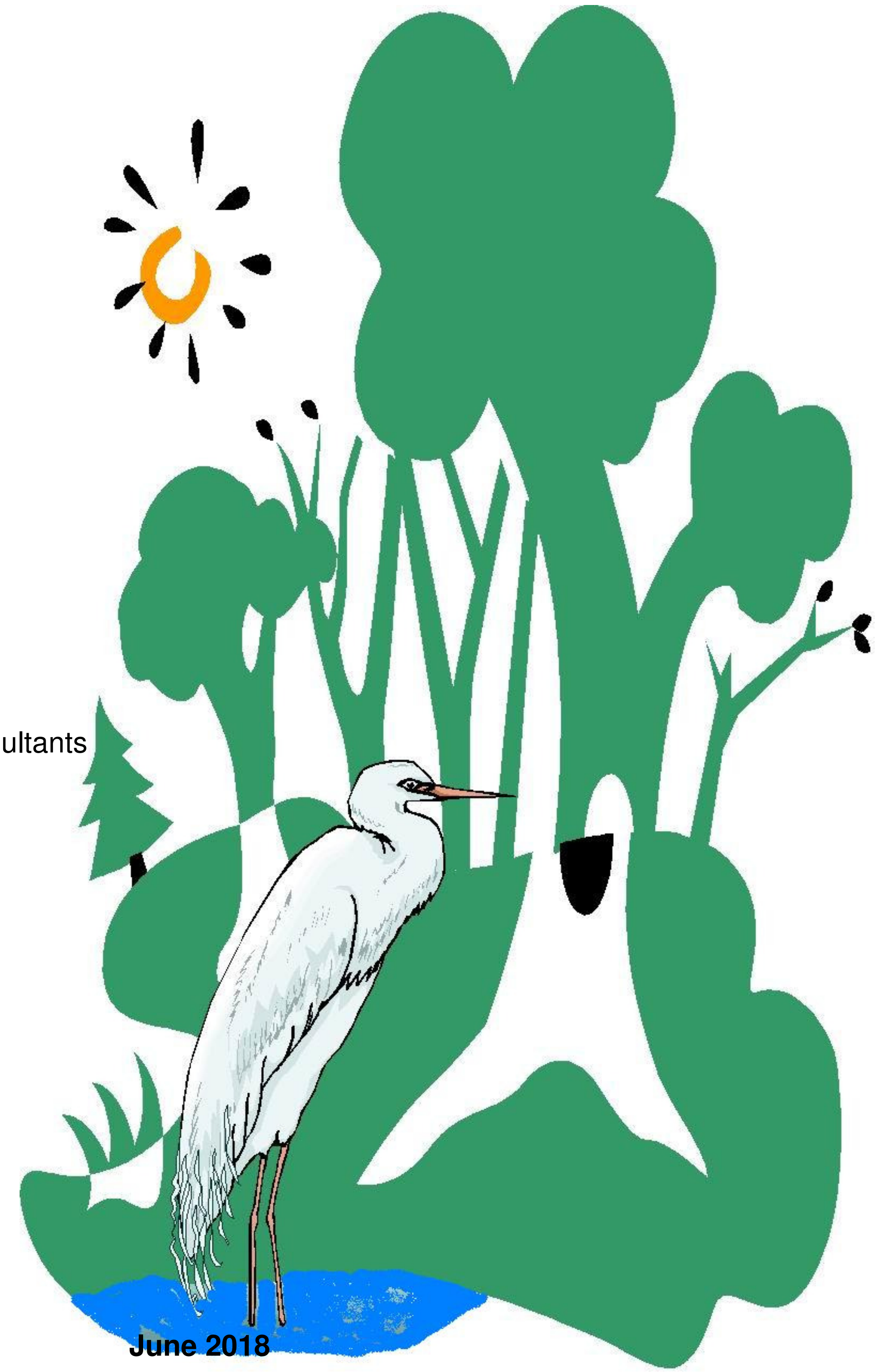
WETLAND JURISDICTIONAL DETERMINATION
Project: Improvements to the entrance of the UPR, Mayagüez campus through road PR-2.
Alternatives I-VI
MAYAGUEZ, PUERTO RICO.



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WETLAND JURISDICTIONAL DETERMINATION
Improvements to the entrance of the UPR, Mayagüez campus through road PR-2. Alternatives I-VI

MAYAGUEZ, PUERTO RICO.

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I. EXECUTIVE SUMMARY

Alpha Engineering and Batlle Engineers contracted Ecoaventuras Inc. Environmental Consultants for conducting a Wetland Jurisdictional Delineation for the proposed project in Mayaguez, Puerto Rico.

The PR Highway Authorities (Autoridad de Carreteras y Transposrtación) (ACT) intends to study, evaluate five design alternatives, complete the NEPA process and obtain FHWA approval for the modification of Interstate Access at the following intersections:

• PR-2, PR-2R (Post street) and San Juan street, just at the entrance of the UPR Campus of Mayagüez (La Vita) km 153.90
• PR-2 and Chardón Street in Mayagüez Terrace Access km. 152.80
• PR-2 and PR-3108 km 152.40 in the municipality of Mayagüez

The intersection of La Vita has a very unconventional geometric configuration. From north to south is the PR-2 road that is the main artery of Mayagüez, from the North-West to the Southeast is the PR-2R (Post street) that crosses the PR-2 highway with a 60 degree inclination angle, to the West Is the approach to the San Juan street, and to the East the access to the UPR Mayagüez Campus. These intersections have traffic congestion and geometric problems that ACT wants to address as they cause significant delays in PR-2 traffic.

The methodology proposed by Ecoaventuras for this Jurisdictional Determination is the Routine Wetland Determination. The Wetland delineation was conducted following the guidelines of the 1987 US Army Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region (Version 2.0A "Routine Approach, On-site Inspection" was used for this jurisdictional delineation.

This wetland jurisdictional delineation was developed by characterizing the vegetation, soils, and hydrology of the study area. Wetlands were found within the study area including creeks and associated patches with potential Federal Jurisdiction under the Clean Water Act 404.

II. INTRODUCTION

A Jurisdictional Determination assessment was commissioned to delineate potential existing wetlands. Figure 1: Location Map depicts the study area that comprises the proposed acreage within Alternatives I-VI. Figure 2 illustrates in an aerial photo the location of the project site.

This report contains the results of a wetland jurisdictional delineation for the alignment studied in Mayaguez, Puerto Rico. The procedures outlined in the 1987 Corps of Engineers Wetland Delineation Manual and the recently released Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region (Version 2.0) established protocols were followed.

As part of the delineation assessment, the available literature including published FWS, Planning Board, NRCS, DNER and technical journal/articles were revised. In addition, sampling of soils, vegetation, and hydrology was collected systematically along the study area.

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III. GENERAL DESCRIPTION OF THE PROJECT

The PR Highway Authorities (Autoridad de Carreteras y Transposrtación) (ACT) intends to study, evaluate five design alternatives, complete the NEPA process and obtain FHWA approval for the modification of Interstate access at the various intersections on road PR 2 in Mayaguez.

IV. GENERAL DESCRIPTION OF STUDY AREA

A. Site Location and Landscape Features

The proposed lineal project is located in an area approximately 22 acres and 2.0 km long on PR-2, at coordinates N 18 12' 55 73" and W 67 09' 00 31", in the Municipality of Mayaguez, Puerto Rico. The project footprint includes PR-2R (Post street) and San Juan street, just at the entrance of the UPR Campus of Mayagüez (La Vita) km 153.90; PR-2 and Chardón Street in Mayagüez Terrace Access km. 152.80; PR-2 and PR-3108 km 152.40 in the municipality of Mayagüez

Refer to Figure 1: Location Map, Figure 2: Aerial Image.

A mosaic of coverage including herbaceous, forest fragments and ornamental landscapes exist within the studied area. Disturbance regime is obvious particularly vegetation coverage and soils.

B. Geology

The study area contains Yauco and Maricao formations and alluvium, swamp and beach deposits. See Figure 3: Geologic map for Mayagüez area.

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C. Soils

The Mayaguez Soil Survey shows the prevalence of:

The Consumo series consists of very deep, moderately well drained, moderately permeable soils on summits and side slopes of mountains. They formed in residuum that weathered from basic volcanic rocks. Near the type location, the mean annual precipitation is about 76 inches and the mean annual temperature is about 77 degrees F. Slopes range from 20 to 60 percent.

Levelled clayey land is in areas that have been so disturbed by earth moving machinery that it is impossible to recognize the original soil. The profile of the original soil has been changed by cuts, fillings and leveling. The existing soil material is mostly well drained, strongly acidic, moderately permeable, slightly sticky and plastic, clayey texture.

Alluvial land occurs in low lagoons and in depressions located in the flood plains of streams and rivers. The water table is at or near the surface for most of the year and the water covers the surface during the rainy season. The texture of the soil material varies from fine to medium.

Levelled land, frequently Flooded: Levelled, flooded land that is often in the floodplains along rivers, It consists of material that has been so disturbed by earth moving machinery, to the extent that it is not possible to recognize the original soil.

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D. Climatology

The study area is located in the humid subtropical zone. The average annual rainfall is 70” and the average annual temperature is 79F. Rainfall is more frequent during the months of July to October. The average relative humidity is 70%. The winds blow usually from the Northeast.

E. Flora and Fauna

Flora and Fauna, Listed Species

During the assessment, we recorded a cumulative list of plant and animal species that were observed along the sampling array period. A list of species is provided as baseline data obtained during our field visits.

Table 1: Flora Composition List for the study site

Scientific Name	Common Name	Family	Habit
Acalypha bisetosa Bertol. Ex Spreng.	Acalypha	Euphorbiaceae	Herbaceous
Aeschynomene americana L.	Moriviví bobo,yerba rosario	Leguminosae-Papilonoideae	Herbaceous
Albizia procera (Roxb.)Benth.	Albizia	Leguminosae-Mimosoideae	Tree
Amaranthus dubius Mart. ex Thellung	Blero blanco	Amaranthaceae	Herbaceous
Andira inermis (W.Wr.)DC.	Moca	Leguminosae-Papilonoideae	Tree
Antigonon leptopus Hook & Arn.	Coral	Polygonaceae	Herbaceous
Asplenium auritum Sw.	helecho macho	Polypodiaceae	Herbaceous
Axonopus compressus(Sw.) Beauv.	Gramma colorada,carpet grass	Poaceae	Herbaceous
Bambusa vulgaris	Bambu	Poaceae	Tree

Bauhinia purpurea L.	Palos de Orquídeas	Leguminosae-Caesalpinoidea	Tree
Bracharia purpurecens	Malojillo	Poaceae	Herbaceous
Bucida buceras L.	Úcar	Combretaceae	Tree
Callistemon citrinus (Curtis)Stapf	Crimson bottlebrush	Myrtaceae	Tree
Calophyllum calaba	Maria	Cluseacea	Tree
Canna glauca L.	Maraca boba,Maraca de pántano,Maraca amarilla	Cannaceae	Herbaceous
Casearia sylvestris Sw.	Cafeillo,Cafeillo cimarrón,Café silvestre	Flacourtiaceae	Tree
Cassia javanica L.	Casia rosada	Leguminosae-Caesalpinoidea	Tree
Cecropia schreberiana Mig.	Yagrumo hembra	Cecropiaceae-Urticaceae	Tree
Chloris radiata(L.)Sw.	Radiate fingergrass	Poaceae	Herbaceous
Chrysalidocarpus lutesens	Areca	Arecaceae-Palmae	Tree
Chrysobalanus icaco L.	Icaco	Chrysobalanaceae	Shrub
Cissus verticillata (L.) Nicolson & Jarvis	Vine de caro,Puddin vine	Vitaceae	Vine
Cleome viscosa L.	Spider flower,Bee plant	Capparaceae	Herbaceous
Coccoloba venosa	Calambreña	Polygonaceae	Tree
Cocos nucifera L.	Palma de Cocos	Arecaceae-Palmae	Tree
Colocasia esculenta (L.)	Malanga	Araceae	Herbaceous
Commelina diffusa Burm f.	Cohitre	Commelinaceae	Herbaceous
Conocarpus erectus sp.	mangle boton plateado	Combretaceae	Shrub
Cuphea carthaginensis (Jacq.) J.F.Macbr.	Colombian waxweed	Lythraceae	Herbaceous
Cynodon dactylon(L.)Pers	Bermudagrass	Poaceae	Herbaceous
Dactyloctenium aegyptium (L.)Willd.	Yerba egipcia	Poaceae	Herbaceous
Delonix regia (Bojer ex Hook.)Raf.	Flamboyán	Leguminosae-Caesalpinoidea	Tree
Dieffenbachia seguine(Jacq.) Schott	Rábano cimarron,dumpe cane	Araceae	Herbaceous
Digitaria horizontalis Willd	Pata de Gallina	Poaceae	Herbaceous
Dracaena fragans L.	Dracinia	Dracaenaceae-Liliaceae	Shrub
Enterolobium cyclocarpum (Jacq.)Griseb.	Guanacaste,Oreja de Mono,Earpod tre	Leguminosae-Mimosoideae	Tree
Epiprenum aureum	Potho de agua	Araceae	Vine
Eugenia biflora (L.) DC Blackrodwood	Birijí,Hoja menuda,Pitangueira	Myrtaceae	Tree

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Ficus benjamina	Laurel	Moraceae	Tree
Ficus elastica	Palo de goma	Moraceae	Tree
Gouania lupuloides (L.) Uirban	Vine indio	Rhamnaceae	Vine
Guarea guidonia (L.)Sleumer	Guaraguao	Meliaceae	Tree
Guazuma ulmifolia	Guacima	Sterculiaceae(Malvaceae)	Tree
Hibiscus cannanibus L.	Mañanera ,Pavona encendida	Malvaceae	Shrub
Hura crepitans	Molinillo	Euphorbiaceae	Tree
Inga vera	Guama	Leguminosea	Tree
Ipomoea violacea L	Vine de vaca ,Flor de luna	Convolvulaceae	Vine
Ixora coccinea L.	Cruz de Malta	Rubiaceae	Shrub
Jatropha gossypifolia L.	Higuereta	Euphorbiaceae	Herbaceous
Lagerstroemia indica L.	Astromelia	Lythraceae	Shrub
Lagerstroemia speciosa (L.)Pers.	Reina de las Flores	Lythraceae	Tree
Latania loddigesii Mart.	Palma Azul	Arecaceae-Palmae	Tree
Leucaena leucocephala (Lam.) de Wit	Zarcilla	Leguminosae-Mimosoideae	Shrub
Malachra capitata (L.) L.	Malva	Malvaceae	Shrub
Mangifera indica	Mango	Anacardiaceae	Tree
Melaleuca quiqueinervia	Melaleuca	Myrtaceae	Tree
Melicoccus bijugatus	Quenepa	Sapindaceae	Tree
Mimosa pigra	Morivivi gigante	Leguminosae-Mimosoideae	Shrub
Mutingia calabura	Capulin	Elaeocarpaceae	Tree
Neolamarckia cadamba	kadam	Rubiaceae	Tree
Nephrolepis cordifolia(L.) K.L.Presl	Dryopteridaceae	Helecho Boston	Herbaceous
Nerium oleander	Aleli	Apocynaceae	Shrub
Panicum maximum	Yerba guinea	Poaceae	Herbaceous
Paspallum millegrana	Cortadora,Paja brava	Poaceae	Herbaceous
Passiflora suberosa	Parcha hiedra	Passifloraceae	Vine
Peltophorum macrocarpum	Flamboyan amarillo	Leguminosae-Caesalpinoidea	Tree
Pennisetum purpureum	Elephant grass,Napier grass,Yerba elefante	Poaceae	Herbaceous
Philodendrum sp.	Filodendro	Araceae	Vine
Phoenix canairensis	Phoenix	Poaceae	Tree
Phoenix roebellini	Robelini	Arecaceae-Palmae	Tree

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Phyllanthus niruri subsp. niruri L.	quino de pobre	Euphorbiaceae	Herbaceous
Piptadenia peregrina	Cojoba	Leguminosae-Mimosoideae	Tree
Plumeria rubra L.	Aleli	Apocynaceae	Tree
Polygala cowellii	palo de Violeta	Polygalaceae	Tree
Polyscias guilfoylei (Bull ex Cogn. & E. March.) Bailey	Gallego,Geranium aralia	Araliaceae	Herbaceous
Pritchardia pacifica	Palma	Arecaceae-Palmae	Tree
Pterocarpus indicus	Pterocarpo	Leguminosae-Papilonoideae	Tree
Ptychosperma macarthurii (H.Wendl ex anon.)H.Wendl ex Hook	Palma	Arecaceae-Palmae	Tree
Pueraria phaseoloides	Kudzu	Leguminosae-Papilonoideae	Vine
Ricinus comunis	Higuereta	Euphorbiaceae	Shrub
Roystonea borinquena	Palma real	Arecaceae-Palmae	Tree
Sansevieria hyacinthoides(L.) Druce	Lengua de suegra	Dracaenaceae-Liliaceae	Herbaceous
Schefflera morototoni	Yagrumo macho	Araliaceae	Tree
Senna alata	Sena	Leguminosae-Caesalpinoidea	Shrub
Senna spectabilis	Acacia amarilla	Leguminosae-Caesalpinoidea	Tree
Sesbania sericea (Willd.) Link.	Papagayo	Leguminosae-Papilonoideae	Shrub
Simarouba glauca DC.	Paradise tree	Simaroubaceae	Tree
Sorgum halepense	Johnson"s grass	Poaceae	Herbaceous
Spathodea campanulata	Tulipan amarillo	Bignonaceae	Tree
Spondias mombin L.	Jobillo	Anacardiaceae	Tree
Sporobolus indicus (L.) R.Br.	cerrillo	Poaceae	Herbaceous
Sterculia apetala	Anacaguita	Sterculiaceae(Malvaceae)	Tree
Switenia macrophyla	Caoba	Meliaceae	Tree
Syagrus romanzoffiana	Coco plumoso	Arecaceae-Palmae	Tree
Syngonium podophyllum Schott	Cinco dedos	Araceae	Vine
Tabebuia argentea	Roble plateado	Bignonaceae	Tree
Tabebuia heterophyla	Roble comun	Bignonaceae	Tree
Tephrosia cinerea (L.) Pers.	Añil cenizo	Leguminosae-Papilonoideae	Herbaceous
Terminalia cattapa	Almendra	Combretaceae	Tree
Thespesia pernambusense	Emajagua	Malvaceae	Tree
Trichillia hirta	Gaeta	Meliaceae	Tree
Tricostigma octandra	Vine de nasa	Phytolaccaceae	Vine

Ura crepitans	Molinillo	Euphorbiaceae	Tree
Vetchia merilli	Adonidia	Arecaceae-Palmae	Tree
Washingtonia filifera	Palma	Arecaceae-Palmae	Tree
Wedelia trilobata	margarita	Asteraceae-Helianthae	Herbaceous
Wodeytia bifurcata	Palma cola de zorra	Arecaceae-Palmae	Tree

Table 2: Fauna of the study site

Observed fauna species included few herps and plenty of birds including the following:

Vertebrates			
Class	**Family**	**Scientific Name**	**Nombre común**
Amphibia	Bufonidae	Bufo marinus	sapo
Amphibia	Leptodactylidae	Eleutherodactylus portoricensis	coquí
Amphibia	Leptodactylidae	Leptodactylus albilabris	rana labio blanco
Reptilia	Testudinae	Pseudemys stenjgerii	jicotea de puerto rico
Reptilia	Iguanidae	Anolis cristatellus	lagartijo
Reptilia	Iguanidae	Anolis stratulus	lagartijo
Reptilia	Iguanidae	Anolis pulchelus	lagartijo de jardín
Reptilia	Colubridae	Alsophis portoricensis	Culebra
Aves	Ardeidae	Butorides virescens	Martinete
Aves	Ardeidae	Egretta thula	Garza Blanca
Aves	Ardeidae	Ardea alba	Garza Real
Aves	Ardeidae	Bubulcus ibis	garza ganadera
Aves	Ardeidae	Ardea erodias	Garzon ceniso
Aves	Rallidae	Gallinula chloropus	Gallareta Común
Aves	Falconidae	Pandion aleatus	agulia de mar
Aves	Falconidae	Falco columbarius	merlin
Aves	Falconidae	Falco sparverius	falcón comun
Aves	Accipitridae	Buteus jamaicensis	guaraguao
Aves	Cuculidae	Coccyzus minor	Pájaro Bobo Menor
Aves	Picidae	Melanerpes portoricensis	Carpintero de PR
Aves	Columbidae	Columbina passerina	rolitade P. R.
Aves	Columbidae	Columba squamosa	paloma turca
Aves	Columbidae	Zenaida asiatica	tórtola aliblanca
Aves	Columbidae	Zenaida aurita	Tórtola Cardosantera

Aves	Columbidae	Columba livia	paloma casera
Aves	Cuculidae	Crotophaga anis	judio
Aves	Cuculidae	Saurothera vielloti	pajaro bobo mayor
Aves	Trochilidae	Anthracothorax dominicus	Zumbador Dorado
Aves	Trochilidae	Anthracothorax viridis	Zumbador verde
Aves	Todidae	Todus mexicanus	San Pedrito de Puerto Rico
Aves	Tyrannidae	Myiarchus antillarum	Juí de Puerto Rico
Aves	Tyranidae	Tyranus dominicensis	pitirre
Aves	Vireonidae	Vireo latimeri	julian chivi
Aves	Mimidae	Mimos polyglotus	ruiseñor
Aves	Emberizidae	Dendroica striata	Reinita rayada
Aves	Emberizidae	Coereba flaveola	reinita comun
Aves	Emberizidae	Seiurus motacilla	Pizpita de rio
Aves	Emberizidae	Tiaris bicolor	Gorrion negro
Aves	Emberizidae	Spindalis portoricensis	Reina Mora
Aves	Emberizidae	Ammodramus savannarum	chamorro
Aves	Emberizidae	Tiaris olivacea	Gorrión Barba Amarilla
Aves	Emberizidae	Molothrus bonariensis	Tordo
Aves	Emberizidae	Loxigilla portoricensis	Comeñame
Aves	Icteridae	Quiscalus niger	chango
Aves	Icteridae	Icterus dominicensis	Calandria
Aves	Estrilididadae	Estrilda melpoda	veterano
Aves	Estrilididadae	Lonchura cucullata	diablito
Aves	Muscicapidae	Turdus plumbeus	zorzal de patas coloradas
Aves	Estrilididadae	Lonchura malacca	manaquen finch
Aves	Ploceidae	Euplectes orix	obispo
Mammalia	Muridae	Ratus ratus	rata
Mammalia	Herpestidae	Herpestes aurupunctatus	mangosta
Mammalia	Phyllostomidae	Stenoderma rufus	murcielago
Mammalia	Phyllostomidae	Artibeus jamaicensis	murcielago
Invertebrates			
Clase	Familia	Genero/especie	N. común
Gastropoda	Camaenidae	Caracolus caracola	caracol
Gastropoda		Megalmastoma sp.	caracol
Gastropoda	Bulimulidae	Bulimulus sp.	caracol
Gastropoda		Polydontes acutangula	Caracol
Arachnida	Araneida	Argiope argentata	araña
Arachnida	Theriidae	Unknown species	araña
Insecta	Libellulidae	Orthemis ferruginea	libelulas

Insecta	Aeschinidae	Unknown species	libelulas
Insecta	Coenagrionidae	Unknown species	damselflies
Insecta	Ephemeroptera	Ephemeridae	mayflies
Insecta	Neuroptera	Chrysopidae	lacewing
Insecta	Trichoptera	Unknown	caddisflies
Insecta	Acrididae	Schistocerca americana	saltamonte
Insecta	Acrididae	Rhammatocereus gregarius	saltamonte
Insecta	Gryllidae	Orochalis vaginalis	grillo
Insecta	Blattidae	Pycnoscelus sp.	cucaracha
Insecta	Buprestidae	Desconocido	escarabajo
Insecta	Curculionidae	Diaprepes abreviatus	vaquita
Insecta	Scarabaeidae	Phyllophaga sp.	escarabajo
Insecta	Carabidae	Unknown species	escarabajo
Insecta	Carabidae	Unknown species	escarabajo
Insecta	Coccinelidae	Coccinella novemnotata	mariquita
Insecta	Buprestidae	Desconocido	escarabajo
Insecta	Scarabaeidae	Unknown species	escarabajo
Insecta	Scarabaeidae	Unknown species	escarabajo
Insecta	Chrysomelidae	Unknown species	escarabajo
Insecta	Pieriidae	Phoebis sp.	mariposa
Insecta	Danaidae	Danaus plexipus	monarca
Insecta	Danaidae	Limenitis archippus	viceroy
Insecta	Nymphalidae	Heliconius charitonius	mariposa
Insecta	Nymphalidae	Colfitalaria sp.	mariposa
Insecta	Arctidae	Utetheisa bella	alevilla
Insecta	Muscidae	Mosca domestica	mosca
Insecta	Formicidae	Odontomachus laematoda	hormiga
Insecta	Formicidae	Solenopsis invicta	hormiga
Insecta	Anthophoridae	Xylocopa brasilianorum	cigarron
Insecta	Apidae	Apis melifera	abeja

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In Puerto Rico, endangered and threatened species are protected by two regulations:

1. Regulations for the Conservation and Management of Threatened and Endangered Species in the Commonwealth of Puerto Rico (Department of Natural Resources, 1985, 2004, Law 241), and;
2. The Endangered and Threatened Wildlife and Plants Rule (50 CFR 17.11 and 17.12, August 20, 1994 as amended).

These regulations include endangered species, threatened species, species similar to endanger and threatened species and their habitats. The PRDNER Regulations for the Management of Threatened and Endangered Species in the Commonwealth of Puerto Rico (Department of Natural Resources, 1985, 2004, Law 241) refers to these species by the collective name of "Critical Biological Species" and catalog them by status.
The following statuses are recognized:

- E; Species determined by the local authorities to be endangered.
- EF; Species determined by Federal authorities to be endangered.
- V; Species determined by local authorities to be threatened.
- VF; Species determined by Federal authorities to be threatened.
- NHDCE; Species adopted by the PRDNER Natural Heritage Division as a critical element for its similarity to a threatened or endangered species. The Natural Heritage Division inventories were reviewed for the occurrence of critical biological species in the study area. Se Figure 5: Listed Species Map.

A single individual of a listed species was observed within the studied area. *Polygalla cowellii*, Arbol de Violeta, planted at the University of PR, Mayaguez Campus.

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F. Hydrology

The study area hydrology is influenced by tides and orographic rain. The site collects rainwater from the Miradero Basin. Several drainage channels and creeks exist within the area and should not be impacted by the proposed highway project. Refer to Figure 6: Wetland Inventory Map.

G. Cultural Resources

We did not found obvious elements associated to pre-Columbian and or historic settlements. A general literature revision did not produced historic and/or cultural findings in the project surroundings other than the University of Puerto , Mayagüez Campus entrance.

V. DESCRIPTION OF WETLANDS

The USA CoE (Federal Register 1982) and the U.S. Environmental Protection Agency (Federal Register 1980) jointly defined wetlands as *"those areas that are inundated by surface water or ground water at a frequency and duration to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".* The Rapanos case included elements of connectivity among hydrographical basins.

According to the above definition, **wetlands have the following diagnostic environmental characteristics**: (1) hydrophitic vegetation, (2) hydric soils, and (3) hydrographic regime resulting in saturated or flooded conditions.

The USA CoE considers an area a jurisdictional wetland only when a positive wetland indicator is present for each of the diagnostic environmental characteristics (USA CoE, 1987). Connectivity among water bodies and habitats is a determinant element as well.

The information available was congruent and allowed us to characterize the site vegetation, soils, and hydrology. Therefore, a "Routine Approach-On Site Inspection", was used for this jurisdictional pre-delineation.

Note that both the wetland definitions, as well as the indicators used, have the underlying assumptions of normal conditions.

The Corps Manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to influence plant occurrence. The manual uses a plant-community approach to evaluate vegetation.

Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. Hydrophytic vegetation is present when the plant community is dominated by species that require or can tolerate prolonged inundation or soil saturation during the growing season. Hydrophytic vegetation in the Caribbean Islands Region is identified by using the indicators described in this chapter.

According to the U.S. Fish and Wildlife National Wetland Inventory (Figure 6), the study site is mainly composed of riparian systems.

The protocols described in the 1987 USA CoE Wetland Delineation Manual and the recently published Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region were followed in the jurisdictional delineation of these wetlands. The USA CoE (Federal Register 1982) and the U.S. Environmental Protection Agency (Federal Register 1980) jointly defined wetlands as *"those areas that are inundated by surface water or ground water at a frequency and duration to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".*

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In general terms, wetlands are habitats between terrestrial and aquatic ecosystems where standing waters or saturated soil conditions occur at least periodically and where a prevalence of vegetation typically adapted for anoxic soil conditions occur. Wetlands are important ecosystems with a myriad of functional values such as habitat, erosion control, water quality, and flood control. The study area does not have a map set from the USFWS WIM series.

The classification system used in the inventory defines five systems:

1. Marine

Consist of the open ocean overlying the continental shelf and it is associated with a high-energy coastline. They are exposed to the waves and currents of the open ocean, and the Marine system extends from the outer edge of the continental shelf shoreward to one of two lines:

a. The landward limit of tidal inundation

b. The seaward limit of the Estuarine System

2. Estuarine

Consist of deep-water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land, but are connected to the ocean; in which ocean water is at least occasionally diluted by freshwater runoff from the land. This system extends upstream and landward to where ocean-derived salts measure less than 0.5 percent during the period of average annual low flow; to an imaginary line closing the mouth of river, bay or sound; and to the seaward limit of wetland emergent, shrub, and trees. The Estuarine system also includes offshore areas of continuously diluted seawater and lagoons.

Estuarine wetlands may be divided into subtidal and intertidal subsystems. In the subtidal subsystem, the substrate is continuously submerged, whereas in the intertidal subsystem the substrate is exposed and floods only during high tides.

3. Riverine Wetlands

Includes all wetland and deep-water habitats contained within the channel, with two exceptions:

a. wetlands dominated by trees, shrubs, persistent emergent, mosses, or lichens.

b. habitats with water containing ocean-derived salts in excess of 0.5 percent.

The Riverine system is bounded on the landward side by upland, channel bank, or wetlands dominated by trees, shrubs, persistent emergent, mosses, or lichens. It terminates at the downstream end where the concentrations of ocean-derived salts in the water exceed 0.5 percent during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake.

The Riverine system is divided into four (4) subsystems:

a. tidal - the grading is low and water velocity fluctuates under tidal influence,

b. lower perennial- the grading is low and water velocity is low,

c. upper perennial - the grading is high and velocity of the water fast, and

d. Intermittent - the channel contains non-tidal flowing water for only part of the year.

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4. Lacustrine

Include wetlands or deep-water habitats with the following characteristics:

a. situated in topographic depression or a dammed river channel,

b. blacks trees, shrubs, persistent, emergent, mosses or lichens with aerial coverage greater than 30 percent, and

c. total area exceeds 0.08 km^2 (0.03 square miles).

The Lacustrine system is divided into two subsystems: limnetic and littoral. The limnetic subsystem includes all deep-water habitats within the lacustrine system and in the littoral, all wetlands habitats in the lacustrine system. It extends from the shore boundary of the system to a depth of 2 m (6.6 feet.) below water or to the maximum extent of non-persistent emergent, if these grow at depth greater than 2 m.

5. Palustrine

Includes all non-tidal wetlands dominated by trees, shrubs, persistent emergent, mosses or lichens and all such wetlands that occur in tidal areas were the salinity due to ocean-derived salts is below 0.5 percent. It also includes wetlands lacking the above mentioned vegetation, but with the characteristics: area less than 8 ha (20 acres), active wave-formed of bedrock shoreline feature lacking water depth in the deepest part of the basin less than 2 m (6.6 feet) at low water, and salinity due to ocean-derived salts measuring less than 0.5%.

This system is bounded by upland or by any of the other four systems. The Palustrine system was developed to group the vegetated wetlands, traditionally known as swamp, mash, bog, prairie, and/or ponds and it is a system that lacks subsystems.

VI. SAMPLING METHODS

The protocols described in the 1987 USA CoE Wetland Delineation Manual and the recently published Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region, were followed in the jurisdictional delineation of these landscape.

A systematic sampling approach was developed along the studied area, including five alternatives. See Figure 7: Sampling Design. Ten (10) transects with two point counts each (20 point counts), diameter varied according to stratum. Transects were 10-20 meters long, approximately, with two points counts each.

All plants and animals observed while sampling, were included in the flora and fauna.

Soils and hydrologic data were collected from an 18" deep by 6" wide soil-bore hole at each sampling site. Vegetation was observed and identified around the point sampling site in a 1-5 meters diameter nested circular plots. Please refer to Figure 7: Sampling Design for the Study Site. It shows points (point counts) over aerial image.

Table 3: GPS Coordinates

Sampling Transect	N Coord	W Coord	NAD 83 HARN UTM 19N Date
1	18.217503	-67.15286	2016-11-23T11:28:44Z
2	18.217508	-67.152804	2016-11-23T11:29:17Z
3	18.217486	-67.152752	2016-11-23T11:29:59Z
4	18.21731	-67.152617	2016-11-23T11:31:51Z
5	18.217221	-67.152628	2016-11-23T11:32:59Z
6	18.217201	-67.152498	2016-11-23T11:34:09Z
7	18.216994	-67.152613	2016-11-23T11:35:26Z
8	18.216828	-67.152422	2016-11-23T11:40:06Z
9	18.217032	-67.152324	2016-11-23T11:43:58Z
10	18.216746	-67.151994	2016-11-23T11:48:20Z

Wetlands were identified on the aerial photograph based on vegetation, visible hydrology, and soils according to the classification system developed by Cowarding, et al (1979).

A sub metrical GPS unit using DGPS and post processed data was used to take geo referenced points associated to sampling points, upland and wetland boundaries. All data collection and GIS/RS database was projected on the Lambert Conformal Conic with the NAD 83 HARN datum in the UTM zone 19N grid.

A. Sampling Vegetation:

The Corps Manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to influence plant occurrence. The manual uses a plant-community approach to evaluate vegetation. Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. Hydrophytic vegetation is present when the plant community is dominated by species that require or can tolerate prolonged inundation or soil saturation during the growing season. Vegetation sampling done as part of a wetland delineation is designed to characterize the site in question rapidly and effectively. The first step is to identify the major landscape units or vegetation communities in advance using an aerial photograph or topographic map, and/or by walking the site. In general, routine wetland determinations are based on visual estimates of percent cover of plant species that can be made either (1) within the vegetation community as a whole, or (2) within one or more sampling plots established in representative locations within each community.

A stratum for sampling purposes is defined as having 5 percent or more total plant cover, unless it is the only stratum present. If a stratum has less than 5 percent cover during the peak of annual plant growth, then those species and their cover-values may be combined with another stratum for hydrophytic vegetation determinations.

- *Tree stratum* – This stratum consists of woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

- *Sapling/shrub stratum* – – This stratum consists of woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

- *Herb stratum* – – This stratum consists of all herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants less than 3.28 ft tall.

- *Woody vines* – Consists of all woody vines greater than 3.28 ft. in height.

Our sampling involves a series of plots arrayed perpendicular to the perceived wetland boundary based on an initial site reconnaissance. Plots were placed within a particular plant community along transect lines at regular or random intervals.

The appropriate size and shape for a sample plot depend on the type of vegetation (i.e., trees, shrubs, herbaceous plants, etc.) and the size or shape of the plant community or patch being sampled. Plot sizes should make visual sampling both accurate and efficient.

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In the Caribbean Islands Region, the following plot sizes are recommended:

1. Trees – (9.0m) radius
2. Saplings and shrubs – (5.0-m) radius
3. Herbaceous plants – (1.0-m) radius
4. Woody vines – (5.0-m) radius

Indicators of hydrophytic vegetation involve looking up the wetland indicator status of plant species on the wetland plant list (Region C of Reed (1988 and recently published 2012 Wetland Plant List) or current list). For the purposes of this study, only the five basic levels of wetland indicator status (i.e., OBL, FACW, FAC, FACU, and UPL) are used in hydrophytic vegetation indicators.

For species listed as NI (reviewed but given no regional indicator) or NO (not known occurrence in the region at the time the list was compiled), the indicator status assigned applies to the species in the nearest adjacent region (i.e., Southeast – Region 2). In general, species that are not listed on the wetland plant list are assumed to be; upland (UPL) species

Evaluation of the vegetation can begin with a rapid field test for hydrophytic Vegetation. The rapid test for hydrophytic vegetation (Indicator 1) is met if all dominant species across all strata are OBL or FACW, or a combination of the two, based on a visual assessment. If the site is not dominated solely by OBL and FACW species, proceed to the standard dominance test (Indicator 2), which is the basic hydrophytic vegetation indicator.

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Procedure

The procedure for using hydrophytic vegetation indicators is as follows:

1. Apply Indicator 1 (Rapid Test for Hydrophytic Vegetation).

a. If the plant community passes the rapid test for hydrophytic vegetation, then the vegetation is hydrophytic and no further vegetation analysis is required.

b. If the rapid test for hydrophytic vegetation is not met, then proceed to step 2.

2. Apply Indicator 2 (Dominance Test).

a. If the plant community passes the dominance test, then the vegetation is hydrophytic and no further vegetation analysis is required.

b. If the plant community fails the dominance test, and indicators of hydric soil and/or wetland hydrology are absent, then hydrophytic vegetation is absent unless the site meets the requirements for a problematic wetland situation.

c. If the plant community fails the dominance test, but indicators of hydric soil and wetland hydrology are both present, proceed to step 3.

3. Apply Indicator 3 (Prevalence Index). This step assumes that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.

a. If the plant community satisfies the prevalence index, then the vegetation is hydrophytic. No further vegetation analysis is required.

b. If the plant community fails the prevalence index, then hydrophytic vegetation is absent unless indicators of hydric soil and wetland hydrology are present and the site meets the requirements for a problematic wetland situation.

Procedure for Calculating a Plot-Based Prevalence Index

The prevalence index is a weighted-average wetland indicator status of all plant species in the sampling plot, where each indicator status category is given a numeric value (OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL=5) and weighting is by abundance (absolute percent cover). It is a more comprehensive analysis of the hydrophytic status of the community than one based on just a few dominant species.

It is particularly useful in:

- communities with only one or two dominants,
- highly diverse communities where many species may be present at roughly equal coverage,
- cases where strata differ greatly in total plant cover (e.g., total herb cover is 80 percent but sapling/shrub cover is only 10 percent).

The following procedure is used to calculate a plot-based prevalence index. The method was described by Wentworth et al. (1988) and modified by Wakeley and Lichvar (1997). It uses the same field data (i.e., percent cover estimates for each plant species) that were used to select dominant species by the 50/20 rule, with the added constraint that at least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned indicator status (including UPL). For any species that occurs in more than one stratum, cover estimates are summed across strata. Steps for determining the prevalence index are as follows:

1. Identify and estimate the absolute percent cover of each species in each stratum of the community. Sum the cover estimates for any species that is present in more than one stratum.

2. Organize all species (across all strata) into groups according to their wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and sum their cover values within groups. Do not include species that were not identified.

3. Calculate the prevalence index using the following formula:

3. Calculate the prevalence index using the following formula:

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

where:

PI = Prevalence index
A_{OBL} = Summed percent cover values of obligate (OBL) plant species;
A_{FACW} = Summed percent cover values of facultative wetland (FACW) plant species;
A_{FAC} = Summed percent cover values of facultative (FAC) plant species;
A_{FACU} = Summed percent cover values of facultative upland (FACU) plant species; and
A_{UPL} = Summed percent cover values of upland (UPL) plant species.

B. Sampling Soils:

The National Technical Committee for Hydric Soils (NTCHS) defines a hydric soil as a soil that is formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994).
Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days.

Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persisting the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service 2010).

Procedures for sampling soils:

- Observe and document the site
- Always look at the landscape features of the immediate site and compare them to the surrounding areas.
- Try to contrast the features of wet and dry sites that are in close proximity. When observing slope features, look first at the area immediately around the sampling point.
- By understanding how water moves across the site, the reasons for the presence or absence of hydric soil indicators should be clear.
- If one or more of the hydric soil indicators is present, then the soil is hydric. If no hydric soil indicator is present, the additional site information below may be useful in documenting whether the soil is indeed non-hydric or if it might represent a “problem” hydric soil that meets the hydric soil definition despite the absence of indicators.

   Hydrology–Is standing water observed on the site or is water observed in the soil pit? What is the depth of the water table in the area? Is there indirect evidence of ponding or flooding?

   Slope–Is the site level or nearly level so that surface water does not run off readily, or is it steeper where surface water would run off from the soil?

   Slope shape–Is the surface concave (e.g., a depression), where water would tend to collect and possibly pond on the soil surface? On hillsides, are there convergent slopes (Figure 4), where surface or groundwater may be directed toward a central stream or swale? Or is the surface or slope shape convex, causing water to run off or disperse?

 Landform–Is the soil in a floodplain, flat, or drainage way that may be subject to seasonal high water tables or flooding? Has the micro-topography been altered by cultivation or other disturbances?

 Soil materials–Is there a restrictive layer in the soil that could slow or prevent the infiltration of water, perhaps resulting in a perched water table or hill slope seep? Restrictive layers could include consolidated bedrock, cemented layers such as duripans and petrocalcic horizons, layers of silt or substantial clay content, or strongly contrasting soil textures (e.g., silt over sand). Or is there relatively loose soil material (sand, gravel, or rocks) or fractured bedrock that would allow the water to flow laterally down slope?

 Vegetation–Does the vegetation at the site indicate wetter conditions than at other nearby sites, or is it similar to what is found at nearby upland sites?

Observe and document the soil

- To observe and document a hydric soil, first remove any loose leaves, needles, or bark from the soil surface. Do not remove the organic surface layers of the soil, which usually consist of plant remains in varying stages of decomposition.
- Dig a hole and describe the soil profile. In general, the hole should be dug to the depth needed to document an indicator or to confirm the absence of indicators.
- For most soils, the recommended excavation depth is approximately 20 in. (50 cm) from the soil surface, although a shallower soil pit may suffice for some indicators. (Gretag/Macbeth 2000). Dry soils should be moistened until the color no longer changes and wet soils should be allowed to dry until they no longer glisten. Care should be taken to avoid over-moistening dry soil.

- Soil colors specified in the indicators do not have decimal points (except for indicator A12); however, intermediate colors do occur between Munsel chips. Soil colors should not be rounded to qualify as meeting an indicator. For example, a soil matrix with a chroma between 2 and 3 should be recorded as having a chroma of 2+. This soil material does not have a chroma of 2and would not meet any indicator that requires a chroma of 2 or less.

Use of existing soil data

- Soil surveys are available for most areas of the Caribbean region and can provide useful information regarding soil properties and soil moisture conditions for an area.
- Those soils that are hydric are noted in the *Hydric Soils List* published separately from the soil survey report. Soil survey information can be valuable for planning purposes, but it is not site-specific and does not preclude the need for an on-site investigation.
- Hydric Soils Lists are developed for each detailed soil survey. Using criteria approved by the NTCHS, these lists rate each soil component as either hydric or non-hydric based on soil property data.
- Hydric soil indicators- Many of the hydric soil indicators were developed specifically for wetland delineation purposes.

Hydric Soil Indicators:		**Indicators for Problematic Hydric Soils[3]:**
___ Histosol (A1)	___ Sandy Gleyed Matrix (S4)	___ Stratified Layers (A5)
___ Histic Epipedon (A2)	___ Sandy Redox (S5)	___ Red Parent Material (F21)
___ Black Histic (A3)	___ Stripped Matrix (S6)	___ Very Shallow Dark Surface (TF12)
___ Hydrogen Sulfide (A4)	___ Dark Surface (S7)	___ Other (Explain in Remarks)
___ Organic Bodies (A6)	___ Loamy Gleyed Matrix (F2)	
___ 5 cm Mucky Mineral (A7)	___ Depleted Matrix (F3)	
___ Muck Presence (A8)	___ Redox Dark Surface (F6)	[3]Indicators of hydrophytic vegetation and
___ Depleted Below Dark Surface (A11)	___ Depleted Dark Surface (F7)	wetland hydrology must be present,
___ Thick Dark Surface (A12)	___ Redox Depressions (F8)	unless disturbed or problematic.

http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).

The most restrictive requirements for thickness of layers in any indicators used ERDC/EL TR-11-4 33 must be met. Not all indicators are possible candidates for combination. For example, indicator F2 (Loamy Gleyed Matrix) has no thickness requirement, so a site would either meet the requirements of this indicator or it would not. The following lists show the indicators that are the most likely candidates for combining in the region.

Minimum thickness requirements for commonly combined indicators in the Caribbean Islands Region.

Indicator Thickness Requirement
S5 – Sandy Redox 4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface
S7 – Dark Surface 4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface
F3 – Depleted Matrix 6 in. (15 cm) thick starting within 10 in. (25 cm) of the soil surface
F6 – Redox Dark Surface 4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)
F7 – Depleted Dark Surface 4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)

Indicator A1: Histosol
Indicator A2: Histic Epipedon
Indicator A3: Black Histic
Indicator A4: Hydrogen Sulfide
Indicator A6: Organic Bodies
Indicator A7: 5 cm Mucky Mineral
Indicator A8: Muck Presence
Indicator A11: Depleted Below Dark Surface
Indicator A12: Thick Dark Surface
Indicator S4: Sandy Gleyed Matrix
Indicator S6: Stripped Matrix
Indicator S7: Dark Surface
Indicator F2: Loamy Gleyed Matrix
Indicator F3: Depleted Matrix
Indicator F6: Redox Dark Surface
Indicator F7: Depleted Dark Surface
Indicator F8: Redox Depressions
Indicator A5: Stratified Layers
Indicator F21: Red Parent Material
Indicator TF12: Very Shallow Dark Surface

C. Sampling Hydrology:

The 1987 USA CoE Wetland Delineation Manual defines wetland hydrology as all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. The following hydrologic criteria were used during this jurisdictional delineation.

Group A – Observation of Surface Water or Saturated Soils
Group B – Evidence of Recent Inundation
Group C – Evidence of Current or Recent Soil Saturation
Group D – Evidence from Other Site Conditions or Data

The recorded features include the following indicators:

Primary

A1 – Surface water
A2 – High water table
A3 – Saturation
B1 – Water marks
B2 – Sediment deposits
B3 – Drift deposits
B4 – Algal mat or crust
B5 – Iron deposits
B7 – Inundation visible on aerial imagery
B9 – Water-stained leaves
B13 – Aquatic fauna
C1 – Hydrogen sulfide odor
C3 – Oxidized rhizospheres along living roots
C4 – Presence of reduced iron
C6 – Recent iron reduction in tilled soils
C7 – Thin muck surface
C10 – Fiddler crab burrows

Secondary
B6 – Surface soil cracks
B8 – Sparsely vegetated concave surface
B10 – Drainage patterns
C2 – Dry-season water table
C9 – Saturation visible on aerial imagery
D2 – Geomorphic position
D3 – Shallow aquitard
D5 – FAC-neutral test

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Water is the principal feature of a wetland. The occurrence, quantity, and movement of water (the hydrologic regime) are fundamental to the functional values that a particular wetland possesses. Furthermore, the hydrologic regime controls the wetland diversity found in a given area. The hydrologic regime is the most important factor controlling the wetlands' plant composition, succession and zonation.

The hydrologic regime may be defined in terms of:

- Water sources - the source(s) of water that subsidize a wetland,
- Hydroperiod - duration, depth and frequency, with which floodwaters occurred,
- Water flow - movement of water within the wetland, in terms of velocity and direction.

Direct rainfall, overland runoff, stream flow, and ground water are sources to wetlands. The other two components of the hydrologic regime, hydroperiod, and water flow are intimately related to the water sources. The differences between water inputs and outputs result in water storage or deficit. Water storage within a wetland will determine whether standing waters will occur at any particular time. The hydroperiod is expressed in terms of duration, frequency, and depth at which the flooded water occurs within a wetland.

D. Remote Sense Imagery and Analysis

This Jurisdictional Pre-Determination was complemented with computerized (ERDAS Imagine) analysis of high-resolution aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography according to the classification system developed by Cowarding, et al (1979).

Remote sensing techniques were applied to categorize color bands and depict wet areas by means of infrared bands. The aerial photographs typically reflect conditions during the specific year and season when they were taken.

In addition, there is a margin of error inherent in the use of aerial photographs. Thus, a detailed field survey using sub-metric GPS, real time and WAAS enabled to located specific boundaries with a precision degree of less than 10 cm. per waypoint.

A sub metrical GPS unit using DGPS and post processed data was used to take geo referenced points associated to sampling points, upland and wetland boundaries. All data collection and GIS/RS database was projected on the Lambert Conformal Conic with the NAD 83 HARN datum in the UTM zone 19N grid.

All geographical data and figures were developed and processed using ArcGIS 10.1 with extensions from ESRI and the imagery was analyzed using ERDAS Imagine 8.7 for RS. A total of 42-point counts were sampled and geo-referenced to existing datasets. In addition, a series of points were collected with the GPS unit to define property lines and wetland boundaries as well.

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This GIS/ Remote sensing involved compiling existing data, creating new digital data, and geo-processing digital data including among others;

1) NWI polygon data,

2) Digital line graph (DLG) hydrology coverage for study area quad

3) Digital raster graphics (DRGs) and digital ortho quad (DOQ) for study quads

4) Aerial and Satellite RS imagery

The NWI polygon data served as the prime source of wetland habitat data, while the DLG hydrology layer was the major source of stream data. DRGs were used as collateral data to evaluate wetlands that were not readily identified as isolated or non-isolated. The analysis was a series of a GIS operations complemented with real data. The output is composed of a categorization of imagery and the presentation of the infrared band imagery.

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VII. RESULTS

This section of the report includes; (1) a jurisdictional pre-delineation of the wetlands occurring in the acreage of the proposed project, including five design alterantives, (2) a qualitative and quantitative description of the wetlands plant composition, soils and hydrology, and (3) an evaluation of the wetland functional values.

After ground-truthing and field sampling, **we have found jurisdictional wetlands within the studied area, mainly associated to herbaceous coverage.**

According to the National Wetlands Inventory for this area a series of Palustrine Emergent Persistent Seasonally Flooded (PEMIC) fragment do exist along the studied area. Refer to Figure 6: FWS Wetlands Inventory Map.

Our assessment included mainly Palustrine Emergent Persistent Seasonally Flooded (PEMIC) with herbaceous coverage.

The vegetation along the studied area is not diverse in composition and structure. Plant species common along the study area includes trees like; *Albizzia, Andira, Terminalia and Spathodea among the most commons.*

Herbaceous species includes; *Canna, Cyperus sp., Pennisteum purperum, Commelina difusa, Cleomoe espinosa, Sesbania sp.,Sansiveria sp. Mimosa, Collocasia, Pennisetum, Paspalum, Panicum, Uroclhola, Chloris, Achrostichum, Typha, Brachiaria, Echinocloa, and Ludwigia* among others.

The vines included *Cissus, Merremia, and Ipomea* among the most common.
The Soil Survey shows the prevalence of alluvial land soil series. See Figure 4: Soils map for the Mayaguez area. The soils found are mainly considered hydric soil (Soil Conservation Service, 1993).

After ground truthing and field sampling, we have found jurisdictional wetlands within the studied area, including all six design alterantives. According to the National Wetlands Inventory Map a series of palustrine systems do exist along the studied area. The studied area does contain natural hydrographical features influenced by tidal regime and the Miradero basin.

The vegetation, soil, and hydrologic data we used to delineate the area, met the wetland jurisdictional criteria. Figure 8: Jurisdictional Delineation of existing wetlands shows the results of the jurisdictional determination.

Each sampling site (20) is composed of a nested plot with 1 and 5 meters diameters round plots located in a transect with four sampling points.

Each sampling point was evaluated for the existence of wetlands following the three criteria: vegetation, soils and hydrology. **N** goes for Non Wetland and **Y** goes for Existing Wetland. All Y's correspond to wetlands associated to mangrove forest.

Table 5 summarizes the field results of the wetland jurisdictional determination based on the three indicators used (vegetation, soils, and hydrology). See included Data Sheets for sampling sites.

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Table 4 - Summary of the field survey for wetland indicators

Site	Points		Soils		Vegetation		Hydrology	
Transect	A	B	A	B	A	B	A	B
1	N	Y	N	Y	N	Y	N	Y
2	N	Y	N	Y	N	Y	N	Y
3	N	Y	N	Y	N	Y	N	Y
4	N	Y	N	Y	N	Y	N	Y
5	N	Y	N	Y	N	Y	N	Y
6	N	Y	N	Y	N	Y	N	Y
7	N	Y	N	Y	N	Y	N	Y
8	N	Y	N	Y	N	Y	N	Y
9	N	Y	N	Y	N	Y	N	Y
10	N	Y	N	Y	N	Y	N	Y

The remote sensing and GIS effort included the categorization of aerial imagery. Images were analyzed for color in the infrared spectrum to check for wet sites. Please refer to Figures 9 and 10; Infrared Image and Band Categorization

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VIII. WETLAND FUNCTIONAL VALUES

Wetlands' functional values were evaluated following Wetland Evaluation Technique (WET) method developed by Federal Highway Administration. WET evaluates 11 different functions and values and assigned a qualitative probability rating of HIGH, MODERATE, or LOW to the functions, in terms of social significance, effectiveness, and opportunity.

Social significance refers to the importance society may attach to the wetland due to recognition-of its natural features, potential economic value, or strategic location.

Effectiveness refers to the capability of a wetland to perform a function due to its physical, chemical, and biological attributes.

Opportunity refers to the chance a wetland has to perform a function.
The wetland functions and values to be evaluated are groundwater recharge, groundwater discharge, flood-flow alteration, sediment stabilization, sediment toxicant retention, nutrient removal transformation, production export, wildlife diversity/abundance, aquatic diversity/abundance, uniqueness heritage, and recreation.

Table 5 shows the results of the functional values evaluation conducted for wetlands in the study area.

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Table 5: Functional value evaluation for wetlands in the study area.

FUNCTIONAL VALUE	SOCIAL SIGNIFICANCE	EFFECTIVENESS	OPPORTUNITY
Groundwater Recharge	MODERATE	LOW	LOW
Groundwater Discharge	MODERATE	MODERATE	MODERATE
Flood flow Alteration	LOW	LOW	LOW
Sediment Stabilization	MODERATE	MODERATE	MODERATE
Sediment Toxicant Retention	MODERATE	MODERATE	MODERATE
Nutrient Removal Transformation	MODERATE	MODERATE	MODERATE
Production Export	LOW	LOW	LOW
Wildlife Diversity/Abundance	LOW	LOW	LOW
Aquatic Diversity/Abundance	LOW	LOW	LOW
Uniqueness Heritage	LOW	LOW	LOW
Recreation	LOW	LOW	LOW

IX. CONCLUSION

The wetland delineation was conducted following the guidelines of the 1987 US Army Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region A "Routine Approach, On site Inspection" was used for this jurisdictional delineation. Accordingly, this wetland jurisdictional delineation was developed by characterizing the vegetation, soils, and hydrology of the study area. Refer to Figure 8: Jurisdictional Delineation Boundaries.

Altenative	**Uplands**	**Wetlands**	**Impact acres**	**Mitigation** acres
I	NA	NA	0.65	1.95
II	NA	NA	0.72	2.16
III	NA	NA	0.57	1.71
IV	NA	NA	0.65	1.95
V	NA	NA	0.82	2.46
VI	NA	NA	0.39	1.17 NWP

Avoidance is recommended as designs takes place.

If impacts are foreseen, then a Joint Permit must be submitted with the corresponding JD and Mitigation Plan. If avoidance is adopted, a Non Permit Required can be requested to the USACoE or even a Nationwide. This action will produce a faster regulatory process.

Other NWP can be studied to complement an expedite permitting process. Among them we can include 1) NWP 9, NWP 13, NWP 19, NWP 39, NWP 43 and/or NWP 45.

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ACTIONS RECOMMENDED:

Alternative VI was selected, and the estimation of impact upon the footprint will be determined as follows.

Altenative	**Uplands**	**Wetlands**	**Impact acres**	**Mitigation** acres
I	NA	NA	0.65	1.95
II	NA	NA	0.72	2.16
III	NA	NA	0.57	1.71
IV	NA	NA	0.65	1.95
V	NA	NA	0.82	2.46
VI	NA	NA	0.39	1.17 NWP

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X. MITIGATION PLAN

(Included ONLY IF mitigation is required by USACE)

Wetland functions within the project area are considered to be low values and potential impacts will be avoided. Nevertheless various ecological functions can be enhanced including mainly:

- Sediment removal
- Habitat for wetland associated wildlife

The project has avoided and minimized impacts to wetlands and wetland buffers to the greatest extent possible. Total avoidance and minimization are the focus of the design and construction group.

Design modifications to avoid/minimize wetland impacts given the final development footprint area will be modeled, recommended and applied.

Altenative	**Uplands**	**Wetlands**	**Impact acres**	**Mitigation** acres
I	NA	NA	0.65	1.95
II	NA	NA	0.72	2.16
III	NA	NA	0.57	1.71
IV	NA	NA	0.65	1.95
V	NA	NA	0.82	2.46
VI	NA	NA	0.39	1.17 NWP

Protection will require the use of high visibility fencing to define construction limits near wetlands and other sensitive areas. The General Construction contractor, as part of their ESC plan, will set erosion control measures.

Measures must be taken to minimize soil compaction. Compacted soils can decrease the success of wetland mitigation sites by changing surface hydrology and increasing competition pressure on native plants.

Temporary Erosion and Sedimentation Control (TESC) plans will be physically present, easily accessible, and closely followed during construction by grading contractor.

Planting Guidelines

Planting methods will include linear and clumps plantings. Planting will be done manually with shovels along ponds waterlines borders with herbaceous plants.

Plant establishment is essential to plant community development and the success of the overall mitigation site. The establishment period for this project is of seven months after initial planting, assuming that grading is developed continuously in coordination with the wetland creation management. During this time, Contractor will monitor the site for plant survival, health and growth, herbivores, weeds, and vandalism.

Plant establishment activities such as plant replacement, adjustment of planting layout to reflect specific site conditions, weed control, operation and maintenance of any irrigation system, maintenance and adjustment of flow control structures to provide the necessary site hydrology, litter pickup, installation and adjustment of tree protection devices, and repair of any vandalism will be conducted parallel to the mitigation effort.

Plant Species

Nine plant species will be planted in the enhancement/mitigation area. A diverse array of species will provide higher diversity indexes, will minimize pest attacks and will also provide a robust and balanced forest structure. A density of 400 trees per acre is assumed.

Species Name	Quantity	Size	Pot
Pterocarpus officinalis	100	24”	1 gal
Cyperus gigantus	150	36”	1 gal
Anona glabra	50	24”	1 gal
Bontia daphnoides	25	24”	1 gal
Sagitaria sp	100	12”	1 gal
Thalia geniculate	25	24”	1 gal
Anfitecnia latifolia	25	24”	1 gal
Sthalia monosperma	25	24”	1 gal
Cyperus haspan	100	12”	1 gal
Gran total	**600**		

Plant Specifications

Planting types and densities should be specific to demonstrated hydrology and site conditions. The following densities should enable mitigations to meet their performance standards. Quantities are average, based on container-grown material. Rough equation to correlate is: 1'-3' = 1 lt.; 2'-4' = 1 gal.; 4'-6' = 3 gal. Planting densities only give figures for total plants per area. Plants should be placed in random, naturalized clusters. The following minimum acceptable densities per plant community are:

HERBACEOUS WETLANDS SPECIES ARE TO BE PLANTED TO:

Trees 1m O.C.

The performance goal for these wet areas is the creation of mature, forested wetlands with some herb, shrub (sub-canopy), and tree layers.

- Vegetation performance standards (FAC, FACW, or OBL species):
- Emergent Cover: 60% by Year One, 80% by Year Three, 85% by Year Five;
- Shrub or sapling tree cover by Year Three -- > 85%.
- 100% survival by Year One, 85% survival by Year Three.
- Emergent vegetation will be measured by coverage.

Cover	Year1	Year2	Year3	Year4	Year 5
Herbaceous	100%	90%	85%	85%	85%

Irrigation

Irrigation will be contemplated at the initial planting phase, there after it will be considered a supplementary activity. In case of drought, we will apply supplementary water. With an agricultural tractor and hitch water tanks and a PTO Pump with air sprayers will distribute water as needed. We rely heavily on the grading and achieving the ideal hydrological regime to minimize irrigation efforts.

Post-Construction

Within a month of completing wetland creation and early planting (or initial acceptance), as-built plans should be sent to the lead consultant and to the contractor liaison, including an as-built topographic survey, plant species and quantities used, photographs of the site, and notes about any changes to the original approved plan. Also, list the contractor's responsibility concerning plant replacement; fertilization and irrigation, protection from wildlife, and contingency plan requirements.

REGULATORY COMPLIANCE

The proposed, in kind, mitigation site will be monitored for 5 years to demonstrate the provision of intended functions. Goals describe the overall intent of mitigation efforts and objectives describe individual components of the mitigation site in detail. Performance measures and success standards describe specific on-site characteristics that indicate a function is being provided. Performance measures are used to guide management of the mitigation site. Success standards are thresholds to be measured during the final year of the monitoring period that demonstrate the site has complied with regulatory requirements and is providing intended functions. Contingency plans describe what actions can be taken to correct site deficiencies.

A. Goals

The goal of the proposed compensatory mitigation is to replace wetland types, acreage and functions, which will be lost due to wetland impacts associated with the proposed project. The created and enhanced wetlands are anticipated to provide the following functions:

B. Functions and Values

The following is a general list of functions and values that will be provided by the proposed mitigation site.

Storm water management

Bio-filtration

Wildlife Habitat

Landscape

Functions are placed in three categories:

Water quality improvement

Hydrology

Habitat

C. Objectives/Goals, Performance Criteria Measures, and Success Standards

The following list describes the thresholds that will determine site success and guide management.

Objective/Goals

The mitigation site will provide feature/attribute, such as “ground or surface water inundation or saturation sufficient to support the wetland sites”.

Wildlife habitat will be provided by establishing woody cover within the mitigation area zones; this will increase habitat diversity within the mitigation site.

Measure Performance Criteria

The development of complete, well-articulated performance criteria is a key component of each wetland mitigation plan. A performance criterion is a clear description of a measurable standard, desired state, threshold value, amount of change, or trend used to achieve for a particular population or habitat characteristic. It may also set a limit on the extent of an undesirable change.

As part of the adaptive management cycle, the performance criteria will include:

- Focus and sharpen thinking about the desired state or condition of the resource.
- Describe to others the desired condition of the resource.
- Determine the management that will be implemented, and set the stage for alternative management if measures or standards are not met.
- Provide direction for the appropriate type of monitoring.
- Provide a measure of management success.
- Identify resource needs.

- Performance criteria must be meaningful, measurable, and achievable and it should include the following components to be complete:
- Species or Habitat Indicator: identifies what will be monitored
- Hydrology performance standards: Saturation between soil surface and 12" depth March 1 through May 15, on average.
- Soil performance standards: Soil deconsolidated to at least 12" depth (measured at installation). Soil to contain at least 30% organic matter by bulk density, estimated.
- Location: geographical area (site)
- Attribute: aspect of the species or indicator (e.g. size, density, cover)
- Action: the verb of your objective (e.g. increase, decrease, maintain)
- Quantity/Status: measurable state or degree of change for the attribute (e.g., 30%)
- Time Frame**:** the time needed for management to prove itself effective (Monitoring Year X)

Performance Measures for Objectives/Goals

Year 1 - All woody plant material will exhibit a survival rate of 100% during the first semester following installation.

Year 3 - The mitigation area zones (see planting plan, Appendix 4) will include an average of living woody stems per acre during the 3rd year of monitoring.

Cover	**Year1**	**Year2**	**Year3**	**Year4**	**Year 5**
Herbacous	100%	90%	85%	85%	85%

Success Standards

Most wetland functions cannot be measured easily (if at all) in a manner that allows them to be monitored directly. Instead, indicators are most often used to support the supposition that a particular function will be provided by a wetland if certain characteristics are present. The following success standards should be used sparingly. Several are listed in order to cover the wide range of possible performance objectives that may be used in mitigation planning. However, each standard should be used only as needed to verify establishment of a site characteristic that must be present in order for the site to provide a particular function.

Success Standards

S1 - Wetland hydrology: saturation
S2 - Size of wetland area: %
S3 - Herbaceous cover: %
S4 - Survival of planted individuals: 100%- 85%
S5 - Woody cover: %
S6 - Control of invasives: %
S7 - Size of any specified area: %
S8 - Relative presence of wetland classes: herbaceous, forested
S9 - Plant species diversity: Shannon
S10 –-Slope:%
S11 - Aquatic invertebrate diversity: BI
S12- Aquatic invertebrate taxa presence: Cumulative
S13 - Area and depth of open water: cm
S14 - Surface water depth and duration: cm/day
S15 - Canalized water flow: gal/min
S16 - % invasive species area
S17 - Presence of ___ (miscellaneous design features)

S18 - Presence of ___ (amphibians, birds, reptiles, etc.)

Final Success Standard

Year 5 – Non woody vegetation within the mitigation area zones will attain a minimum aerial cover of 85% during the 5th year of monitoring. Years 1-5

- Plant coverage will be at least 85% of the total mitigated area.
- Water levels will be sufficient to support facultative or wetter vegetative species within the created wetland areas.
- The mitigation area will have an average coverage of 85% for the area.

Cover	Year1	Year2	Year3	Year4	Year 5
Herbacous	100%	90%	85%	85%	85%

Monitoring

Monitoring is driven by performance criteria, which describe the desired condition. Management activities are planned to meet the performance criteria for that site. Monitoring activities are designed to determine if the performance criteria have been achieved. Valid monitoring data are critical to making meaningful management decisions that help meet the objectives for the site.

When activities such as excavation, grading, or hydrology modification occur, a wetland response is difficult to predict. Wetlands are dynamic systems where plant communities can evolve rapidly as conditions change. Static monitoring plans that remain the same from year to year do not adequately address the possibility of dynamic change in the plant communities they are intended to measure. Thus, the monitoring uses annual site conditions and plant community development to develop monitoring plans and strategies for measuring performance criteria. These factors are considered with performance criteria to develop site-specific monitoring plans at the beginning of each field season.

Appropriate monitoring activities are used to make sure valid data is provided to guide site management decisions.

All wetland creation, enhancement, and buffer enhancement areas will be monitored for a minimum of five years. Formal monitoring procedures will be performed every year on a monthly basis, after Initial Acceptance of the mitigation construction. The site should be evaluated formally following plant installation to evaluate survival rates and to document the presence of any non-native invasive species. A monitoring report will be submitted to the Corps of Engineers, and other resource agencies for review and comment. Report submittals will occur for monitoring every year. Successful mitigation will be measured by attainment of the performance standards described in this mitigation plan document. Reports will be submitted at the beginning of the project; every month during the first year; every six months during years for years 2-5 a year report during years 2-5 and a final report at the end of the project.

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