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.

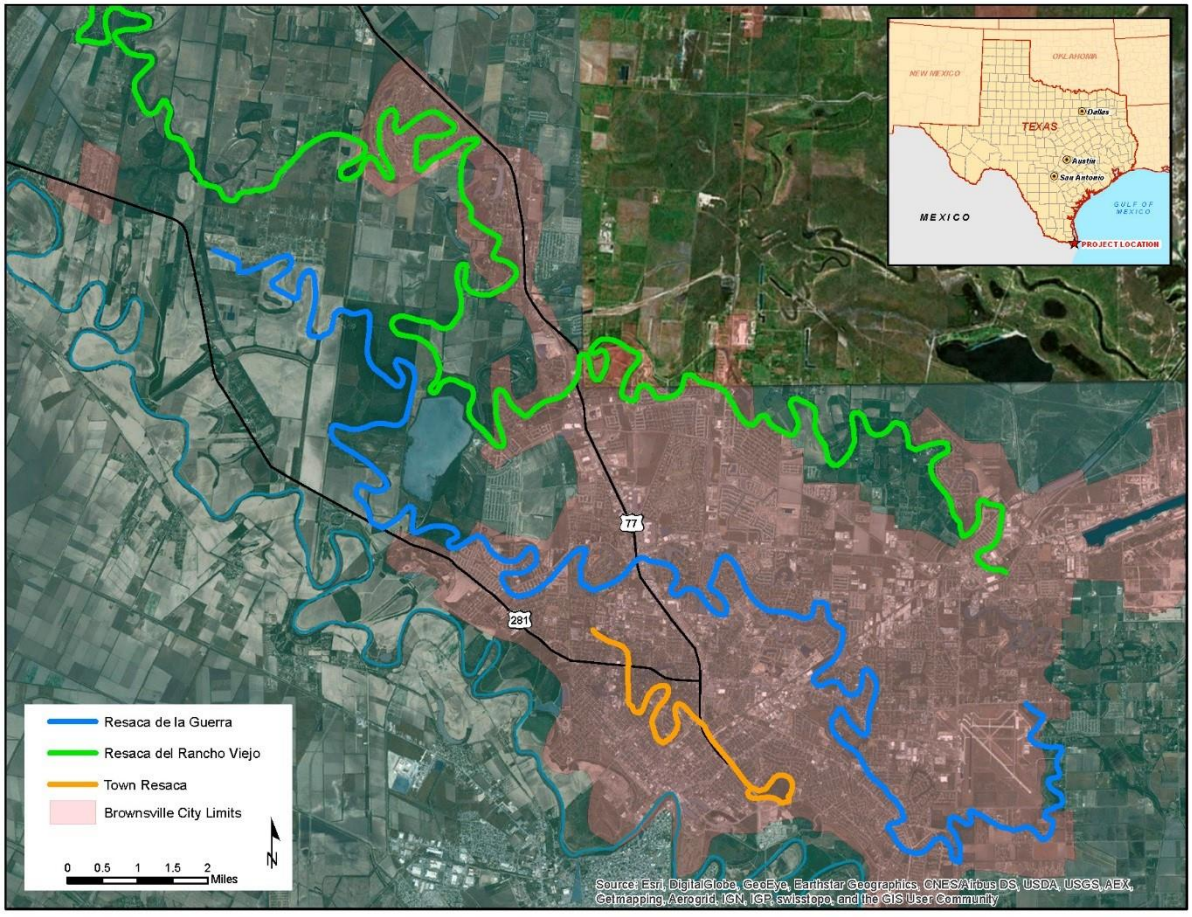


Figure A-1: Resaca de la Guerra, Resaca del Rancho, and Town

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).

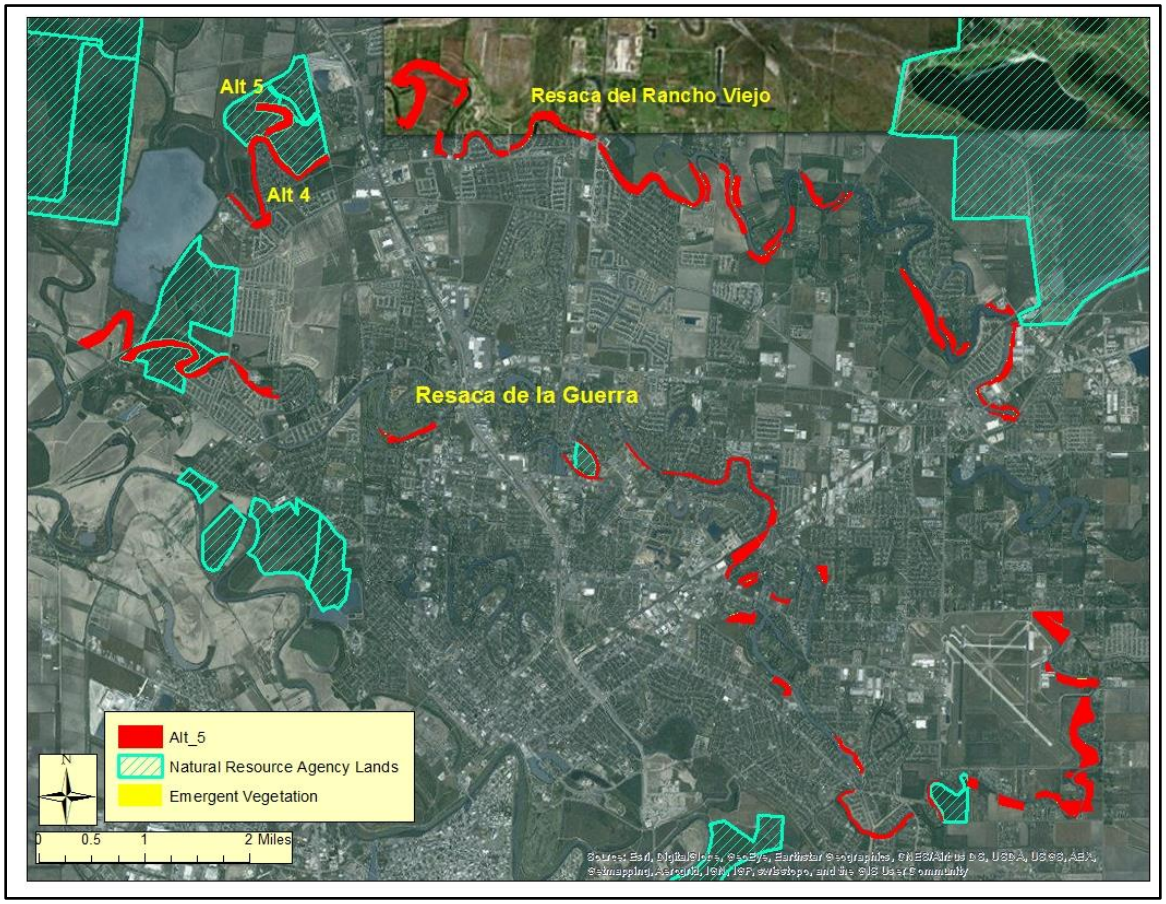


Figure A- 2: Habitat Connectivity and Resaca Habitats

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

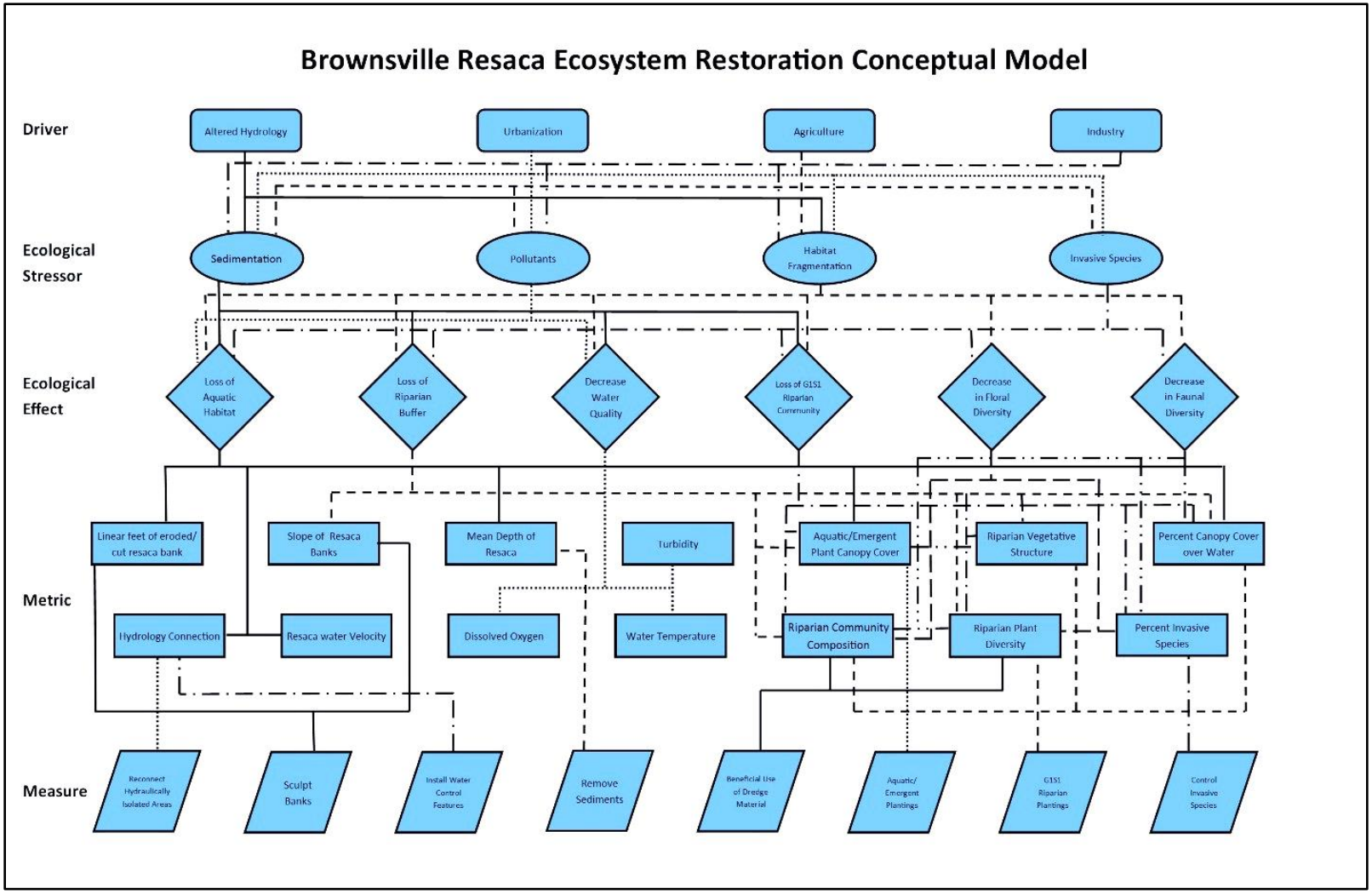
Since the early 1870s and the introduction of irrigation, the loss of native thornscrub vegetation, including resaca habitats, to cultivated agriculture uses has resulted in the loss of 95 percent of thorn-scrub habitat in the LRGV and 99 percent of riparian resaca habitats (Jahrsdorfer and Leslie, 1988).

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).

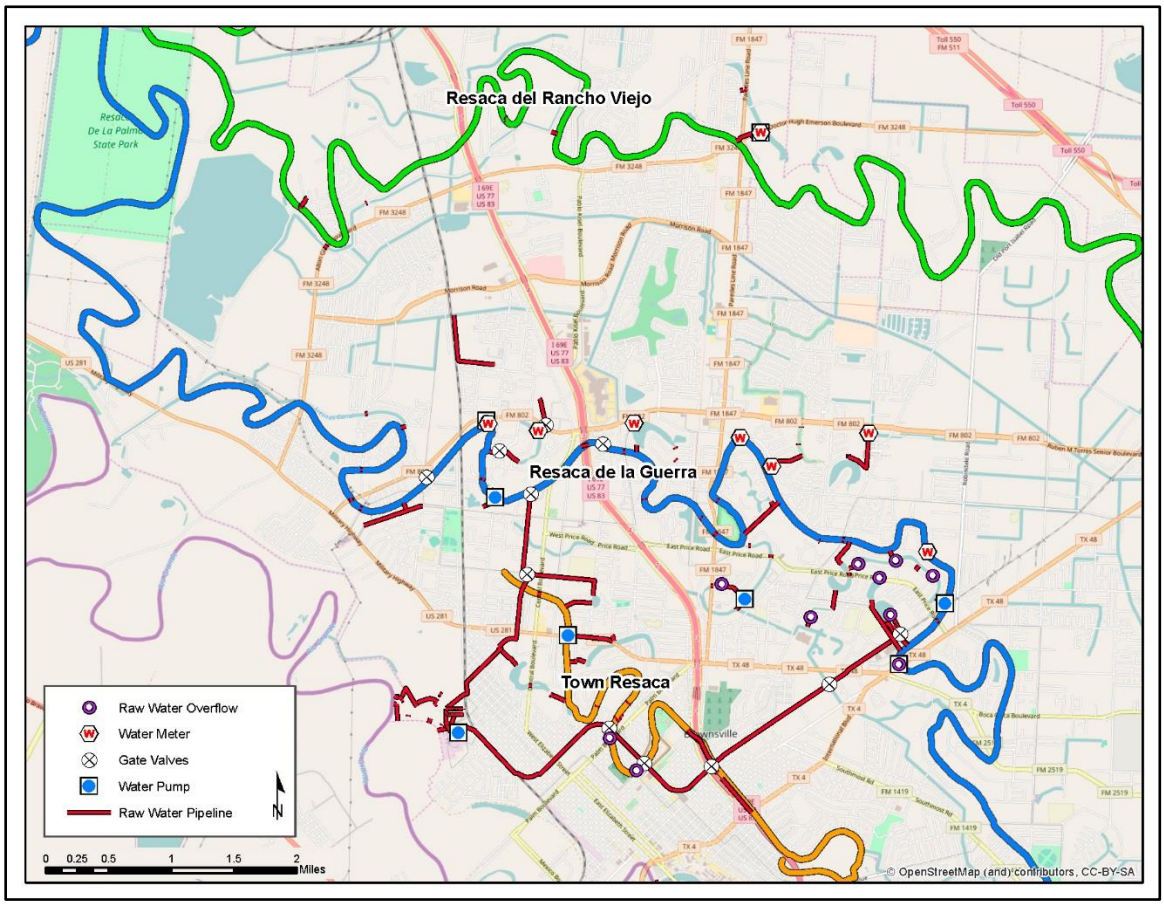


Figure A-4: Water Control Structures for Resaca de la Guerra and Resaca del Rancho Viejo

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.

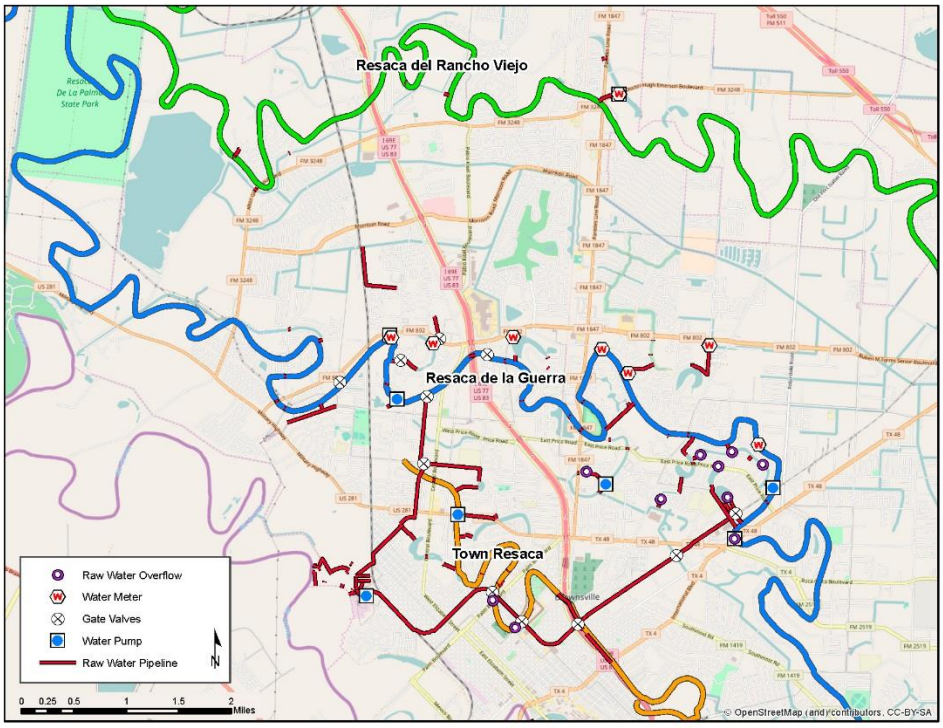


Figure A-5 BPUB Water Management of the Resaca Systems.

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 16.4	6.4	0.7
PAB3F	Palustrine		Aquatic Bed	Rooted Vascular			1.6 1.6	0.6	0.1
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.

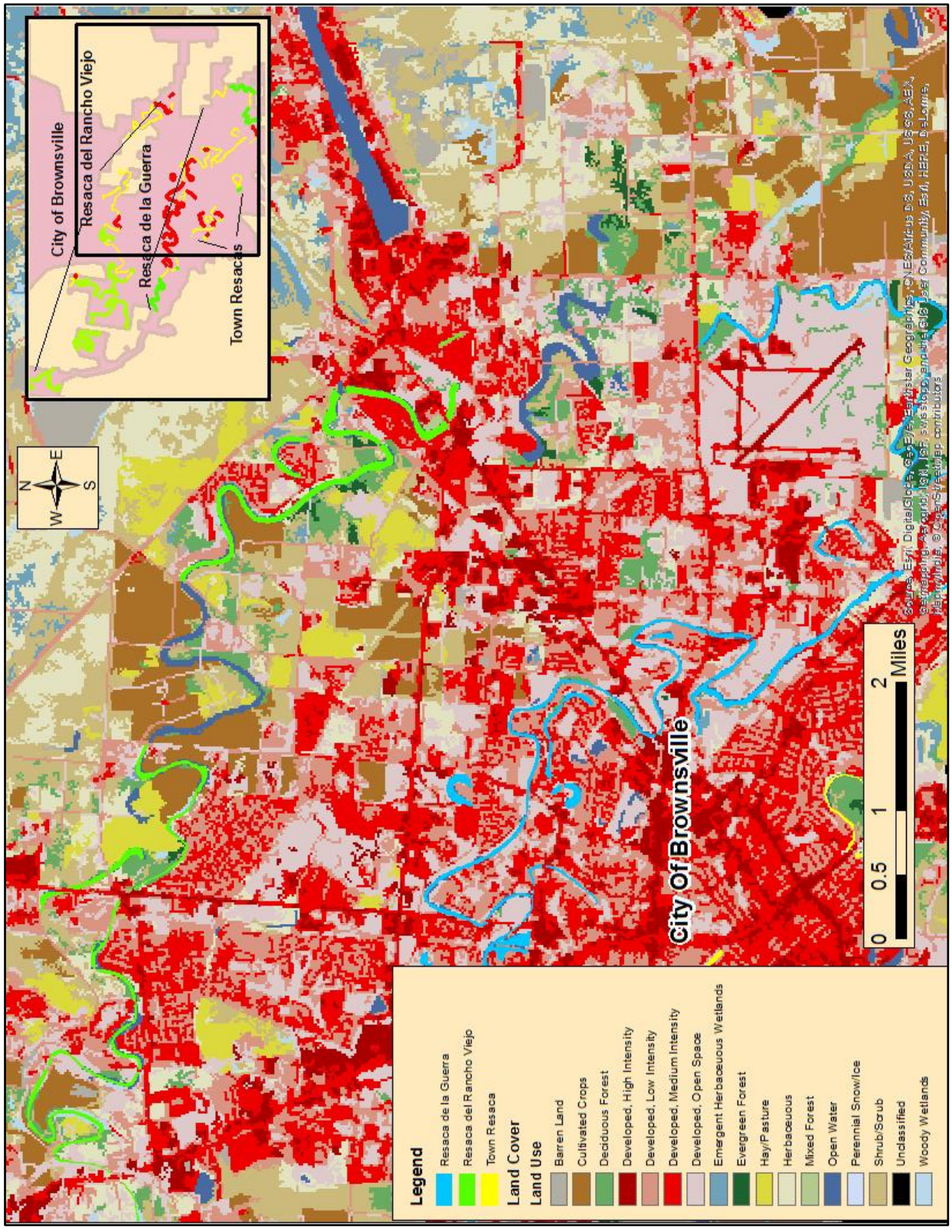


Figure A-6: Land Use Map of Resacas Study Area

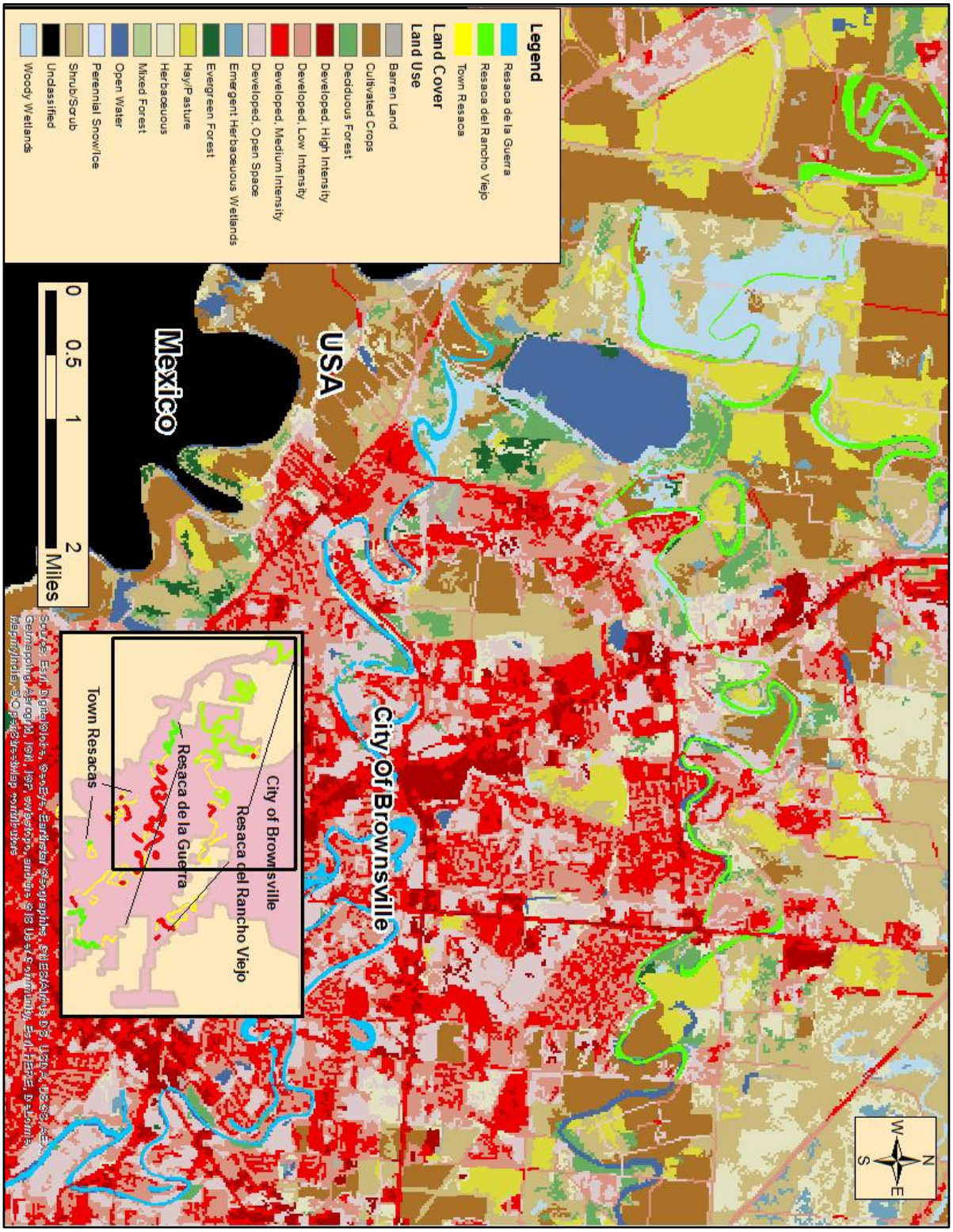


Figure A-7: Land Use Map of Resacas Study Area

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 Tract	Total	Not Hisp	White	Black or Afr	Indian and	Asian	Native Hawai	Some	Two or more	Hisp or Latino	White alone	Black or Afr	Am Indian and	Asian alone	Native Hawai	Some other	Two or more	Persons Belo	Percent Belo
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

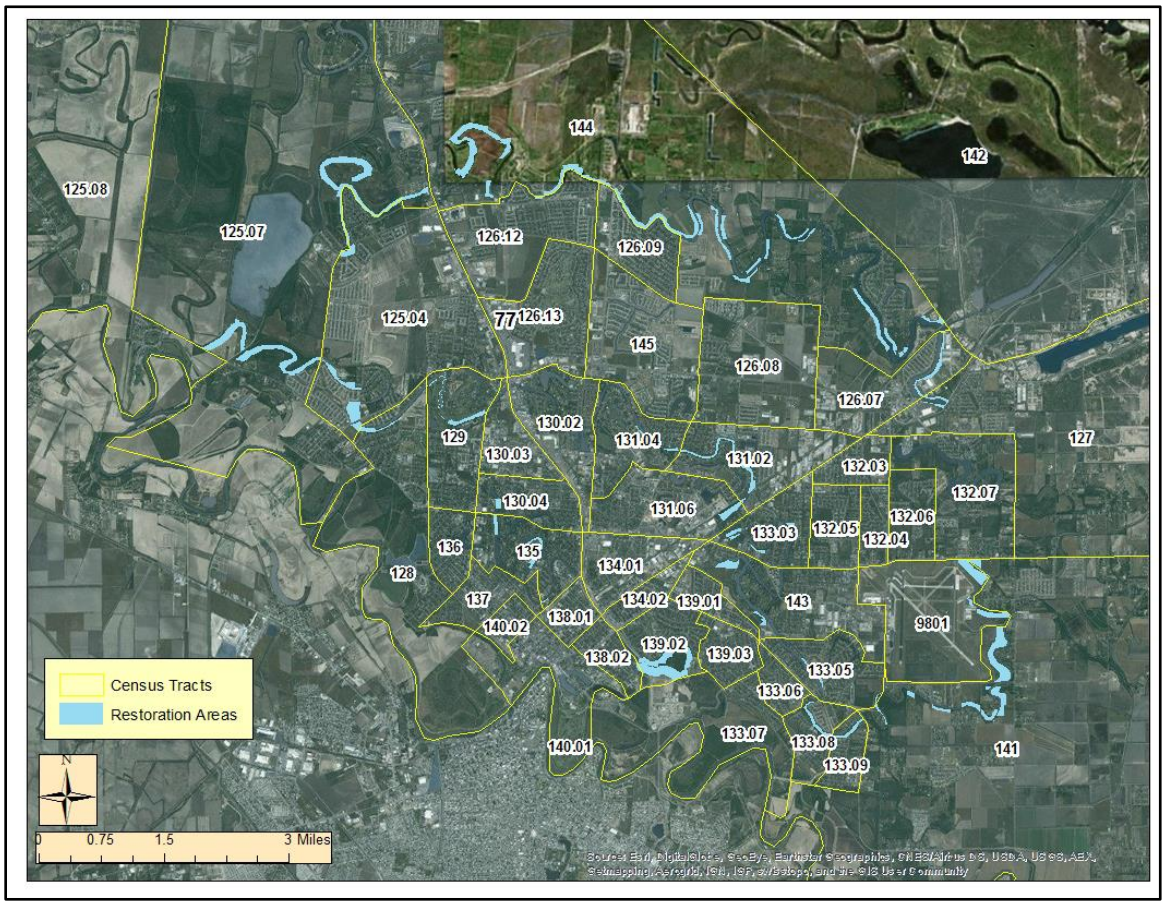


Figure A- 8: Census tracts in relation to resaca restoration areas. Environmental Justice

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 .

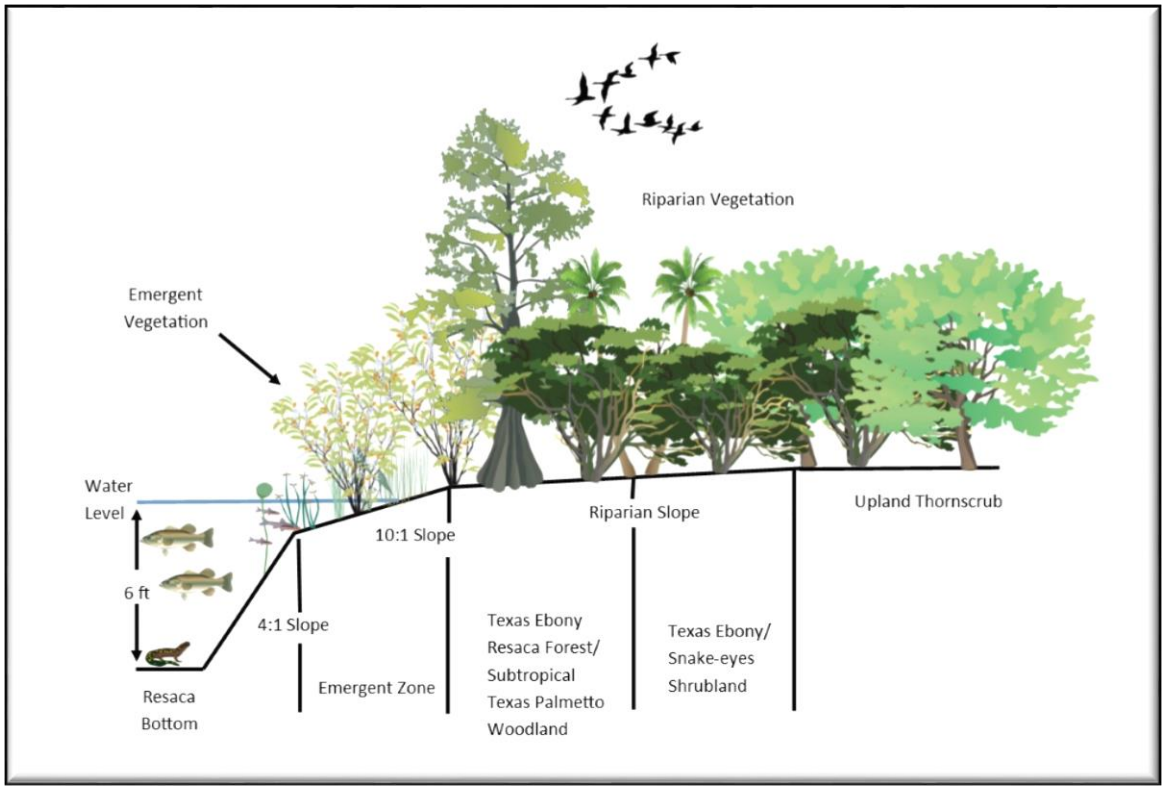


Figure A-9: Conceptual design of the proposed resaca restoration.

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.

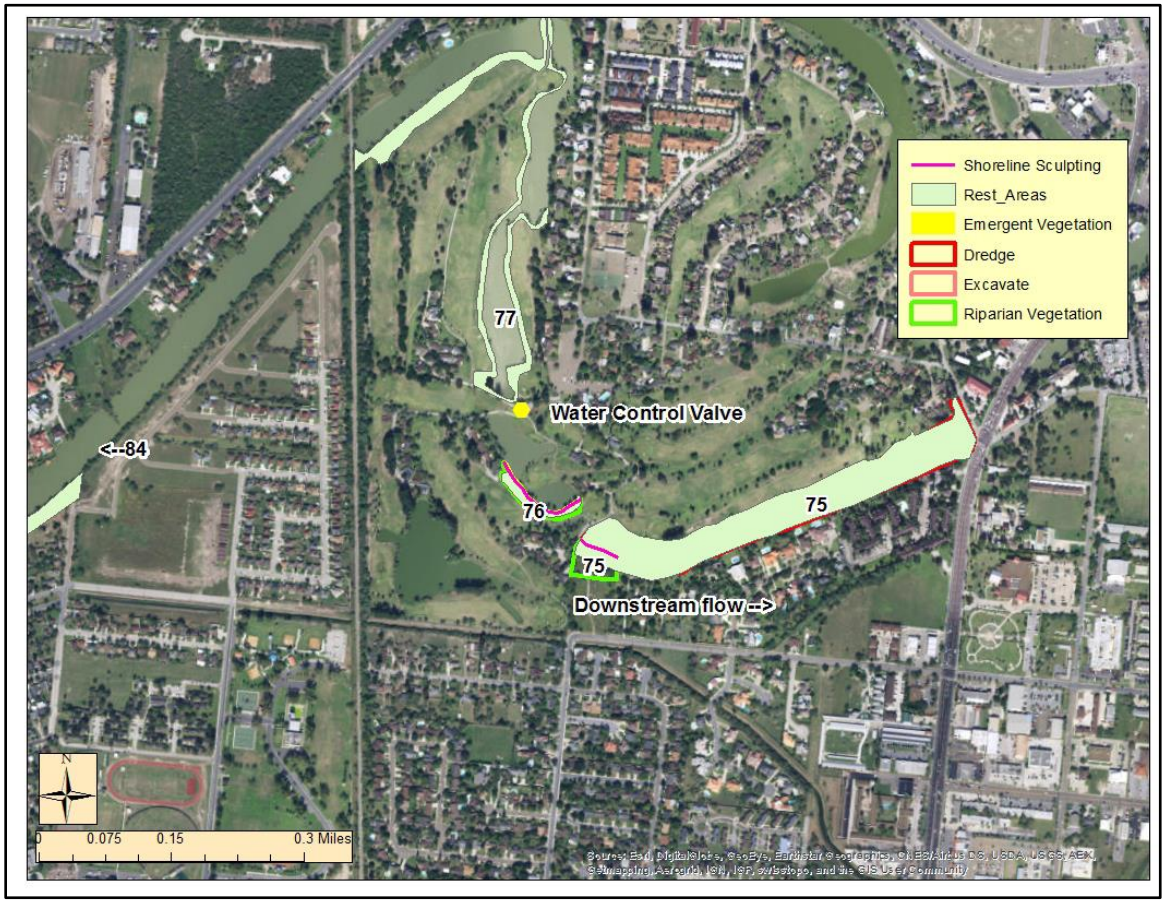


Figure A- 10: Example of water supply control for Resaca de la Guerra at the City of Brownsville Country Club.

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.

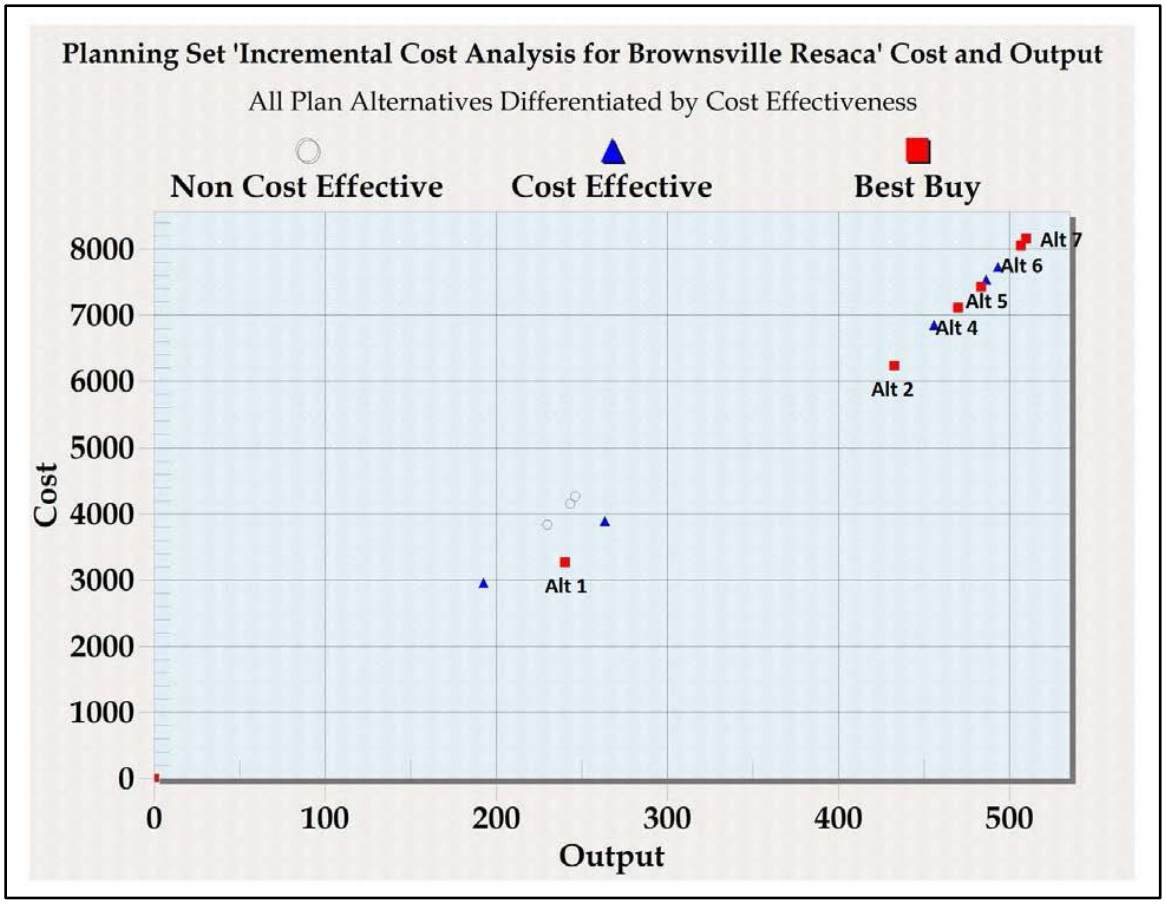


Figure A-11: CE/ICA Cost-effective and Best-buy Alternatives.

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

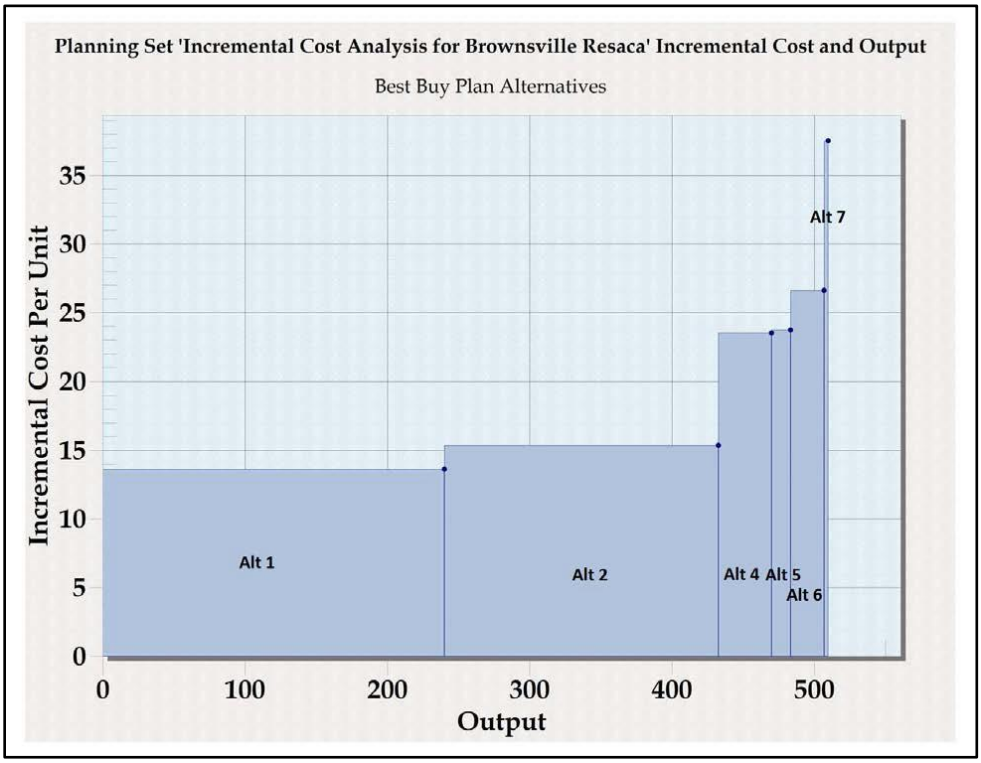


Figure A-12: Best Buy Array from CE/ICA.

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.

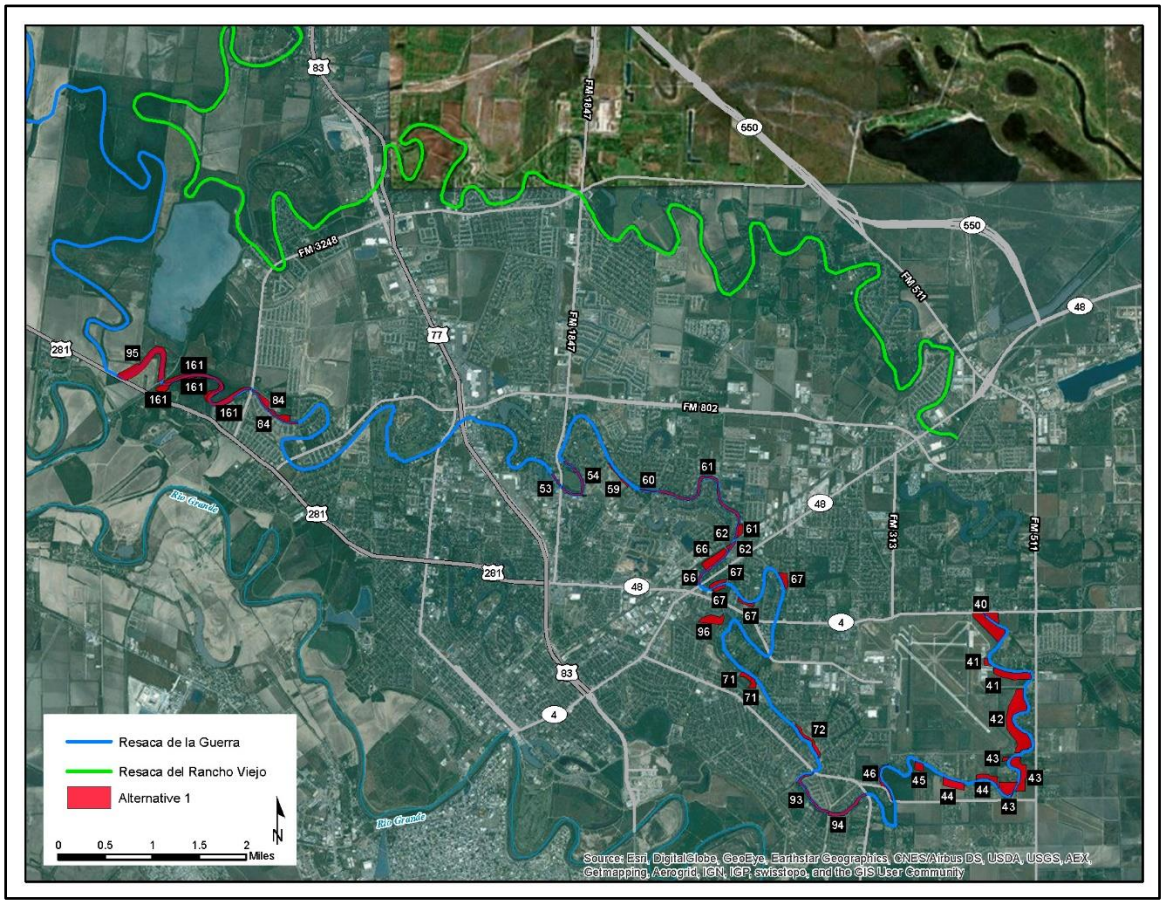


Figure A-13: Alternative 1

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.

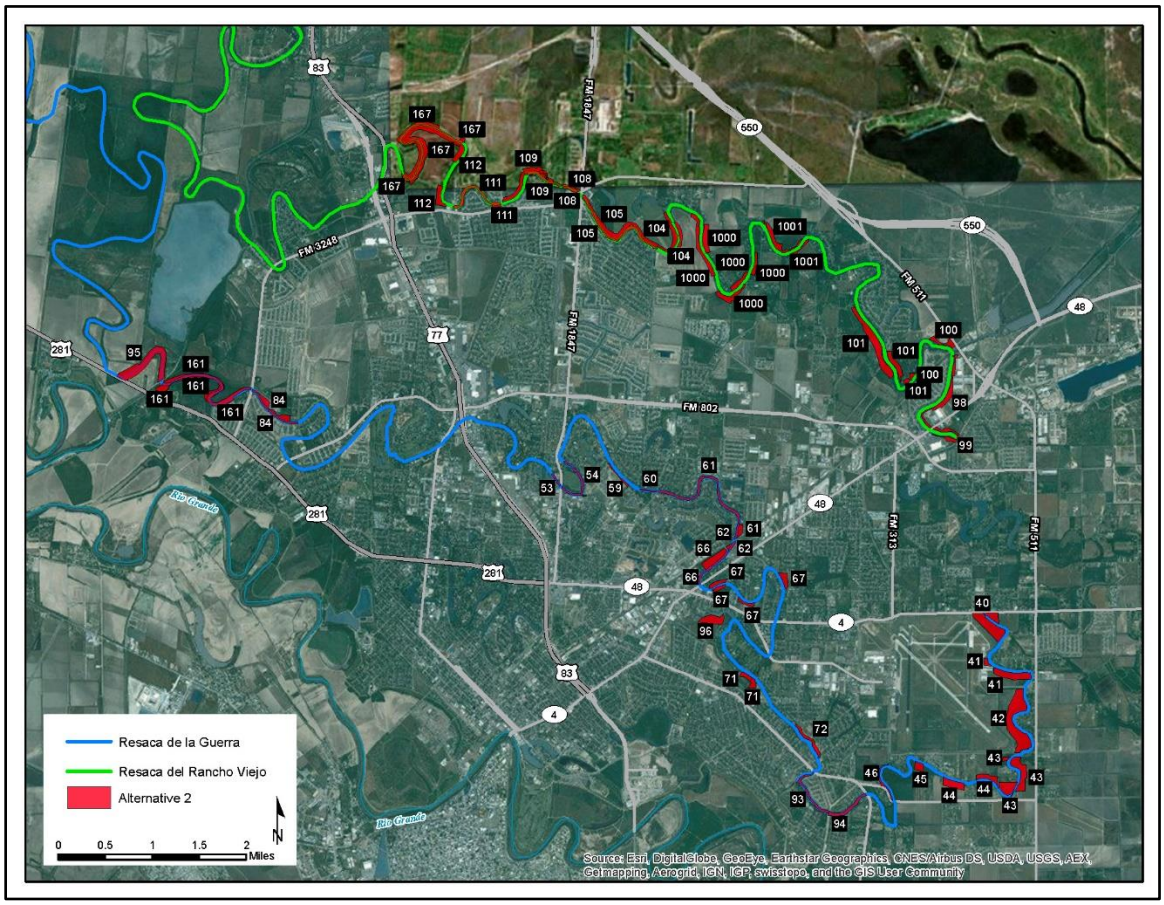


Figure A- 14: Alternative 2.

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.

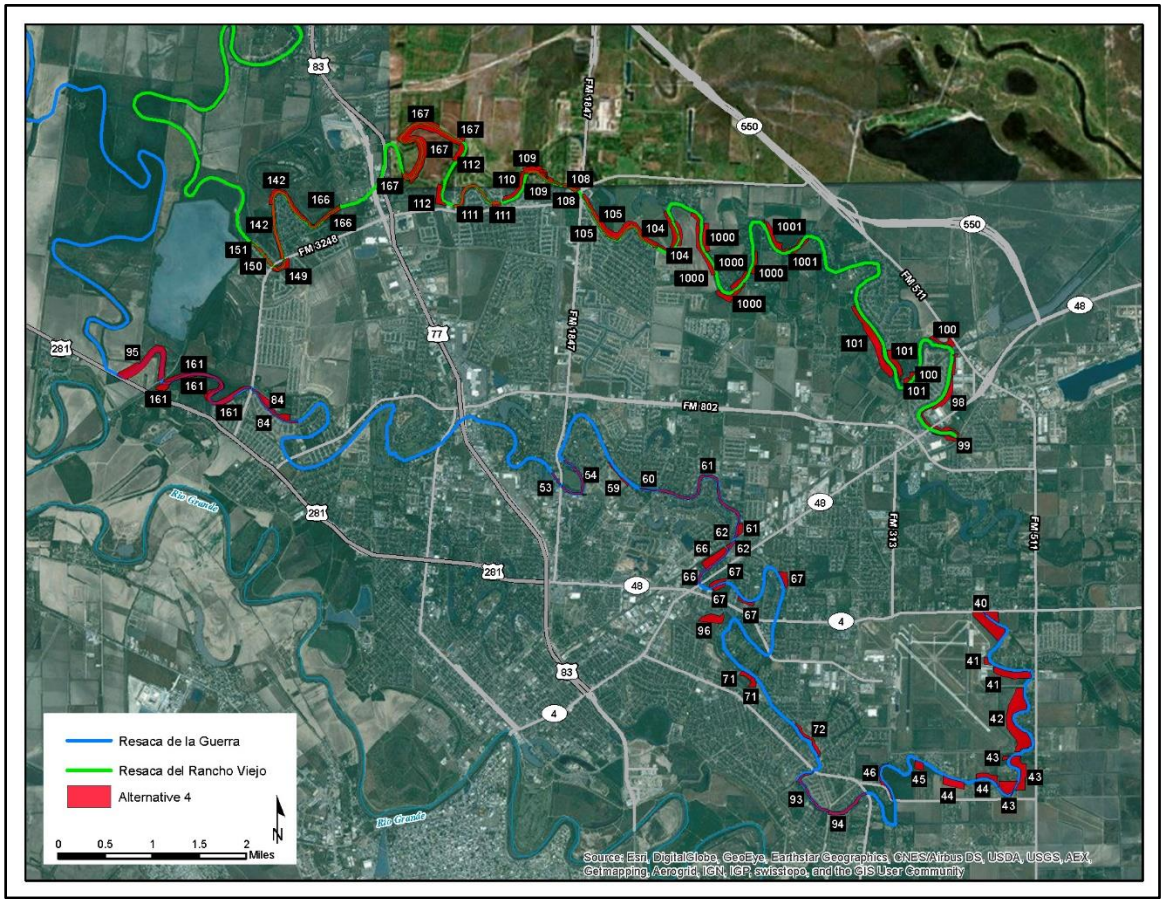


Figure A- 15: Alternative 4.

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).

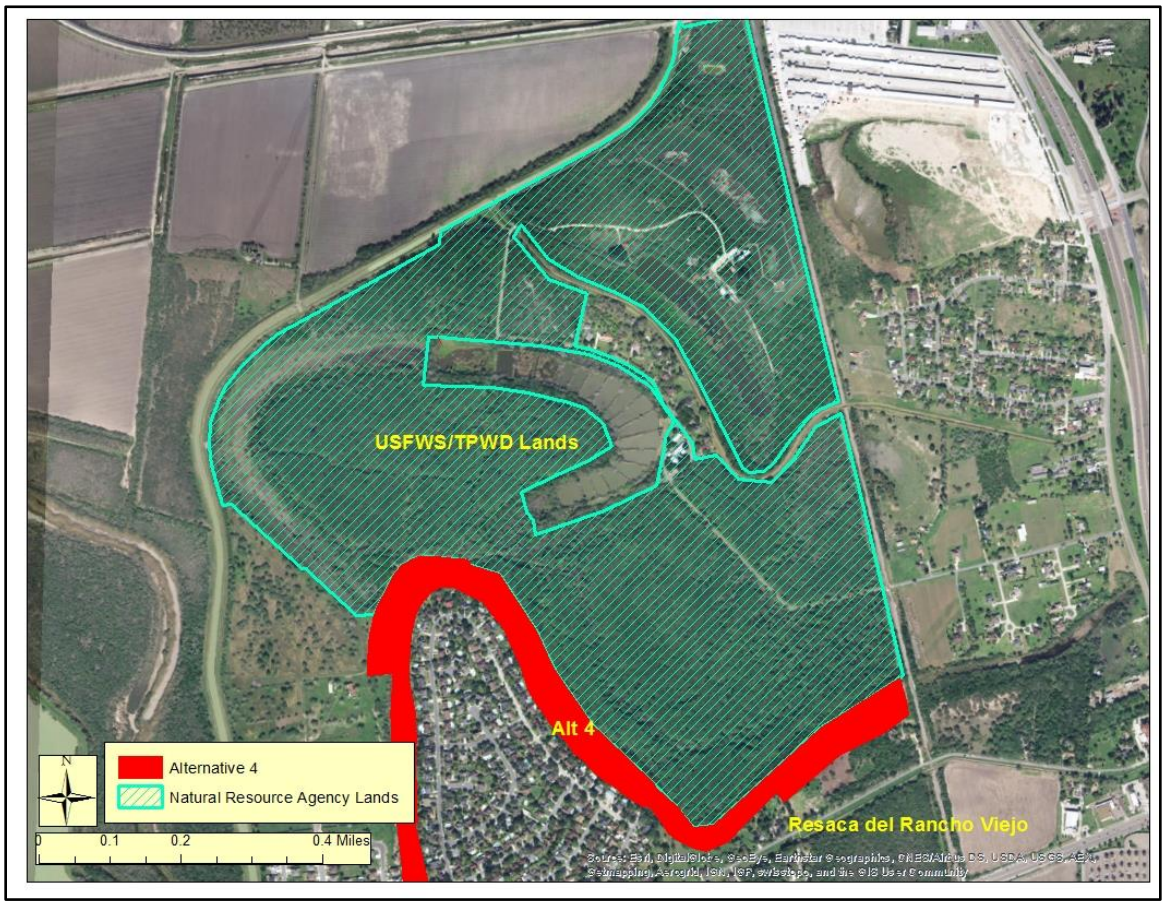


Figure A- 16:Proximity of Alternative 4 resaca segment to high quality upland thornscrub habitat manage by natural resource agencies.

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.

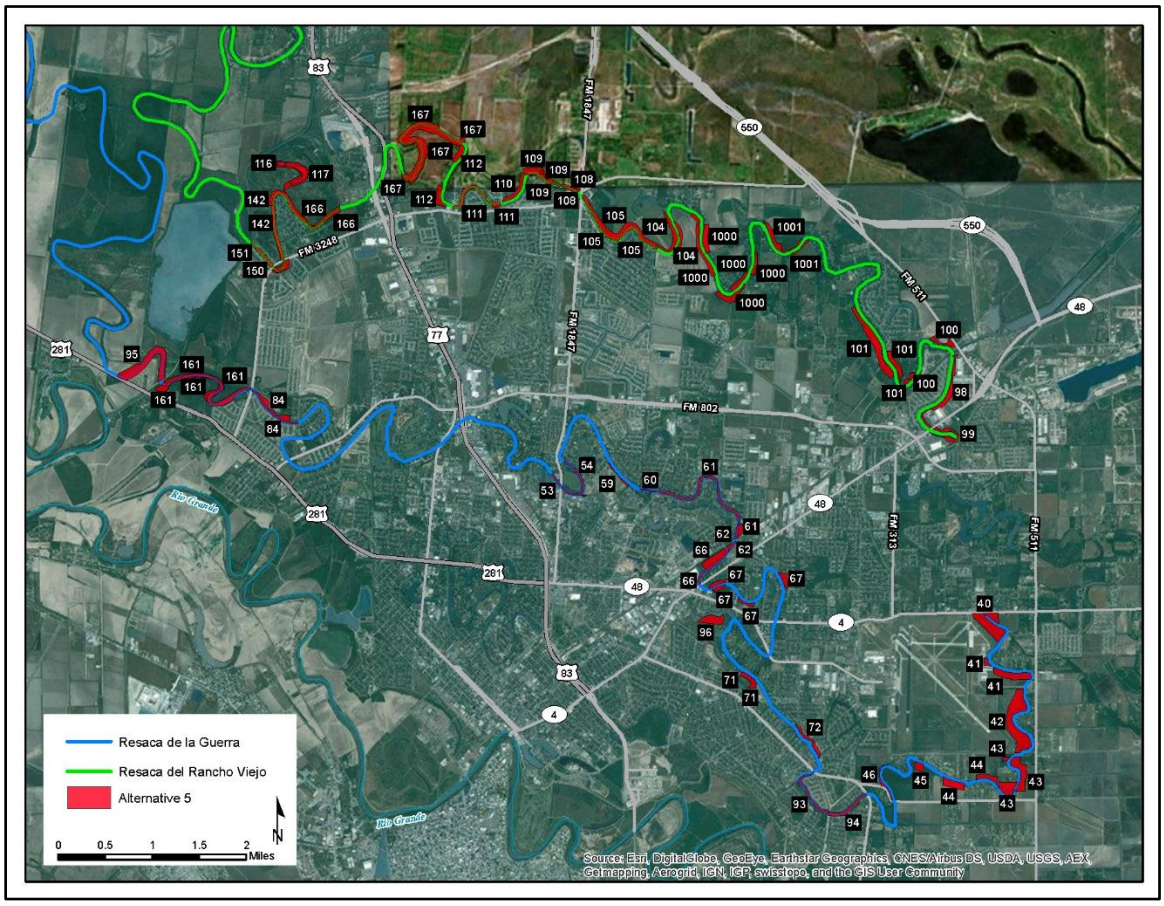


Figure A-17: Alternative 5.

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.

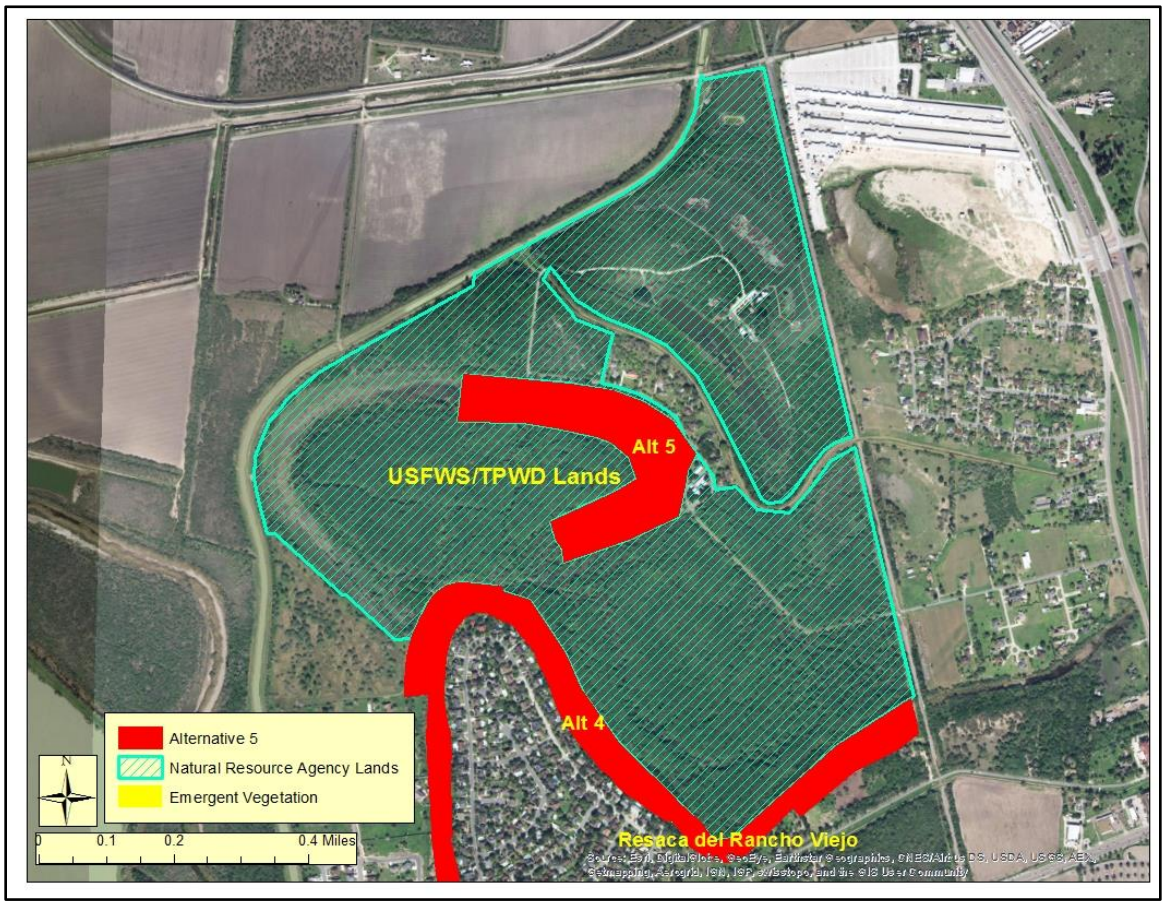


Figure A-18: Proximity of Alternative 5 to high quality upland thornscrub managed by the USFWS and TPWD

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.

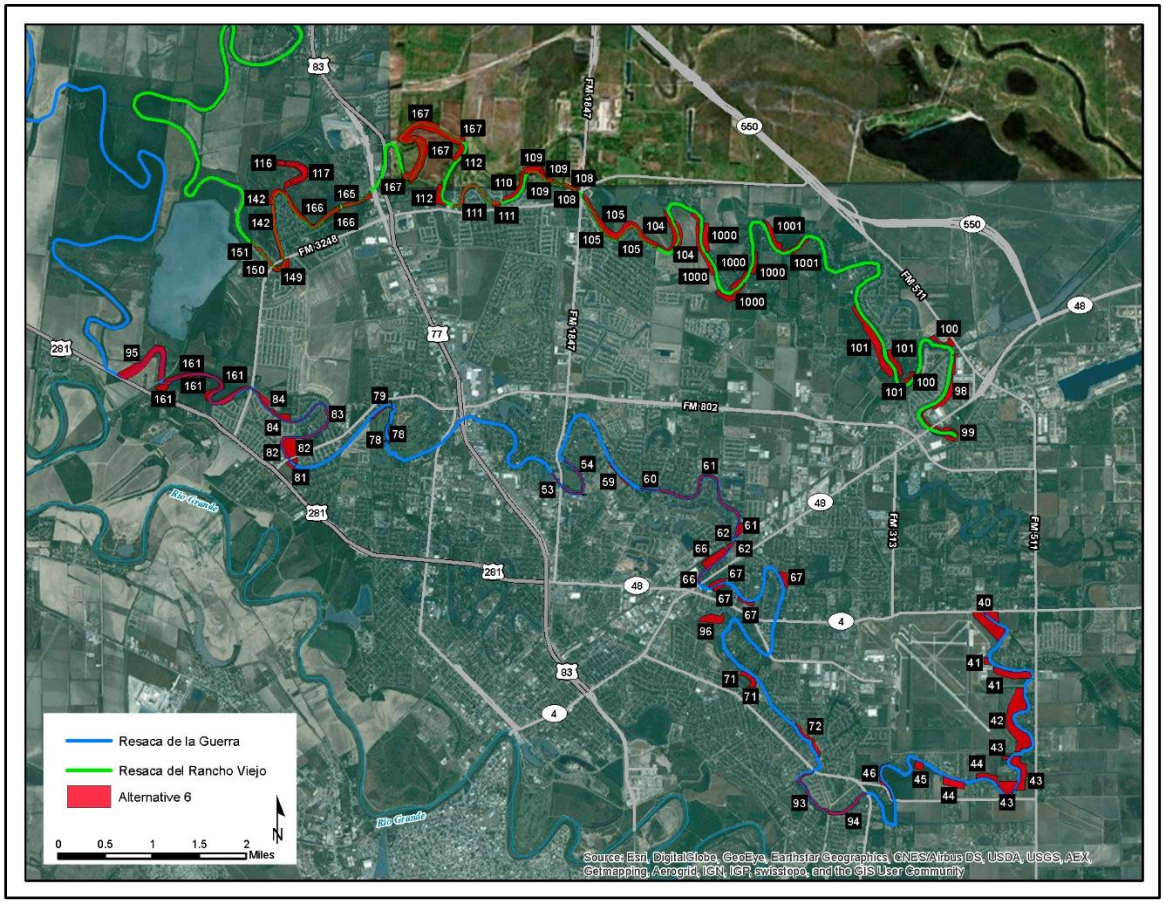


Figure A-19: Alternative 6.

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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