$2,602	0.0%	$2,169	$434	$2,602	2028Q1	50.8%	$3,271	$654	$3,925
31	CONSTRUCTION MANAGEMENT (USFWS)	$1,721	$344	20.0%	$2,065	3.9%	$1,788	$358	$2,146	2028Q1	45.2%	$2,596	$519	$3,115
	CONTRACT COST TOTALS:	$168,599	$33,720		**$202,319**		$168,743	$33,749	**$202,492**			$212,997	$42,599	**$255,597**

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TPCS

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APPENDIX E-3

Engineering Appendix

Contents:

Cost Engineering
Cost Schedule Risk Analysis (CSRA

US Army Corps of Engineers®

City of Brownsville (Resacas), Texas

Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,

Sacramento District

Prepared by:

U.S. Army Corps of Engineers

Cost Engineering Technical Center of Expertise, Walla Walla, WA

June 13, 2017

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LIST OF APPENDICES

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), Galveston District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the City of Brownsville (Resacas), Texas. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The Study, evaluating the need for ecosystem restoration of the resacas in the city of Brownsville, is the first of its type for the region. Resacas (oxbow lakes) are former channels of the Rio Grande River that have been cut off from the river, having no inlet or outlet. Before land development and water control, floodwaters from the Rio Grande drained into resacas from the surrounding terrain. During the past decades, siltation and development have reduced the capacity of the resacas, and the city would like to investigate economical ways of preserving and restoring the resacas to a natural state. It is estimated that 99% of the riparian habitat along the U.S. side of the Rio Grande River has been cleared (USFWS 1997). The lower Rio Grande Valley is one of the most biologically diverse ecological regions in North America and a critical migratory stopover for birds moving between the Americas. Yet more than 75% of the region's wildlife habitat has been replaced by human development and agriculture. The resacas become more valuable as time passes given the unpredictable nature of the contamination in the Rio Grande and continuing drought conditions. The Feasibility Cost Sharing Agreement was signed on 17 April 2002. The study has not been in the President' Budget since FY08. Since then, the project has been minimally funded in appropriations. Therefore the completion of the study is to be determined. The study effort will evaluate the environmental restoration of the resacas, improved flood protection, enhanced water storage, and ecosystem restoration.

The current project base cost for the City of Brownsville Resacas estimate is approximately $126.1M excluding Lands and Damages and contingency and expressed in FY 2017 dollars. This CSRA study included all estimated construction costs, Planning, Engineering, Design and Construction Management costs. Based on the results of the analysis, the Cost Engineering Mandatory Center of Expertise for Civil

Works (MCX located in Walla Walla District) recommends a contingency value of $25.2M or approximately 20% of base project cost at an 80% confidence level of successful execution.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and per cent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	$126,066,000		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency ($)**
50%	$146,236,560	16%	$20,170,560
80%	**$151,279,200**	**20%**	**$25,213,200**
90%	$153,800,520	22%	$27,734,520

KEY FINDINGS/OBSERVATIONS/ASSUMPTIONS & RECOMMENDATIONS

The PDT worked through the risk register in April and May 2017. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $20.6M and schedule risks adding a potential 49 months; all at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- <u>CA1 – Acquisition Strategy</u> – Cost estimate is based on full and open large business contractor markups. Given relatively simple construction requirements and small dollar values (some $5M each or less) it is very likely large portions of this work could be awarded to Small Disadvantaged Business.

- ET1 – Variations in Quantities – Survey data for dredging was lacking. Limited survey information was available for estimating dredge quantities was. Limited survey data was extrapolated to those areas that had no data.
- ET2 – Level of Estimate – Estimate is a feasibility level estimate based on with estimated crews, production rates and material quotes. Level of Estimate varies between a Class 4 and Class 3 with associated Risk Levels.

Moderate risks, when combined, can also become a cost impact.

- CO4 – Market Conditions & Bidding Climate – Bidding climate could lead to higher awarded construction costs. Mechanical Marine Dredging is highly specialized work with few available contractors in the area.
- ET3 – Fuel Variations – Fuel cost has varied significantly recently and will most likely continue to fluctuate for the life of this project. Estimate is based on current AAA fuel rates.

Schedule Risks: From the CSRA, the key or greater Schedule Risk items include:

- PR1 – Federal Funding – Schedule is entirely funding dependent. Baseline schedule requires some $10M to $15M per year for total project. Federal share would be some $10M / year. There is currently funding uncertainty for Environmental Restoration projects.
- PM4 – Native Plantings – Native Plantings will need to be coordinated with nurseries to insure plants are available. The Nature Conservancy and Commercial Supply all appear to have limited additional supply capacity. Their ability to provide plants for quantities required is uncertain. Schedule risk exists early on as supply growers are developed. Worst case the first construction season could be missed as suppliers are developed.

Recommendations: The CSRA study serves as a “road map” towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

MAIN REPORT

1.0 PURPOSE

Within the authority of the US Army Corps of Engineers (USACE), Galveston District, this report presents the efforts and results of the cost and schedule risk analysis for City of Brownsville (Resacas), Texas. The report includes risk methodology, discussions, findings and recommendations regarding the identified risks and the necessary contingencies to confidently administer the project, presenting a cost and schedule contingency value with an 80% confidence level of successful execution.

2.0 BACKGROUND

The Study, evaluating the need for ecosystem restoration of the resacas in the city of Brownsville, is the first of its type for the region. Resacas (oxbow lakes) are former channels of the Rio Grande River that have been cut off from the river, having no inlet or outlet. Before land development and water control, floodwaters from the Rio Grande drained into resacas from the surrounding terrain. During the past decades, siltation and development have reduced the capacity of the resacas, and the city would like to investigate economical ways of preserving and restoring the resacas to a natural state. It is estimated that 99% of the riparian habitat along the U.S. side of the Rio Grande River has been cleared (USFWS 1997). The lower Rio Grande Valley is one of the most biologically diverse ecological regions in North America and a critical migratory stopover for birds moving between the Americas. Yet more than 75% of the region's wildlife habitat has been replaced by human development and agriculture. The resacas become more valuable as time passes given the unpredictable nature of the contamination in the Rio Grande and continuing drought conditions. The Feasibility Cost Sharing Agreement was signed on 17 April 2002. The study has not been in the President' Budget since FY08. Since then, the project has been minimally funded in appropriations. Therefore the completion of the study is to be determined. The study effort will evaluate the environmental restoration of the resacas, improved flood protection, enhanced water storage, and ecosystem restoration.

3.0 REPORT SCOPE

The scope of the risk analysis report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for construction features. The CSRA does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The Cost Engineering MCX performed the Cost and Schedule Risk Analysis, relying on local District staff to provide expertise and information gathering. The District PDT conducted initial risk identification via meetings with the Walla Walla Cost Engineering MCX facilitator in May 2016. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Participants in the risk identification meeting on April 24, 2017 included:

Name	Office	Representing
Jeromy Carpenter	MVM	Cost Engineer
Josh Giannini	MVM	Civil Engineer
David Mairs	SWG	Real Estate
William Bolte	NWW	Risk Facilitator

Follow up discussions were held on May 8, 2017 included:

Name	Office	Representing
Jeromy Carpenter	MVM	Cost Engineer
Daniel Allen	SWF	Environmental Planner
Shakhar Misir	SWG	Project Manager
William Bolte	NWW	Risk Facilitator

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost MCX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

A formal PDT meeting was held with the District office and project owners for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, environmental compliance, real estate, construction, contracting and representatives of the sponsoring agencies.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment.

4.2 Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers of cost and time) of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty

- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. The District provided estimate files electronically. The files transmitted and resulting independent review, served as the basis for the final cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level of design.

c. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. The Cost Engineering MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

e. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P5, P50 and P90 confidence levels are also provided for illustrative purposes only.

Table 1. Construction Cost Contingency Summary

Base Case Construction Cost Estimate	$126,066,000		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency ($)**
50%	$146,236,560	16%	$20,170,560
80%	**$151,279,200**	**20%**	**$25,213,200**
90%	$153,800,520	22%	$27,734,520

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

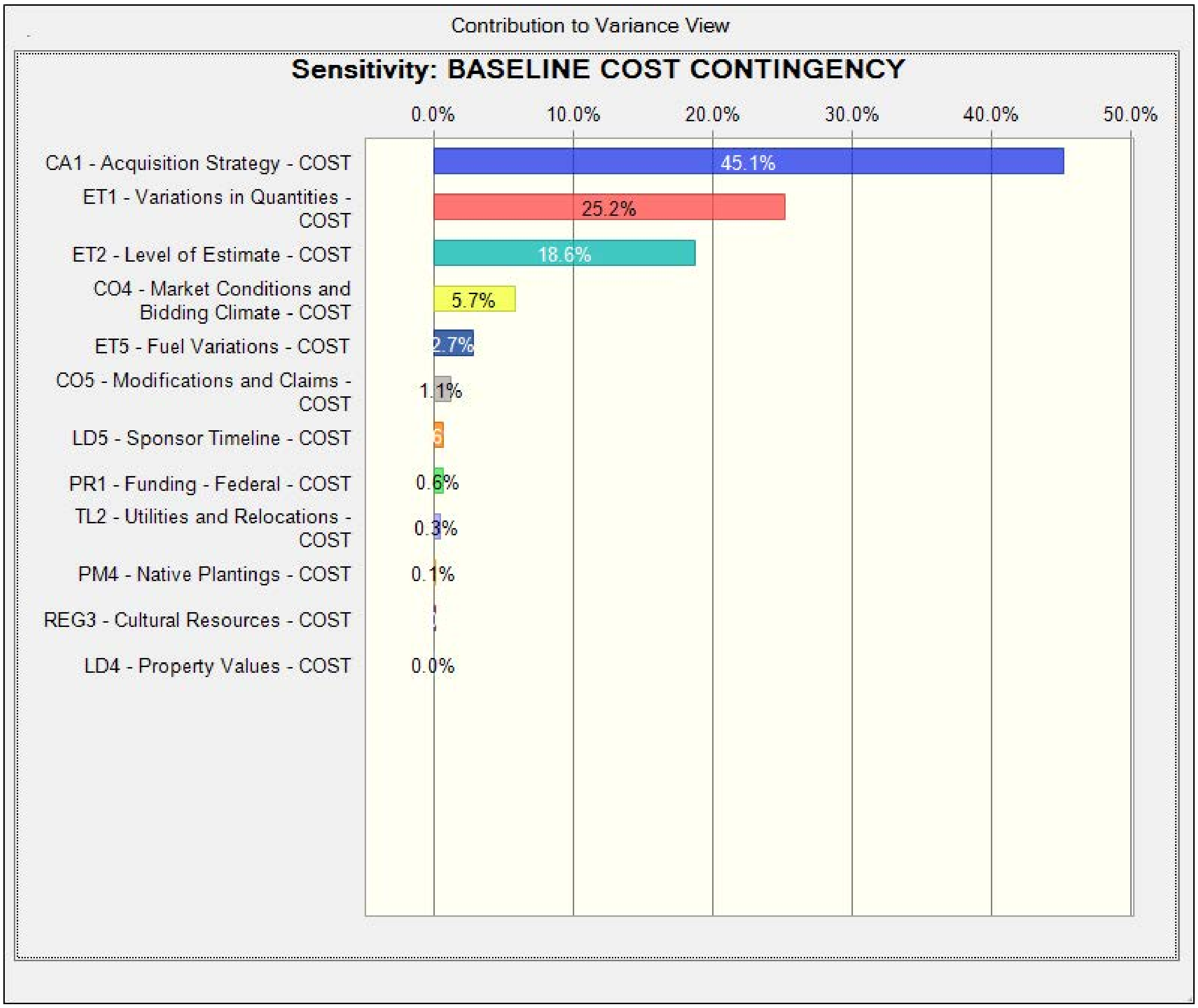
Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

Figure 1. Cost Sensitivity Analysis



6.3 Schedule and Contingency Risk Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P90 confidence levels are also provided for illustrative purposes.

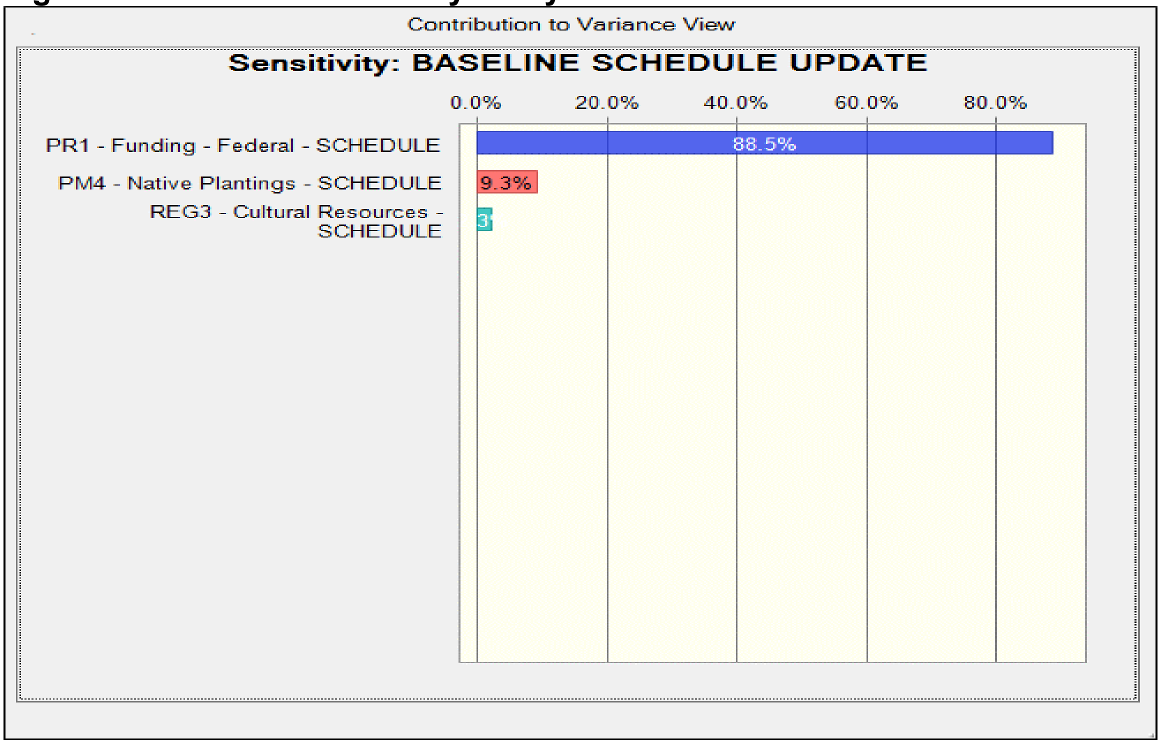
Schedule duration including contingency was quantified as 49 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast (base schedule of 195 months)	**Duration w/ Contingencies (months)**	**Contingency (months)**
50% Confidence	226	31
80% Confidence	244	49
90% Confidence	252	57

Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost and schedule comparison summaries are provided in Table 3 and Table 4 respectively. Additional major findings and observations of the risk analysis are listed below.

The PDT worked through the risk register in April and May 2017. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $25.2M and schedule risks adding a potential 49 months; all at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- CA1 – Acquisition Strategy – Cost estimate is based on full and open large business contractor markups. Given relatively simple construction requirements and small dollar values (some $5M each or less) it is very likely large portions of this work could be awarded to Small Disadvantaged Business.
- ET1 – Variations in Quantities – Survey data for dredging was lacking. Limited survey information was available for estimating dredge quantities was. Limited survey data was extrapolated to those areas that had no data.
- ET2 – Level of Estimate – Estimate is a feasibility level estimate based on with estimated crews, production rates and material quotes. Level of Estimate varies between a Class 4 and Class 3 with associated Risk Levels.

Moderate risks, when combined, can also become a cost impact.

- CO4 – Market Conditions & Bidding Climate – Bidding climate could lead to higher awarded construction costs. Mechanical Marine Dredging is highly specialized work with few available contractors in the area.
- ET3 – Fuel Variations – Fuel cost has varied significantly recently and will most likely continue to fluctuate for the life of this project. Estimate is based on current AAA fuel rates.

Schedule Risks: From the CSRA, the key or greater Schedule Risk items include:

- PR1 – Federal Funding – Schedule is entirely funding dependent. Baseline schedule requires some $10M to $15M per year for total project. Federal share would be some $10M / year. There is currently funding uncertainty for Environmental Restoration projects.
- PM4 – Native Plantings – Native Plantings will need to be coordinated with nurseries to insure plants are available. The Nature Conservancy and Commercial Supply all appear to have limited additional supply capacity. Their ability to provide plants for quantities required is uncertain. Schedule risk exists early on as supply growers are developed. Worst case the first construction season could be missed as suppliers are developed.

Table 3. Construction Cost Comparison Summary (Uncertainty Analysis)

PROJECT FIRST COST BASE ESTIMATE	**$126,066,000**		
Confidence Level	**Project First Cost**	**Contingency**	**Contingency %**
0%	$127,326,660	$1,260,660	1%
5%	$136,151,280	$10,085,280	8%
10%	$138,672,600	$12,606,600	10%

15%	$139,933,260	$13,867,260	11%
20%	$141,193,920	$15,127,920	12%
25%	$141,193,920	$15,127,920	12%
30%	$142,454,580	$16,388,580	13%
35%	$143,715,240	$17,649,240	14%
40%	$143,715,240	$17,649,240	14%
45%	$144,975,900	$18,909,900	15%
50%	$146,236,560	$20,170,560	16%
55%	$146,236,560	$20,170,560	16%
60%	$147,497,220	$21,431,220	17%
65%	$148,757,880	$22,691,880	18%
70%	$148,757,880	$22,691,880	18%
75%	$150,018,540	$23,952,540	19%
80%	**$151,279,200**	**$25,213,200**	**20%**
85%	$152,539,860	$26,473,860	21%
90%	$153,800,520	$27,734,520	22%
95%	$156,321,840	$30,255,840	24%
100%	$173,971,080	$47,905,080	38%

Table 4. Construction Schedule Comparison Summary (Uncertainty Analysis)

Base Schedule Duration	195.0 Months		
Confidence Level	**Duration**	**Contingency**	**Contingency %**
0%	197.0 Months	1.9 Months	1%
5%	204.8 Months	9.8 Months	5%
10%	208.7 Months	13.7 Months	7%
15%	210.6 Months	15.6 Months	8%
20%	214.5 Months	19.5 Months	10%
25%	216.5 Months	21.5 Months	11%
30%	218.4 Months	23.4 Months	12%
35%	220.4 Months	25.4 Months	13%
40%	222.3 Months	27.3 Months	14%
45%	224.3 Months	29.3 Months	15%
50%	226.2 Months	31.2 Months	16%
55%	228.2 Months	33.2 Months	17%
60%	232.1 Months	37.1 Months	19%

65%	234.0 Months	39.0 Months	20%
70%	236.0 Months	41.0 Months	21%
75%	239.9 Months	44.9 Months	23%
80%	**243.8 Months**	**48.8 Months**	**25%**
85%	247.7 Months	52.7 Months	27%
90%	251.6 Months	56.6 Months	29%
95%	259.4 Months	64.4 Months	33%
100%	280.8 Months	85.8 Months	44%

7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

The CSRA study serves as a "road map" towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

Risk Management: Project leadership should use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

Brownsville, Texas Resaca City Wide Feasibility Study

Risk Matrix

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
	Impact or Consequence of Occurrence				
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope

Resacas (oxbow lakes) are former channels of the Rio Grande River that have been cut off from the river, having no inlet or outlet. The study effort will evaluate the environmental restoration of the resacas, improved flood protection, enhanced water storage, and ecosystem restoration.

SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			**$630,330**		**6 Months**
Marginal ---*between*	**$630,331**	**and**	**$2,521,320**	**6 Months**	**and 10 Months**
Significant ---*between*	**$2,521,321**	**and**	**$3,781,980**	**10 Months**	**and 20 Months**
Critical--- *between*	**$3,781,981**	**and**	**$6,303,300**	**20 Months**	**and 39 Months**
Crisis ---*Over*	**$6,303,301**			**39 Months**	

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost: Likelihood*	Project Cost: Impact*	Project Cost: Risk Level*	Project Cost: Rough Order Impact ($)	Project Schedule: Likelihood*	Project Schedule: Impact*	Project Schedule: Risk Level*	Project Schedule: Rough Order Impact (mo)	Variance Distribution
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)												
	PROJECT & PROGRAM MGMT											
PM1	Environmental Restoration Project	Environmental Restoration Project intended to restoring native habitat to the Resacas (oxbow lakes) improving aqua habitat.	Overall fairly simple construction with overall minimal design and construction.	Very Unlikely	Marginal	LOW		Unlikely	Negligible	LOW		
PM2	Mechanical Dredging - Marine	9"-10" Mechanical Dredging (cutter suction head with pipelin pumping) some three to five feet of some 45 Resacas segments (64 segments were in the feasibility study).	Scope of work is well defined and unlikely to change. Some 800,000CY will be in-water marine dredging. Sponsor has self performed dredging work in the past and owns there own mechanical cutter suction dredge. Availability of other additional contractors may be limited. See Bidder Competition Risk mentioned below for risk modelin Dredge material is dewatered and disposed of offsite with multiple handlings (costs included in estimate). Dredge material may be suitable planting shelfs but suitability will need to be confirmed and cost savings evaluated (potential opportunity) . Resacas will also be used as raw water storage.	Likely	Significant	HIGH		Unlikely	Negligible	LOW		
PM3	Mechanical Dredging - Land Based	Some 400,000CY of Resacas dredging can be performed from shore with conventional excavation equipment.	Scope of work is well defined and unlikely to change. Dredge material is dewatered and disposed of offsite with multiple handlings (costs included in estimate). Dredge material may be suitable planting shelfs but suitability will need to be confirmed and cost savings evaluated (potential opportunity) . Relatively low risk feature of work with multiple contractors available to perform.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW		
PM4	Native Plantings	Invasive and Non-Native species will be removed from about 1,000 acres or more and replanted in either native plantings or turfing.	Mitigation requirements are not driving planting areas. Brownsville Pub Utility Board (BPUB) Sponsor is very supportive of the project and will attempt to restore as much area as justifiable. Native Plantings will need to be coordinated with nurseries to insure plants are available. The Nature Conservancy and Commercial Supply appear to limited additional supply capacity. Their ability to provide plar for quantities required is uncertain. Schedule Risk if sufficient supply is not available. Lousville Aqutic Ecosystem Research Facility (a department of ERDC) has also been contacted about supplying plants. As project continues to develop PDT must coordinate with suppliers to insure adequate capacity. Commercial growers may need to be actively contacted in order to develop the capacity to supply the project. Schedule risk exists early on as supply growers are developed. Worst case the first construction season could be missed as suppliers are developed. PDT costs could also be impacted due to delay.	Unlikely	Marginal	LOW		Unlikely	Significant	MODERATE		

PM5	Control Structure Modifications	Control Structures are intended to mimic seasonal water levels for aquatic species establishment.	Most work involves adding adjustable weirs to existing structures to control water levels. HECRAS model has been established water flows During dry periods HECRAS model is not as accurate. During PED water flow models will need additional refinement but weir structure configurations and requirements are not likely to change.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
PM6	Planting Shelf	Planting shelf at water edge consisting of offsite material with topsoil overcoat will be required for planting establishments	Scope is well defined and unlikely to change. Estimate assumptions (offsite material) is likely conservative.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW		
PM7	Turfing	Native grass turfing will be planted in an effort to control non-native species intrusion.	Turfing costs are well established and scope risk is negligible.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW		
PM8	Staffing - Design	A regional design staff has been used in the Feasibility study development.	Project is scheduled for some 16years or more. Yearly staffing requirements are not that extensive and districts are likely to be able to staff with existing personnel as project funds become available. Design Staffing risk is minimal.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW		
PM9	Staffing - Construction	Brownsville TX is located on the far southern border. Local staff availability for Construction Management will need to be coordinated.	USACE Corps Field Office is located in Brownsville. Sufficient CM staff should available to oversee project. Cost and Schedule Risk is low.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW		
PM10						0				0		
	CONTRACT ACQUISITION RISKS											
CA1	Acquisition Strategy	Cost estimate is based on full and open large business contractor markups. Given relatively simple construction requirements and small dollar values (some $5M each or less) it is very likely large portions of this work could be awarded to Small Disadvantaged Business.	Districts have SDB goals. It is likely this project could be used to supplement districts overall SDB contracting goals.	Likely	Critical	HIGH		Likely	Marginal	MODERATE		
CA2	Multiple Contracts	Schedule assumes 1 construction contract per year (some 1 contracts total).	Funding limitations could lead to schedule delays with multiple additional contracts required. Funding risk is discussed and modeled below.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW		
CA3						0				0		
CA4						0				0		
	TECHNICAL RISKS											
TL1	Survey Data	Survey data for dredging was lacking.	Limited survey information was available for estimating dredge quantities was. Limited survey data was extrapolated to those areas that had no data. Quantities varied from 3' to 5' of excavation. Environmental intent is 5' deep Resacas. BPUB spot checked various locations to confirm assumptions. See quantity variations modeled below.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW		
TL2	Utilities and Relocations	Estimate assumes some 5% of construction costs for roads bridges and utilities.	Placeholder costs. Utilities may be impacted for site access, construction clearance or excavation/construction. Some sites do have known and probably unknown existing utilities but it is currently not studied what relocations would be required. Cost uncertainty is moderate and could vary +/-10% from estimated.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW		
TL3	Material Disposal	Scope assumes offsite disposal.	Estimate includes disposal costs and dump fee ($5/CY) for some 1.2M CY. If material could be reused disposal costs could decrease. If assumed landfill is unable to accommodate all material additional landfill site may be required. Overall cost and technical risk is neutral.	Unlikely	Marginal	LOW		Very Unlikely	Negligible	LOW		
TL4	HTRW	No HTRW has been experienced in any pervious work performed by the local sponsor.	Resacas are currently used for raw water storage. HTRW risks are unlikely.	Unlikely	Marginal	LOW		Very Unlikely	Negligible	LOW		

TL5						0				0		
	LANDS AND DAMAGES RISKS											
LD1	Real Estate Footprint	Real Estate footprint has been evaluated by parcels in an attempt to minimize the number of impacted parcels.	Real Estate has included a rough approximation for renting staging areas across the various site locations. Real Estate is fairly well defined and not likely to change. Additional Real Estate requirements are unlikely beyond what is assumed in the baseline model.	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		
LD2	Real Estate Acquisition	Some 75% of the property is residential (personal) and 25% city owned. Some 663 parcels in all are impacted.	Some 60% to 70% of property acquistions will be purchase of the submerged water areas and would not affect the owners effective property usage. Dry land property acquisitions will focus on agricultural properties that would not impact private residences. There are a few agricultural areas owned adjacent to residences that ma require condementation actions (say some 10 at most). The project schedule is flexibile and would allow difficult properties to be worked around until made available. BPUB will need to condemn properties on behalf of the City of Brownsville. Brownsville is aware and have granted that authority. Schedules could be delayed if the condemnation process is required. Public hearings are scheduled in the coming months and a better understanding of the public concerns will be available.	Unlikely	Negligible	LOW		Unlikely	Marginal	LOW		
LD3	Subdivision CCR and HOA Rights	Local subdivision CCRs allow the local owners the rights to clear brush and maintain yards. Environmental restoration work would involve the establishment of native plants that should not be cut and cleared.	CCR/HOA rights of the subdivisions will need to be condemned for area within the property footprints. Public hearings and court negotiations will need to be conducted to determine the value of the CCR and negotiate settlements. Dollar impacts are likely marginal but schedule could be delayed significantly Similar to Risk LD2, project schedule is flexible and will be able to work around areas until issues are resolved. Schedule impacts are unlikely	Unlikely	Negligible	LOW		Unlikely	Marginal	LOW		
LD4	Property Values	Real Estate estimate includes real property costs but does not include loss of aesthetic value.	Homes on Resacas will loose waterfront access due to native plantings. A comparison will need to be performed evaluating the difference in property values between those homes on Resacas versus comparable homes not on Resacas. Those costs are not included in the current baseline Real Estate estimate. Areas are primarilay agricultural tracts without houses. Assumes some half of the 10 residential parcels will have impacted views/property values at an impact of some $25K each. A mass appraisal is schedule for June 2017 and a better understanding of those potential cost impacts should be available then.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW		
LD5	Sponsor Timeline	Some 40-50 private property parcel acquisitions will be required per year. In addition some will need to be condemnations.	BPUB has a limited staff available but has planned to augment with contracting support. Initial real estate acquisitions may impact first contract awards but as project progresses sponsor should be staffed an in a battle rhythm to meet out year timelines. Initial schedule risks are discused in Risk LD2. BPUB administrative costs of approximately $2000/parcel may be understated. For Ecosystem Restoration Projects, sponsor credit costs can not excee 35% of the project costs. 01 and 02 account costs already exceed 35% of the total project cost. Additional contract	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW		
LD6				Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		

	REGULATORY AND ENVIRONMENTAL RISKS											
REG1	Planting Establishments	Replantings may be required to establish sufficient stands o native species.	Estimate includes 25% replanting and assumed sufficient.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
REG2	Endangered Species	A consultation has been completed with Fish and Wildlife and NGOs. This project will supply endangered habitat. No endangered species are present.	The likelihood of impacts from encountering endangered species is minimal.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
REG3	Cultural Resources	Cultural surveys will be competed during PED. Programatic agreement has been reached with SHPO.	Excavations are not very deep. It's likely palo-lithic artificats may be located but baseline estimate includes costs to cover documentation surveys, onsite archelogist during excavations and collection of artifacts necessary. Risk exists additional cultural resources could be discovered but cost ar schedule impacts are likely marginal.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE		
REG4	Mitigation Requirements	Project is an environmental restoration project.	Mitigation ratios are not required. Changes in mitigation required are n likely.	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		
REG5				Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		
	CONSTRUCTION RISKS											
CO1	Residential Construction	Much of the work is residential Brownsville areas. Construction could have impacts on surrounding residence traffic.	Cost estimate includes turbidity curtains, silt fence, traffic controls and flagging, construction site access points, street sweeping etc.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
CO2	Street Repairs	Heavy truck haul traffic through residential areas will be required for some 400,000cy of excavated material.	Baseline Estimate includes residential street resurfacing. Low cost risk	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
CO3	Temporary Construction Easements and Lay Down Areas	Real Estate estimate includes costs for temporary staging areas.	Exact locations have not been located but representative costs have be included.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
CO4	Market Conditions and Bidding Climate	Bidding climate could lead to higher awarded construction costs. Mechanical Marine Dredging is highly specialized work with few available contractors in the area.	Landscape and Environmental Restoration is fairly simple work with ma available contractors. As economy continues to improve, contractor competition for Federal Projects is no longer as advantageous for dredging work. Most other work is fairly simple with multiple contracts capable of performing the work. Mechanical Marine Dredging could experience limited bidder competition. Limited marine dredging competition could lead to 10% higher marine dredging costs.	Likely	Marginal	MODERATE		Unlikely	Marginal	LOW		
CO5	Modifications and Claims	Possibility of Mods and Claims impacting construction costs	Relatively simple projects with minimal technical requirements should minimize the extent of potential construction modifications. Worst case cost growth for restoration would be 4% cost growth. Closure structure work could experience worst case 10% cost growth.	Likely	Marginal	MODERATE		Unlikely	Marginal	LOW		
CO6	Government Furnished Material	Native plantings are likely to be separately procured from nurseys and provided as GFM to planting contractors.	Early coordination with nursery will be required to insure GFM plantings are available in a timely manner.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		

CO7				Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		
	ESTIMATE AND SCHEDULE RISKS											
ET1	Variations in Quantities	Survey data for dredging was lacking.	Limited survey information was available for estimating dredge quantities was. Limited survey data was extrapolated to those areas that had no data. Quantities varied from 3' to 5' of excavation. Environmental intent is 5' deep Resacas. BPUB spot checked various locations to confirm assumptions. Overall quantities are likely fairly accurate.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW		
ET2	Level of Estimate	Level of Estimate varies between a Class 4 and Class 3 with associated Risk Levels	Estimate is a feasibility level estimate based on with estimated crews, production rates and material quotes. Cost estimate fluctuation is likely neutral.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW		
ET3	Inflation Greater than National Average	If local inflation should be greater than CWCCIS national average the buying power of the project could be impacted	Brownsville has experienced fairly standard cost growth. Inflation greater than CWCCIS is not likely.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW		
ET4	Labor Rates	Galveston District standard estimating practice is to use default Cost Book Seattle labor rates for budgetary estimate	Seattle Labor rates likely overstate local rates (potential cost opportunity). Risk Model does not attempt to quantify savings.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW		
ET5	Fuel Variations	Fuel cost has varied significantly recently and will most likely continue to fluctuate for the life of this project. Estimate is based on current AAA fuel rates.	Fuel fluctuation for large earth moving projects is always a concern and captured here.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW		
ET6				Unlikely	Negligible	LOW		Unlikely	Negligible	LOW		
	Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)										
PR1	Funding - Federal	Schedule is entirely funding dependent.	Baseline schedule requires some $10M to $15M per year for total project. Federal share would be some $10M / year. There is currently funding uncertainty for Environmental Restoration projects. Its likely project could experience critical schedule delays (2yrs to 3yrs) which would also impact PDT costs.	Unlikely	Marginal	LOW		Likely	Critical	HIGH		
PR2	Funding - Sponsor	Sponsor is currently self performing areas of work and is likely to meet there funding commitments.	Sponsor funding risk is minimal.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
PR3	Community Support	Community has yet to become fully engaged with the project.	While community is supportive of environmental restoration, specific restoration impacts and the publics acceptance have yet to be fully vetted. Public meeting is scheduled for 31May. For now, risk is considered neutral.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		
PR4	Political Support	Political Climate will affect available funding.	Sponsor is activiely engaged with congressional and ASA USACE HQ to bring visability to project.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW		

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).
1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item fo respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

APPENDIX E-4

HYDROLOGY AND HYDRAULICS

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HYDROLOGY AND HYDRAULICS

Introduction

This appendix discusses the interim hydrologic and hydraulic (H&H) data gathering efforts and engineering analyses for the Resacas Ecosystem Restoration Study in Brownsville, Texas. The H&H analysis was used to select the recommended plan, the National Ecosystem Restoration (NER) plan.

The study area focused on the Resaca De La Guerra, Resaca Del Rancho Viejo, a Town Resaca. These water systems are used for multiple purposes which include recreation, irrigation, and flood control. Figure E-4- 1 shows the location of the project area. These water systems are regulated by the Brownsville Public Utility Board (BPUB).

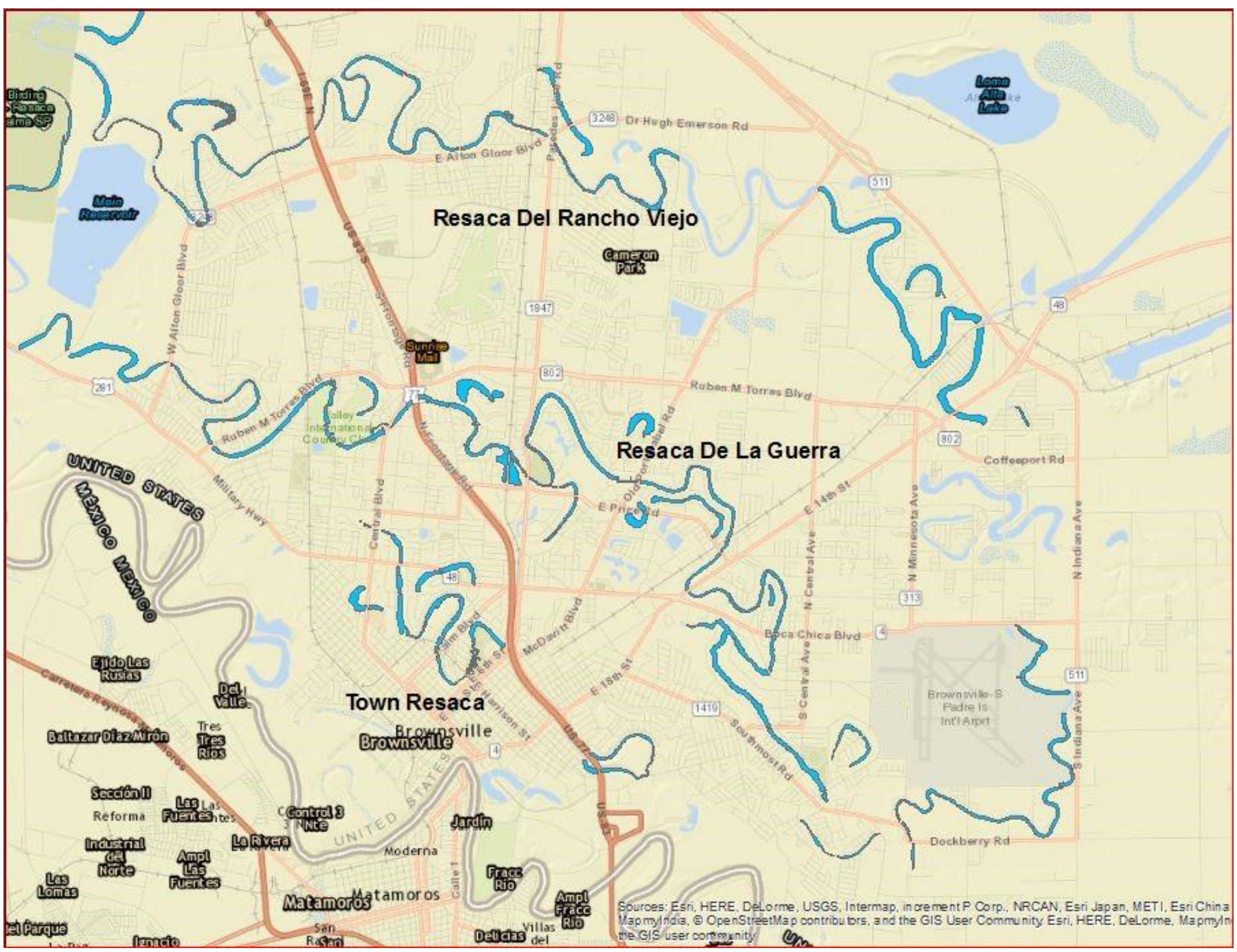

Figure E-4- 1: Location of Resacas in Project Area

The analyses were conducted to assess if restoration alternatives were sustainable, resilient, and to assess potential negative environmental impacts. The sections below will discuss the analyses and include recommendations for the next phase of investigation – preconstruction engineering and design.

Regional Data

Units and Coordinate System

All units are in US Customary Units (US), unless stated otherwise. Vertical and elevation data are in feet, referenced to NAVD 88 datum, unless noted otherwise. Horizontal coordinates shown are in Texas State Plane Zone 5426, FIPS 4205 TX-South. The project horizontal datum is NAD 83.

Climate

The project area is located in Brownsville where the climate is subtropical and subhumid, with hot summers and mild winters. Temperatures range from an average low of 50 degrees F to 69 degrees F in January and from an average high of 75 degrees F to 94 degrees F in July. Rainfall averages 27 inches per year. Snowfall is exceedingly rare. Figure E-4-2 below shows the average monthly rainfall and temperature for Brownsville.

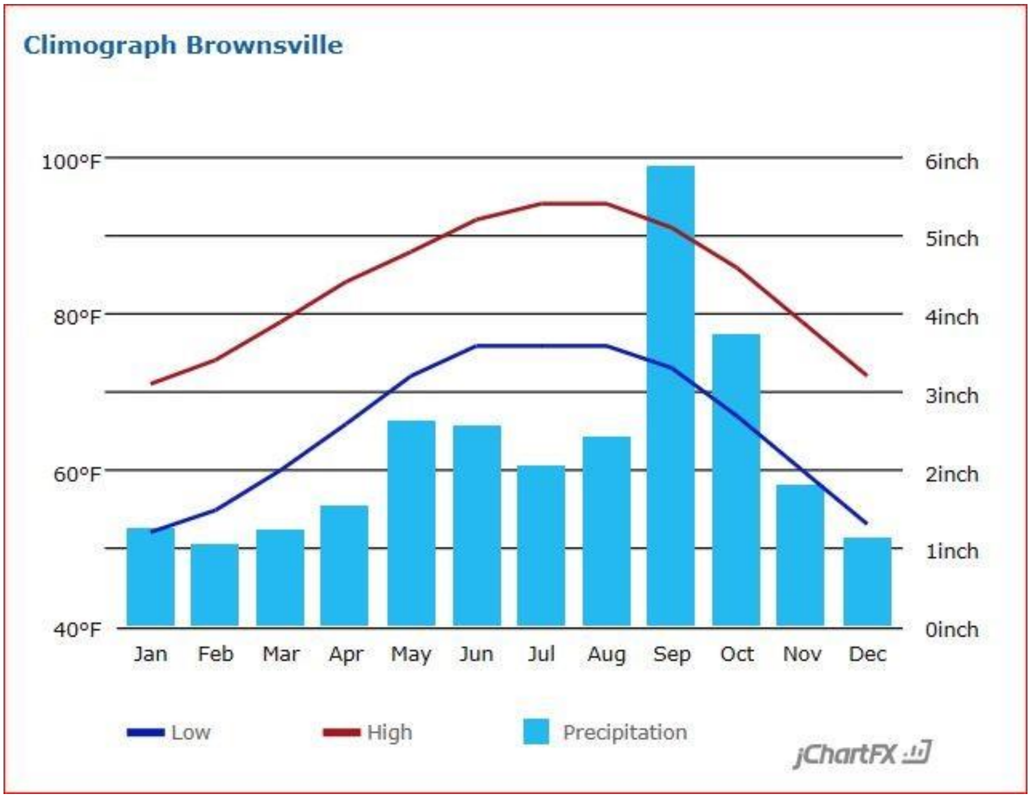

Figure E-4-2: Climograph for Crownsville, Texas

Data Collection

Previous Studies

The most recent H&H study conducted in the project area was the "Flood Protection Plan – Phase II" in August 2011 by Ambiotec Civil Engineering Group, Inc. This study was an extension of the "Flood Protection Plan" study conducted in March 2006 by Ambiotec Civil Engineering Group, Inc., Texas Water Development Board, and Rice University. The hydrologic and hydraulic models provided by these previous studies served as the base models for this study.

The purpose for both of these studies was to evaluate potential flood risk within the City of Brownsville. The studies considered impacts from future development, coastal storm surge, and implementation of proposed structural and non-structural flood risk management measures. These studies noted they were intended for planning purposes only and were not be used for engineering design.

The H&H analyses also considered the “Master Drainage Plan – Volumes I & II” completed in July 1987 by Hogan and Rasor, Inc for the City of Brownsville. Volume II provided the most pertinent data, which include existing normal water surface elevations for each segment of the resacas, and historic flood index elevations.

The “2015 Water and Wastewater Master Plan and System Models” by AECOM in April 2016 and the “Water Conservation and Drought Contingency Plan” by Brownsville Public Utility Board in May 2014 was also considered.

Hydraulic Structure Inventory

To understand the water management process of the resacas system, two field reconnaissance trips were conducted in July 2016 and in December 2016. Data collected included photos and measurements of each hydraulic structure in the base hydraulic models, comparison of observed structures versus structures in the hydraulic models, and a brief explanation of the type and purposes of structures. This data was input into ArcGIS Online. A view of the hydraulic structure inventory for Town Resaca and Resaca del la Guerra can be seen in Figure E-4-3 and in Figure E-4-4 for Resaca Rancho Viejo. Notes collected about each hydraulic structure for the three resacas systems can be seen in Table E-4-1, Table E-4-2, and Table E-4-3.

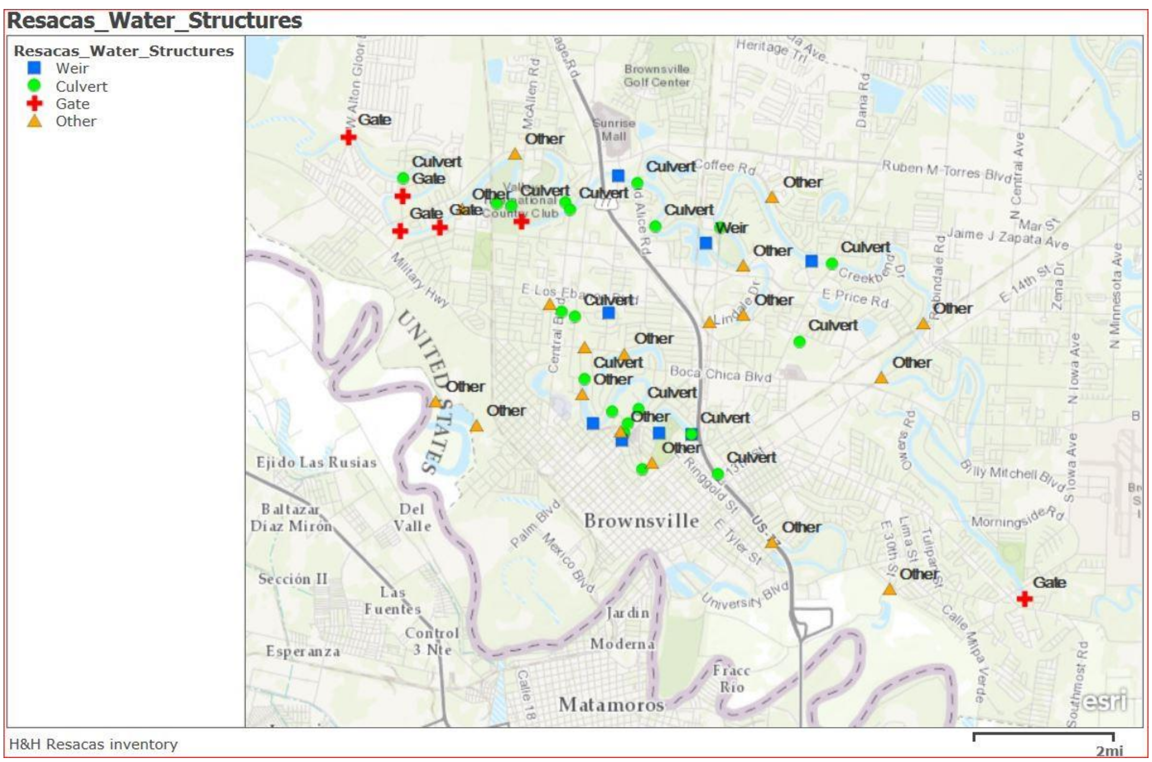

Figure E-4-3: Hydraulic Structure Inventory on ArcGIS Online for Resaca de la Guerra and Town Resaca

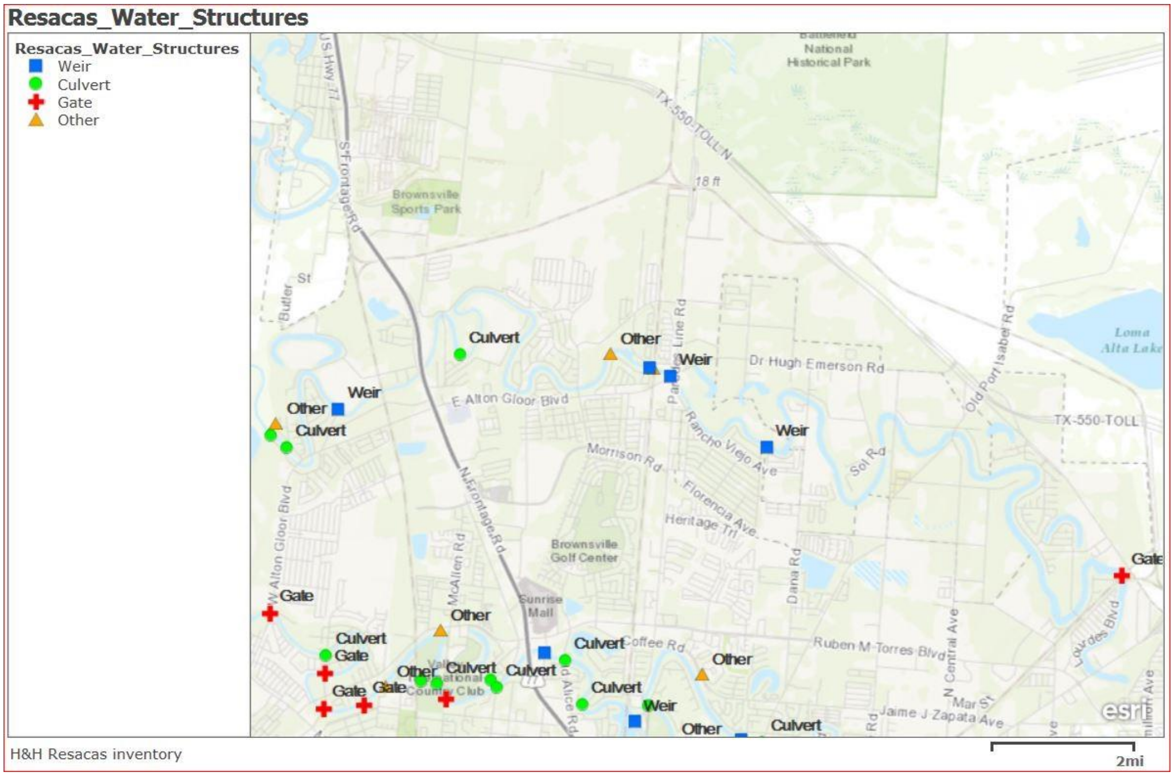

Figure E-4-4: Hydraulic Structure Inventory on ArcGIS Online for Resaca del Rancho Viejo

Table E-4-1: Town Resaca Field Reconnaissance Notes

Resaca	Station	Location	Structure Type	Number of Barrels	Size (ft.) (Dia. or W	Length (ft.)	Upstream Invert Ele	Downstream Invert Ele	Slope (%)	Notes
Town Resaca	394+50	Los Ebanos Blvd.	Circular Culvert	1	1.5	94	24.53	24.44	0.10	
Town Resaca	390+00	Weir at 8" Valve	Weir	1	67	10	29.90	29.90	0.00	
Town Resaca	376+00	Central Blvd.	Circular Culvert	1	1.5	126	22.00	27.20	-4.13	
Town Resaca	370+00	Coria Blvd.	Circular Culvert	1	1.25	70	22.00	21.50	0.71	Culvert measured 42" Dia. during 7/27/2016 site visit.
Town Resaca	351+50	Boca Chica Blvd.	Circular Culvert	1	2	130	25.20	23.00	1.69	Culvert measured 48" Dia. during 7/27/2016 site visit.
Town Resaca	337+00	Belthair St.	Circular Culvert	1	1.5	71	22.50	22.50	0.00	Culvert measured 36" Dia. during 7/27/2016 site visit.
Town Resaca	316+00	Putegnat Weirs (Resaca Blvd.)	Weir	1	98	10	26.50	26.50	0.00	Weir length & crest width not modeled correctly. Should be modeled as 2 weirs, combined length 14.875' L x 2" W.
Town Resaca	303+00	Calle Retama (west crossing)	Box Culvert	1	10 x 8	71	21.00	22.85	-2.61	
Town Resaca	281+00	Pedestrian Bridge	Box Culvert	1	12 x 6.5	40	20.60	19.00	4.00	
Town Resaca	264+00	Ringold	Box Culvert	1	10 x 10	70	17.63	19.73	-3.00	
Town Resaca	255+00	Calle Retama (east crossing)	Box Culvert	1	10 x 8	86	19.30	20.00	-0.81	
Town Resaca	251+00	Railroad	Box Culvert	1	9 x 4	55	22.00	19.80	4.00	
Town Resaca	247+00	Palm Blvd.	Box Culvert	1	10 x 6	148	19.74	18.86	0.59	
Town Resaca	244+50	Rotary Park Weir (Palm Blvd.)	Weir	1	261	10	25.64	25.64	0.00	Weir length & crest width not modeled correctly. Should be 5' L x 2" W.
Town Resaca	226+00	Old Alice Rd.	Box Culvert	2	9 x 4	65	19.50	19.50	0.00	
Town Resaca	221+00	Railroad	Box Culvert	3	8 x 10	68	21.87	21.34	0.78	
Town Resaca	203+00	Zoo Dam/Weir	Weir	1	69	10	22.53	22.53	0.00	Weir length & crest width not modeled correctly. Should be 45' L x 1' W.
Town Resaca	172+00	Interstate Culvert	Box Culvert	2	9 x 9	1395	19.74	19.30	0.03	Appears to be upstream culvert under Interstate. Should be extended to 12th St.
Town Resaca	158+00	Railroad	Box Culvert	2	10 x 8	67	19.30	19.70	-0.60	Unclear what this culvert is supposed to be. Remnant of model from before Interstate?
Town Resaca	154+00	12th St.	Box Culvert	2	10 x 9	90	19.63	19.85	-0.24	Should be incorporated into upstream culvert under Interstate.
Town Resaca	140+00	13th St.	Box Culvert	2	10 x 9	1910	19.30	19.30	0.00	
Town Resaca	110+00	24th St. Bridge	Bridge	1	Cross Section	52	N/A	N/A	N/A	
Town Resaca	107+75	Weir near 24th St.	Weir	1	200	20	19.95	19.95	0.00	
Town Resaca at "Duck Head"	104+00	Highway 77 Bridge (north crossing)	Bridge	1	Cross Section	73	N/A	N/A	N/A	
Town Resaca at "Duck Head"	047+00	E. Ringgold St. (at "Duck Head")	Circular Culvert	1	3.33	58	17.27	17.26	0.02	
Town Resaca at "Duck Head"	047+00	E. Ringgold St. (at "Duck Head")	Circular Culvert	2	1.5	58	18.20	18.10	0.17	
Town Resaca at "Duck Head"	038+00	Highway 77 Bridge (south crossing)	Bridge	1	Cross Section	75	N/A	N/A	N/A	Twin 36" RCP culvert near sta. 15+25 missing from model.
Town Resaca Ditch	045+00	East Ave. Bridge	Bridge	1	Cross Section	40	N/A	N/A	N/A	
Town Resaca Ditch	026+00	Impala Dr. Bridge	Bridge	1	Cross Section	50	N/A	N/A	N/A	Pump station not modeled.
Town Resaca Ditch	017+00	Calle Milpa Verde Bridge	Bridge	1	Cross Section	55	N/A	N/A	N/A	
Town Resaca Ditch	004+00	Tulipan St. Bridge	Bridge	1	Cross Section	50	N/A	N/A	N/A	

Table E-4-2: Resaca de la Guerra Field Reconnaissance Notes

Resaca	Statioı	Location	Structure Type	Number of Barrels	Size (ft.) (Dia. or W	Length (ft.)	Upstream Invert Ele	Downstream Invert Ele	Slope (%)	Notes
Resaca de la Guerra	843+00	W. Alton Gloor Blvd.	Circular Culvert	1	3	90	28.70	28.50	0.22	
Resaca de la Guerra	809+00	Laredo Rd. (north crossing)	Box Culvert	1	8 x 4	49	27.25	26.98	0.56	
Resaca de la Guerra	761+60	Laredo Rd. Overflow (mid. crossing)	Box Culvert	1	39.6 x 1	10	31.49	28.87	26.20	Overflow structure modeled as box culvert. Why not model as weir? Structure not found during 7/27/2016 site visit.
Resaca de la Guerra	760+00	Laredo Rd. (mid. crossing)	Box Culvert	2	6 x 2	60	28.87	28.60	0.45	Upstream (east) side: south box sandbagged, north box has 24" dia. gate valve (SCADA
Resaca de la Guerra	740+00	W. Ruben M. Torres Sr. Blvd.	Circular Culvert	2	4	120	28.10	28.05	0.04	
Resaca de la Guerra	736+00	Laredo Rd. Overflow (south crossing)	Box Culvert	1	27 x 1	10	30.30	30.30	0.00	Overflow structure modeled as box culvert. Why not model as weir? Structure not found during 7/27/2016 site visit.
Resaca de la Guerra	734+00	Laredo Rd. (south crossing)	Circular Culvert	2	4	75	25.00	24.95	0.07	Box with 42" dia. gate valve (SCADA controlled) restricting flow on upstream end of culvert.
Resaca de la Guerra	702+00	Weir near Siene River Dr.	Weir	1	10	35	27.80	27.80	0.00	Earthen berm across resaca. 42' cut through weir appears between 1/2009 and 1/2011.
Resaca de la Guerra	680+00	Railroad Bridge	Bridge	1	Cross Section	35	N/A	N/A	N/A	
Resaca de la Guerra	666+00	VICC Northwest Access Rd.	Circular Culvert	2	1.5	40	28.00	27.50	1.25	
Resaca de la Guerra	656+00	VICC Cart Path Bridge	Bridge	1	Cross Section	6	N/A	N/A	N/A	
Resaca de la Guerra	640+00	Fairway Dr./Los Ebanes Ln.	Circular Culvert	1	2	115	27.70	27.60	0.09	
Resaca de la Guerra	633+00	VICC Cart Path/Las Palmas Ln.	Circular Culvert	1	1.5	240	27.50	27.10	0.17	Culvert modeled through area where pond & gate valve control structure observed on
Resaca de la Guerra	612+00	VICC Pedestrian Bridge	Bridge	1	Cross Section	6	N/A	N/A	N/A	Bridge was demolished sometime between 10/2008 and 1/2009.
Resaca de la Guerra	605+00	Old Highway 77 Bridge	Bridge	1	Cross Section	25	N/A	N/A	N/A	
Resaca de la Guerra	600+00	Central Blvd.	Circular Culvert	1	4	120	27.50	27.40	0.08	
Resaca de la Guerra	586+00	Highway 77	Box Culvert	1	5 x 5	350	25.00	24.00	0.29	
Resaca de la Guerra	575+00	Stationary Laredo Bank Weir	Weir	1	5	1	26.00	26.00	0.00	
Resaca de la Guerra	565+00	Old Alice Rd.	Circular Culvert	2	4.33	75	24.00	23.90	0.13	
Resaca de la Guerra	535+00	Hidden Valley Dr.	Circular Culvert	2	2	65	24.00	23.90	0.15	Google Earth aerial imagery indicats 3 culvert pipes at this location.
Resaca de la Guerra	504+00	Shorelake Dam/Weir (Lakeshore Dr.)	Weir	1	190	1	27.36	27.36	0.00	Weir not modeled correctly. Should reflect a rectangular channel approx. 15' wide & ?' deep.
Resaca de la Guerra	498+00	Paredes Line Rd.	Circular Culvert	1	4.33	80	22.60	22.50	0.13	Pedestrian bridge upstream not modeled.
Resaca de la Guerra	460+00	Palo Verde Dr.	Circular Culvert	1	3.5	70	23.00	22.50	0.71	
Resaca de la Guerra	370+00	Hackberry Weir (645 Hackberry Ln.)	Weir	1	150	2	26.00	26.00	0.00	Weir not modeled correctly. Should reflect a rectangular channel approx. 10' wide & ?' deep.
Resaca de la Guerra	364+00	Old Port Isabel Rd.	Box Culvert	2	8 x 8	60	20.00	19.30	1.17	
Resaca de la Guerra	285+00	Railroad Bridge	Bridge	1	Cross Section	60	N/A	N/A	N/A	
Resaca de la Guerra	275+00	E. Price Rd.	Box Culvert	1	10 x 8	63	18.40	18.30	0.16	
Resaca de la Guerra	250+00	BPUB Resaca Pump #4 Weir (Hwy 48)	Weir	1	25	75	23.16	23.16	0.00	
Resaca de la Guerra	156+00	Boca Chica Blvd.	Box Culvert	2	10 x 8	100	17.70	17.70	0.00	Skipped Highway 48 upstream.
Resaca de la Guerra	155+00	Weir near Boca Chica Blvd.	Weir	1	300	10	22.48	22.48	0.00	Unclear what is being modeled with this structure. No evidence of weir on aerial imagery.
Resaca de la Guerra	136+00	Billy Mitchell Blvd.	Circular Culvert	3	3.5	90	17.00	17.00	0.00	
Resaca de la Guerra	111+00	Acacia Lake Dr. Bridge	Bridge	1	Cross Section	30	N/A	N/A	N/A	
Resaca de la Guerra	047+00	Morningside Rd. (west crossing)	Circular Culvert	2	2.5	65	16.50	15.40	1.69	
Resaca de la Guerra	047+00	Morningside Rd. (west crossing)	Circular Culvert	1	1.25	65	16.50	15.40	1.69	
Resaca de la Guerra	005+00	Morningside Rd. (east crossing)	Circular Culvert	3	2.5	100	14.50	14.00	0.50	
Resaca de la Guerra	000+60	Outlet to North Main Drain	Box Culvert	1	30 x 1	6	19.03	15.20	63.83	Overflow structure modeled as box culvert. Why not model as weir?

Table E-4-3: Resaca del Rancho Viejo Field Reconnaissance Notes

Resaca	Statioı	Location	Structure Type	Number of Barrels	Size (ft.) (Dia. or W	Length (ft.)	Upstream Invert Ele	Downstream Invert Ele	Slope (%)	Notes
Resaca del Rancho Viejo	906+00	Northeast corner of reservoir	Circular Culvert	1	2	33	24.40	24.13	0.82	
Resaca del Rancho Viejo	889+00	Near aqueduct east of reservoir	Circular Culvert	1	4	150	24.25	22.40	1.23	
Resaca del Rancho Viejo	868+50	W. Alton Gloor Blvd. (west crossing)	Circular Culvert	1	5	103	21.16	20.78	0.37	Dawn Dr. Culvert upstream missing from model. Constructed between 11/2006 & 10/2008.
Resaca del Rancho Viejo	858+00	W. Alton Gloor Blvd. (east crossing)	Circular Culvert	1	5	113	20.04	19.99	0.04	
Resaca del Rancho Viejo	795+00	Sandy Hill Dr. Overflow	Box Culvert	1	24 x 1	8	23.87	17.98	73.63	Overflow structure modeled as box culvert. Why not model as weir with culvert downstream?
Resaca del Rancho Viejo	794+00	Sandy Hill Dr. Overflow (outlet pipe)	Circular Culvert	1	1.5	60	17.98	17.99	-0.02	
Resaca del Rancho Viejo	769+00	Old Railroad (west of Highway 77)	Circular Culvert	1	8.5	100	19.71	19.63	0.08	
Resaca del Rancho Viejo	769+00	Old Railroad (west of Highway 77)	Circular Culvert	1	8.5	100	20.23	19.36	0.87	
Resaca del Rancho Viejo	748+00	Highway 77	Circular Culvert	2	6	440	16.37	16.36	0.00	
Resaca del Rancho Viejo	720+00	Resaca Point Rd.	Box Culvert	1	4 x 4	60	13.64	13.35	0.48	Earthen berm downstream (Professional Estates Subdivision) near Klegerg Ave. & Robert Ln. missing from model.
Resaca del Rancho Viejo	619+00	Duncan Rd.	Circular Culvert	1	3	25	16.05	16.05	0.00	Road crossing removed between 1/2009 & 5/2010.
Resaca del Rancho Viejo	575+00	Rustic Manor Dr.	Box Culvert	2	8 x 6	80	11.36	11.36	0.00	
Resaca del Rancho Viejo	536+00	Stagecoach Trail	Box Culvert	1	8 x 6	81	12.08	12.09	-0.01	
Resaca del Rancho Viejo	512+00	Weir near north part of Ridgeline Dr.	Weir	1	20	81	17.00	17.00	0.00	
Resaca del Rancho Viejo	490+00	Hike & Bike Trail Overflow	Box Culvert	3	5 x 2	65	17.50	14.05	5.31	Overflow structure modeled as box culvert. Why not model as weir with culvert
Resaca del Rancho Viejo	480+00	E. Alton Gloor Blvd. & Paredes Line Rd.	Box Culvert	1	14 x 1	460	17.92	13.72	0.91	Overflow structure modeled as box culvert. Why not model as weir with culvert
Resaca del Rancho Viejo	413+00	Weir near Katarina Ave.	Weir	1	5	40	16.00	16.00	0.00	
Resaca del Rancho Viejo	362+00	Dana Ave.	Circular Culvert	1	5	86	12.31	11.83	0.56	
Resaca del Rancho Viejo	276+50	Sol Rd.	Circular Culvert	1	5	33	11.73	11.62	0.33	
Resaca del Rancho Viejo	254+00	Robindale Rd.	Circular Culvert	1	5	42	10.36	10.19	0.40	
Resaca del Rancho Viejo	215+00	Old Port Isabel Rd. Bridge	Bridge	1	Cross Section	30	N/A	N/A	N/A	"check top elevation" noted in model.
Resaca del Rancho Viejo	071+00	Charmaine Ln.	Circular Culvert	1	4	32	11.18	9.99	3.72	
Resaca del Rancho Viejo	029+00	Heron Cove Ln. Overflow	Box Culvert	1	12.6 x 1	89	17.44	8.11	10.48	Overflow structure modeled as box culvert. Why not model as weir with culvert
Resaca del Rancho Viejo	023+50	FM 511 Bridge	Bridge	1	Cross Section	75	N/A	N/A	N/A	
Resaca del Rancho Viejo	012+00	Railroad (east of FM 511)	Circular Culvert	1	6.7	110	3.86	3.26	0.55	
Resaca del Rancho Viejo	012+00	Railroad (east of FM 511)	Circular Culvert	1	5	110	10.18	10.41	-0.21	
Resaca del Rancho Viejo	012+00	Railroad (east of FM 511)	Circular Culvert	1	5	110	10.69	10.52	0.15	

Topographic, Bathymetric, and Survey Data

Detailed terrain data was obtained in the form of LiDAR data from Cameron County, Texas. The LiDAR data was collected with 1-meter resolution. Bathymetry data for this study comes from the base hydraulic models. The original coordinate system was converted to Texas State Plane Zone 5426, FIPS 4205 TX-South. That was accomplished using the script shown in Table E-4-3.

Table E-4-4: Python Script to Post-process LIDAR Data to Import to HEC-RAS-MAPPER

```
# -*- coding: utf-8 -*-
#Author: Mohamamd "Shahidul" Islam, PH.D., P.E.
# Civil (Hydraulic) Engineer
# H&H Branch
#H&H Branch Chief: Coraggio Maglio, P.E.
# USACE at Galveston District, Galveston,TX
# Description: This script will read the raw Lidar dataset (which is readable format only),
#define co-ordinate system and merge the raw dataset for their use in HEC-RAS model
# ---------------------------------------------------------------------------
# Import arcpy module
import arcpy
import glob
lidar_dir= r'E:\lidar_raw_data' # FOlder contains raw Lidar DATA
raster_folder=r'E:\processed_raster' # Folder to contain mosaic raster data
mosaic_filename="test_mosaic.tif" # Mosaic raster data set name
listing = glob.glob(lidar_dir+'\*.dem')
for filename in listing:

# Process: DEM to Raster
    arcpy.DEMToRaster_conversion(filename, filename[:-4]+'_r', "FLOAT", "1")

# Process: Define Projection
    arcpy.DefineProjection_management(filename[:-4]+'_r',
"PROJCS['NAD_1983_StatePlane_Texas_South_FIPS_4205_Feet',GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHEROID['GRS_1980',6378137.0,298.257222101]],PRIMEM['Greenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Lambert_Conformal_Conic'],PARAMETER['False_Easting',984250.0],PARAMETER['False_Northing',16404166.66666666],PARAMETER['Central_Meridian',-98.5],PARAMETER['Standard_Parallel_1',26.16666666666667],PARAMETER['Standard_Parallel_2',27.83333333333333],PARAMETER['Latitude_Of_Origin',25.66666666666667],UNIT['Foot_US',0.3048006096012192]],
VERTCS['NAVD_1988_Foot_US',VDATUM['North_American_Vertical_Datum_1988'],PARAMETER['Vertical_Shift',0.0],PARAMETER['Direction',1.0],UNIT['Foot_US',0.3048006096012192]]")
listing_raster=glob.glob(lidar_dir+'\*_r')
arcpy.MosaicToNewRaster_management(listing_raster, raster_folder, mosaic_filename,
"PROJCS['NAD_1983_StatePlane_Texas_South_FIPS_4205_Feet',GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHEROID['GRS_1980',6378137.0,298.257222101]],PRIMEM['Greenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Lambert_Conformal_Conic'],PARAMETER['False_Easting',984250.0],PARAMETER['False_Northing',16404166.66666666],PARAMETER['Central_Meridian',-98.5],PARAMETER['Standard_Parallel_1',26.16666666666667],PARAMETER['Standard_Parallel_2',27.83333333333333],PARAMETER['Latitude_Of_Origin',25.66666666666667],UNIT['Foot_US',0.3048006096012192]],
VERTCS['NAVD_1988_Foot_US',VDATUM['North_American_Vertical_Datum_1988'],PARAMETER['Vertical_Shift',0.0],PARAMETER['Direction',1.0],UNIT['Foot_US',0.3048006096012192]]", "32_BIT_FLOAT", "",
"1", "BLEND", "FIRST")
```

H&H Analysis

Without Project Hydraulic Modeling

The hydraulic models are based on the referenced hydraulic studies. The previous study developed hydraulic models for the Lower Resaca del Rancho Viejo (LRRV) and for the watershed regions of Resaca de la Guerra (RDLG), North Main Drain (NMD), and Town Resaca (TR) (RDLG, NMD, TR) that share hydraulic connections. The models were developed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center’s River Analysis System (HEC-RAS). These models had several limitations including model domain with several hydraulically incorrect intersecting cross-sections (see green line in Figure E-4-5), and outdated topographic and land use data. These models were updated with the latest topographic datas and modified cross-sections.

The latest topographic datasets were post-processed for their conversion into RAS-Mapper. These topographic datasets were then used in HEC-RAS 5.0.3 to update station–elevation data along the overbank regions of all cross-sections. Elevation data within the channel of the cross-sections were kept the same as of the previous model. Figure E-4-6 shows an example of the topographic update in the current model versus the previous model for XS 33252.91of the LRRV model.

During review of the base models it was discovered that many cross-sections had to be modified because of intersecting cross-sections. During this modification, original model cross-section stationing was kept the same. The green color in Figure E-4-7 denotes the location of the original LRRV model cross-sections whereas the red-color denotes the updated LRRV model cross-section locations. Table E-4-5 lists the cross-section changes that are made for the LRRV model and Table E-4-6 lists the cross-section changes made to the merged HEC-RAS model (i.e., linked RDLG, NMD, TR models). Figure E-4-7 and Figure E-4-8 display the cross-sections of the LRRV and merged model, respectively. Both models also incorporate updated culvert data from the reconnaissance trips. Land use in the region has changed since the previous analysis in 2011, so changes were made to roughness coefficients to reflect the land use changes. These changes were based on the Google Earth satellite imagery, roughness coefficients were changed if Manning’s n values of observed land use were significantly different from the previous model.

Both updated LRRV and merged (RDLG,NMD,TR) HEC-RAS models were simulated for steady flow conditions. Figure E-4-9,Figure E-4-10, and Figure E-4-11 display water surface elevation profiles along the reaches of LRRV, RDLG, and TR, respectively. The computed water surface elevations (WSEs) for both models did not significantly deviate from previous studies.

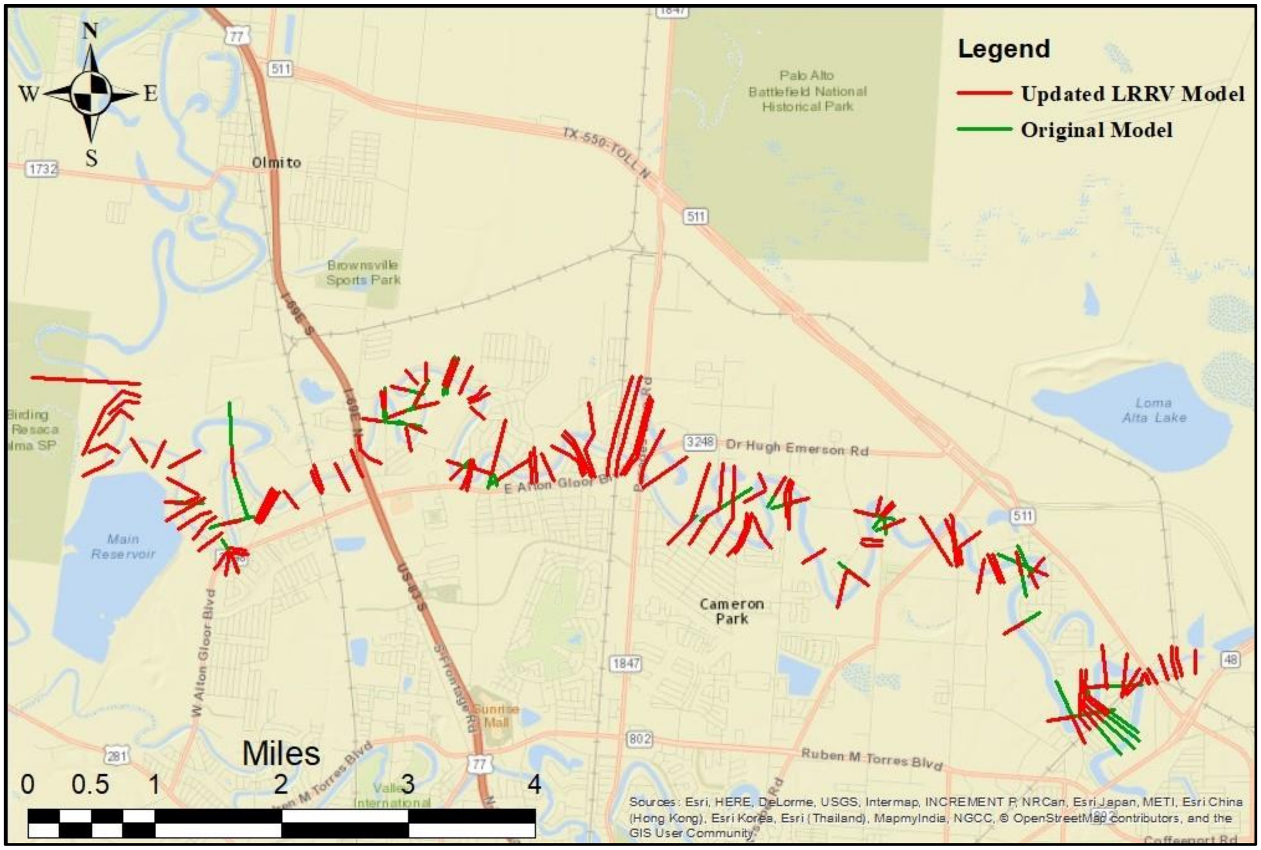

Figure E-4-5: Comparison of Updated and Previous Model Cross-sections (red colored line - Updated Model XS; green colored line - Previous Model XS)

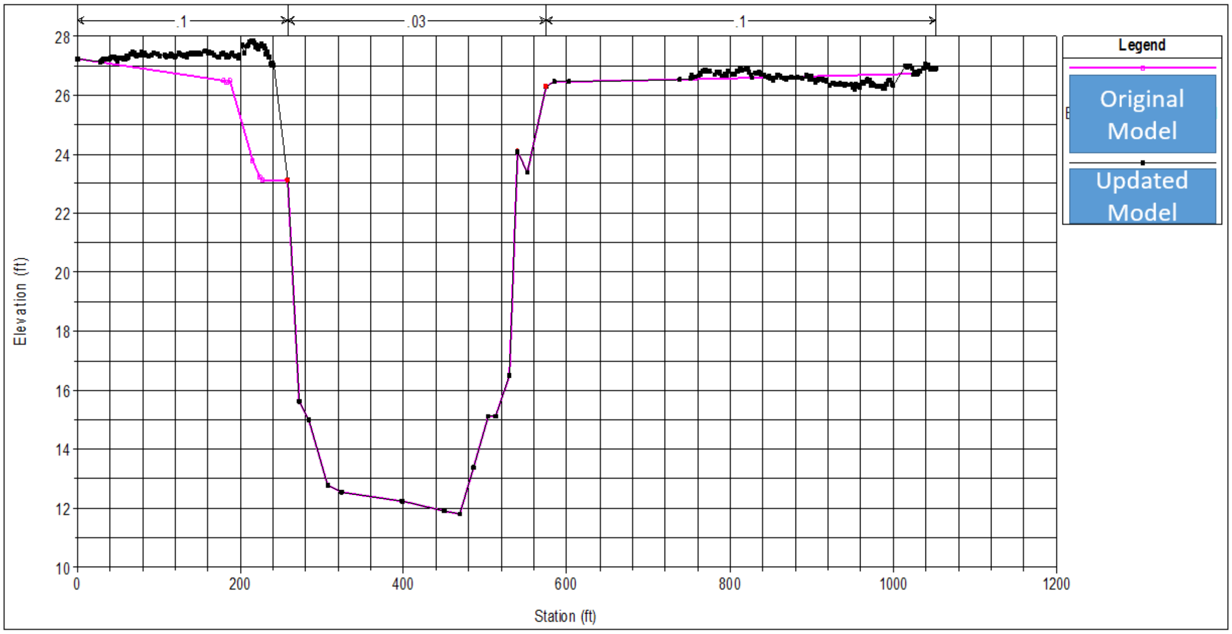

Figure E-4-6: Example of Updated Terrain Data for XS #33252.91 of Model LRRV (black line represents updated model; magenta line represents original model)

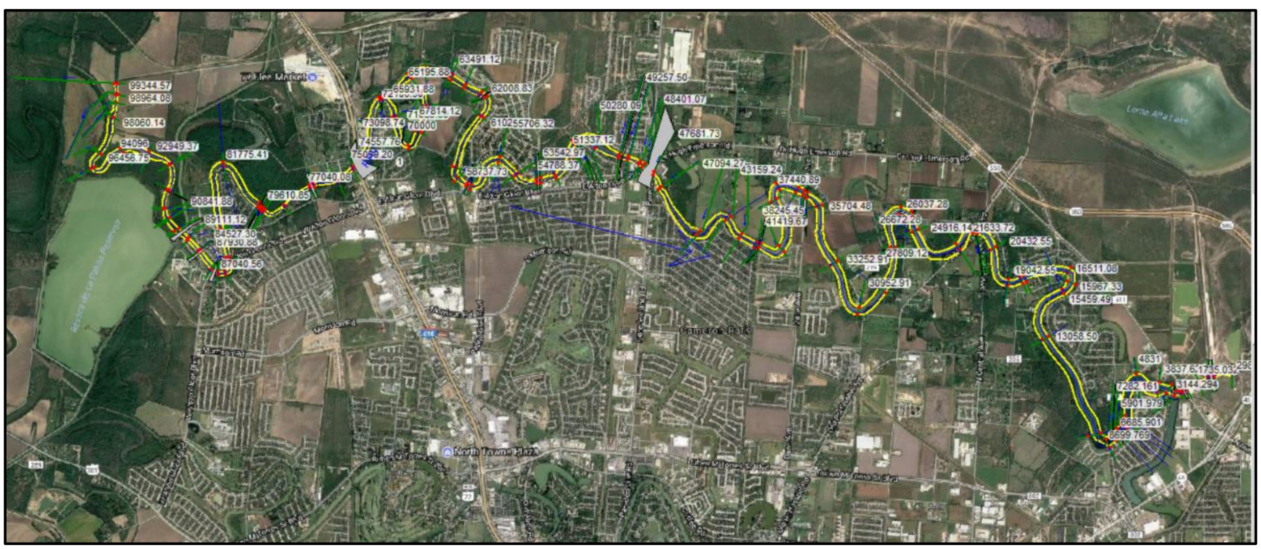

Figure E-4-7: LRRV Model Geometry

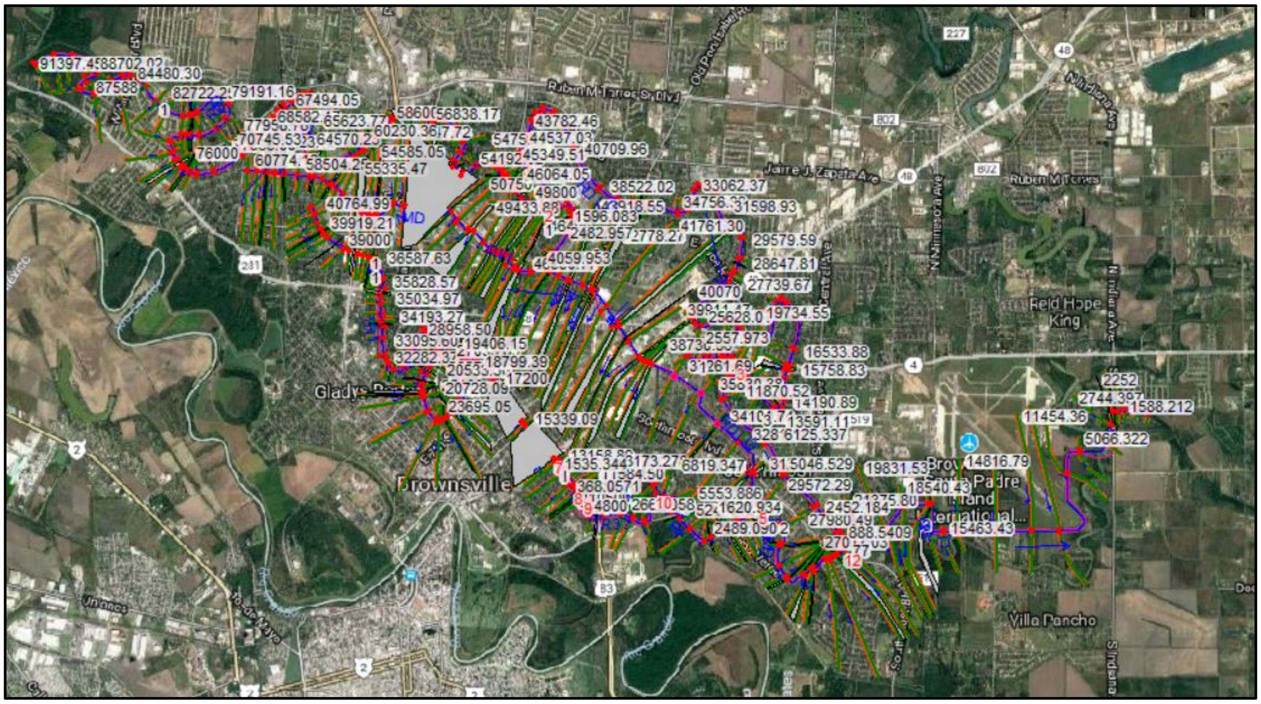

Figure E-4-8: Merged (RDLG, NMD, TR) Model Geometry

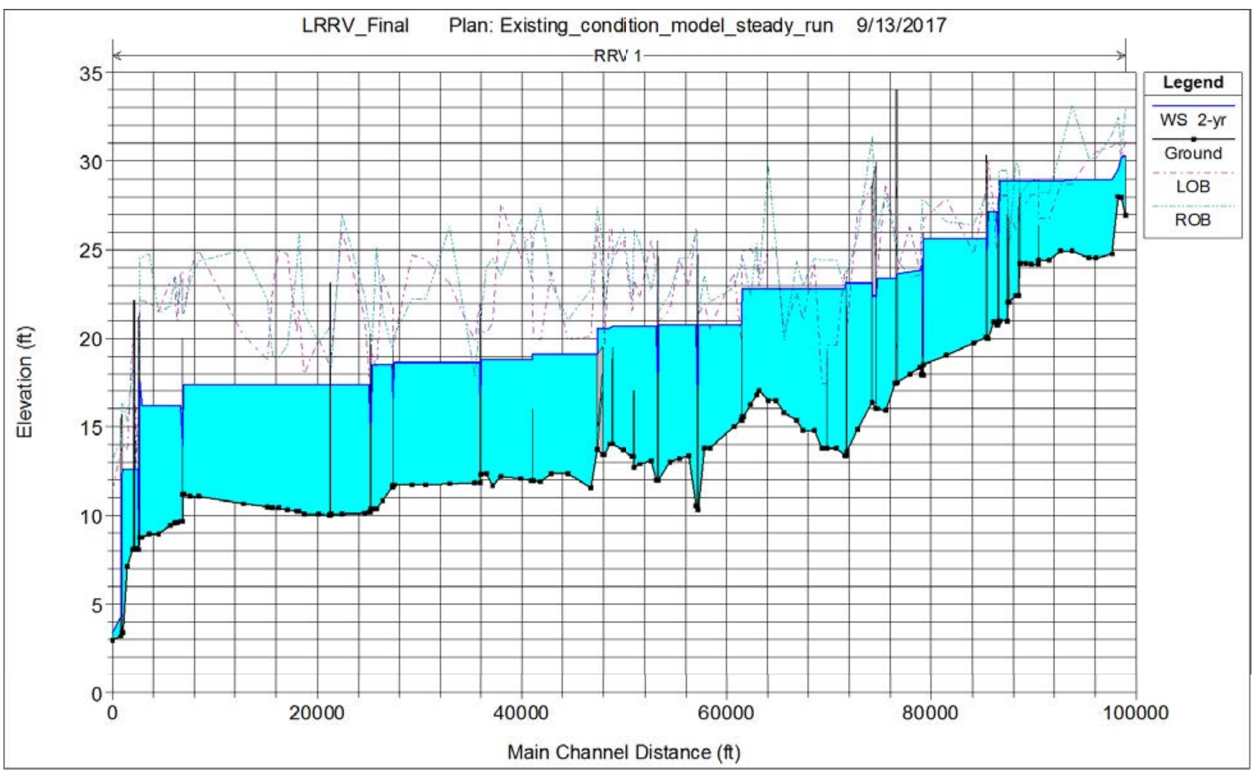

Figure E-4-9: Water Surface Elevation Profile for LRRV Model

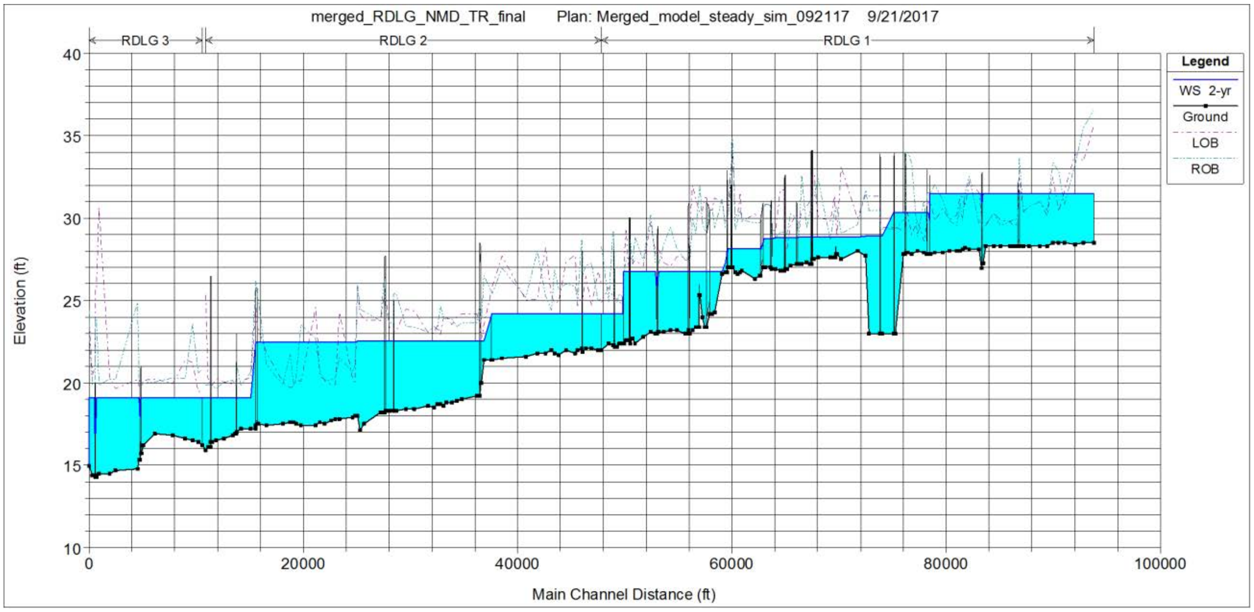

Figure E-4-10: Water Surface Elevation Profile for RDLG Model

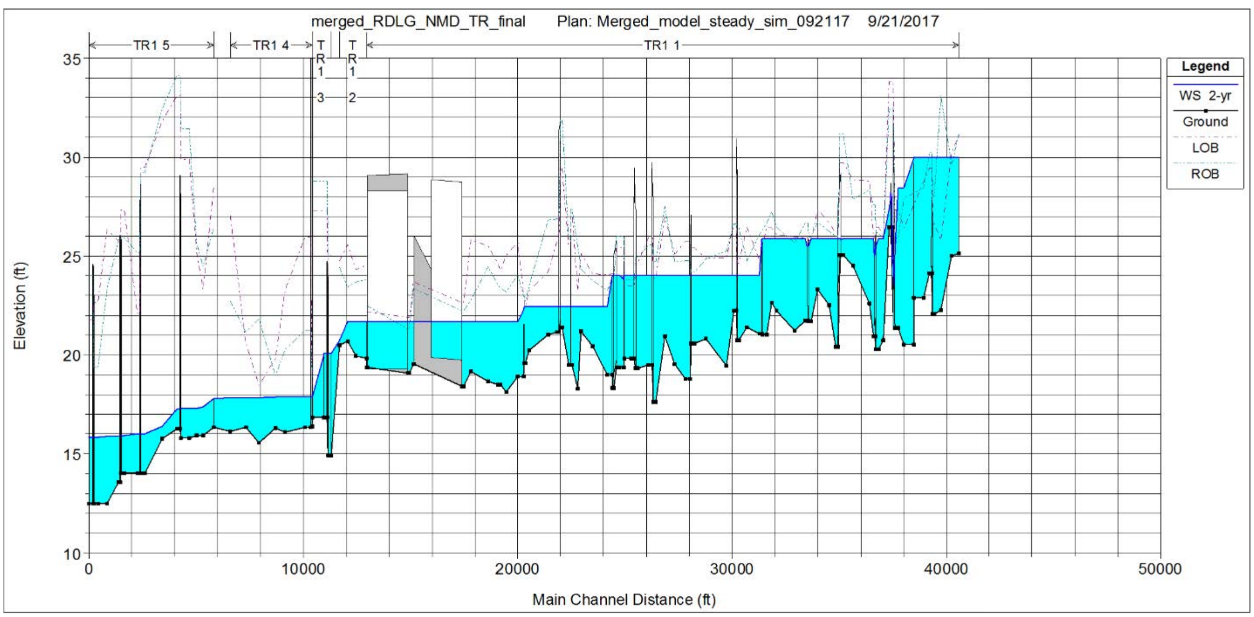

Figure E-4-11: Water Surface Elevation Profile for TR Model

Table E-4-5: LRRV Model XS Modifications

Cross-Section Station Number	Cross-section changes in the updated LRRV Model
90124.13	XS cutline is bended to avoid intersecting with XS 89609.19.
86422.92	The left flooplain portion of the XS cutline is shorten
84527.3	Both left and right side of the original XS is shorten
81775.41	Both left and right side of the original XS is shorten
73098.74	XS was shortened to prevent crossing with section 68899.12.
72100.9	XS cutline was shorten
71950.06	XS cutline was shorten
71089.69	XS cutline was shorten
68899.12	The left flood plain of the original XS was shorten
67814.12	XS cutline was shorten
67216.65	XS cutline was shorten
65931.88	XS cutline was shorten
63491.12	XS cutline was shorten
63333.39	XS cutline was shorten
58737.73	XS cutline was shorten
58177.73	XS cutline was shorten
56628.58	XS cutline was shorten
55706.32	XS cutline was shorten
54788.37	XS cutline was shorten
44776.27	XS cutline was shorten
36792.03	XS cutline was shorten
35704.48	XS cutline was shorten
29559.34	XS Cutline was shorten
26672.28	XS cutline was shorten
26037.28	XS cutline was shorten
25637.6	XS cutline was shorten
25334.66	XS cutline was shorten
24916.14	XS cutline was shorten
18502.34	XS cutline was extended
18337.42	XS cutline was extended
17396.08	XS cutline was shorten
16511.08	XS cutline was shorten
15967.33	XS cutline was shorten
13058.5	XS cutline was shorten
8699.769	XS cutline was shorten
7889.769	XS cutline was shorten
6685.901	XS cutline was shorten
6461.005	XS cutline was shorten
6294.25	XS cutline was shorten
5901.979	XS cutline was shorten

Table E-4-6: Merged (RDLF, NMD, TR) Model XS Modifications

River	Reach	Cross-Sections Station Number	Cross-section changes in the updated Model
RDLG	1	73033.74	Left side of the original XS was shorten
RDLG	3	255.3978	Right side of the original XS was shorten
NMD	1	29572.29	Right side of the original XS was bent to prevent crossing with section # 664.767 of River TR, Reach 1
NMD	3	2744.397	Right side of the original XS was bent
NMD	3	2084.659	Right side of the original XS was bent

Impacts From Relative Sea Level Change

Relative sea level change was assessed using the Port Isabel NOAA gage to forecast sea level change (SLC) for the project area.

The Port Isabel NOAA gage is located about 20 miles east of the project area and is the nearest gage that assesses long term climate change. The historical sea level change with the 95 percent confidence interval is shown in Figure E-4-12.

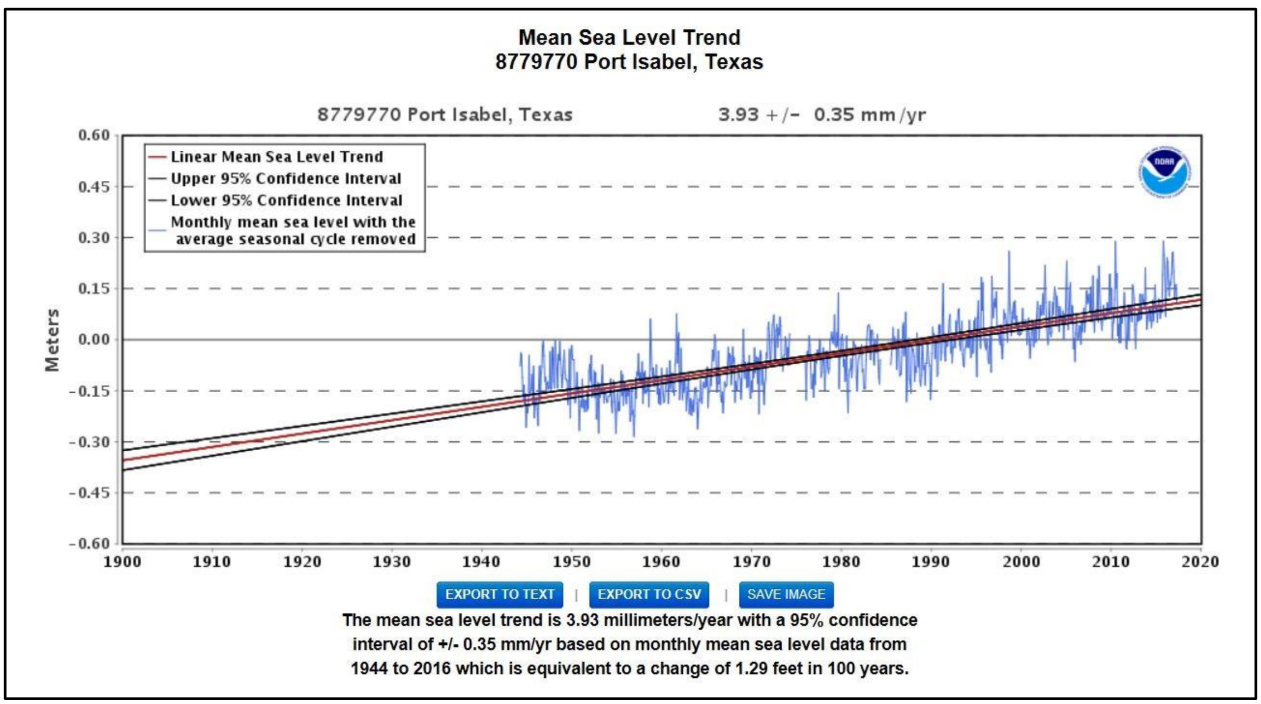

Figure E-4-12: Historical Sea Level Trend for Port Isabel, Texas Gage

This graph shows a change of 1.29 feet in relative sea level rise over the course of 72 years with a trend of 0.013 ft/yr.

Using the USACE guidance on SLC ER 1100-2-8162, “Incorporating Sea Level Change in Civil Works Programs” and the data provided from the NOAA gage an estimation of the high, intermediate, and low sea level change vulnerability assessment were developed (Figure E-4-13).

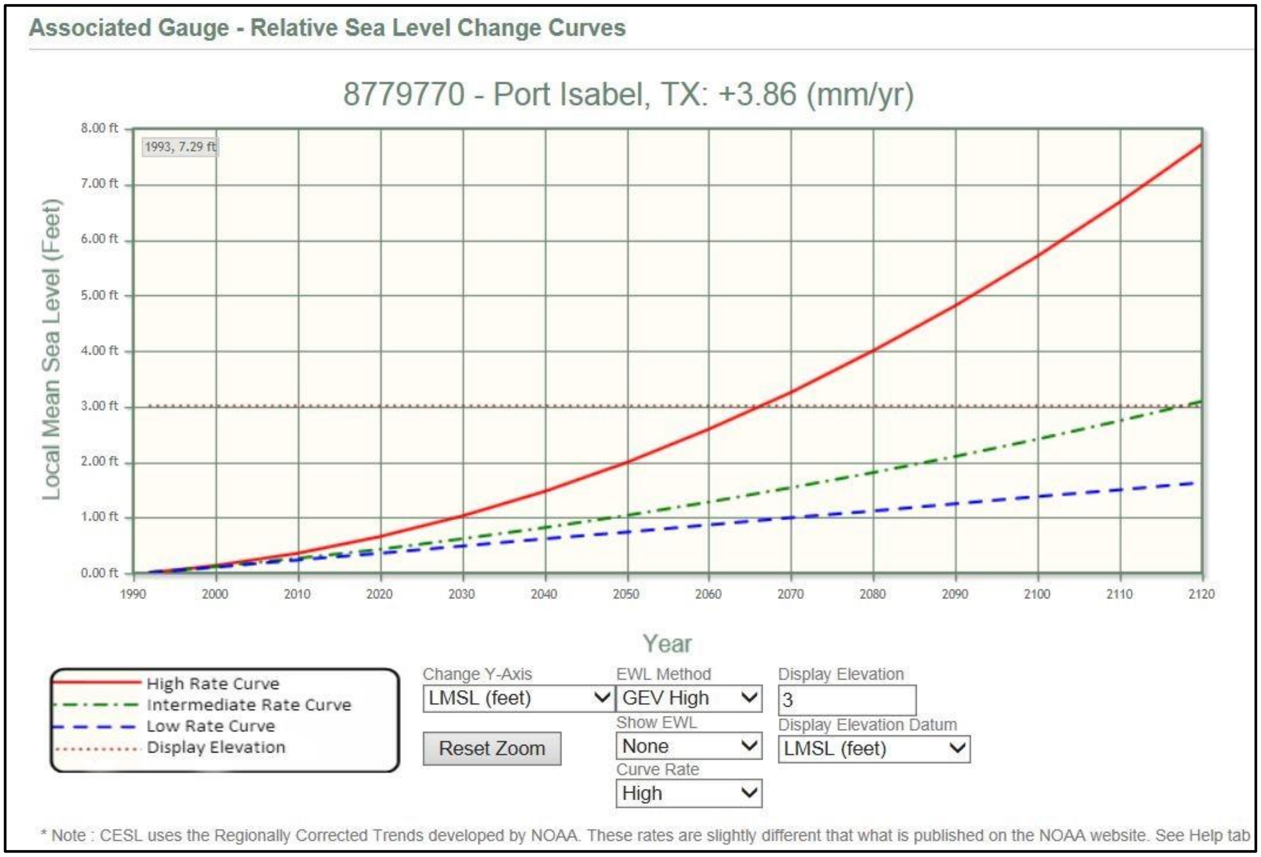

Figure E-4-13: Relative Sea Level Change Curves at Port Isabel, Texas Gage

Table E-4-7: Relative Sea Level Change Impacts at the Resacas with respect to the Port Isabel, Texas Gage

	75-Year Planning Horizon	
Controlling Tidal Gauge Rate Curve	**Impacted at 2095?**	**Level of Consequential Impacts**
High	No	N/A
Intermediate	No	N/A
Low	No	N/A

The intermediate rate of sea level rise rate was used to assess the impacts of the SLC on the project. The data above was taken from the Comprehensive Evaluation of Projects with Respect to Sea Level Change (CESL) web-based tool which assesses the vulnerability that the project area has to SLC over the lifetime of the project. The period of analysis for this ecosystem restoration project is 75 years. At 2095, there are no impacts to the project from sea level rise at the high, intermediate or low rates (Table E-4-7). Since this project will experience no impacts due to SLC, no additional analyses of SLC impacts to alternatives were conducted. This project will likely not experience impacts due to SLC over the life of the project for the low and intermediate expected SLC and should have no effect on the design or operation of the project.

Impact to Hydrology due to Project Climate Change

This section is in compliance with Engineering and Construction Bulletin (ECB) 2016-25 “Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects”. Average annual temperature in South Texas, which includes the Brownsville area, is anticipated to increase by 6-8 degrees F by 2100, with stronger warming in the summer (Norwine and John, eds., (2007) “The Changing Climate of South Texas 1900-2100”). While total annual precipitation is anticipated to remain unchanged, precipitation events, including hurricanes, are likely to be more intense, and separated by longer dry spells (Norwine and John, eds. 2013). The primary projected impacts of these changes is an estimated 25 percent reduction in Rio Grande water supplies accompanied by an estimated 12.5 percent increase in evaporation and rising water demand (U.S. Bureau of Reclamation (2013), “Lower Rio Grande Basin Study”). These hydrologic changes could have an impact to the performance and sustainability of the proposed NER plan.

The vulnerability of the project area to these changes was investigated using the USACE Vulnerability Assessment Tool, which provides a qualitative assessment of parameters that could impact the performance and sustainability of the project. Figure E-4-14 and Figure E-4-15show the projected change in low flow reduction, precipitation runoff, and drought severity, respectively for the driest (lowest runoff) 50 percent of model outputs for the region. Use of just the lowest runoff models in this analysis is justified because the primary anticipated impacts to the project relate to water supply, the primary source for which is the Rio Grande. The shades of red indicate increased vulnerability for that parameter and shades of green represent decreased vulnerability. Analyses of the annual maximum flow series and nonstationarities in annual maximum flow, as required by ECB 2016-25, could not be performed due to the absence of long-term stream gage data for the Rio Grande below Falcon Reservoir, and the highly regulated nature of releases from this reservoir.

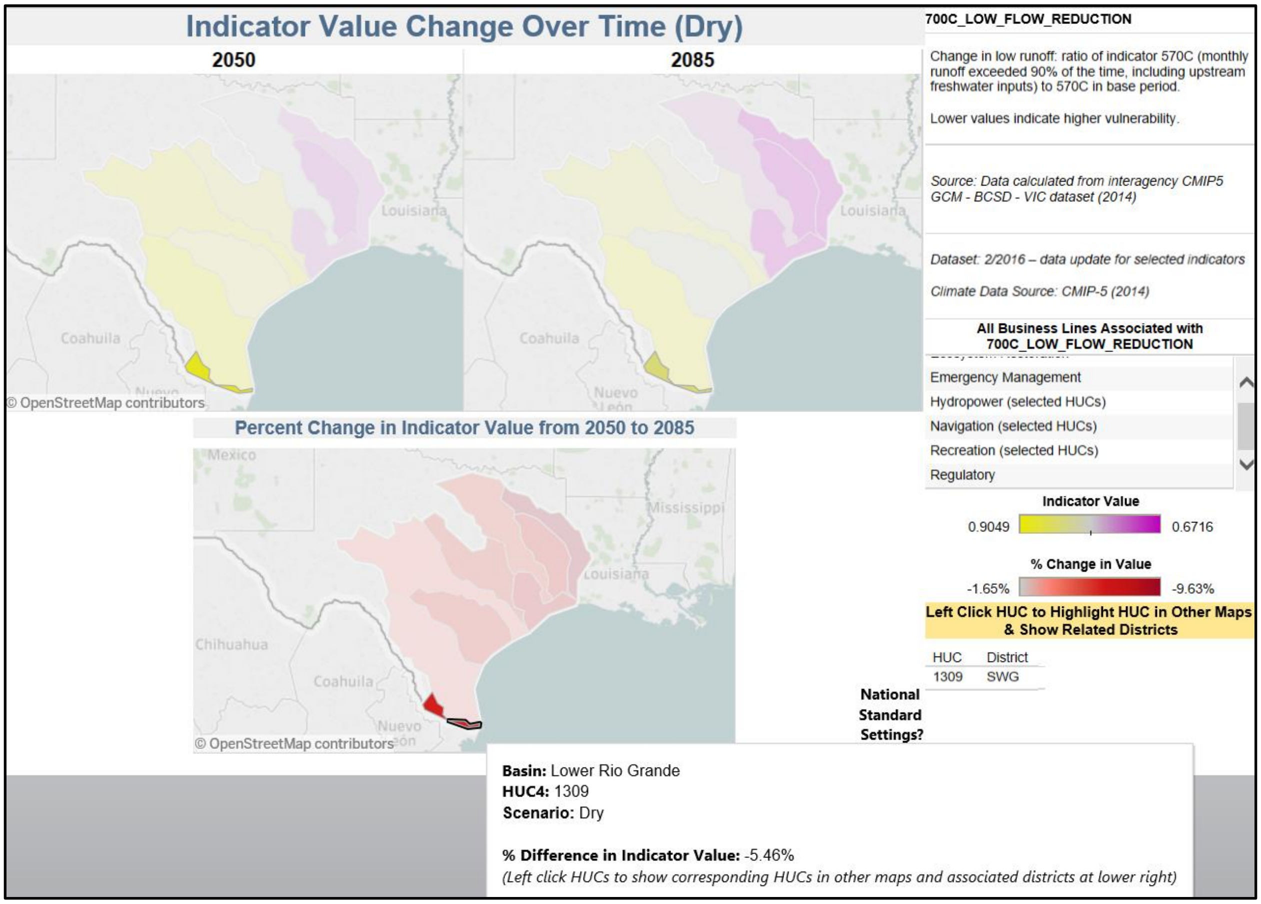

Figure E-4-14: Projected Change in Low Flow Reduction (2050-2085)

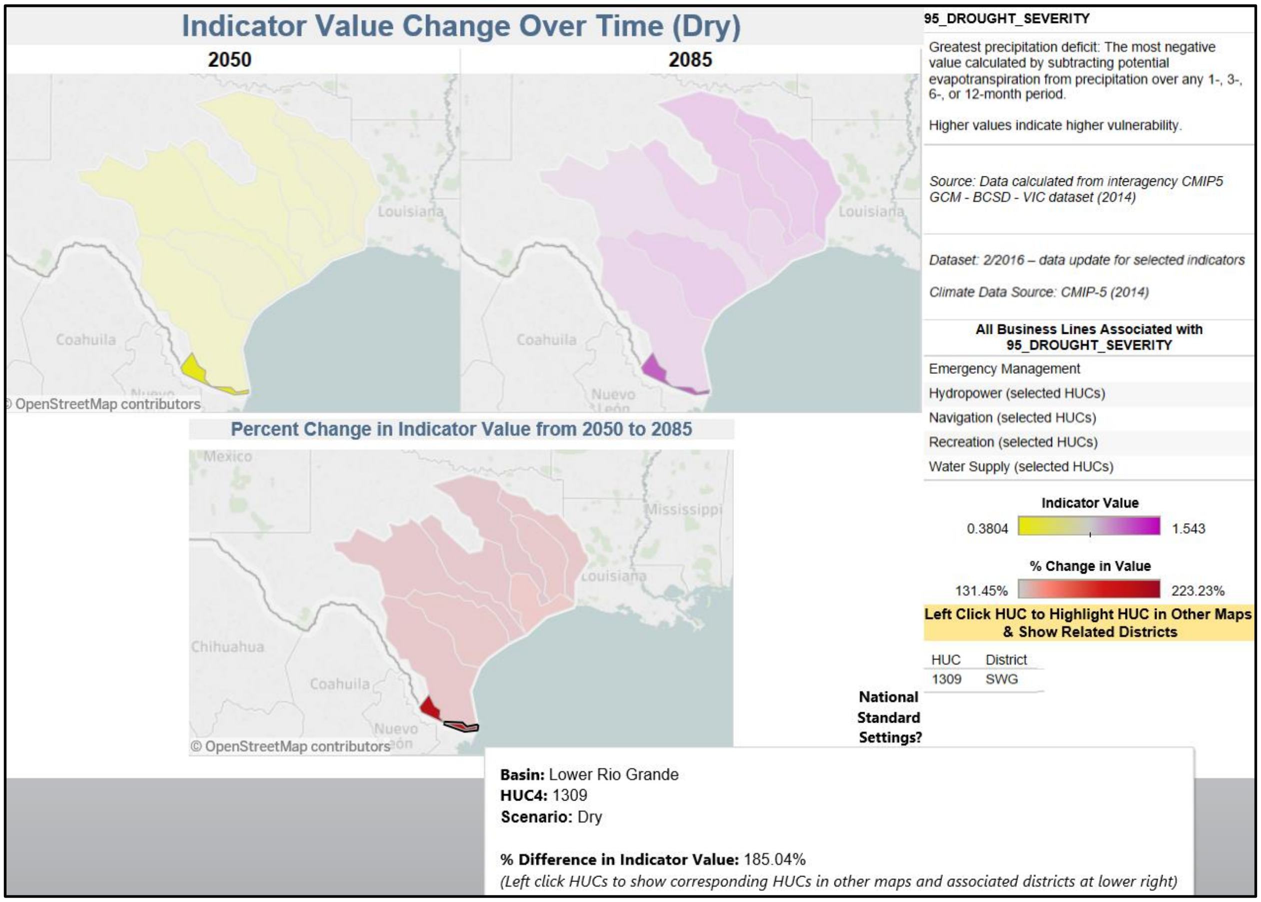

Figure E-4-15: Projected Change in Drought Severity (2050-2085)

The figures above show that the Lower Rio Grande (HUC 1309) can expect significantly more severe droughts during the life cycle of this project (Figure E-4-15). This would cause lower runoff during rain events due to dry soil conditions. Also, air temperature is expected to increase which could increase evaporation in reservoirs upstream that control flow rates in river, as well as evaporation of water in the restored resacas. The reduced low flow conditions (Figure E-4-14) could present challenges for the project since most of the raw water used to manage the resacas system comes from the Rio Grande. These projections are in agreement with the "Lower Rio Grande Basin Study" published by the U.S. Bureau of Reclamation in 2013. Finally, the Vulnerability Assessment tool shows significant regional vulnerability for ecosystem restoration projects generally due to the projected reduction in water availability in aquatic and riparian areas (data not shown).

However, the anticipated reduction in water availability in the project area is unlikely to significantly impact the project since the sponsor has secure water rights that can be used to meet project needs. BPUB recently published a report entitled "BPUB Water Conservation and Drought Contingency Plan" in May 2014. This report shows that

BPUB currently has rights to 40,215 acre-feet of municipal water plus an additional 40,000 acre-feet of water from the Rio Grande River, when excess water is available. Table E-4-8, below, compares the available amount of raw water with the amount of material to be removed from the project area. It is recognized that the projected-year 2060 water demands of 90,584 ac-ft per year, exceed the raw water supply, however the BPUB continues their efforts “to secure additional raw water supplies, [develop] water reuse as an alternative to potable supply needs, [plan] a regional seawater desalination plant, and [implement] measures to reduce water demands.”

Table E-4-8: Volume of Dredge/Excavation Material Compared to Available Water Supply

	Volume
Total amount of material to be dredged/excavated	946 ac-feet (1,527,000 feet^3)
Total amount of available raw water (2013)	80,215 ac-feet (40,000 ac-feet from Rio Grande River, when available)
Projected raw water demand (2060)	90,584 ac-feet
Percentage of volume to be removed from resacas system	1.1 percent (total), 2.2 percent (if no water available from Rio Grande River)

From the information gathered, the amount of material to be removed by the NER plan would be insignificant (<2.2 percent) to the total amount of water available for use by BPUB. It is also important to note that the resacas would need to be operated at lower levels than current conditions for several reasons discussed in the next section. This would lower the amount of water needed to regulate the resacas systems.

The estimated amount of additional water necessary to regulate the resacas system under the NER plan should not require a significant amount of additional water. However, there are still concerns about the availability of water from the Rio Grande and nearby reservoirs during severe droughts. This could reduce the desired water levels in the resacas and affect the resiliency of the proposed project. BPUB is actively pursuing additional sources and implementing new water conservations plans.

In addition, resacas now and historically have experienced extremely low water levels, or have completely dried up during droughts. The ecosystem is adapted to this variability. Currently, when water in a resaca is extremely low and stagnant, the resaca is allowed to dry out and then refilled or flushed out. It is a fairly routine occurrence currently and will almost certainly continue to happen in the future. It is anticipated that the restored resaca ecosystem will continue to be resilient to such drought episodes.

Based on the information available, there is a risk of reduced performance and sustainability of the NER plan due to projected climate changes. Although there is not a current water supply issue, there is a risk that water availability may be reduced in the future. The sponsor is actively working to mitigate that risk. Consequently, the risk of climate change to the project is considered “low” at this time.

Summary of H&H Analysis

The H&H analyses conducted during this phase of the study were completed in order to obtain enough information to make sound engineering decisions about the sustainability and resiliency of the NER plan. After reviewing all of the available information, there is no reason to believe that the NER plan would not be sustainable and resilient, from an H&H perspective, for the entire lifespan of the project. The NER plan was not modeled in this phase of the study, however there are some key constraints that need to be followed in order for the NER plan to function properly:

The water levels for each segment of the resacas need to be lowered in order to:

1. Create flow conditions that will allow riparian areas to thrive,
2. Mitigate any risk of induced flooding due to increased overbank roughness caused by riparian areas,
3. Offset water supply needed to replenish volume removed by dredge material.

Recommendations/Future Analyses

- New hydrologic and hydraulic models for the project area. This would include full calibration, frequency analysis, future conditions analysis, and alternative analysis. The current models are not detailed enough for design requirements.
- New bathymetric data for resacas within NER plan extents
- Perform more detailed climate change analysis, including quantitative inland hydrology and salt water intrusion analysis.
- Development of new water management plan for resacas system. This would include operational guidelines for existing and new water control structures, flood and drought contingency plans, and operation and maintenance manual.

APPENDIX F

REAL ESTATE PLAN

REAL ESTATE PLAN

Purpose

This real estate plan (REP) identifies the real estate requirements for the interim Ecosystem Restoration Project, the Resacas in the Vicinity of Brownsville, Texas. The REP includes the estimated costs and schedule for land acquisition of the recommended plan, Alternative 5, identified in the feasibility report.

The REP is for planning purposes. Real property acquisition and the real estate cost estimate are subject to change during more detailed investigations, such as preconstruction engineering and design (PED).

Project Authority

Resolution of the Committee on Transportation and Infrastructure of the United States House of Representatives dated 10 November 1999. The final resolution reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review that report of the Chief of Engineers on Louisiana and Texas Intracoastal Waterway, Corpus Christi, Texas to the Rio Grande, published as House Document No. 402, 77th Congress, 1st Session, and other pertinent reports to determine the feasibility of providing improvements to the Resacas in the vicinity of the City of Brownsville, Texas in the interest of flood control, watershed management, environmental restoration and protection, water quality, and other allied purposes.*

Project Location and Description

The scope of the ecosystem restoration study included 66 potential restoration areas along three resacas in the vicinity of Brownsville, Texas, in Cameron County. The recommended plan consists of 44 restoration areas. Restoration measures would consist of:

- Dredging
- Riparian Soil Supplementation with Dredged Material
- Planting Riparian Species
- Bank Slope Restoration
- Bank Stabilization

- Plant aquatic and emergent vegetation
- Water Control Structure/Flow Management
- Invasive Plant Species Management

The restoration would consist of 16 1-year implementation phases.

Non-Federal Sponsor

The City of Brownsville would be the non-federal sponsor for construction of the project. The City of Brownsville was founded in 1848 and incorporated in 1853. The City of Brownsville would be the entity responsible for the acquisition of the lands, easements, right-of-way, relocation, and disposal areas for this project.

Real Estate Requirements

The 44 restoration areas affect 646 real estate tracts consisting of residential, commercial and vacant/undeveloped land. The restored area consists of a total of 970.28 acres, which consists of 844.58 acres for ecosystem restoration purposes, and the remaining 125.71 acres are parcel remnants from the required footprint acquisitions. The 844.61 acres of ecosystem restoration can be further broken down into 762.80 acres of land to acquire including city owned property, 53.6 acres of U.S. Fish and Wildlife Services and 28.21 acres of Texas Parks and Wildlife, Fish Hatchery. The remnants are illustrated within the project maps in Exhibit A.

The project footprint was adjusted to avoid pipeline or road easements. Of the 646 tracts, less than three percent is City-owned property, less than two percent is state, federal or local school district, 75 percent of the tracts are residential and the remaining 20 percent is commercial properties.

The non-federal sponsor would be responsible for acquiring and furnishing all lands, easements, rights-of-way, relocations (i.e., Public Law 91-646 relocations and utility/facility relocations), borrow material, and dredged or excavated material disposal areas (LERRD) for the project, if required. Lands required for ecosystem restoration would be acquired in fee except minerals, in accordance with Engineering Regulation 405-1-12 Paragraph 12-9.

Standard Estate #2 - Fee Excepting and Subordinating Subsurface Minerals.

> The fee simple title to (the land-described in Sc*hedule A) (Tracts Nos. , and), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; excepting and excluding from the taking all (coal) (oil and gas) in and under said land and all appurtenant rights used in connection with the exploration, development,*

production and removal of said (coal) (oil and gas), including any existing structures and improvements; provided, however, that the said (coal) (oil and gas) and appurtenant rights so excepted and excluded are hereby subordinated to the prior right of the United States to flood and submerge the land as may be necessary in the construction, operation and maintenance of the project; provided further that any exploration or development of said (coal) (oil and gas) in and under said land shall be subject to Federal and State laws with respect to pollution of waters of the reservoir, and provided that the type and location of any structure, improvement and appurtenance thereto now existing or to be erected or constructed on said land in connection with the exploration and/or development of said (coal) (oil and gas) shall be subject to the prior written approval of the District Commander, U.S. Army Engineer District, or his duly authorized representative.

Lands to support construction activities will require temporary work easements for dewatering dredge material. There are three dewatering/staging areas, each encompassing approximately two acres that will require three-year temporary easements. The dewatering equipment is owned by BPUB and will be deployed to one site, at a time, during the dredging phase of the construction of this project.

Standard Estate #15 - Temporary Work Area Easement.

A temporary easement and right-of-way in, on, over and across the land described, for a period not to exceed ___ months, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove there from all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

List of required property for this project is in Exhibit B.

Federally Owned Land & Existing Federal Project

There are six federally-owned tracts. One by the U.S. National Park Service (NPS) and five by the USFWS.

National Park Service Lands

One tract is owned by the federal government and is currently being operated by the NPS, (Table F-1). The tract of land is submerged within resaca 54. The restoration measure at this tract would be to dredge from 3 feet to 6 feet. A permit from the agency would be obtained for the use of this property. The permit will require headquarters approval, prior to execution, within PED.

Table F-1: Tract of Land Owned by the Federal Government

Property ID	Owner	Division	Usage	Resaca Number	Total Acres	Acres affected
62343	United States of America	Land Resources Program Center	Resaca de la Palma National Battlefield	54	33.04	3.64 (Dredging)

USFWS Lands

There are five tracts within resacas 142, 161, and 166 that are owned by the federal government and are operated by the U.S. Fish and Wildlife Service. These tracts are within the project footprint; however, the sponsor would not acquire them. Instead, the intent is to work with the federal agency to align the ecosystem restoration project with their management plan.

The initial coordination to outline the joint agency implementation during the feasibility phase was positive and detailed coordination would continue during the USACE preconstruction engineering and design.

Failure to reach an agreement on implementation, or conflicting USFWS priorities would potentially result in the USACE implementing a slightly smaller plan or refinements to the recommended plan. The final array of alternatives was coordinated with the public and resource agencies. Adoption of a smaller alternative would not require additional NEPA documentation or review. See Table F-2.

Table F-2 U.S Fish and Wildlife Property

Map Page Number	Resaca	Measure	Owner	Impacted Acres
32	161	Dredge, Veg	U.S. Fish and Wildlife	0.34
26	166	Dredge, Veg	U.S. Fish and Wildlife	4.89
32	161	Dredge, Veg	U.S. Fish and Wildlife	4.92
32	161	Dredge, Veg	U.S. Fish and Wildlife	9.24
32	161	Dredge, Veg	U.S. Fish and Wildlife	14.05
26	142	Dredge, Veg	U.S. Fish and Wildlife	15.46
27	142	Dredge, Veg	U.S. Fish and Wildlife	24.56
32	161	Dredge, Veg	U.S. Fish and Wildlife	35.75
32	161	Dredge, Veg	U.S. Fish and Wildlife	0.50
26	142	Dredge, Veg	U.S. Fish and Wildlife	0.00
32	161	Dredge, Veg	U.S. Fish and Wildlife	4.11
			Total Acres	113.82

Unidentified Ownerships

Eighteen tracts were not identified by the appraisal district. These properties would be identified in PED and may affect the project depending on the location and property owner.

Non-Federal Sponsor Owned Property

There are 24 tracts that have been identified for this project that are owned by the City of Brownsville. A sampling of deeds was conducted. One of the deeds is from the Morningside Park which has a life estate of 1/2 of 1/8 interest remaining on the property. It is assumed that at least one more tract within the project would be less than fee ownership. These properties would have to be condemned to obtain clear title and obtain a fee interest in each tract of land. No Federal funds were used to purchase these tracts.

Texas Parks and Wildlife Services

Texas Parks and Wildlife Services land is within the project footprint consisting of 28.21 acres and illustrated on the real estate maps in Exhibit A. For the use of this property the Texas Parks and Wildlife Services and the City of Brownsville will enter into an interlocal cooperation agreement.

Within in the project footprint 28.21 acres are within Texas Parks and Wildlife Services maintained lands (Exhibit A). The City of Brownsville will enter into an interlocal cooperation agreement with Texas Parks and Wildlife Services to utilize this portion of the project footprint.

Navigation Servitude

Navigation servitude is the dominant right of the government under the Commerce Clause of the U.S. Constitution (U.S. CONST. Art. I, §8, cl.3) to use, control and regulate the navigable waters of the U.S. and the submerged lands hereunder for various commerce-related purposes including navigation and flood control. In tidal areas, the servitude extends to all lands below the mean high water mark. In non-tidal areas, the servitude extends to all lands within the bed and banks of a navigable stream that lie below the ordinary high water mark. United States v. Cress, 243 U.S. 316, 37 S.Ct. 380, 61 L.Ed. 746 (1917), Kaiser Aetna v. United States, 444 U.S. 164, 100 S.Ct. 383, 62 L.Ed.2d 332 (1979). The Government’s rights under the navigation servitude exist irrespective of the ownership of the banks and bed of a stream below the ordinary high water mark and irrespective of western water rights under prior appropriation doctrine.

The Galveston District Office of Counsel determined on August 28, 2017 that the Brownsville Resacas system was not subject to Section 10 of the Rivers and Harbors Act of 1899 jurisdiction as they did not met the definition under 33CFR 329.4

Mitigation Feature

No environmental mitigation would be required for the recommended plan.

Borrow Material

No borrow material would be required.

Access/Staging

There are three staging/dewatering sites, one at Resaca Segment 75, one between Resaca Segment 105-111 and one at Resaca Segment 161. The material removed from the dewatering sites will be either placed in a local landfill, used to slope the banks within the Resaca or sent to the local farm land for soil nutrition. The cost of transportation and tipping fees were calculated in the construction costs.

The staging/dewatering sites are two to three acres in size and will be accessed from public roads. These locations will require three-year temporary work area easements. The acquisition of the easements for the three sites will be staggered over the entire length of the construction timeframe, thus allowing for shorter easement time durations.

Recreation Feature

The recommended plan would not include recreation features.

Project Induced Flooding

Neither construction nor operation of the project would induce flooding, based on existing data and engineering analysis. The sponsor has the ability to adjust water levels in response to storm events. Refer to the Hydrology and Hydraulics, Appendix E for further information.

Baseline Cost Estimate

Land Acquisition Costs

The land acquisition cost was determine by a gross appraisal with an effective date of value of August 15, 2017 and a report data of September 17, 2017. A summary of the appraisal is shown in Table F-3. The following is an excerpt from the gross appraisal.

> *"The subject consists of roughly 691 tracts of numerous parcels with hundreds of owners. In total, the subject proposed taking area is 856± acres. A breakdown is an excerpt from the gross appraisal illustrating the land acquisition costs."*

Table F-3: Gross Appraisal of Land Acquisition Cost

Type	No. of Parcels	Acres	Gross Value Estimates (RE only)	Gross Value Estimates with 20% Incremental Costs
SFR	509	114.62	$1,248,212	$1,497,854
Multi	7	6.91	$552,880	$663,456
Ind	29	57.30	$2,693,100	$3,231,720
Comm	36	31.42	$8,483,400	$10,180,080
Urban Ag	59	343.25	$6,868,000	$8,241,600
Rec/GS	51	302.54	$1,512,700	$1,815,240
Total	691	856.04	$21,358,292	$25,629,950
			Rounded	**$25,630,000**

Before acquiring any properties within the project area, an appraisal must be conducted. The appraisal must meet requirements laid out in both uniform appraisal standards for federal land acquisitions (UASFLA) and uniform standards of professional appraisal practice (USPAP). The appraisal cost range was dependent upon location, available data, and scope of work. A cost of $2,000 per tract appraisal was used as a baseline cost, across the entire project.

The cost to acquire property remnants consisting of 125.71 acres, were captured within the 20 percent contingency of the gross appraisal. No additional costs were added for the acquisition of the parcel remnants.

Because the gross appraisal was completed before the USFWS ownership was identified the cost of the USFWS and several duplicate tracts were removed from the appraisal estimate. This action reduced the parcel count from 691 to 683, which reduced the land acquisition cost to $24,873,743.

Subdivisions and Covenants, Conditions & Restrictions (CCRs)

To obtain fee title, the land must be free of all covenants to include subdivision covenants, conditions & restrictions (CCRs) and Home Owners Association (HOA) covenants. To clear title, the covenants would have to be condemned removing these rights from the land being acquired. A cost of $35,000, per subdivision, was used to determine the overall costs to condemn the covenants. There are a total of 16 subdivisions according to the information obtained from the local appraisal district. The number of subdivisions may vary once the property to be acquired has been surveyed and the local covenants are determined.

Sponsor Owned Property

A sampling was conducted on the deeds for property owned by the City of Brownsville. Of the 11 deeds that were sampled, one of them is less than fee and would have to be condemned to clear title. It is assumed that this trend would be the same for the remaining deeds leaving at least two tracts that would have to be condemned. A cost of $20,000 per tract was added to the cost estimate to cover the condemnation of these tracts.

Dewatering Sites

The recommended plan includes, three dewatering locations ranging in size from two to three acres. These locations would require three-year temporary easements with access from public roads. According to a mass appraisal that was completed for a separate planning study, the cost of a three-year work area easement represented 10 percent of the land value, which, in this instance, is $54,000. The value determination of $54,000 came from the commercial evaluation in the Resaca Gross Appraisal, which concluded a rate of $270,000 for one acre of commercial land.

$270,000 X 10 percent = $27,000 (one acre) X 2 = $54,000 (two acre site) for three year easement

The cost of $162,000 for three, two acre work area/dewatering sites is included in the cost estimate.

The Real Estate baseline cost is in Exhibit D.

Public Law 91-646 Relocation Assistance

The project includes partial takings of property along the banks of the Resacas and will not require the purchase of any structures. In many cases these partial acquisition will leave an uneconomic remnant which was included in the costs analysis and real estate maps as shown in Exhibit A.

Mineral Activity that May affect the Project

The non-federal sponsor does not own the mineral rights within the project footprint. The potential risks to the government associated with the non-federal sponsor not owning the mineral rights are sufficiently mitigated and there would no anticipated effect to construction, operation, or maintenance of the project. The City of Brownsville has to approve all oil wells within the city limits. According to City Ordinance Sec. 22-587 (b) “a permittee shall not interfere with or damage existing water, sewer, or gas lines; the facilities of public utilities; or any other improvement or facility located on, under or across the course of such rights-of-way.”

The City of Brownsville would not issue a permit for mineral extraction on City-owned property, especially in a densely populated area of the city.

Accordingly, the additional costs and time associated with the non-federal sponsor acquiring the mineral rights far outweigh the risks to the government.

Data from the Texas State General Land Office was used to determine the location of active hard mineral leases (minerals other than oil & gas) issued by or through the General Land Office. While there were active hard mineral leases within the Brownsville area, there were none located within the project footprint.

Assessment of the Non-Federal Sponsor’s Legal and Professional Capability

Non-Federal Sponsor’s Real Estate Acquisition Capability Survey was sent to the City of Brownsville and was returned on January 12, 2017, which is referenced in exhibit C.

The City of Brownsville has the ability to acquire property under the City’s right of eminent domain. The City of Brownsville House Rule Amendment, Article II, Section 9, Right of Eminent Domain:

"Said city shall have the right of eminent domain and the power to appropriate private property for public purposes whenever the governing authority shall deem it necessary; and to take any private property, within or without the city limits, for any of the following purposes, to-wit: city halls, police stations, jails, calabooses, fire stations and fire alarm systems, libraries, hospitals, sanitariums, auditoriums, market houses, slaughterhouses, reformatories, abattoirs, streets, alleys, parks, highways, playgrounds, sewer systems, storm sewers, sewage disposal plants, filtering beds and emptying grounds for sewer systems, drainage, drainage water, water supply sources, wells, water and electric light and power systems, street car systems, telephone and telegraph systems, gas plants or gas systems, cemeteries, crematories, prison farms, pest houses, and to acquire lands, within or without the city, for any other municipal purpose that may be deemed advisable. That the power herein granted for the purpose of acquiring private property shall include the power of improvement and enlargement of waterworks, including water supply, riparian rights, stand pipes, watersheds, and the construction of supply reservoirs. That in all cases wherein the city exercises the power of eminent domain it shall be controlled as nearly as practicable, by the laws governing the condemnation of property by railroad corporations in this state; the city taking the position of the railroad corporation in any such cases."

Before the acquisition of property, the City of Brownsville would enter into a resolution that outlines the responsibilities of both parties and the real estate requirements for the project. At which point the City of Brownsville would acquire the property.

The Galveston District Office of Council has reviewed the City of Brownsville ability to condemn property within the city limits and their extraterritorial jurisdiction to acquire property beyond the city boundaries.

Zoning

No application or enactment of zoning ordinances is proposed in connection with the recommend plan.

Facility or Utility Relocation

There are power lines and other utility lines within the project footprint that would be affected by the project. There are no plans to relocate any utilities for the project. Local pipelines were identified and the project footprint was adjusted accordingly to not include the pipeline easements However, the cost schedule risk analysis included

$5,059,000 in the 02 account for unknown utilities and fiber optics within the project footprint which was not included in the real estate costs.

> *"Any conclusion or categorization contained in this report that an item is a utility or facility relocation to be performed by the non-federal sponsor as part of its LERRD [land, easements, rights-of-way, relocation and disposal areas] responsibilities is preliminary only. The government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis and completion and approval of final attorney's opinions of compensability for each of the impacted utilities and facilities."*

HAZARDOUS, TOXIC AND RADIOACTIVE WASTE OR OTHER ENVIRONMENTAL CONTAMINANTS

There are no known hazardous or toxic wastes or other environmental contaminants on or within the proposed project area. See Appendix D.

LANDOWNER OPPOSITION

A public meeting was held June 14, 2017 at the Ringgold Civic Pavilion at 501 E Ringgold St #5, Brownsville, Texas, 78520. Attendees in addition to members of the BPUB and the USACE consisted of five local citizens. The feedback was positive with no opposition to the project during the public hearing.

Risks Associated with Acquiring Land before the Execution of the Project Cooperation Agreement

A risk letter would be sent to the City of Brownsville identifying the risks associated with any property acquisition prior to the execution of the project cooperation agreement (PCA) and will be noted in the final Real Estate Plan, referenced in exhibit E.

Description of Any Other Real Estate Issues Relevant to Planning, Designing, or Implementing the Project.

The real estate issues for this project are held within the current unknowns. The data used for this study came from the local appraisal district. Within their data, 18 tracts did not have ownership information attached.

Land Acquisition Schedule

The implementation scenario would restore areas from upstream to downstream, in adjacent groups, over the 16-year construction period. Restoration efforts (dredging, planting, etc.) generally would be completed for a group of areas annually. Assuming that the first year of construction may be 2021 and the end of construction would be 2037. See Table F-4.

Table F-4: Purposed Project Implementation Schedule for Resacas

Construction Year Start	Resaca Areas
2021	149, 150, 151
2022	116, 117, 142
2023	166
2024	148, 167
2025	108, 109, 110, 111, 112
2026	104, 105
2027	98, 99, 100, 101, 1000, 1001
2028	161
2029	84
2030	75, 95
2031	53, 54, 59, 60
2032	61
2033	62, 66, 67, 71, 72, 96
2034	93, 94
2035	45, 46
2036	40, 41, 42, 43, 44

The milestones for land acquisition are presented in Table F-5 and they are to be completed before the contract are released for the proceeding Resaca Segment(s). This acquisition schedule will repeat for each following contract.

Table F-5: Milestones for Land Acquisition

Milestones are Based on the Project Partnership Agreement Being Signed	
Transmittal of ROW drawings & estate(s)	30 days after PPA signed
Milestones to complete before Contract 1	
Obtain Surveys	120 days after transmittal of ROW drawings & estate(s)
Obtain Title Evidence	120 days after obtaining surveys
Obtain Appraisals & Reviews	120 days after obtaining titles
Authorization to Proceed with Offer	30 days after obtaining appraisals & reviews
Conclude Negotiations	90 days after start of negotiations
Conduct Closings	90 days after conducting closings
Conclude Condemnations	365 days after condemnation process starts
Attorney Certify Availability of LERRD	30 days after condemnations concluded
Corps Certifies Availability of LERRD	30 days after NFS Attorney Certifies LERRD
Review LERRD Credit Request	120 days after receiving LERRD documentation
Repeat milestones be completed before the next Resaca segment(s)	

Exhibit A: Maps.

See Drawings at the end of the main report.

Exhibit B: Property to Acquire

Table F-6 presents the list of property to acquire.

Table F-6: Property to Acquire

Resaca	Measure	Property ID	Acres to Acquire
40	Veg	0	31.47
41	Veg	0	0.29
41	Veg	0	0.90
41	Veg	0	1.32
41	Veg	0	1.55
41	Veg	129290	16.29
42	Veg	129290	2.56
42	Veg	129267	6.14
42	Veg	129282	10.07
42	Veg	129297	10.89
42	Veg	129259	11.30
42	Veg	129268	12.08
43	Veg	129232	0.27
43	Veg	359022	1.02
43	Veg	129258	1.63
43	Veg	0	2.24
43	Veg	129235	2.50
43	Veg	129242	4.26
43	Veg	129240	9.65
43	Veg	129247	12.41
44	Veg	128882	3.29
44	Veg	128883	4.24
44	Veg	128896	11.08
45	Veg	128451	4.87
46	Veg	0	4.08
53	Dredge	44250	0.03
53	Dredge	44255	0.03
53	Dredge	44256	0.03
53	Dredge	44252	0.04
53	Dredge	44254	0.04
53	Dredge	44251	0.04
53	Dredge	44253	0.05
53	Dredge	44257	0.07
53	Dredge	44258	0.07
53	Dredge	44259	0.10
53	Dredge	44260	0.10
53	Dredge	62569	1.02

Resaca	Measure	Property ID	Acres to Acquire
54	Dredge	53460	0.03
54	Dredge	53467	0.03
54	Dredge	53468	0.03
54	Dredge	50030	0.07
54	Dredge	53466	0.08
54	Dredge	53473	0.08
54	Dredge	53469	0.09
54	Dredge	53474	0.11
54	Dredge	53472	0.12
54	Dredge	53470	0.12
54	Dredge	53461	0.12
54	Dredge	53465	0.13
54	Dredge	53475	0.13
54	Dredge	53477	0.13
54	Dredge	53471	0.13
54	Dredge	53462	0.14
54	Dredge	50027	0.14
54	Dredge	53463	0.14
54	Dredge	53464	0.15
54	Dredge	53478	0.16
54	Dredge	50025	0.20
54	Dredge	50029	0.22
54	Dredge	50026	0.23
54	Dredge	50028	0.23
54	Dredge	53476	0.30
54	Dredge	50041	0.33
54	Dredge	56722	0.37
54	Dredge	50038	0.45
54	Dredge	62340	0.52
54	Dredge	62343	3.64
59	Veg	62336	1.32
59	Veg	62340	1.71
60	Dredge	62394	0.03
60	Dredge	40932	0.06
60	Dredge	40967	0.09
60	Dredge	40968	0.09
60	Dredge	40966	0.10
60	Dredge	40931	0.11
60	Dredge	40929	0.12
60	Dredge	40963	0.13
60	Dredge	62347	1.07
61	Dredge, Veg	399840	0.01
61	Dredge, Veg	47473	0.05
61	Dredge, Veg	61569	0.05
61	Dredge, Veg	399841	0.05
61	Dredge, Veg	47477	0.06
61	Dredge, Veg	47478	0.06

Resaca	Measure	Property ID	Acres to Acquire
61	Dredge, Veg	399842	0.07
61	Dredge, Veg	47480	0.07
61	Dredge, Veg	47481	0.07
61	Dredge, Veg	47479	0.08
61	Dredge, Veg	399843	0.09
61	Dredge, Veg	399845	0.09
61	Dredge, Veg	47329	0.09
61	Dredge, Veg	399844	0.10
61	Dredge, Veg	47471	0.11
61	Dredge, Veg	47260	0.11
61	Dredge, Veg	47470	0.12
61	Dredge, Veg	47482	0.12
61	Dredge, Veg	47267	0.13
61	Dredge, Veg	47268	0.13
61	Dredge, Veg	47483	0.14
61	Dredge, Veg	61549	0.14
61	Dredge, Veg	47265	0.14
61	Dredge, Veg	61551	0.15
61	Dredge, Veg	47269	0.15
61	Dredge, Veg	47266	0.15
61	Dredge, Veg	47270	0.15
61	Dredge, Veg	47484	0.15
61	Dredge, Veg	47274	0.15
61	Dredge, Veg	47277	0.15
61	Dredge, Veg	47485	0.15
61	Dredge, Veg	47271	0.16
61	Dredge, Veg	47336	0.16
61	Dredge, Veg	47275	0.16
61	Dredge, Veg	47340	0.16
61	Dredge, Veg	47276	0.16
61	Dredge, Veg	47264	0.16
61	Dredge, Veg	47322	0.16
61	Dredge, Veg	41471	0.16
61	Dredge, Veg	41470	0.17
61	Dredge, Veg	47330	0.17
61	Dredge, Veg	47316	0.17
61	Dredge, Veg	61571	0.17
61	Dredge, Veg	47317	0.17
61	Dredge, Veg	40972	0.17
61	Dredge, Veg	61550	0.17
61	Dredge, Veg	47335	0.17
61	Dredge, Veg	47326	0.17
61	Dredge, Veg	47328	0.17
61	Dredge, Veg	47273	0.18
61	Dredge, Veg	47272	0.18
61	Dredge, Veg	61548	0.18
61	Dredge, Veg	47475	0.18

Resaca	Measure	Property ID	Acres to Acquire
61	Dredge, Veg	61570	0.18
61	Dredge, Veg	47323	0.18
61	Dredge, Veg	47261	0.19
61	Dredge, Veg	61545	0.19
61	Dredge, Veg	47263	0.19
61	Dredge, Veg	47315	0.19
61	Dredge, Veg	47476	0.20
61	Dredge, Veg	47321	0.20
61	Dredge, Veg	47262	0.21
61	Dredge, Veg	61546	0.22
61	Dredge, Veg	61572	0.22
61	Dredge, Veg	40954	0.22
61	Dredge, Veg	47332	0.22
61	Dredge, Veg	47318	0.22
61	Dredge, Veg	61547	0.23
61	Dredge, Veg	61574	0.23
61	Dredge, Veg	47338	0.23
61	Dredge, Veg	47337	0.23
61	Dredge, Veg	40958	0.23
61	Dredge, Veg	47320	0.24
61	Dredge, Veg	47331	0.24
61	Dredge, Veg	40957	0.25
61	Dredge, Veg	40952	0.25
61	Dredge, Veg	47333	0.26
61	Dredge, Veg	47334	0.26
61	Dredge, Veg	47339	0.27
61	Dredge, Veg	40955	0.30
61	Dredge, Veg	47341	0.33
61	Dredge, Veg	61553	0.34
61	Dredge, Veg	61552	0.35
61	Dredge, Veg	0	0.36
61	Dredge, Veg	41468	0.36
61	Dredge, Veg	47327	0.37
61	Dredge, Veg	40956	0.52
61	Dredge, Veg	41467	0.55
61	Dredge, Veg	41469	0.71
61	Dredge, Veg	47324	0.81
61	Dredge, Veg	41474	1.01
61	Dredge, Veg	40946	2.60
61	Dredge, Veg	41472	4.52
62	Dredge, Veg	45562	2.99
66	Veg	45550	0.08
66	Veg	45586	0.12
66	Veg	45553	0.15
66	Veg	45555	0.16
66	Veg	41371	0.29
66	Veg	45585	0.56

Resaca	Measure	Property ID	Acres to Acquire
66	Veg	45552	1.06
66	Veg	45562	3.40
66	Veg	45560	4.45
66	Veg	45557	4.49
66	Veg	45554	5.09
67	Veg	41353	0.07
67	Veg	45465	0.17
67	Veg	41245	0.48
67	Veg	0	1.10
67	Veg	45466	1.21
67	Veg	41248	1.22
67	Veg	45468	2.09
67	Veg	402400	2.52
67	Veg	41285	3.69
67	Veg	41354	5.67
71	Veg	352550	0.41
71	Veg	352551	0.42
71	Veg	352549	0.42
71	Veg	352552	0.44
71	Veg	352553	0.48
71	Veg	352548	0.49
71	Veg	352546	0.55
71	Veg	352547	0.59
71	Veg	29770	3.65
72	Veg	29896	0.32
72	Veg	41013	2.06
72	Veg	41014	5.16
75	Dredge, Veg	37002	0.11
75	Dredge, Veg	34443	0.12
75	Dredge, Veg	34448	0.15
75	Dredge, Veg	37005	0.16
75	Dredge, Veg	37004	0.17
75	Dredge, Veg	0	0.17
75	Dredge, Veg	37003	0.17
75	Dredge, Veg	37006	0.17
75	Dredge, Veg	37007	0.18
75	Dredge, Veg	126241	0.23
75	Dredge, Veg	36997	0.27
75	Dredge, Veg	34444	0.28
75	Dredge, Veg	126245	0.29
75	Dredge, Veg	34442	0.34
75	Dredge, Veg	37008	0.40
75	Dredge, Veg	36996	0.44
75	Dredge, Veg	126243	0.47
75	Dredge, Veg	34445	0.50
75	Dredge, Veg	34446	0.61
75	Dredge, Veg	36909	1.13

Resaca	Measure	Property ID	Acres to Acquire
75	Dredge, Veg	122919	5.25
84	Dredge, Veg	161345	0.05
84	Dredge, Veg	161339	0.05
84	Dredge, Veg	161344	0.05
84	Dredge, Veg	161356	0.05
84	Dredge, Veg	161357	0.05
84	Dredge, Veg	161343	0.06
84	Dredge, Veg	161355	0.06
84	Dredge, Veg	0	0.06
84	Dredge, Veg	152586	0.06
84	Dredge, Veg	161358	0.06
84	Dredge, Veg	161354	0.06
84	Dredge, Veg	161346	0.06
84	Dredge, Veg	161359	0.06
84	Dredge, Veg	161341	0.07
84	Dredge, Veg	152587	0.07
84	Dredge, Veg	161342	0.07
84	Dredge, Veg	161347	0.07
84	Dredge, Veg	161360	0.07
84	Dredge, Veg	161351	0.07
84	Dredge, Veg	161352	0.07
84	Dredge, Veg	161353	0.07
84	Dredge, Veg	161348	0.07
84	Dredge, Veg	161350	0.07
84	Dredge, Veg	161340	0.07
84	Dredge, Veg	161361	0.07
84	Dredge, Veg	152584	0.07
84	Dredge, Veg	152585	0.08
84	Dredge, Veg	161362	0.08
84	Dredge, Veg	161349	0.08
84	Dredge, Veg	161338	0.08
84	Dredge, Veg	161363	0.08
84	Dredge, Veg	161364	0.09
84	Dredge, Veg	152583	0.10
84	Dredge, Veg	161335	0.10
84	Dredge, Veg	161365	0.10
84	Dredge, Veg	161337	0.11
84	Dredge, Veg	161336	0.15
84	Dredge, Veg	163520	0.16
84	Dredge, Veg	163521	0.16
84	Dredge, Veg	163524	0.17
84	Dredge, Veg	163519	0.17
84	Dredge, Veg	163522	0.17
84	Dredge, Veg	163523	0.19
84	Dredge, Veg	161366	0.19
84	Dredge, Veg	163514	0.20
84	Dredge, Veg	163518	0.21

Resaca	Measure	Property ID	Acres to Acquire
84	Dredge, Veg	163525	0.25
84	Dredge, Veg	163516	0.25
84	Dredge, Veg	163517	0.26
84	Dredge, Veg	163515	0.26
84	Dredge, Veg	375252	0.34
84	Dredge, Veg	160974	11.44
93	Excavate/Veg	0	0.12
93	Excavate/Veg	0	8.60
94	Excavate/Veg	0	0.73
94	Excavate/Veg	0	8.84
95	Excavate/Veg	158286	0.02
95	Excavate/Veg	371020	0.12
95	Excavate/Veg	158284	9.46
95	Excavate/Veg	158305	15.60
95	Excavate/Veg	160706	16.53
96	Veg	363557	12.43
98	Veg	132147	0.08
98	Veg	150822	0.36
98	Veg	150819	0.42
98	Veg	150821	0.43
98	Veg	150820	0.44
98	Veg	150824	0.66
98	Veg	357833	0.72
98	Veg	132145	0.77
98	Veg	150823	1.08
98	Veg	132146	1.39
98	Veg	129195	1.41
98	Veg	132144	1.44
98	Veg	150817	1.58
98	Veg	150814	1.62
98	Veg	150815	2.65
98	Veg	150816	2.87
99	Veg	366634	0.36
99	Veg	122787	0.70
99	Veg	122791	1.07
99	Veg	122790	3.08
99	Veg	132775	3.85
100	Veg	128712	1.88
100	Veg	129180	2.20
100	Veg	129179	4.06
101	Veg	134429	0.61
101	Veg	153234	1.52
101	Veg	171034	2.59
101	Veg	134428	3.14
101	Veg	171030	3.42
101	Veg	128718	3.64
101	Veg	171031	3.88

Resaca	Measure	Property ID	Acres to Acquire
101	Veg	171014	5.91
101	Veg	134412	6.53
101	Veg	171017	12.26
104	Veg	133646	0.02
104	Veg	133671	0.08
104	Veg	135580	3.63
104	Veg	133218	5.27
104	Veg	135582	9.63
105	Dredge, Veg	369170	0.01
105	Dredge, Veg	123715	0.02
105	Dredge, Veg	123687	0.05
105	Dredge, Veg	123716	0.05
105	Dredge, Veg	123721	0.05
105	Dredge, Veg	123717	0.06
105	Dredge, Veg	123718	0.06
105	Dredge, Veg	123711	0.06
105	Dredge, Veg	123739	0.07
105	Dredge, Veg	123648	0.07
105	Dredge, Veg	123650	0.08
105	Dredge, Veg	123647	0.08
105	Dredge, Veg	123651	0.08
105	Dredge, Veg	123657	0.08
105	Dredge, Veg	123646	0.09
105	Dredge, Veg	123722	0.09
105	Dredge, Veg	123658	0.09
105	Dredge, Veg	123686	0.09
105	Dredge, Veg	123652	0.09
105	Dredge, Veg	123656	0.09
105	Dredge, Veg	123653	0.10
105	Dredge, Veg	123655	0.10
105	Dredge, Veg	123654	0.10
105	Dredge, Veg	123665	0.11
105	Dredge, Veg	123645	0.11
105	Dredge, Veg	123723	0.11
105	Dredge, Veg	123659	0.11
105	Dredge, Veg	123640	0.12
105	Dredge, Veg	123693	0.12
105	Dredge, Veg	123685	0.12
105	Dredge, Veg	123660	0.12
105	Dredge, Veg	123724	0.13
105	Dredge, Veg	123684	0.13
105	Dredge, Veg	123661	0.13
105	Dredge, Veg	123735	0.13
105	Dredge, Veg	123644	0.13
105	Dredge, Veg	123643	0.14
105	Dredge, Veg	123734	0.14
105	Dredge, Veg	123733	0.14

Resaca	Measure	Property ID	Acres to Acquire
105	Dredge, Veg	123736	0.14
105	Dredge, Veg	123662	0.14
105	Dredge, Veg	123731	0.15
105	Dredge, Veg	123695	0.15
105	Dredge, Veg	123694	0.15
105	Dredge, Veg	123663	0.16
105	Dredge, Veg	123664	0.16
105	Dredge, Veg	123669	0.16
105	Dredge, Veg	123670	0.16
105	Dredge, Veg	123696	0.16
105	Dredge, Veg	123725	0.16
105	Dredge, Veg	123683	0.16
105	Dredge, Veg	123705	0.16
105	Dredge, Veg	123706	0.17
105	Dredge, Veg	123730	0.17
105	Dredge, Veg	123737	0.17
105	Dredge, Veg	123668	0.17
105	Dredge, Veg	123673	0.17
105	Dredge, Veg	123671	0.17
105	Dredge, Veg	123699	0.17
105	Dredge, Veg	123672	0.17
105	Dredge, Veg	123679	0.17
105	Dredge, Veg	123674	0.17
105	Dredge, Veg	123700	0.18
105	Dredge, Veg	123704	0.18
105	Dredge, Veg	123677	0.18
105	Dredge, Veg	123667	0.18
105	Dredge, Veg	123703	0.18
105	Dredge, Veg	123666	0.18
105	Dredge, Veg	123675	0.18
105	Dredge, Veg	123702	0.18
105	Dredge, Veg	123726	0.18
105	Dredge, Veg	123676	0.19
105	Dredge, Veg	123698	0.19
105	Dredge, Veg	123701	0.19
105	Dredge, Veg	123697	0.19
105	Dredge, Veg	123727	0.19
105	Dredge, Veg	123729	0.19
105	Dredge, Veg	123728	0.19
105	Dredge, Veg	123681	0.19
105	Dredge, Veg	123680	0.21
105	Dredge, Veg	123641	0.26
105	Dredge, Veg	123639	0.32
105	Dredge, Veg	123738	0.33
105	Dredge, Veg	123710	0.36
105	Dredge, Veg	123707	0.42
105	Dredge, Veg	123638	0.49

Resaca	Measure	Property ID	Acres to Acquire
105	Dredge, Veg	123709	0.55
105	Dredge, Veg	123708	0.56
105	Dredge, Veg	369169	0.56
105	Dredge, Veg	143095	0.90
105	Dredge, Veg	143108	1.11
105	Dredge, Veg	143097	1.21
105	Dredge, Veg	143067	8.09
105	Dredge, Veg	135580	15.75
108	Dredge, Veg	0	0.17
108	Dredge, Veg	62729	0.25
108	Dredge, Veg	0	0.38
108	Dredge, Veg	159947	1.25
108	Dredge, Veg	159946	1.38
108	Dredge, Veg	169512	1.40
109	Dredge, Veg	153322	0.04
109	Dredge, Veg	153316	0.05
109	Dredge, Veg	153321	0.05
109	Dredge, Veg	153319	0.07
109	Dredge, Veg	153320	0.08
109	Dredge, Veg	153323	0.08
109	Dredge, Veg	169546	0.09
109	Dredge, Veg	153318	0.09
109	Dredge, Veg	153317	0.13
109	Dredge, Veg	153313	0.14
109	Dredge, Veg	153314	0.14
109	Dredge, Veg	153315	0.16
109	Dredge, Veg	153312	0.17
109	Dredge, Veg	153311	0.17
109	Dredge, Veg	153310	0.17
109	Dredge, Veg	153309	0.18
109	Dredge, Veg	153308	0.19
109	Dredge, Veg	153307	0.23
109	Dredge, Veg	159476	0.33
109	Dredge, Veg	159475	0.34
109	Dredge, Veg	374708	0.34
109	Dredge, Veg	159464	0.39
109	Dredge, Veg	153305	0.41
109	Dredge, Veg	153303	0.48
109	Dredge, Veg	153304	0.54
109	Dredge, Veg	159480	1.40
109	Dredge, Veg	159477	1.55
109	Dredge, Veg	0	2.02
109	Dredge, Veg	159492	2.19
109	Dredge, Veg	159487	2.87
110	Veg	169546	9.80
111	Veg	54232	0.02
111	Veg	54246	0.02

Resaca	Measure	Property ID	Acres to Acquire
111	Veg	169593	0.02
111	Veg	54259	0.04
111	Veg	169592	0.05
111	Veg	54247	0.06
111	Veg	54248	0.07
111	Veg	169591	0.07
111	Veg	54249	0.07
111	Veg	169564	0.08
111	Veg	54252	0.09
111	Veg	54245	0.09
111	Veg	54255	0.10
111	Veg	169594	0.10
111	Veg	169590	0.10
111	Veg	54253	0.11
111	Veg	169565	0.11
111	Veg	169566	0.11
111	Veg	54243	0.12
111	Veg	54256	0.12
111	Veg	54254	0.12
111	Veg	169586	0.13
111	Veg	54257	0.14
111	Veg	169589	0.15
111	Veg	54258	0.16
111	Veg	169570	0.16
111	Veg	169585	0.17
111	Veg	54250	0.17
111	Veg	169575	0.18
111	Veg	169576	0.19
111	Veg	169581	0.20
111	Veg	169580	0.20
111	Veg	169584	0.21
111	Veg	54233	0.22
111	Veg	169571	0.23
111	Veg	54240	0.24
111	Veg	169574	0.24
111	Veg	54242	0.24
111	Veg	169569	0.25
111	Veg	169583	0.25
111	Veg	169582	0.25
111	Veg	54239	0.26
111	Veg	169568	0.27
111	Veg	54244	0.27
111	Veg	169567	0.27
111	Veg	169573	0.28
111	Veg	169577	0.30
111	Veg	169579	0.30
111	Veg	54238	0.30

Resaca	Measure	Property ID	Acres to Acquire
111	Veg	169572	0.31
111	Veg	54235	0.32
111	Veg	54237	0.34
111	Veg	169578	0.35
111	Veg	54236	0.36
111	Veg	54241	0.41
111	Veg	400175	0.51
111	Veg	400176	0.82
111	Veg	400178	0.84
111	Veg	169520	1.03
112	Veg	127719	1.03
112	Veg	127704	1.36
112	Veg	127707	1.84
112	Veg	169528	2.78
112	Veg	127708	3.61
112	Veg	127728	4.51
142	Dredge, Veg	142193	0.04
142	Dredge, Veg	142194	0.05
142	Dredge, Veg	142195	0.06
142	Dredge, Veg	142196	0.07
142	Dredge, Veg	142197	0.09
142	Dredge, Veg	142198	0.11
142	Dredge, Veg	142199	0.14
142	Dredge, Veg	142203	0.14
142	Dredge, Veg	142204	0.15
142	Dredge, Veg	142201	0.17
142	Dredge, Veg	142200	0.17
142	Dredge, Veg	142202	0.18
142	Dredge, Veg	0	24.56
149	Dredge, Veg	377252	1.06
149	Dredge, Veg	377253	1.24
149	Dredge, Veg	377250	2.98
149	Dredge, Veg	377251	3.42
150	Dredge	57677	0.02
150	Dredge	57675	0.02
150	Dredge	57676	0.05
150	Dredge	57684	0.05
150	Dredge	57670	0.07
150	Dredge	57671	0.08
150	Dredge	57669	0.09
150	Dredge	241553	0.12
150	Dredge	241552	0.17
150	Dredge	241543	0.18
150	Dredge	241547	0.18
150	Dredge	241546	0.18
150	Dredge	241550	0.18
150	Dredge	241549	0.18

Resaca	Measure	Property ID	Acres to Acquire
150	Dredge	241551	0.18
150	Dredge	57672	0.18
150	Dredge	241548	0.18
150	Dredge	241545	0.18
150	Dredge	241544	0.20
151	Dredge	57697	0.01
151	Dredge	241530	0.03
151	Dredge	57700	0.04
151	Dredge	57707	0.05
151	Dredge	241531	0.05
151	Dredge	57705	0.06
151	Dredge	57704	0.06
151	Dredge	57706	0.06
151	Dredge	57703	0.07
151	Dredge	57701	0.08
151	Dredge	57702	0.08
151	Dredge	241532	0.09
151	Dredge	241535	0.11
151	Dredge	241533	0.11
151	Dredge	241534	0.12
151	Dredge	241536	0.12
151	Dredge	241537	0.14
151	Dredge	241538	0.17
151	Dredge	241539	0.19
151	Dredge	241540	0.19
151	Dredge	241541	0.19
151	Dredge	241542	0.20
151	Dredge	57699	0.23
161	Dredge, Veg	165652	2.47
161	Dredge, Veg	0	9.24
161	Dredge, Veg	165651	12.62
167	Dredge, Veg	151281	0.11
167	Dredge, Veg	151280	0.11
167	Dredge, Veg	151282	0.11
167	Dredge, Veg	151279	0.12
167	Dredge, Veg	151226	0.12
167	Dredge, Veg	151278	0.13
167	Dredge, Veg	151276	0.13
167	Dredge, Veg	151277	0.13
167	Dredge, Veg	151283	0.13
167	Dredge, Veg	151274	0.16
167	Dredge, Veg	140535	0.17
167	Dredge, Veg	151275	0.18
167	Dredge, Veg	140536	0.22
167	Dredge, Veg	151284	0.24
167	Dredge, Veg	151285	0.24
167	Dredge, Veg	0	0.95

Resaca	Measure	Property ID	Acres to Acquire
167	Dredge, Veg	169546	1.53
167	Dredge, Veg	127706	1.94
167	Dredge, Veg	127702	2.16
167	Dredge, Veg	127701	2.30
167	Dredge, Veg	127699	3.19
167	Dredge, Veg	151227	24.71
167	Dredge, Veg	169545	34.72
1000	Veg	135714	0.48
1000	Veg	133231	1.08
1000	Veg	134227	1.10
1000	Veg	133222	1.31
1000	Veg	133223	1.39
1000	Veg	133226	1.88
1000	Veg	133225	1.92
1000	Veg	156543	2.14
1000	Veg	134301	3.42
1000	Veg	135713	3.45
1000	Veg	133219	4.02
1000	Veg	134316	4.92
1000	Veg	133220	4.99
1000	Veg	133233	5.88
1000	Veg	135708	10.20
1001	Veg	134354	0.35
1001	Veg	134356	0.83
1001	Veg	134357	1.76
1001	Veg	134351	2.91
1001	Veg	134360	9.76
		Total Acres	762.80

Exhibit C: Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

Resaca Boulevard Resaca
Brownsville
Cameron County, Texas

I. **Legal Authority**

a. Does the Sponsor have the legal authority to acquire and hold title to real property for project purposes? (Yes/No) YES

b. Does the Sponsor have the power of eminent domain for this project? (Yes/No) YES

c. Does the Sponsor have "quick-take" authority for this project? (Yes/No) NO

d. Are there any of the lands/interests in land required for the project outside the Sponsor's political boundary? (Yes/No) NO

e. Are any of the lands/interests in land required for the project owned by an entity whose property the Sponsor cannot condemn? (Yes/No) NO

II. **Human Resource Requirements**

a. Will the Sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended? (Yes/No) NO

b. If the answer to II.a. is "Yes", has a reasonable plan been developed to provide such training? (Yes/No) N/A

c. Does the Sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? (Yes/No) YES

d. Is the Sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule? (Yes/No) YES

e. Can the Sponsor obtain contractor support, if required, in a timely fashion? (Yes/No) YES

f. Will the sponsor likely request USACE assistance in acquiring real estate? (Yes/No) NO

III. Other Project Variables

a. Will the Sponsor's staff be located within reasonable proximity to the project site? (Yes/No) YES

b. Has the Sponsor approved the project/real estate schedule/milestones? (Yes/No) YES

IV. Overall Assessment

a. Has the Sponsor performed satisfactorily on other USACE projects? (Yes/No) YES

b. With regard to this project, the Sponsor is anticipated to be: highly capable/fully capable/marginally capable/insufficiently capable. (If sponsor is believed to be "insufficiently capable," provide explanation.)

V. Coordination

a. Has this assessment been coordinated with the Sponsor? (Yes/No) YES

b. Does the Sponsor concur with this assessment? (Yes/No) YES

Prepared by:

JAN 12, 2017
Dave Mairs Date
Realty Specialist
United States Corp of Engineers

Reviewed by:

Date JAN. 6, 2017
Rights-of-Way Agent
City of Brownsville
J. EDUARDO SANTILLAN
R/W - NAC

Approved by:

1/12/17
Tim Nelson Date
Chief, Real Estate Division
United States Corp of Engineers

Exhibit D: Baseline Cost Estimate

Federal Costs

Federal costs are presented in Table F-7.

Table F-7: Federal Costs

Account	Description	Total
0102	Acquisitions (Review RE Planning Documents & Mapping) (10 hours x $125 an hour each tract)	$786,250.00
0105	Appraisals (6hrs x $120 an hour, each tract)	$452,880.00
0112	Project Related Administration	$207,550.00
02-0117	LERRD Crediting (2hr x $100 an hour, each tract)	$125,800.00
	Total Admin & Payments (FED COSTS)	$1,572,500.00
	Contingencies	$315,000.00
	Grand Total Fed	$1,887,000.00

Non-Federal Costs

Table F-8 presents the non-federal costs.

Table F-8: Non-Federal Costs

Account	Description	Total
0102	Acquisitions (Labor) (20 hours X $100 for each tract)	$1,258,000.00
0103	Condemnation Subdivisions ($35,000 each)	$560,000.00
0103	Condemnation ($90,000 per tract)	$5,625,000.00
0103	Condemnation of City Property ($20,000 per tract)	$48,000.00
0103	Dewatering Sites (3 sites x $54,000)	$162,000.00
0105	Appraisals ($2,000 each)	$1,258,000.00
	Survey (20K each Resaca)	$840,000.00
0107	Temporary Permits/Licenses/R.O.W.	$5,000
0112	Project Related Administration (14 hours x $80 an hour, per tract)	$704,480.00
011501	Payments by Sponsor (Land)	$25,099,419.00
	Total Admin and Payments	$35,748,599.00
	Contingencies	$7,134,623.80
	Grand Total Non Fed	$42,883,222.80

Exhibit E: Risk Letter

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON, TEXAS 77553-1229

Real Estate Division

Mr. Charlie Cabler
City of Brownsville
1001 East Elizabeth Street
Brownsville, Texas 78520

Dear Mr. Cabler:

It is our understanding, that you may or have begun acquiring rights-of-way in connection with the Resaca Blvd Project prior to execution of an amended Project Partnership Agreement (PPA) with the Federal Government. We appreciate your support for this proposed project, but our regulations require us to inform you that **IF FOR ANY REASON, THE AMENDED PPA NEVER GETS SIGNED OR IF CONGRESS FAILS TO AUTHORIZE OR FUND THE PROJECT, ANY LAND YOU ACQUIRED OR ANY MONEY YOU SPEND IN YOUR EFFORTS TO ACQUIRE LAND WILL BE AT THE SOLE RISK OF BROWNSVILLE PUBLIC UTILITY DISTRICT.** Furthermore, for any property that qualifies for Federal participation in the project, your acquisition efforts must be in compliance with all of the provisions of P.L. 91-646, the Federal Relocation Assistance Law.

Please ensure that records are kept regarding purchase price and real estate administrative expenses such as title evidence, surveys and appraisal fees. This will be necessary for you to receive credit in the event of Federal Authorization. Be advised that regulations dictate that credit will not be given for real estate administrative costs for properties acquired five years' prior to execution of an amended PPA.

If you have any questions, please contact Mr. Dave Mairs of my staff at (409) 766-3815 or David.E.Mairs@usace.army.mil.

Sincerely,

Timothy J. Nelson
Chief, Real Estate Division
Galveston District
U.S. Army Corps of Engineers