

V. DELINEATION AND DESCRIPTION OF THE WETLANDS

This section of the report includes; (1) a jurisdictional delineation of the wetlands occurring in the corridor along the study area, (2) a qualitative and quantitative description of the wetlands plant composition, soils and hydrology, and (3) an evaluation of the wetland functional values.

According to the U.S. Fish and Wildlife National Wetland Inventory (Figure 7), the study site is composed of a complex mosaic of uplands and wetlands upon an urban landscape.

The protocols described in the 1987 USA CoE Wetland Delineation Manual 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"*.

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).

Wetlands

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 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.

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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 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.

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 km² (0.03 square miles).

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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 emergents, 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 where 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 or 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, marsh, bog, prairie, and/or ponds and it is a system that lacks subsystems.

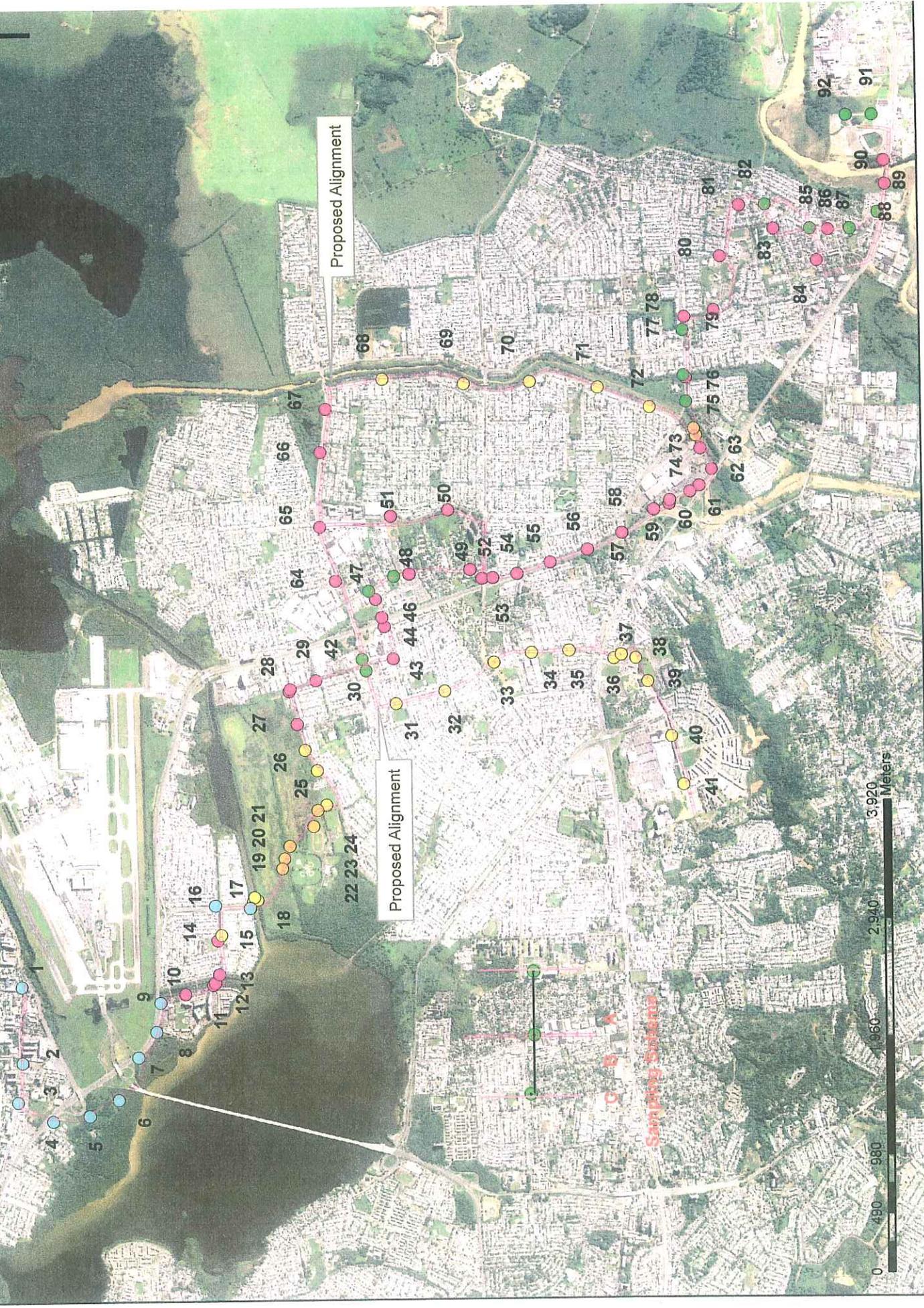
VI. METHODS

The information available was congruent and allows us to characterize the site vegetation, soils, and hydrology. Therefore, a "Routine Approach-On Site Inspection", was used for this jurisdictional delineation. Note that both the wetland definitions, as well as the indicators used, have the underlying assumptions of normal conditions.

A systematic sampling approach was developed along the studied area. See figure 8 Sampling Design. A total of 92 transects with three point counts each, 5m diameter each were established perpendicular to the proposed alignment footprint. Transects were 50 meters long with three points counts each at 0m, 25m and 50m.

Soils and hydrologic data were collected from an 18" deep by 6" wide soil-bore hole at each sampling site. (See Appendix D: Photos that shows soil sample collection and analyses). Vegetation was observed and identified around the point sampling site in a 5 meters diameter. Please refer to Figure 8: Sampling Design for the Study Site. It shows points (point counts) over aerial image. Refer to Table 4 that summarizes GPS points coordinate, given in degrees minutes and seconds (hddd° mm'ss.s") on NAD 83 Harn Datum.

Figure 8: Sampling Design
Wetlands Jurisdictional Determination
Tranvia de Carolina
Carolina, Puerto Rico



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Table 4: GPS Coordinates

Sampling Site	LAT	LONG	Sampling Site	LAT	LONG
1	18.41877884	-65.96731335	47	18.37860806	-65.95604788
2	18.41968727	-65.96764150	48	18.37651138	-65.95481035
3	18.42056033	-65.96782414	49	18.37669945	-65.94717761
4	18.42075194	-65.96779799	50	18.37863548	-65.94715346
5	18.42257484	-65.96827744	51	18.41575394	-65.98970782
6	18.42400211	-65.96836301	52	18.41537882	-65.98347159
7	18.43229449	-65.97624167	53	18.41347121	-65.98237128
8	18.43274661	-65.97744472	54	18.39127632	-65.96926585
9	18.43290260	-65.97838400	55	18.39141577	-65.96720289
10	18.43287201	-65.98010162	56	18.39137515	-65.96367590
11	18.43286044	-65.98151280	57	18.38491979	-65.95401612
12	18.43263715	-65.98345161	58	18.38160965	-65.95595898
13	18.43161271	-65.98431973	59	18.37860806	-65.95604788
14	18.43152294	-65.98508290	60	18.37651138	-65.95481035
15	18.42999022	-65.98648461	61	18.37669945	-65.94717761
16	18.42947021	-65.98691963	62	18.37863548	-65.94715346
17	18.42923585	-65.98668954	63	18.42472295	-66.00761488
18	18.42769199	-65.98616618	64	18.42436538	-66.00746082
19	18.42472295	-66.00761488	65	18.42458465	-66.00724306
20	18.42436538	-66.00746082	66	18.42489101	-66.00805057
21	18.42458465	-66.00724306	67	18.42714063	-66.01016566
22	18.42992208	-65.98750460	68	18.42048950	-65.99580444
23	18.42992526	-65.98750577	69	18.41960748	-65.99741000
24	18.42983591	-65.98724937	70	18.41899677	-66.00013210
25	18.42992065	-65.98708173	71	18.41356312	-65.99234574
26	18.42993884	-65.98696413	72	18.40993158	-65.99147854
27	18.42967959	-65.98705927	73	18.40618352	-65.98931492
28	18.42489101	-66.00805057	74	18.40337927	-65.98862375
29	18.41575394	-65.98970782	75	18.40058441	-65.98854530
30	18.41537882	-65.98347159	76	18.39727675	-65.98925306
31	18.41347121	-65.98237128	77	18.39671390	-65.98897202
32	18.41265718	-65.97789750	78	18.39561696	-65.98928014
33	18.40749911	-65.97748415	79	18.39473552	-65.99112784
34	18.40446064	-65.97783833	80	18.39226252	-65.99928319
35	18.40099666	-65.97795657	81	18.39310348	-65.99548467
36	18.39675318	-65.97802463	82	18.39402901	-65.96964033
37	18.39454511	-65.97476602	83	18.39791184	-65.96800134
38	18.39127632	-65.96926585	84	18.40292950	-65.96740010
39	18.39141577	-65.96720289	85	18.40783015	-65.96744503
40	18.39137515	-65.96367590	86	18.41391407	-65.96689291
41	18.39144840	-65.96009387	87	18.42224518	-66.00425969
42	18.39173300	-65.95642675	88	18.42227720	-66.00495622
43	18.39160777	-65.95245318	89	18.42190580	-66.00327733
44	18.38773265	-65.95291778	90	18.41999413	-66.00176993
45	18.38491979	-65.95401612	91	18.41965894	-66.00054584
46	18.38160965	-65.95595898	92	18.39060567	-65.97195198

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This inventory 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 submetric GPS , real time and WAAS enabled to located specific boundaries with a precision degree of less than 10cm 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 datum in the UTM zone 19N grid.

All geographical data and figures were developed and processed using ArcGIS 9.2 with extensions from ESRI and the imagery was analyzed using ERDAS Imagine 8.7 for RS. A total of 276 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.

This GIS/ Remote sensing involved compiling existing data, creating new digital data, and geoprocessing 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



Figure 10. Infrared Band Image
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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.

A. Vegetation: As used in the definition, a prevalence of vegetation refers to the dominant vegetation plant community or communities in an area at some point in time. For the area to be considered a wetland, the prevalent vegetation must consist of macrophytes that are typically adapted for life in flooded or saturated soils. Operationally, it is determined that a positive wetland vegetation indicator is present when more than 50 percent of the dominant plant species are:

1. Obligated Wetland Plants (OBL) - Plants that occur almost always (probability > 99%) in wetlands under natural conditions, but which may occur rarely (probability < 1%) in non-wetlands.
2. Facultative Wetland Plants (FACW) - Plants that occur usually (Probability 67% to 99%) in wetlands, but also occur (probability 15 to 33%) in non-wetlands;
3. Facultative Plants (FAC) - Plants with a similar likelihood (probability 33% to 67%) of occurring in both wetlands and non-wetlands.

B. Soils: According to the 1987 USA CoE Wetland Delineation Manual, only hydric soils that support hydrophytic vegetation may be classified as wetland soils. A hydric soil is saturated or flooded for a long enough period during the growing season to develop anaerobic conditions (U.S. Department of Agriculture, Soil Conservation Service, 1985, and Technical Committee for Hydric Soils, 1986).

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The following criteria for sandy soils were used during this jurisdictional delineation:

1. Occurrence of organic soil - Qualitative estimates of organic matter content was used as indicators of sandy hydric soils by observing whether the following conditions were present:
 - a. High organic matter content in the surface horizon.
 - b. Streaking of subsurface horizons by organic matter.
 - c. Organic pans.
2. Soil color - Grayed or low matrix chrome «1). It was determined that a positive wetland soil indicator was present when: (a) more than 50 percent (by volume) of the upper 32 inches of soil is composed of organic soil material; or (b) organic soil material of any thickness rests on bedrock. Organic soils are saturated for long periods and are commonly called peat or mucks. Note that during the determination the soil color criteria were used as an indicator for non-sandy soils only. Our field survey shows that most of the land is composed of Rio Lajas sands. (Figure 5: Soils Map).

C. 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.

1. Visual observation of inundation - Standing waters occurring at the site.
2. Visual observation of soil saturation - Water level in a soil pit is less than 18 inches from land surface.
3. Tide elevation - Site is within the intertidal zone.
4. Physiological adaptations-Occurrence of gas-exchange structures in woody vegetation.

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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:

1. Water sources - the source(s) of water that subsidize a wetland,
2. Hydroperiod - duration, depth and frequency, with which floodwaters occurred,
3. 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.

VII. RESULTS

After groundtruthing and field sampling, we found jurisdictional wetlands within the studied area.

According to the National Wetlands Inventory, we may find in the study area the following associations.

E2FO3= Estuarine Intertidal Forested Broad Leave

E1UBL= Estuarine Subtidal Unconsolidated Bottom

E2EM1 FO3M= Estuarine Intertidal Emergent Persistent Forested Mangrove

E2FO3M= Estuarine Intertidal Forested Broad Leave Mangrove

The studied area shows about 34.56 acres of wetland with potential impact approximately, including 31.08 acres of herbaceous wetland and 3.38 acres of forested wetland mainly fringe mangroves. Refer to Figure 7 Wetlands Inventory Map.

The vegetation along the studied area is diverse in composition and structure. Plant species associated to human settlements are common like Cocos, Tabebuia, Delonix, Pterocarpus indicus. Ornamental plants and trees are common along landscaped areas. Tracts of mangroves are found along Suarez Channel, San Jose Lagoon and Blasina Channel. Large tracts of herbaceous wetlands area are found near Ciudad Deportiva Roberto Clemente.

Most of the studied area soils have been modified either by fill or by move. Mostly soils from mixed origin used as fill for urban developments were found. The soils found are considered non-hydric soil (Soil Conservation Service, 1993).

The studied area does contain natural hydrographical features including rivers, channels, creek, lagoons, pond, and mangroves. Influence of tide are driven force to hydro features.

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The vegetation, soil, and hydrologic data were used to delineate the area that met the wetland jurisdictional criteria. Figure 9 Jurisdictional Delineation of existing wetlands shows the results of the jurisdictional determination.

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 10 and 11; Infrared Image and Band Categorization

The analysis of the field data shows that a total of approximately 34.56 acres of land are to be considered wetlands. 31.8 acres of those are herbaceous and 3.48 acres are mangrove forested wetlands.

Table 5 summarizes the field results of the wetland jurisdictional determination based on the three indicators used (vegetation, soils, and hydrology).

Figure 9: Jurisdictional Delineation Boundaries Map A
Wetlands Jurisdictional Determination
Trabaja de Carolina
Carolina, Puerto Rico





Figure 9. Jurisdictional Delineation Boundaries Map B
 Wetlands Jurisdictional Determination
 Tronva de Carolina
 Carolina, Puerto Rico

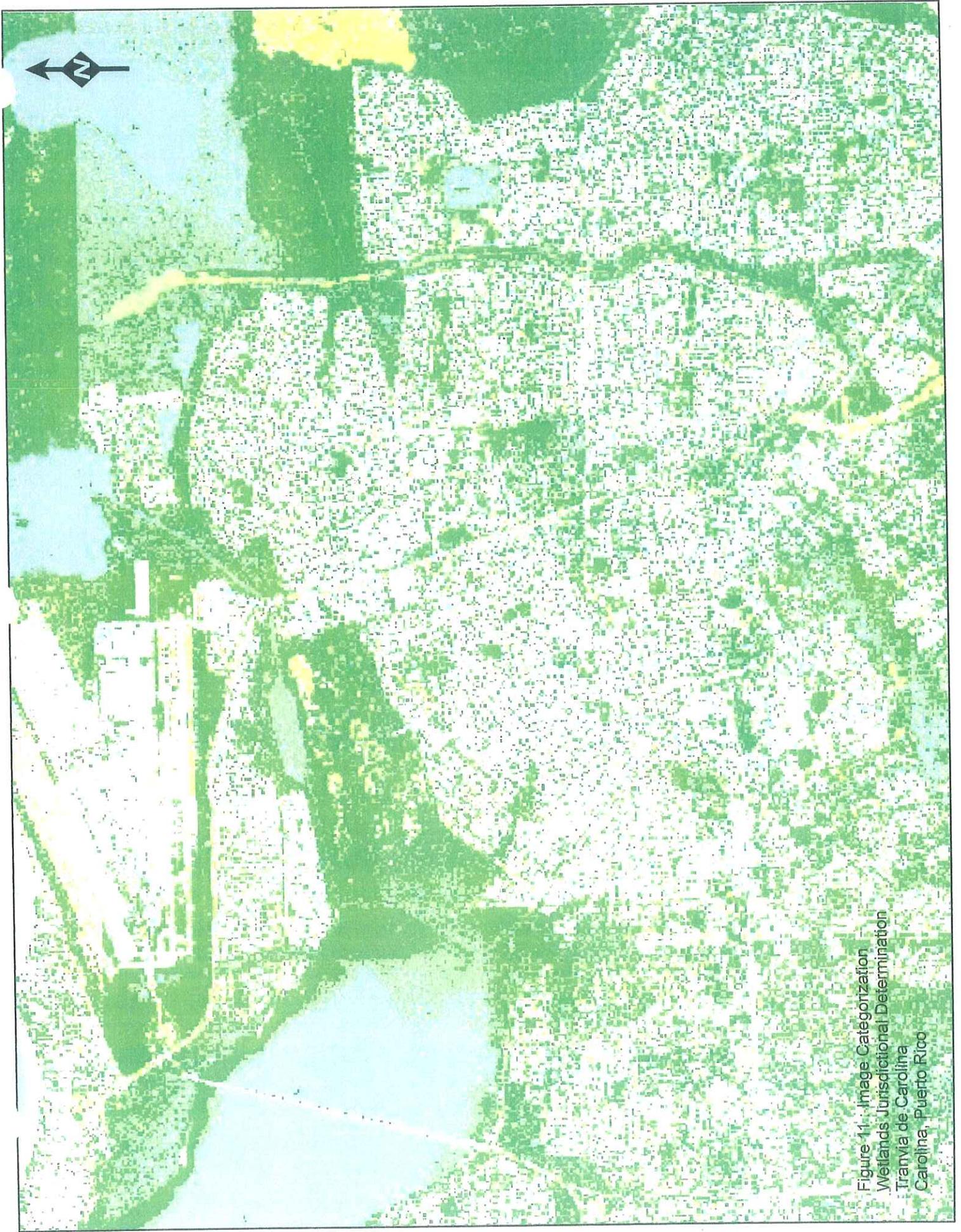


Figure 11: Image Categorization
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Table 5 - Summary of the field survey for wetland indicators

Samp	Veg Ind	Soil Ind	Hyd Ind	Wetland	Samp	Veg Ind	Soil Ind	Hyd Ind	Wetlan
Site	A B C	A B C	A B C	A B C	Site	A B C	A B C	A B C	A B C
1	N N N	N N N	N N N	N N N	47	N N N	N N N	N N N	N N N
2	N N N	N N N	N N N	N N N	48	N N N	N N N	N N N	N N N
3	N N N	N N N	N N N	N N N	49	N N N	N N N	N N N	N N N
4	N N N	N N N	N N N	N N N	50	N N N	N N N	N N N	N N N
5	N N N	N N N	N N N	N N N	51	N N N	N N N	N N N	N N N
6	N N N	N N N	N N N	N N N	52	N N N	N N N	N N N	N N N
7	N N N	N N N	N N N	N N N	53	N N N	N N N	N N N	N N N
8	N N N	N N N	N N N	N N N	54	N N N	N N N	N N N	N N N
9	N N N	N N N	N N N	N N N	55	N N N	N N N	N N N	N N N
10	N N N	N N N	N N N	N N N	56	N N N	N N N	N N N	N N N
11	Y Y Y	N N N	Y Y Y	Y Y Y	57	N N N	N N N	N N N	N N N
12	Y Y Y	N N N	Y Y Y	Y Y Y	58	N N N	N N N	N N N	N N N
13	Y Y Y	N N N	Y Y Y	Y Y Y	59	N N N	N N N	N N N	N N N
14	Y Y Y	N N N	Y Y Y	Y Y Y	60	N N N	N N N	N N N	N N N
15	Y Y Y	N N N	Y Y Y	Y Y Y	61	N N N	N N N	N N N	N N N
16	N N N	N N N	N N N	N N N	62	N N N	N N N	N N N	N N N
17	Y Y Y	N N N	Y Y Y	Y Y Y	63	Y Y Y	N N N	Y Y Y	Y Y Y
18	Y Y Y	N N N	Y Y Y	Y Y Y	64	N N N	N N N	N N N	N N N
19	Y Y Y	N N N	Y Y Y	Y Y Y	65	N N N	N N N	N N N	N N N
20	Y Y Y	N N N	Y Y Y	Y Y Y	66	N N N	N N N	N N N	N N N
21	Y Y Y	N N N	Y Y Y	Y Y Y	67	N N N	N N N	N N N	N N N
22	Y Y Y	N N N	Y Y Y	Y Y Y	68	N N N	N N N	N N N	N N N
23	Y Y Y	N N N	Y Y Y	Y Y Y	69	N N N	N N N	N N N	N N N
24	Y Y Y	N N N	Y Y Y	Y Y Y	70	N N N	N N N	N N N	N N N
25	N N N	N N N	N N N	N N N	71	N N N	N N N	N N N	N N N
26	N N N	N N N	N N N	N N N	72	N N N	N N N	N N N	N N N
27	N N N	N N N	N N N	N N N	73	Y Y Y	N N N	Y Y Y	Y Y Y
28	Y Y Y	N N N	Y Y Y	Y Y Y	74	Y Y Y	N N N	Y Y Y	Y Y Y
29	Y Y Y	N N N	Y Y Y	Y Y Y	75	N N N	N N N	N N N	N N N
30	N N N	N N N	N N N	N N N	76	Y Y Y	N N N	Y Y Y	Y Y Y
31	N N N	N N N	N N N	N N N	77	N N N	N N N	N N N	N N N
32	N N N	N N N	N N N	N N N	78	Y Y Y	N N N	Y Y Y	Y Y Y
33	N N N	N N N	N N N	N N N	79	N N N	N N N	N N N	N N N
34	N N N	N N N	N N N	N N N	80	N N N	N N N	N N N	N N N
35	N N N	N N N	N N N	N N N	81	N N N	N N N	N N N	N N N
36	N N N	N N N	N N N	N N N	82	N N N	N N N	N N N	N N N
37	N N N	N N N	N N N	N N N	83	N N N	N N N	N N N	N N N
38	N N N	N N N	N N N	N N N	84	N N N	N N N	N N N	N N N
39	N N N	N N N	N N N	N N N	85	N N N	N N N	N N N	N N N
40	N N N	N N N	N N N	N N N	86	N N N	N N N	N N N	N N N
41	N N N	N N N	N N N	N N N	87	N N N	N N N	N N N	N N N
42	N N N	N N N	N N N	N N N	88	N N N	N N N	N N N	N N N
43	N N N	N N N	N N N	N N N	89	Y Y Y	N N N	Y Y Y	Y Y Y
44	N N N	N N N	N N N	N N N	90	Y Y Y	N N N	Y Y Y	Y Y Y
45	N N N	N N N	N N N	N N N	91	N N N	N N N	N N N	N N N
46	N N N	N N N	N N N	N N N	92	N N N	N N N	N N N	N N N

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

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Table 6: Functional value evaluation for wetlands in the study area

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

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IX. MITIGATION PLAN

The impact upon wetlands is estimated in 34.56 acres of wetlands including 3.48 acres of Estuarine Intertidal Forested and 31.08 acres of Estuarine Intertidal Emergent Persistent.

The Wetland Jurisdictional Determination report includes wetland descriptions, classification according to the USFWS system (Cowardin et al. 1979). Latin names of plant species are provided as well. Impact areas are presented in Table 7.

Table 7: Wetland Areas

Proposed Development	345 acres
JD Wetlands	34.56 acres
JD Wetlands Impact Herb	31.08 acres
JD Wetlands Impact Forest	3.48 acres
Uplands	310.44 acres
Forested Wetland Creation (3:1)	10.44 acres
Wetland Enhancement (2:1)	62.16 acres

Wetland functions within the project area are considered low values nonetheless some potential functions and values can be slightly impacted including:

- Flood storage/Flow alteration
- Sediment removal
- Habitat for wetland associated wildlife

Tranvia de Carolina has avoided and minimized impacts to wetlands and wetland buffers to the greatest extent possible. Total avoidance was not possible due to project constraints.

Design alternatives were considered to reduce wetland impacts. On site mitigation alternatives were selected because of practical and cost effectiveness issues.

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Design modifications to avoid/minimize wetland impacts given the final development footprint were modeled and recommended.

The project contemplates the creation of 10.44 acres of forested wetlands and the enhancement of 62.16 acre of herbaceous wetlands to forested wetlands. The product will consist of 72.6 acres of forested wetlands. All the mitigation will be conducted on site in the same parcel of land.

The onsite mitigation is an obvious selection in terms of land tenancy, existing wetlands, hydrology, location within the sub-basin, construction access, existing vegetation (buffer & wetland), and other on-site features. The proposed mitigation will connect to on-site and off-site wetland areas.

The mitigation consists of the creation of forested wetlands and enhancement of herbaceous wetlands to forested wetlands. Grading to adequate levels is of utmost importance toward a successful effort. Hydrology determines many wetland functions and design specifies grades. The proposed mitigation will connect to on-site and off-site wetland areas by means of canopy connection, enhancing both riparian corridor habitats.

Among the work plan we can include the following general tasks.

- Access control
- Herbivore control (fencing)
- Erosion control (double fencing)
- Grading revision
- Decrease soil permeability
- Modify water inlet/outlet controls
- Substrate amendment
- Weed control
- Plant vegetation
- Supplement surface water inputs

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Work Plan Bi-Month Periods	1	2	3	4	5	6	7	8	9	10	11	12
Preplanning	X	X	-	-	-	-	-	-	-	-	-	-
Grading	-	X	X	X	X	X	X	-	-	-	-	-
Planting Preparation	-	X	X	X	X	-	-	-	-	-	-	-
Planting	-	X	X	X	X	X		X	-	-	-	-
Maintenance	-	-	X	X	X	X	X	X	X	X	X	X
Monitoring	X	X	X	X	X	X	X	X	X	X	X	X

Two fencing approaches are to be conducted.

- Barbwire will be placed around all the mitigation area to exclude cattle from the site.
- High visibility fencing will allocated to mark construction boundaries and JD.

Wetland mitigation site construction plans includes fencing of critical areas to prevent unintended and non permitted impacts that could lead to violations of local, state, and/or federal environmental permits. Critical areas may be wetlands, existing vegetation, or other aquatic resources such as streams and lakes that are shown in the plans. Existing critical areas must be identified and protected during construction.

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. A double fence will be installed at the top of the cut and the graded area.

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.

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These measures to minimize soil compaction include:

- Using low ground pressure equipment.
- Restricting ingress and egress points on the mitigation site.
- Limiting paths or roadways within the site.
- Ripping or tilling compacted soils.
- Using mats such as steel or plastic plates to reduce compaction caused by equipment.

Special attention should be paid to the sequencing construction activity of wetland mitigation sites, and the timing shall not be compromised without prior permission from regulatory agencies. The following must be considered.

1. Storage
2. Staging
3. Excavation
4. Weed Control
5. Planting
6. Contingencies

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

The various components and sequence of site grading and construction includes clearing and grubbing, soil preparation/weed control, temporary erosion control, general site grading, drainage structures, topsoil and soil amendments necessary for wetland and upland development, and stockpile/ haul areas.

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Soil topography is directly associated to site hydrology. Being hydrology the most critical element to wetland establishments soil grading is also as critical. The Construction Contractor will conduct all grading and related activities including erosion control plan and level assurances will be coordinated with project leader.

A series of level stations will be established, maintained, and used to monitor the grading levels with laser levels. By grading, we will create the proper hydrology including saturation of soils at 25 centimeters above graded sites. The geoclimatic life zone of the site shows abundant rain periods with peaks in May and October. An average of 80 inches of rain is estimated for the area. The water table will be maintained high mainly due to hydrological regimes. In addition, storm water management from commercial complex may input to the wetlands.

Tilling will be conducted mainly in the enhancement areas with a large agricultural tractor with one hoe as deep as possible (40-60 cm). The tractor will ride through a single sinuous pathway followed by the planters. Site hydrology will aim for high water table mark.

Planting Guidelines

Planting methods will include linear and clumps plantings. Planting will be done manually with shovels. Every tree will be anchor, fertilized with Agriform 20-15-5 plus in 21 grams tablets, mulched with Vispore mats and or hey. The more water loving species will be planted in the center or lower areas and the less water loving species will planted in the outer ranges or higher areas. So, *Pterocarpus*, *Annona*, *Sthalia* and *Enallagma* will be planted in the lower sites and other species like *Manilkara*, *Machaerium*, *Eryrhina*, *Thespesia*, *Hibiscus tiliaceus*, *Cassia allata* and *Conocarpus erectus* will planted from the core toward the outer layers and bank.

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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, herbivory, 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 tree species will be planted in the 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.

Species Name	Quantity	Contingency 10%	Size	Pot
<i>Annona glabra</i>	2618	262	3'	1 lt
<i>Manilkara bidentata</i>	2618	262	3'	1 lt
<i>Pterocarpus officinalis</i>	2618	262	3'	1 lt
<i>Sthalia monesperma</i>	2618	262	3'	1 lt
<i>Machaerium lunatum</i>	2618	262	3'	1 lt
<i>Conocarpus erectus</i>	2618	262	3'	1 lt
<i>Hibiscus tilliaceous</i>	2618	262	3'	1 lt
<i>Myrica cerifera</i>	2618	262	3'	1 lt
<i>Erythrihna fusca</i>	2618	262	3'	1 lt
<i>Enalagama latifolia</i>	2618	262	3'	1 lt
<i>Thespesia populnea</i>	2618	262	3'	1 lt
Gran total	28880	31762		

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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:

FORESTED WETLANDS SPECIES ARE TO BE PLANTED TO:

Trees 3m O.C., or 400 trees per acre ; (this assumes 1ft. size).

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.
- Shrubs and trees will be measured by individual survival.

Cover	Year1	Year2	Year3	Year4	Year 5
Emergent	60%	80%	80%	85%	85%
Shrub/Tree	100%	90%	85%	85%	85%

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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 construction 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 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.

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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)