Wetland Delineation Report for the Site Specific Environmental Assessment for the Morovis, Puerto Rico National Cemetery Annex

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1. Introduction

On behalf of Mabbett & Associates, Inc. (Mabbett), AECOM has prepared this Wetland Delineation Report for the U.S. Department of Veterans Affairs (VA) proposed Morovis, Puerto Rico National Cemetery Annex (Proposed Action). The purpose of the Proposed Action is to develop a new National Cemetery and ancillary facilities for Veterans and their eligible family members in Puerto Rico.

The Project Study Area for this Wetland Delineation Report is the approximately 247-acre site located at State Road PR-137, Morovis Municipality, Puerto Rico (Figure 1). The purpose of this report is to identify regulated aquatic resources within the Project Study Area and to provide the results of the delineation along with related information necessary for the United States Army Corps of Engineers (USACE) to verify wetland delineation boundaries and to make and document Jurisdictional Determinations of the wetlands within the Project Study Area.

1.1. Project Overview

The purpose of this Wetland Delineation Report is to describe the methodology and results of the field investigation to identify and delineate aquatic resources that may be subject to regulation under federal and/or state jurisdiction at the Project Study Area. A secondary purpose of this report is to characterize those aquatic resources found and documented at the Project Study Area. The need for this wetland delineation arose because jurisdictional areas were identified during a preliminary wetland evaluation at the site at the time when the VA was still evaluating the adequacy of this site for a new Puerto Rico National Cemetery.

1.2. Regulatory Background

The USACE has regulatory jurisdiction over waters of the United States including wetlands pursuant to Section 404 of the Clean Water Act and Navigable Waters of the United States pursuant to Section 10 of the 1899 Rivers and Harbors Act.

2. Site Description and Location

2.1. Physiography

The Project Study Area is located in the Karstic Area of Northern Puerto Rico, on a high plateau to the east-northeast of the Río Grande de Manatí watershed. The property also occurs within the Restricted Karst Special Planning Area which is locally regulated by the Department of Natural and Environmental Resources. The geology in the study area is mainly comprised by outcrops of the Lares Limestone (Tl).

The Project Study Area includes a pastureland and shrubs areas, forestland and riverine areas, and suspected sinkhole areas.

2.2. Hydrology

The Project Study Area is located within the Cibuco river watershed. As depicted in Figure 2, desktop analysis and field observations in the project study area there are two streams and a jurisdictional wetland area.

2.3. Land Use

The Project Study Area has undergone significant changes over time in terms of land use, mainly agricultural and the presence of residential dwellings has been very limited. Over time, the land has progressively stepped away from agriculture and over to herding of cattle. Also, communities and residential areas have been developed in adjacent areas. The site topography is rolling downward mostly northeast. Topographic elevations vary from 130 to 182 meters above mean sea level (MSL) (Figure 1). The Project Study Area is bounded by State Road PR-155, private lands, rural developments and Fránquez Creek to the west; private lands, rural developments and Hipólito Reyes Street to the north; private lands, rural developments and rural road to the south; and private lands and state road PR-137 to the east.

2.4. Wetland Ecosystems

Wetlands around the study area are associated to streams and rivers. In this region, wetlands occur adjacent to rivers, creeks, depressions and blocked drainages.

2.5. Vegetation

The study area is located in an ecological life zone known as Subtropical Moist Forest (Ewel and Whitmore, 1973). Approximately 58% of the total area of Puerto Rico and U.S. Virgin Islands is under this classification. This life zone provides a much-needed supply of water on some of the drier islands, such as the Virgin Islands and Vieques. Most of the Subtropical Moist Forest zone in the study region has been deforested at one time or another. It has been subject to the highest demand in terms of the land use (e.g. agricultural) due to its ideal conditions for the establishment of a variety of crops. As the result, grasses have formed the dominant landscape of Subtropical Moist Forests for long periods of time.

2.6. Soils

Soil information was obtained from the United State Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Arecibo Area, Puerto Rico Northern Part (Spatial;Version 3, Dec 19, 2013). A list of soils present within the Project Study Area is presented in Table 1. Soils mapped in the Project Study Area by the NRCS are indicated in Figure 3. The dominant soils mapped in the Project Study Area include Coller cobbly clay and Soller-Rock outcrop complex.

Table 1: Soils Mapped within the Project Study Area

Soil Map Unit Symbol	Soil Map Unit Name	Drainage Class
SpD	Coller cobbly clay	Well drained
SrF	Soller-Rock outcrop complex	Well drained
MoC2	Moca clay	Moderately well drained
EcB	Espinosa clay	Well drained
SoC	Soller Clay (5 to 12% slopes)	Well drained

3. Methodology

3.1. Site Resources Review

A desktop analysis was conducted for the Project Study Area using existing information from federal and state agency databases, published literature review and state agency correspondence. The analysis was conducted to determine the presence and extent of biological and natural resources potentially occurring in the Project vicinity.

A review of existing information from USFWS NWI wetland maps (USFWS 2009) was conducted to locate potential jurisdictional waters of the U.S. including wetlands. Current aerial imagery and information from the NRCS soil survey (USDA-NRCS 2013) supplemented the review for potential wetland areas.

3.2. Field Surveys

3.2.1. Project Survey Area

The wetland delineation and surface waters survey in the approximately 247-acre Project Study Area were conducted by AECOM biologists on August 12-13, 2015. The Project Study Area is shown on Figure 1.

3.2.2. Wetland Surveys

Wetlands in the Project Study Area were delineated using the routine methodology set forth in the USACE Wetland Delineation Manual (USACE 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region (Version 2.0) (May 2011). A three parameter approach is used with these methods: vegetation, soils, and hydrology are assessed to identify the presence of wetlands. Initial boundaries of wetlands are established through visual assessment of vegetation and hydrology. Soils are assessed to determine the final boundary. For each plant community, sampling plots were established and vegetation, soils and hydrology were characterized. The sections below describe the results of this sampling. Wetlands were determined to be present if the sample plots exhibited the qualifying criteria of a dominance of hydrophytic vegetation, hydric soils and wetland hydrology.

For delineated wetlands, data recorded on the USACE Wetland Determination Data Forms included:

- Sketch map of wetland feature
- Sample plot locations
- Photo point locations
- Plant, soil, hydrology and other relevant information to support the determination

Photographs taken for wetland areas investigated are presented in Attachment 1. The USACE Wetland Determination and Stream Data Forms are presented in Attachment 2. Field-delineated wetlands and streams are presented in Figure 2. The following sections describe the methods used to evaluate vegetation, soils and hydrology.

Vegetation

For each sample plot, herbaceous, shrub, tree and vine strata were analyzed and characterized based on absolute cover, plant dominance and plant indicator status. The percent cover by species was determined using a 5-foot radius for the herbaceous layer, a 15-foot radius for the shrub/sapling layer, and 30-foot radii for tree and vine strata where present. The wetland indicator status was determined for each dominant plant species based on the USACE Caribbean 2014 Regional Wetland Plant List (Lichvar 2014). Problematic areas of vegetation with irregular shapes or sizes were evaluated using an adjusted survey area but still with the same square footage: 2,827 sq. ft. for a 30-foot radius plot (tree) and 707 sq. ft. for a 15-foot radius plot (shrub/sapling). For potential wetland areas that were smaller than the recommended sampling plot areas, the area was considered on the whole due to the limits of square footage.

Soils

Two soil test pits were dug at each investigated wetland area with a “hand auger” shovel to a maximum depth of 18 inches. The first soil test pit was placed in an area of readily distinguishable wetland plant communities. The second soil pit was placed in an adjacent upland area. The results of the soil survey were used to verify and document the boundary between wetlands and adjacent uplands. Soil profiles were inspected for the presence of hydric soil indicators as described in the USACE Caribbean Islands Region Supplement (USACE 2011). A Munsell Soil Color Chart (Macbeth 1994) was used to define the soil hue, value and chroma of the samples collected from each test pit.

Hydrology

A visual assessment of primary and secondary wetland indicators was conducted. In this region, primary wetland hydrology indicators include surface water, high water table, soil saturation, water-stained leaves, sediment deposits, drift deposits, algal mats or crust, oxidized rhizospheres on living roots and others. Secondary wetland hydrology indicators include surface soil cracks, moss trim lines, drainage patterns, FAC-neutral test and others.

3.2.3. Stream Surveys

AECOM biologists evaluated surface waters in the Project Study Area following guidance provided in the USACE Jurisdictional Determination Form Instruction Guidebook, joint U.S. Environmental Protection Agency (USEPA) and USACE guidance regarding Clean Water Act

(CWA) jurisdiction after Rapanos, and joint guidance on identifying waters protected by CWA (USEPA-USACE 2007, 2008, 2011).

A visual interpretation of the ordinary high water mark (OHWM), as defined by USACE (2005), was conducted for all streams and drainages. The stream bank was evaluated for physical characteristics established by the fluctuations of water to determine the OHWM. These characteristics included a clear, natural line impressed on the bank, shelving along the bank, changes in the character of the soil, disturbed vegetation, and the presence and location of debris in vegetation along the bank.

3.2.4. Mapping Procedures

Wetland boundaries were identified and marked in the field with pink wetland delineation "surveyor" flagging tape. The wetland boundaries were initially surveyed using a Garmin GPSmap 76Cx Global Positioning System (GPS). Ultimately, a professional land surveyor located the top of bank of the creek systems and the delineated wetland area and that data was used to create Figure 2.

4. Results and Discussion

4.1. Ecological Communities and Vegetation

The density and dispersion of existing natural resources in the Project Study Area site is similar to that of the surrounding areas. The Morovis area consists mostly of agriculture lands, forested uplands, some wetlands associated with rivers and/or streams with residential and some commercial areas.

Wetlands delineated in the Project Study Area consisted of emergent (wet meadow), wetland plant communities. The emergent wetland area was primarily dominated by grass *Urochloa mutica* and *Ipomoea setifera*.

No State or Federal listed rare, threatened or endangered species were observed during the August 2015 field investigations. However the results of the recent Flora and Fauna Study conducted by CSA Group in July 2015 indicate the presence of the Puerto Rican boa (*Epicrates inornatus*). This will require that the boa protection protocol be implemented during the construction phase of the project.

4.2. Soils

Five soil units mapped by the NRCS occur within the Project Study Area, as listed in Table 1 and depicted in Figure 3. The dominant soils mapped in the delineated wetland areas are moderate and well drained.

Hydric soils are defined as soils that are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994). Soil characteristics can be important indicators of wetland and upland boundaries. This is especially useful in cases where potential wetland vegetation is lacking or has been removed or impacted. Although hydrophytic vegetation and wetland

hydrology indicators must be confirmed before a wetland determination can be made, hydric soils information is useful in determining the potential presence of wetlands.

According to the NCRS Caribbean Area none of the study area soils have been classified as hydric.

4.3. Hydrology

Local hydrology is influenced by rainfall runoff. Surface water observed during the field work in the Project Study Area included two streams (Fránquez Creek and an unnamed creek).

The prevalent indicators of wetland hydrology in the delineated wetland were Oxidized Rhizospheres on living roots (C3) and Drainage Patterns (B10).

4.4. Wetlands

One wetland totaling approximately 0.05 acres was delineated within the Project Study Area, and depicted in Figure 2.

Based on the results of the field survey it appears that the wetland area delineated has a hydrologic connection to the adjacent unnamed creek.

4.5. Streams

Two streams were delineated in the Project Study Area. Fránquez Creek is a stream with a well-defined channel, which has an approximate width varying from 5 to 20 feet and is mostly covered with rocks. Fránquez Creek flows from south to north along the western limit of the property. The unnamed creek located at the north boundary flows from west to east and is a tributary of Fránqez Creek. This unnamed creek also has a well-defined channel.

5. Discussion

Field surveys for wetland delineations and water resources were conducted on August 12-13, 2015 within the 247-acre Project Study Area. One wetland totaling approximately 0.05 acres was delineated in the Project Study Area. Two streams were identified in the Project Study Area.

Based on the field investigation and a review of aerial imagery, topographic maps and hydrologic data, the delineated wetland appears to have a hydrologic connection to Waters of the U.S. and are therefore likely federal jurisdictional wetlands.

It is anticipated that wetlands permits will be required from the USACE via a Joint Application for Permit in accordance with Section 404 of the Clean Water Act.

6. References

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. Laroe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Washington, D.C. FWS/OBS-79-31. 103 pp.

Federal Interagency Committee for Wetland Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication. 76 pp. plus appendices.

Federal Register 1994. Available at [url] https://www.federalregister.gov/articles/2012/02/29/2012-4733/changes-in-hydric-soils-database-selection-criteria

Lichvar, R.W., M. Butterwick, N.C. Melvin, and W.N. Kirchner. 2014. *Caribbean 2014 Regional Plant List*: 2014 wetland ratings The National Wetland Plant List: 2014 update of wetland ratings. Phytoneuron 2014-41:1-42. Published April 2, 2014.

Macbeth. 1994. Munsell® Soil Color Charts. New Windsor, NY.

USDA-NRCS. 2006. Land resource regions and major land resource areas of the United States, the Carribbean, and the Pacific Basin. Agricultural Handbook 296, re.ed. Available at [url] http://soils.usda.gov/survey/geography/mlra/

USFWS. 2009. National Wetland Inventory. Available online at [url] http://www. fws. gov/wetlands/

USGS. 2010a. National Hydrography Dataset (NHD). Available at [url] http://nhd. usgs. gov/data. html

USACE. 2005. Regulatory Guidance Letter 05-05. Ordinary High Water Mark Identification. Available at [url] http://www.usace.army.mil/CECW/Documents/cecwo/reg/rgls/rgl05-05.pdf

USDA-NRCS. 2009. Soil Conservation Service, in cooperation with the University of Puerto Rico, Agricultural Experimental station. 154 pp.

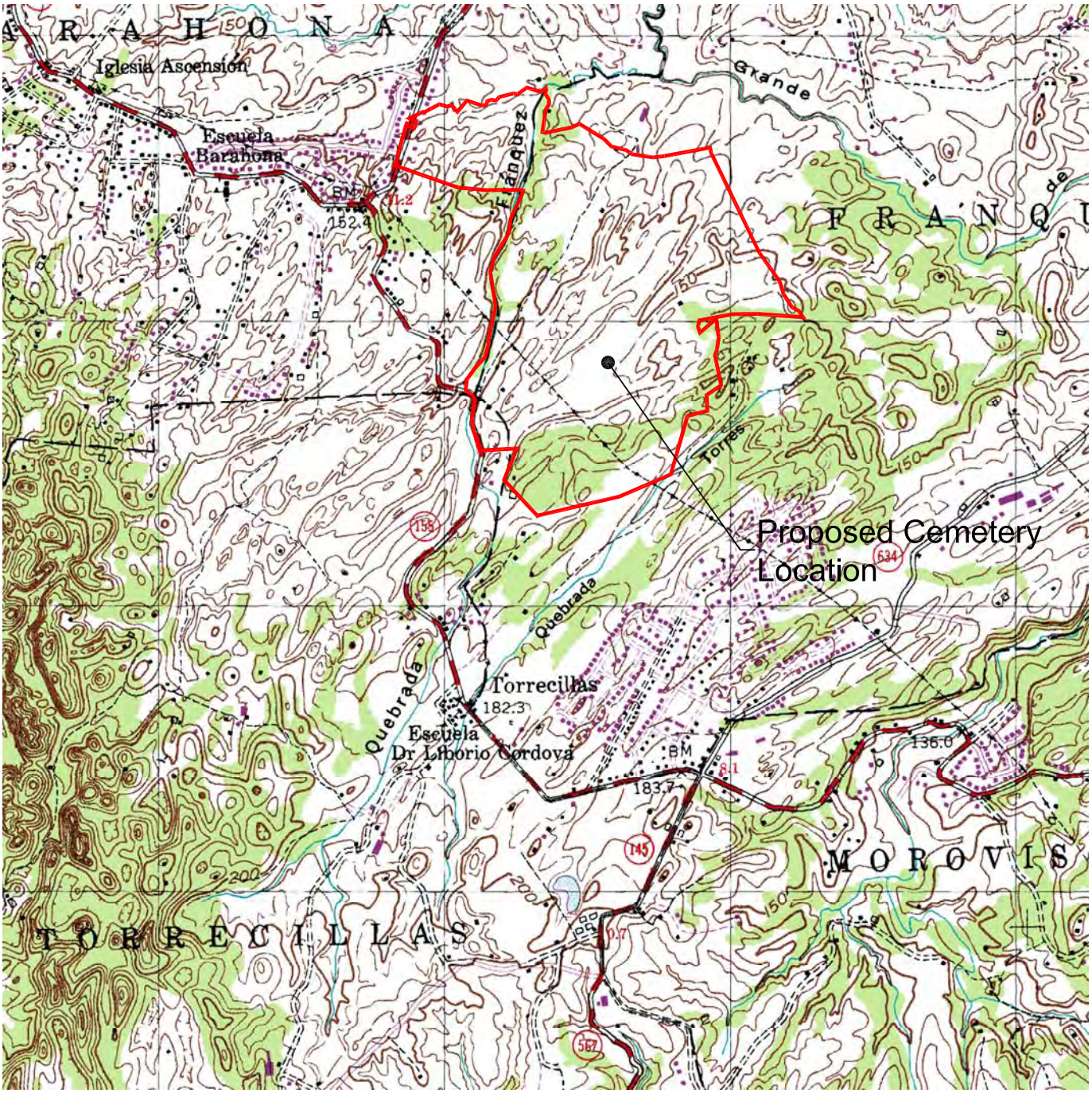
USEPA-USACE. 2007. Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States. Issued June 5, 2007. Available at [url] http://www.usace.army.mil/CECW/Documents/cecwo/reg/cwa_guide/rapanos_guide_memo.pdf

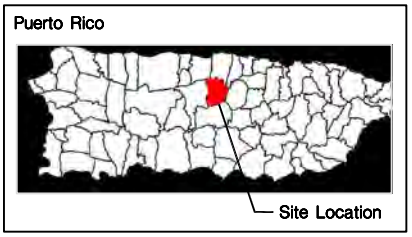
USEPA-USACE. 2008. Revised Guidance on Clean Water Act Jurisdiction Following the Supreme Court Decision in Rapanos v. U.S. and Carabell v. U.S. Available at [url]

http://www.usace.army.mil/CECW/Documents/cecwo/reg/cwa_guide/cwa_juris_2dec08.pdf

USEPA-USACE. 2011. Draft Guidance on Identifying Waters Protected by the Clean Water Act. Available at [url] www.epa.gov/tp/pdf/wous_guidance_4-2011.pdf

USGS. 2007. PR-GAP: Puerto Rico Gap Analysis Project, Assessing Biodiversity and Conservation in Puerto Rico. Final Deport and Data. U. S. Department of Interior. Digital version.





LEGEND :

Site Location

N

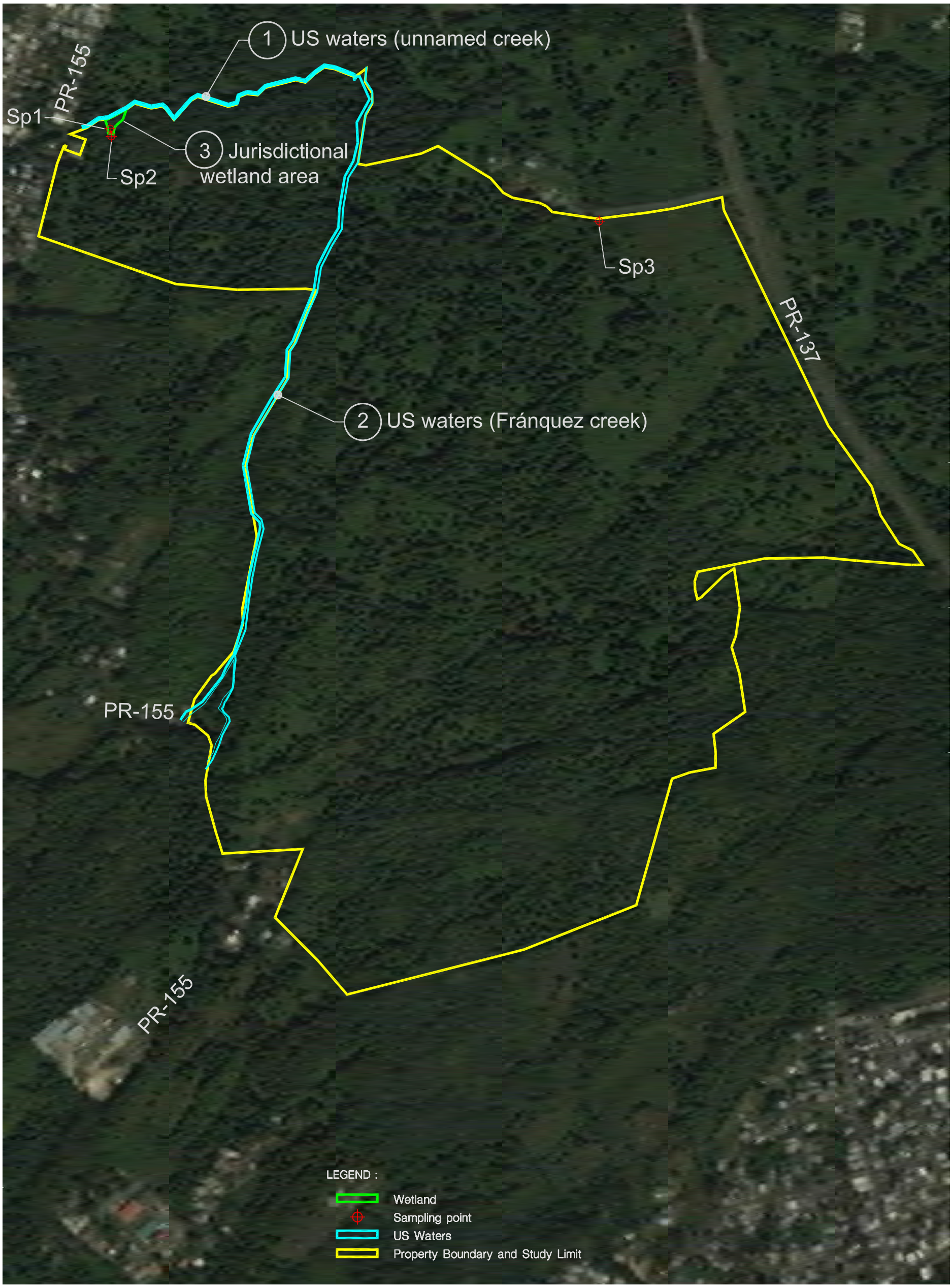
SCALE:
1: 20,000

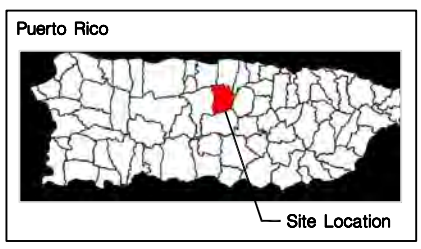
Source:
US Geological Survey, 7.5" Quadrangle Map Series, Ciales, Puerto Rico (1957) - Photorevised 1982.
Symbol Description: SpD Coller cobbly clay SrF Soller-Rock outcrop complex MoC2 Moca clay EcB Espinosa clay

AECOM

SITE LOCATION MAP
PROPOSED CEMETERY LOCATION
VETERANS ADMINISTRATION
MOROVIS, PR

FIGURE 1





NOTES :

This plan shows the approximate location of the jurisdictional areas and sampling points.

1. Unnamed creek (US waters) - Top of bank delineated by a Professional Land Surveyor (PLS) and provided by David Rosa (CSA Group).
2. Fránquez creek (US Waters) - Top of bank delineated by a Professional Land Surveyor (PLS) and provided by David Rosa (CSA Group).
3. Jurisdictional wetland area. This wetland area is connected to the Unnamed creek and delineated by AECOM personnel.

N

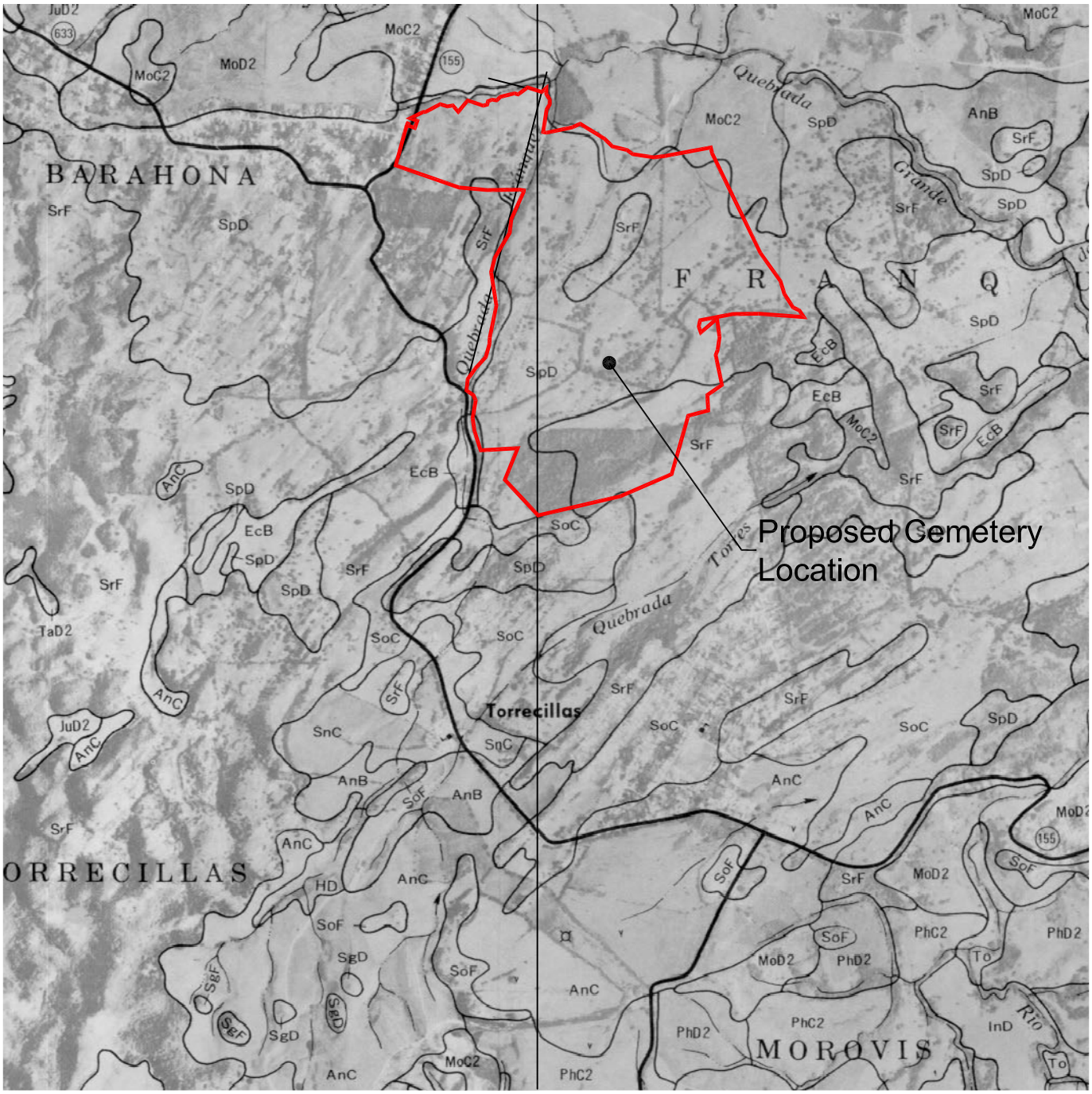
SCALE: 1: 6,000

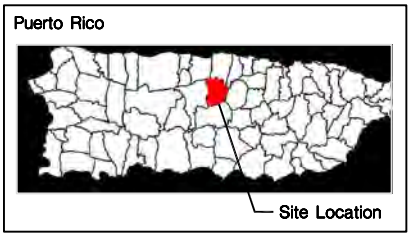
Source:
Google Earth Pro, aereal photo image, image date is 1/27/2015.

AECOM

WETLAND AND STREAM DELINEATION
PROPOSED CEMETERY LOCATION
VETERANS ADMINISTRATION
MOROVIS, PR

FIGURE 2





LEGEND :

Site Location

N

SCALE:
1: 20,000

Source:
USDA- Soil Survey of Arecibo Area Northern Puerto Rico (March 1982) - Sheet 31
Symbol Description: SpD Coller cobbly clay SrF Soller-Rock outcrop complex MoC2 Moca clay EcB Espinosa clay

AECOM

SOILS MAP
PROPOSED CEMETERY LOCATION
VETERANS ADMINISTRATION
MOROVIS, PR

FIGURE 3

Attachment 1
2015 Wetland Delineation Representative Photographic Log

Project #: 60437983
Project Description: VA National Cemetery Project
Location: Morovis, Puerto Rico
Date: August 12, 13, 20, 2015
Photos Taken By: Mayra Marrero, Nancy Camacho

(SP-1) Soil at Sampling Point #1

(SP-2) Sampling Point #2

(SP-3) Soil Profile at Sampling Location #3

(SP-3) Location of Sampling Point 3

Project #: 60437983
Project Description: VA National Cemetery Project
Location: Morovis, Puerto Rico
Date: August 12,13, 20, 2015
Photos Taken By: Mayra Marrero, Nancy Camacho

Franquez Creek 1

Franquez Creek 2

Franquez Creek 3

Franquez Creek 4

Project #: 60437983
Project Description: VA National Cemetery Project
Location: Morovis, Puerto Rico
Date: August 12, 13, 20, 2015
Photos Taken By: Mayra Marrero, Nancy Camacho

Franquez Creek 5

Franquez Creek 6

Wetland area, Northwest portion of parcel

Upland area

Attachment 2
2015 Wetland Data Sheets

WETLAND DETERMINATION DATA FORM – Caribbean Islands Region

Project/Site: PR National Cemetery Municipality/Town: Morovis Sampling Date: Aug.12.2015

Applicant/Owner: Department of Veterans Affairs PR or USVI: PR Sampling Point: Sp-1

Investigator(s): Mayra Marrero/Nancy Camacho Ward/Estate: Barahona Ward

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Lat: 18° 21.418' N Long: 66° 25.928' W Datum: _____

Soil Map Unit Name: Soller Cobbly Clay (SpD) NWI classification: Upland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes X No _____
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes X	No _____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1. Urochloa mutica	50%	Yes	FACW
2. Ipomoea setifera	30%	Yes	FACW
3. Commelina diffusa	5%	Yes	FAC
4. Senna alata	10%	Yes	FACW
5. Syngonium podophyllum	5%	Yes	NI
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	_____ = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	_____	x 1 = _____
FACW species	90	x 2 = 180
FAC species	5	x 3 = 15
FACU species	_____	x 4 = _____
UPL species	_____	x 5 = _____
Column Totals:	95 (A)	195 (B)

Prevalence Index = B/A = 2.05

Hydrophytic Vegetation Indicators:

X 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No _____

Remarks:

SOIL

Sampling Point: SP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/1						Clay	Very dry and dark
2-10	10YR 2/1						Clay	Dry to humid
10-14	10YR 3/2						Clay	Humid
14-18	10YR 3/2						Clay	Humid and very compact

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- X Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Organic Bodies (A6)
- ___ 5 cm Mucky Mineral (A7)
- ___ Muck Presence (A8)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Stratified Layers (A5)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Fiddler Crab Burrows (C10)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Caribbean Islands Region

Project/Site: PR National Cemetery Municipality/Town: Morovis Sampling Date: Aug.12.2015

Applicant/Owner: Department of Veterans Affairs PR or USVI: PR Sampling Point: Sp-2

Investigator(s): Mayra Marrero/Nancy Camacho Ward/Estate: Barahona Ward

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Lat: 18° 21.418' N Long: 66° 26.144' W Datum: _____

Soil Map Unit Name: Soller Cobbly Clay (SpD) NWI classification: Upland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1. Citharexylum fruticosum	25%	Yes	FACU
2. Thespesia grandiflora	25%	Yes	UPL
3. Spathodea campanulata	25%	Yes	FACU
4. Megathyrsus maximus	20%	No	FACU
5. Commelina diffusa	5%	No	FAC
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	_____ = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	_____	x 1 = _____
FACW species	_____	x 2 = _____
FAC species	5	x 3 = 15
FACU species	70	x 4 = 280
UPL species	25	x 5 = 125
Column Totals:	100 (A)	420 (B)

Prevalence Index = B/A = 4.2

Hydrophytic Vegetation Indicators:

__ 1 - Rapid Test for Hydrophytic Vegetation

__ 2 - Dominance Test is >50%

__ 3 - Prevalence Index is ≤3.0[1]

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No X

Remarks:

SOIL

Sampling Point: SP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 3/2						Clay	Very dry and loose
2-9	10YR 3/3						Clay	Dry and loose
9-15	10YR 3/3						Clay	Dry, tiny rocks
15-18	10YR 3/4						Clay	Dry, compact

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Organic Bodies (A6)
- ___ 5 cm Mucky Mineral (A7)
- ___ Muck Presence (A8)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Stratified Layers (A5)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Fiddler Crab Burrows (C10)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Caribbean Islands Region

Project/Site: PR National Cemetery Municipality/Town: Morovis Sampling Date: Aug.20.2015

Applicant/Owner: Department of Veterans Affairs PR or USVI: PR Sampling Point: Sp-3

Investigator(s): Mayra Marrero/Nancy Camacho Ward/Estate: Franquez Ward

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Lat: 18° 21.418' N Long: 66° 26.144' W Datum: _____

Soil Map Unit Name: Soller Cobbly Clay (SpD) NWI classification: Upland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1. Mimosa pellita	20%	Yes	FAC
2. Cissus verticilata	15%	No	FAC
3. Urochloa mutica	55%	Yes	FACW
4. Digitaria eriantha	10%	No	FACU
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	_____ = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	_____	x 1 = _____
FACW species	55	x 2 = 110
FAC species	35	x 3 = 105
FACU species	10	x 4 = 40
UPL species	_____	x 5 = _____
Column Totals:	100 (A)	215 (B)

Prevalence Index = B/A = 2.15

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No _____

Remarks:

Even though the vegetation is hydrophytic we can observe it in others areas of the site.
The area is a low point that allows the growth of this type of vegetation.

SOIL

Sampling Point: SP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 3/2						Clay	Dry and loose
8-12	10YR 3/2						Clay	Dry and loose
12-17	10YR 3/2						Clay	Dry, tiny rocks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Organic Bodies (A6)
- ___ 5 cm Mucky Mineral (A7)
- ___ Muck Presence (A8)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Stratified Layers (A5)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
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- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Fiddler Crab Burrows (C10)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

U.S. Department of Veterans Affairs

Flora and Fauna Study

Puerto Rico National Cemetery Replacement

Municipality of Morovis, Puerto Rico

July 31, 2015

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1.0 EXECUTIVE SUMMARY

This Flora and Fauna Study has been prepared to support the U.S. Department of Veterans Affairs (DOVA) for the environmental review process for a property located in the municipality of Morovis. This study has been performed according to protocols accepted by the Department of Natural and Environmental Resources (DNER) and the U.S. Fish and Wildlife Service (USFWS). The study includes characterization of the biological and ecological resources within the property limits, focusing in the identification of predominant species and potential presence or absence of threatened and endangered species within the site. Also, the study provides recommendations to avoid or minimize potential impacts to the natural resources within the site.

DOVA owns a property (track of land) of approximately 247 acres (254 *cuerdas*[1)] within the northern-central region of Puerto Rico. The property is located at Road PR-137 (PR-137), Km. 11, in Fránquez ward within the municipality of Morovis. The property can be accessed through paved rural roads connected to the PR-137 to the north and the PR-155 to the south.

The property or study area is bound to the North by private lands; to the South by private lands and Torres creek (outside); to the West by private lands, PR-155 and Fránquez creek; and to the East by private lands and PR-137. Additionally, right-of-ways from the Puerto Rico Power and Electric Authority (PREPA) traverse the property from north to south, and west to east. In addition to PREPA infrastructure, existing structures previously occupied by the former land owner are located within the property. Also, an existing paved road of approximately 3.4 meters wide and 1,026 meters long runs from north to south and divides the property in two (2) main areas or land lots (East and West).

The property or study area is located in the Karstic Area of Northern Puerto Rico, on a high plateau to the east-northeast of the Río Grande de Manatí watershed. This is a semi-rugged area, grading downward mostly northeast, an average slope of 12.8% and at some points with gradients up to 70%. The property also occurs within the Restricted Karst Special Planning Area (*Área de Planificación Especial Restringida del Carso*), which is locally regulate by the Department and Natural Environmental Resources (DNER) under the Karst Special Planning Area Regulation (2014) (PRAPEC, by its Spanish acronym).

[1] One (1) cuerda is 0.97 acre. "Spanish acre" refers to various units of measurement in some Spanish-speaking regions, including Spain, Puerto Rico, Guatemala, Cuba, and Paraguay.

Based on available documentation (e.g. historic aerial images), the property has been subject to agriculture and cattle grazing practices. In terms of the **flora** and taking into consideration the natural land features, five (5) main vegetation associations (habitats) were identified within the DOVA's property:

	Habitats	Acres	Cuerdas	Percentage
1.	Pastureland and shrub areas	46	47.4	19%
2.	Forestland (relative dense hardwood areas)	183	188	74%
3.	Urbanized area	2	2.1	1%
4.	Riverine area (Fránquez creek)	2	2.1	1%
5.	Suspected Sinkhole areas	14	14.4	5%
	TOTAL	**247**	**254**	**100%**

A total of **363** species of plants (91 families) were identified within the property; **none** of them listed as protected or considered as species of special concern. Most of these commonly occur within the northern lowlands of the Cordillera Central, especially in areas were previous disturbances took place.

The vegetation association can be grouped in three (3) natural habitat categories designation as per DNER Regulation No. 6765[2] which include:

1. Category 4 (including Forestland, riverine and sinkhole areas)
1. Category 5 (Pastureland and shrub areas)
2. Category 6 (Urbanized areas, internal access roads and PREPA ROWs)

According to Regulation No. 6765, impacts over natural habitats Category 4 would requires a 1:1 compensatory mitigation, consisting on protecting habitat of the same or higher ecological value (e.g. land acquisition, conservation eastment). However, the **PRAPEC** establishes that for Restricted Karst Special Planning Area, habitat compensation (mitigation) of the same or higher ecological value must occur in a **1:1 ratio** based on the footprint of a proposed action, without limiting to a natural habitat designation of Category 4.

In terms of **fauna**, a total of **73** vertebrate species were observed, predominantly birds. Finches were commonly observed within pasturelands. Others vertebrates include five **(5)** mammals, two **(2)** fishes and eleven **(11)** species of amphibians and reptiles. The **Puerto Rican Boa** (*Epicrates inornatus*) was the only federally and locally protected species observed within the property, near the Fránquez creek area (Riparian area); however, the presence of this species is not discarded in other portions of the property. Therefore, the USFWS / DNER Protection Protocol must be implemented during any construction activity.

Please, refer to **Section 5** for a detailed description and the names of the most commonly observed species; a description of the recorded and observed species, and details of the flora and fauna throughout the property.

It is anticipated that most of the impacts that could occur with the use of this property (i.e. National Cemetery, as a federal institutional project) would be caused by the earthwork. Once a project like this is completed, it is

[2] **Category 4** - Natural Habitat with Ecological Value, **Category 5** - Natural Habitat with Great Potential to Became Essential Habitat, High Ecological Value or of Ecological Value, **Category 6** - Natural Habitat with Low Potential to Became Essential Habitat, High Ecological Value or of Ecological Value

understood that many species could return to designated green open areas including those temporarily impacted, and restored to pre-construction conditions. Implementing protective measures and best engineering practices can avoid, or minimize, potential impacts. The general effects on the environment, which cannot be avoided or minimized, must be mitigated according to the applicable laws and regulations at a local and federal level.

Furthermore, the proposed action should implement operational practices that are non-toxic and energy-conserving; low-impact ground practices/protocols design; and be operated and maintained in a way to produce a naturalistic appearance, based on use of plants and materials native to the region following patterns of landscape derived from and compatible with regional ecosystems. Such landscapes may be part of ecological restoration.

In addition, conservation must be executed to the maximum extent to protect those natural features of significance importance such as:

- some forested areas;
- cave;
- riparian area (Fránquez creek); and
- sinkholes (including prominent and well defined solution trenches)

Conservation measures must be included as part of any master planning and establishing the adequate easement to guarantee long-term stewardship.

2.0 INTRODUCTION

The U.S. Department of Veterans Affairs (DOVA) owns a property (track of land) of approximately 247 acres (254 *cuerdas*[3]) within the northern-central region of Puerto Rico. Specifically, the property is located at Road PR-137 (PR-137), Km. 11, in Fránquez ward within the municipality of Morovis. The property can be accessed through paved rural roads connected to PR-137 to the north and PR-155 to the south.

The property or study area is bound to the North by private lands; to the South by private lands and Torres creek; to the West by private lands, PR-155 and Fránquez creek; and to the East by private lands and PR-137. Additionally, right-of-ways from the Puerto Rico Power and Electric Authority (PREPA) traverse the property from north to south and from west to east. In addition to PREPA infrastructure, existing structures previously occupied by the former land owner are located within the property. Also an existing paved road of approximately 3.4 meters wide and 1,026 meters long runs from north to south dividing the property in two (2) main areas or land lots (East and West). For Details see **Figure 1: Location Map** and **Figure 2: Aerial Photo**.

The property or study area is located in the Karstic Area of Northern Puerto Rico, on a high plateau to the east-northeast of the Río Grande de Manatí watershed. This is a semi-rugged area, grading downward mostly northeast, an average slope of 12.8% and at some points with gradients up to 70%. The property also occurs within the Restricted Karst Special Planning Area (*Área de Planificación Especial Restringida del Carso*), which is locally regulated by the Department and Natural Environmental Resources (DNER) under the Karst Special Planning Area Regulation (2014) (PRAPEC, by its Spanish acronym). Based on available documentation (e.g. historic aerial images), the property has been subject to agriculture and cattle grazing practices.

This study has been performed according to protocols accepted by the DNER and the U.S. Fish and Wildlife Service (USFWS). The study includes characterization of the biological and ecological resources within the project limits, focusing in the identification of predominant species, and potential presence or absence of threatened and endangered species within the property owned by DOVA.

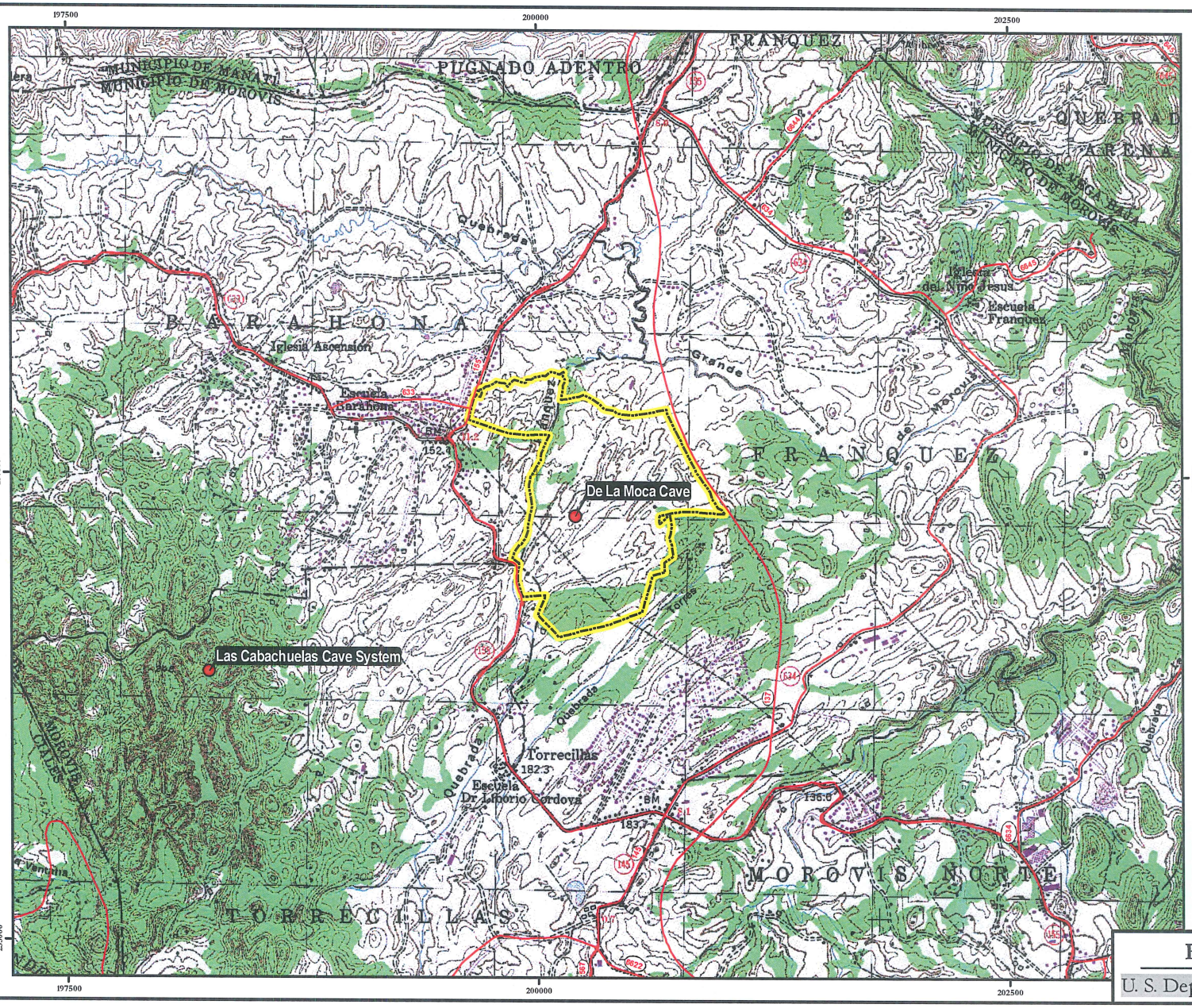
This document contains the following sections:

- General Description of the Area
- Study Methodology
- Results and Discussion

[3] One (1) cuerda is 0.97 acre. "Spanish acre" refers to various units of measurement in some Spanish-speaking regions, including Spain, Puerto Rico, Guatemala, Cuba, and Paraguay.

- DNER Habitat Categorization
- Potential Impacts
- Mitigation Measures and Recommendations
- References
- Other Supporting Information (Appendices)

This study was conducted during the months of June and July 2015 by technical personnel from CSA Architects and Engineers, LLP (CSA or CSA Group).



N
W E
S

Scale 1:20,000

0 250 500 1,000 Meters

Legend:

- Cave
- Roads[1]
- Property Limit

Notes:
1. Location is approximate.

Sources:
1. Puerto Rico Highway and Transportation Authority (ACT by its acronym in Spanish), June 2006
2. Information provided by the Puerto Rico Planning Board
3. United States Geological Survey (USGS) Topographic Map. Ciales Quadrangle (1957). Photorevised on 1982. The original map scale is 1:20,000.

Coordinate System:
State Plane NAD83 Puerto Rico
& Virgin Islands FIPS 5200 (Meters)

CSA Group

Figure 1: Location Map

U. S. Dept. of Veterans Affairs, Morovis, PR

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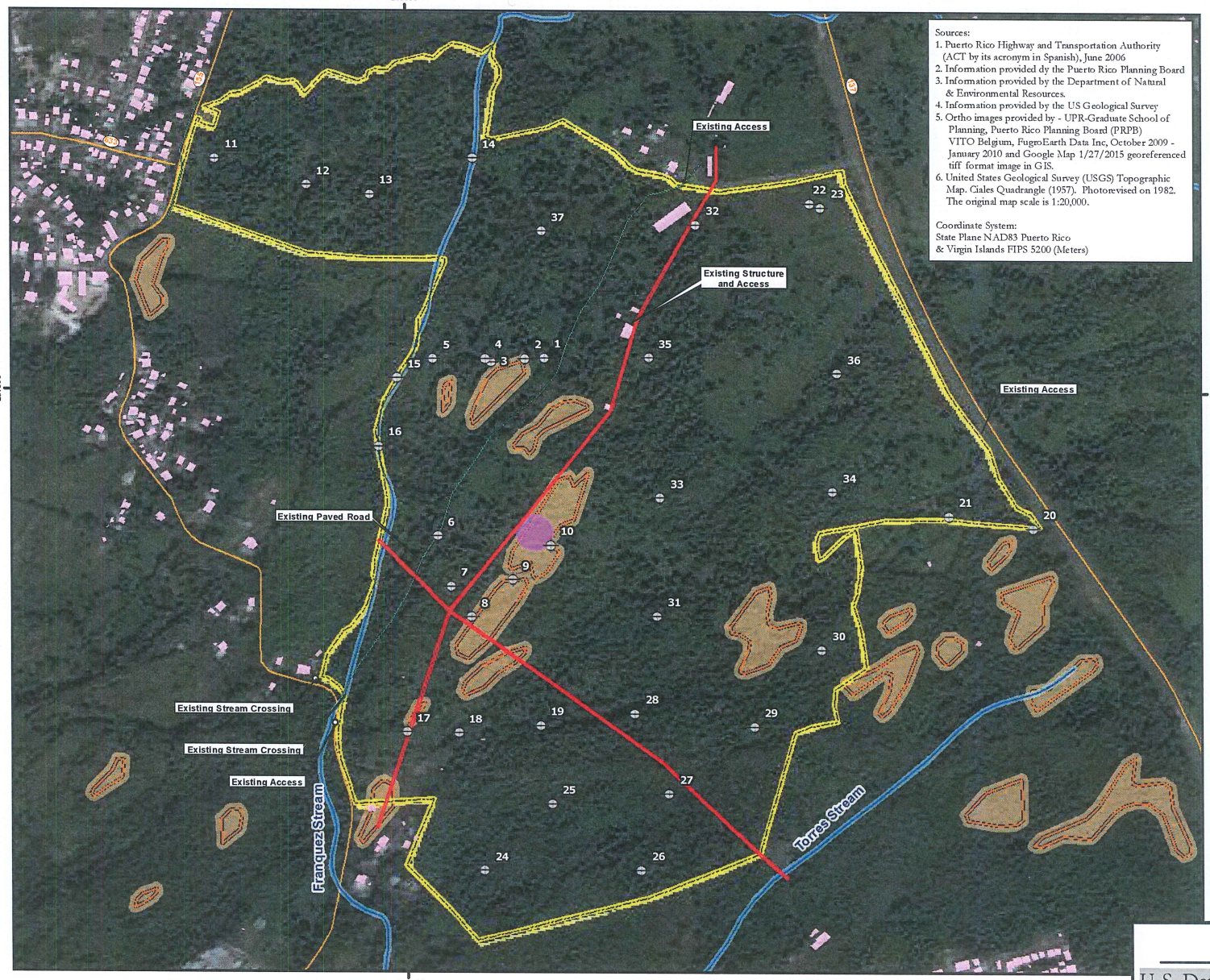


Figure 2: Aerial Photo

U. S. Dept. of Veterans Affairs, Morovis, PR

3.0 GENERAL DESCRIPTION OF THE AREA

The federal property (track of land) is located in the Fránquez ward in the municipality of Morovis, within the northern-central region of Puerto Rico. Access to the property is through roads PR-137 and PR-155. It covers an area of approximately 247 acres (254 *cuerdas*). The coordinates of the approximate center of the property are:

- North: 18° 21' 3.29" N; West: 66° 25' 47.00" W

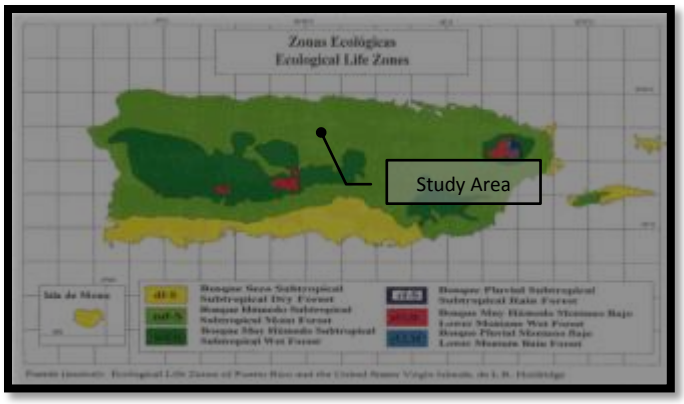
A general description of the boundaries of the property is provided in the following table.

Table 1: DOVA Property Limits

Description	
North	• Private (open) lands • Rural developments (residential) • Hipólito Reyes Ortiz street
South	• Private (open) lands • Torres creek • Rural developments (residential) • Rural road
East	• Road PR-137 • Private (open) lands
West	• Road PR-155 • Private (open) lands • Rural developments (residential) • Fránquez creek

This property has been used in the past for farming and livestock (e.g., cattle grazing). Existing residential structures, access roads and associated infrastructure (e.g., PREPA right-of-way) are observed on the property. The existing internal access road (paved) of approximately 3.4 meters wide and 1,026 meters long running from north to south divides the property in two (2) main areas or land lots (East and West) **Figures 1** and **2** show the location of the property in a topographic map and on aerial photograph, respectively.

3.1. ECOLOGICAL LIFEZONES



The property is located in an ecological life zone known as Subtropical Moist Forest (Ewel and Whitmore, 1973). Approximately 58% of the total area of Puerto Rico and U.S. Virgin Islands is under this classification. This life zone is characterized by an average annual rainfall of 39.4 to 86.6 inches, approximately. It has been subject to the highest demand in terms of the land use (e.g. agricultural) due to its ideal conditions for the

establishment of a variety of crops. As a result, many of these areas have been deforested and impacted in the past at one time or another. As the result, grasses have formed the dominant landscape of Subtropical Moist Forests for long periods of time.

3.2. CLIMATOLOGY

The island of Puerto Rico has a humid tropical climate with a narrow range of daily temperature because of its location in the tropics and the buffering effect of the ocean. Weather is dominated by the easterly trade winds, which are predominantly from the east-northeast (Calvesbert, 1970). Hurricanes and other large storms embedded in the trade winds deliver about 70% of yearly rainfall; such storms affect the Caribbean about nine (9) times a year on average (Calvesbert, 1970; Musk, 1988). The climate of Puerto Rico is influenced by several global-scale climate patterns. The El Niño-Southern Oscillation (ENSO), which involves both ocean and atmospheric interactions, has an average recurrence interval of 3.8 years for *El Niño* episodes of moderate and greater intensity (Quinn and others, 1987). A negative Southern Oscillation Index, which corresponds with *El Niño* episode, tends to be associated with warmer years and fewer tropical storms in Puerto Rico (Gray, 1984; Malmgren and others, 1998).

The National Oceanic and Atmospheric Administration (NOAA) operates various stations recording weather data of the Island. The closest weather station to the DOVA property is located in the north area of Morovis with identification number (ID) **RQC00666390**[4]. The available data period of record used at this station to describe the pattern of rainfall and temperature in the area is from 2014[5].

Rainfall

The path of trade winds over Puerto Rico's substantial topography causes rainfall to vary greatly throughout the Island. In general, rainfall is caused when the trade winds push moist air from the coast to the highland areas of the Central Mountain Range *(Cordillera Central)* that eventually results in precipitation.

Overall, Puerto Rico has an average annual rainfall of 70 inches, with a variation of about 60 inches along the north coast, and around 30 inches in the south. The wet season occurs from May to November and the dry season between December and April.

According to the NOAA, "normal" rainfall is the average rainfall over a period of 30 consecutive years. The latest official normal rainfall values represent the average rainfall from 2014. Precipitation measurements recorded in Morovis Station range from 3.10 inches in January to 9.34 inches in August, resulting in an annual rainfall of 54.2 inches, as illustrated in the table below. More of the rainfall activity occurred between May and September.

[4] http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=normals&layers=01&node=gis&extent=-149.3:20.2:-60.1:69.6&custom=normals; http://www.ncdc.noaa.gov/cdo-web/quickdata

[5] Data were obtained from the NOAA National Climatic Data Center-1981-2010 Normal Data Access on the link http://www.ncdc.noaa.gov/land-based-station-data/climate-normals/1981-2010-normals-data

Table 2: Average rainfall (inches) in Morovis (2014)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Rain (in)	3.10	2.45	0.52	1.87	9.09	0.00	3.94	9.34	7.30	3.48	7.82	5.32	54.23

Temperature

The temperature pattern in Puerto Rico is tropical, with high solar radiation throughout the year and changes due to maritime influence in coastal areas, topography, wind, and cloud cover (Colón Torres, 2009). In sections of the interior of the Island, the evenings are warmer and the nights are cooler, as they exhibit some variability over the coastal areas. The rest of the Island experienced similar temperatures, except for the sharp drop in temperature at higher elevations ranging from 900 to 1,200 meters (2,953 to 3,937 feet).

Table 3: Maximum, Average and Minimum Normal Temperatures (°F) in Morovis[6]

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Morovis	Max	82.5	83.0	84.6	86.2	87.6	89.4	88.9	89.4	88.9	88.1	85.2	83.1	86.4
	Ave.	75.3	75.1	76.3	77.6	79.5	80.5	80.5	80.4	80.3	79.7	78.3	76.4	78.3
	Min.	61.7	61.3	62.9	64.5	67.5	68.5	67.7	67.9	67.7	67.4	65.9	63.5	65.6

The hottest months were July and September when maximum normal temperatures reached 93.3° F (34.1° C) and 92.9° F (33.8° C), while the coldest months were January and February when the minimum normal temperature fell to 61.7° F (16.5° C) and 61.3° F (16.3 ° C), respectively.

Wind

Puerto Rico's wind regime is characterized by two (2) principal factors: Diurnal land and sea breezes, and persistent northeasterly trade wind flow. The winds blow from the east in almost all months through the year with an average speed that varies from six (6) to nine (9) miles per hour (mph) (9.7 a 14.5 km/h). In the mountainous areas, the movement of the trade winds is modified since the winds can be accelerated, channelized through narrow paths between mountains or deviated around high terrains.

[6] http://www.srh.noaa.gov/sju/?n=climo_morovis#Morovis

3.3. Hydrography, Water Bodies and Groundwater

3.3.1. Hydrography

The property is located in the northern-central highlands of Puerto Rico, within the hydrographic watershed of Cibuco river (Quinones and Sigifredo, 2005), where streams and tributaries originate and connect to main rivers (e.g., Cibuco river) which eventually flow into the Atlantic Ocean (Traditional Navigable Waters of the U.S) (TNW).

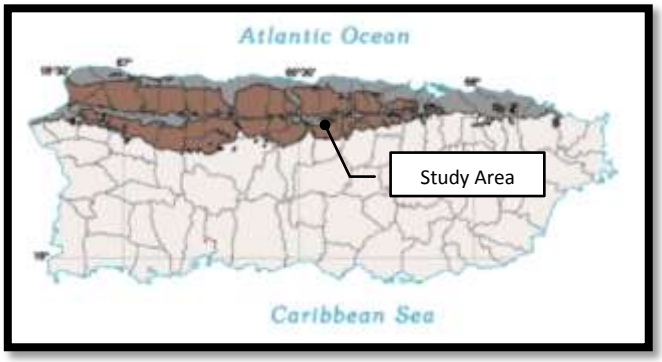
3.3.2. Water Bodies

Water resources can be separated into those associated with drainage ways (e.g., rivers and/or streams), wetlands, and groundwater. Those associated to drainage ways typically function as storm water conveyances during rainfall events. As for groundwater, its abundance depends on the geological nature of the area and its location in relation with the environment. For groundwater and wetlands see sections 3.3.3 and 3.3.5 respectively.

According to the USGS Topographic Map (Ciales Quadrangle, dated 1957 and photo revised on 1982) and field visits, approximately 976 meters of an intermittent stream (Fránquez creek[7]) has been identified at the western boundary, within the property. A crossing of 2-3 meters (8-10 feet) wide and two (2) meters (6-8 feet) long occurs within the Fránquez creek by the existing internal access at the southern end of the existing internal access. The Fránquez creek flows from south to north along the western limit of the property and eventually confluences with Grande de Morovis creek. This intermittent body of water relatively maintains water levels and intermittent flow for fish and other water dependent species. The Fránquez creek is one of the main tributaries of Grande de Morovis creek (Relatively Permanent Waters (RPWs) that flow directly or indirectly into TNWs) and confluence at approximately 600 meters downstream from the property (north limit). The Torres creek (intermittent stream) is located to the southeast, outside of the subject property.

3.3.3. Groundwater

Over 75% of the property is located within the North Coast Limestone Aquifer and the Karstic Area of Northern Puerto Rico. The North Coast Limestone Aquifer system in Puerto Rico is one of the largest and most productive sources of groundwater. The aquifer system underlies inhabited and industrialized area extending approximately 90 miles along the north coast of Puerto Rico and encompasses an area of approximately 700 square miles (mi^2).



This is an area where drainage is commonly underground. The Lares Limestone is the most dominant formation within the property and promotes infiltration and underground drainage. Due to the karst features of this

[7] Tributary of Grande de Morovis creek.

unit, such as sinkholes, solution trenches and cavities formation, it results in a relative pervious area for groundwater recharge.

3.4. Flood Zones

According to the information available from Federal Emergency Management Agency (FEMA), Flood Insurance Rate Maps (FIRMS) (Panel 72000C0660H), dated April 19, 2005, the property is located in **Zone X** (outside flooding areas). Please refer to **Figure 3: FEMA FIRM Map**.

3.5. Wetlands

According to the USFWS National Wetland Inventory (NWI) the Fránquez creek has been identified as riverine wetland type, under the classification code R5UB (Riverine, Unknown Perennial, Unconsolidated Bottom). No other areas outside the Fránquez creek have been identified or recorded as wetland or Waters of the U.S at the property.

[Note: A Wetland Study will be performed by DOVA in order to validate the absence of wetland areas within the property].

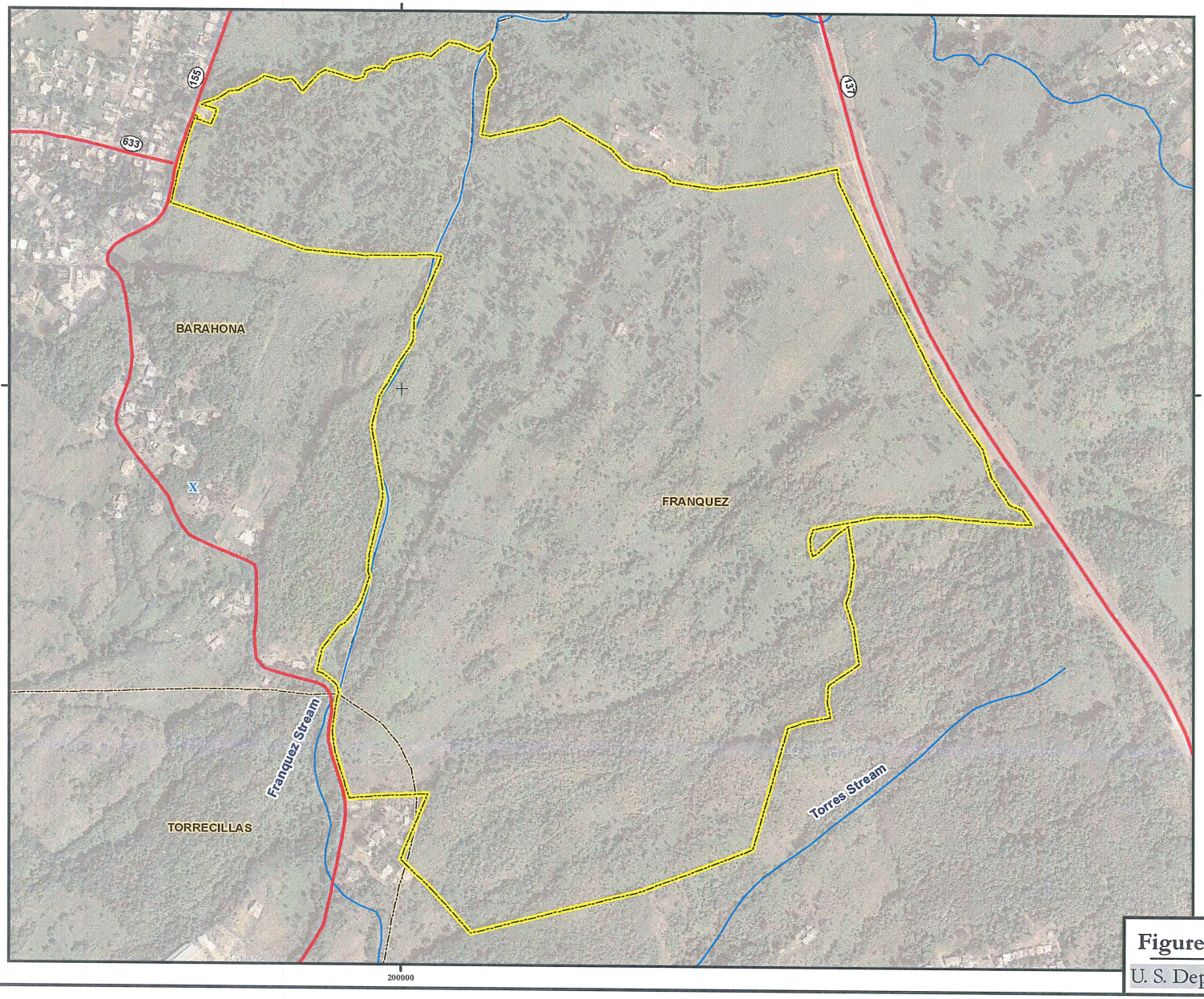
3.6. Topography, Geology, and Soils

3.6.1. Topography

As mentioned before, the property is located in the Karstic Area of Northern Puerto Rico, on a high plateau to the east-northeast of the Río Grande de Manatí (hydrographic watershed of Cibuco River (Quinones and Sigifredo, 2005)). The property exhibits a rolling topography grading downward mostly northeast toward the Grande de Morovis creek, which is an environment of low elevation elongated hills, in a sub-parallel configuration and small, shallow-elongated valleys known as solution trenches (*zanjones*). Topographic elevations vary from 130 to 182 meters above mean sea level (MSL). At some particular areas the property has developed closed depressions (suspected sinkholes or dolines), caverns and solution trenches or channels. These topographic features are commonly developed by underlain Lares Limestone.

The topographic environment in the area is significantly different from the typical karst environment of the North Coast, which is formed by conical hills known as haystack hills (*mogotes*), and alternating with intermediate semi-circular karst depressions known as dolines (*dolinas*).

The area has undergone significant changes over time in terms of land use, mainly agricultural, and the presence of residential dwellings has been very limited. Over time, the land has progressively stepped away from agriculture and over to herding of cattle. Also, communities and residential areas have been developed in adjacent areas. (GMTS, 2015)



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Scale: 1:6,000

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Meters

Legend:

- Main Roads[1]
- Property Limit
- Hydrography[4]
- Ward Limit[2]

Special Flood Hazard Areas:[3]

ZONE X (unshaded): Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level.

Sources:
1. Puerto Rico Highway and Transportation Authority (ACT by it acronym in Spanish), June 2006
2. Information provided by the Puerto Rico Planning Board
3. Federal Emergency Management Agency, Digital Flood Insurance Rate Map (DFIRM) database, Commonwealth of Puerto Rico and Municipalities, Map Numbers 72000C0660H, effective date April and 1972000C0655J, effective date November 18, 2009.
4. Information provided by the US Geological Survey
5. Ortho images provided by - UPR-Graduate School of Planning, Puerto Rico Planning Board (PRPB). VITO Belgium, FugroEarth Data Inc, October 2009 - January 2010

Coordinate System: State Plane NAD83 Puerto Rico & Virgin Islands FIPS 5200 (Meters)

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Figure 3: FEMA Flood Zones Map

U. S. Dept. of Veterans Affairs, Morovis, PR

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3.6.2. GEOLOGY

The United States Geological Survey (USGS) Map of the Ciales Quadrangle (Berryhil, 1965) illustrates a geologic setting within and in the vicinity of the property, dominated by Limestone Series formations located on the broad limestone belt known as the Karstic Area of Northern Puerto Rico, which extends from the municipality of Río Grande to the municipality of Aguadilla, where it abuts the volcanic basement rocks of the Central Mountain Range (*Cordillera Central*) of Puerto Rico. From oldest to youngest, the geologic formations that compose the Limestone Series are: Lares, Ciabo, Aguada, Ayamamón and Camuy. Karst topography is formed mainly by the disolution of the calcareous rock ($CaCO_3$, limestone).

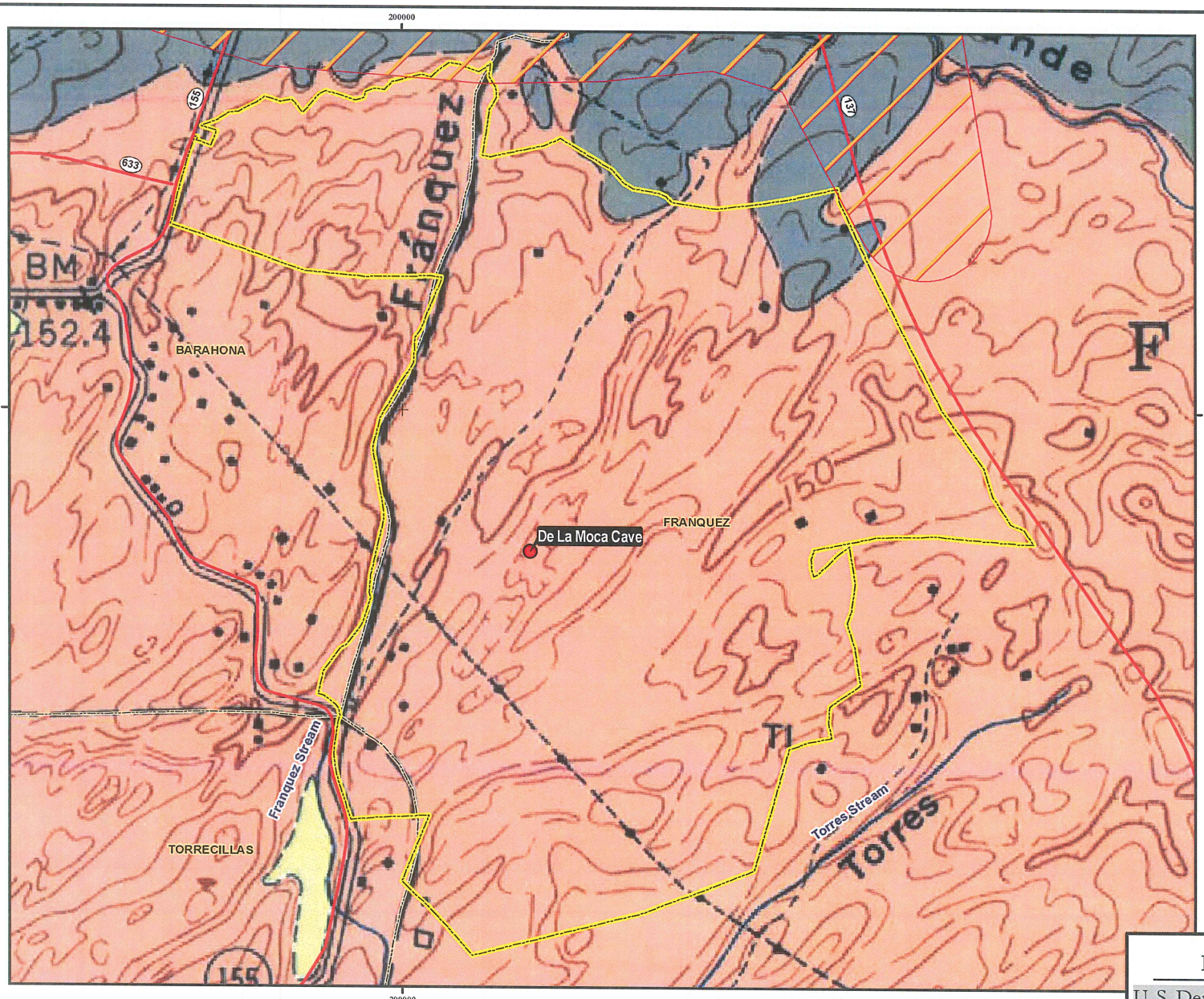
At the property, the geology is mainly comprised by outcrops of the Lares Limestone (Tl). The Cibao Formation (Tc) occupies lesser portions of the property, near the north boundary limits. The Lares represents the base of the Limestone Series of the North Coast, and conformably overlies the San Sebastián Formation[8]. The Lares Limestone (Tl) is overlained by the Cibao Formation (Tc). These formations were deposited during the early Tertiary Period, specifically during the Paleocene. A description of the formations present at the locality of the proposed site from most recent to oldest follows:

- **Lares Limestone (Tl):** Deposited in shallow marine waters, derived from coastal reef deposits and is considered a calcarenite. It is composed of dark to light gray to white colored crystalline limestone of variable stratification from thinly bedded to massive, locally fractured and fossiliferous. Where exposed, it is very indurate and resistant to erosion. The Tl has undergone extensive dissolution and contains many karstic physiographic features and a high solution porosity which includes voids and underground drainage. The stratigraphic variations influence the physiographic characteristics of the property where a solutional trench or *zanjón* karst terrain prevails over the typical alternating karstic hills and dolines karst landscape.
- **Cibao formation (Tc):** Outcrops of the Cibao Formation (Tc) of late Oligocene and early Miocene age are present along northern portions of the site. The Cibao Formation sharply overlies the Lares Formation and is the most heterogeneous formation of the middle Tertiary sequence in northern Puerto Rico. Lenticular in nature, consisting in many areas of calcareous clay and slightly clayey chalk, but it contents varies in some of its member to quartz sand, sand and gravel derived from volcanic rock and of calcarenite. In the northern part of the Ciales Quadrangle, the layers of limestone formations form ridges and scarps where their thickness affects topography. In the vicinity of the site, slopes turn more gentle nearing the contact area where the upper member of the Tc overlays the Lares Formation. The upper member of the Cibao is composed of undifferentiated chalk and marl, lenticular beds of impure limestone, and sandy marl.

[8] The San Sebastián Formation is a mainly terrigenous geologic formation, which represents a phase of stratigraphic transition and discloses the phenomenon of marine ingression that gave way to the deposition of the Limestone Series over the magmatic rocks along most of the North Coast of Puerto Rico.

The landscape along the property is shaped according to the characteristics of outcropping member of the Lares formation, thus the terrain must be carefully evaluated for future use via geotechnical exploration. See **Figure 4: Geological Map**.

Faulting is not common in northern Puerto Rico. One small fault has been recorded at approximately 1.2 miles (2 kilometers) northeast of the property. This fault is reported to have a small displacement and upthrown on the north raises Lares against Cibao (Berryhill, 1965). A structural lineament system is present within the property and has north/northwest orientation. The lineaments are congruent to fractures within the rocks and various orientations of the rocks.



Scale: 1:6,000

0 50 100 200 Meters

Legend:

- Cave
- Main Roads[1]
- Property Limit
- Ward Limit[2]

Geology

- Qa: Alluvium
- Tc: Cibao Formation
- Tl: Lares Limestone
- Area of High Susceptibility to Landsliding

Notes:
1. Location is approximate.

Sources:
1. Puerto Rico Highway and Transportation Authority (ACT by it acronym in Spanish), June 2006
2. Information provided by the Puerto Rico Planning Board
3. United States Geological Survey (USGS). Geologic Map of the GialesQuadrangle, Puerto Rico. Prepared by H.L. Berryhill Jr, W.H. Monroe, 1957-59. Bulletin 1184
5. Ortho images provided by - UPR-Graduate School of Planning, Puerto Rico Planning Board (PRPB). VITO Belgium, FugroEarth Data Inc, October 2009 - January 2010

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Figure 4: Geology Map

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3.6.3. SUSPECTED SINKHOLES AND SOLUTION TRENCHES (*ZANJONES*)

The Karstic Area of Northern Puerto Rico is known for its underground and surface physiographic features. Caves, caverns, dolines, sinkholes, solution trenches, aquifers, and springs are common in this region.

Various suspected sinkholes of different sizes and shapes occur at the property. According to the DNER, solution trenches (*zanjones*) are also present in the area. All those areas are correlated to the Lares Limestone unit in the area. The lineament system present in the property fosters the development of *zanjones* reported by the USGS (Monroe, 1980) occupying the north and central portions of the property. According to the USGS Ciales Quadrangle information, the major density of dolines or sinkholes occurs in the west-central side of the property, where thick layers of the Lares Limestone outcropped. Sinkholes and dolines are a common feature of Puerto Rico's landscape where the bedrock below the land surface is limestone that can naturally be dissolved by groundwater circulating through them. According to the USGS maps, 13 suspected sinkholes occur at different locations within the site. [Note: Sinkholes, dolines and solution trenches are some of the karts features that promote aquifer recharge. Sinkholes are protected by Act No. 111 of the DNER (Law for the Protection and Conservation of Caves, Caverns or Sinkholes of Puerto Rico)].

3.6.4. CAVE FORMATIONS

Caves are protected by Act No. 111 from July 15, 1985 of the DNER. One (1) cave was detected within the property at the following coordinates (NAD83):

- 18° 21' 2.93" N (X: 200201.325871)
- 66° 25' 53.14" W (Y: 257275.542247)

The cave is found at the foot of the west-facing flank of a northeast trending elongated karstic hill. An adjoining doline contains the cave opening. The cave is derived from solution processes within the Lares Limestone and has one opening/entrance.

The cave contains a single arched chamber that spans approximately 80 meters (260 feet) long and approximately two (2) meters (7 feet) wide. The height of the cave varies from approximately two (2) meters (7 feet) near the vestibule to nearly 2.5 meters (8 feet) toward the end. The cave runs southeasterly changing to a southerly direction towards the end. Several fragments of limestone were observed on the floor and adjacent to each wall. Few speleothems are present in the cave. However, a small group of rimstone pools or dams were observed near the end of the cave produced from water dripping from the cave's

ceiling onto the floor surface. Although the rimstone pools did not have water accumulated, water droplets percolating from the exterior via rock diaclase pathways accumulated on the ceiling of the cave.

No other relevant speleothems forms are present as the cave is devoid of significant dripstones or flowstone forms. Some trogloxene species such as cockroaches (*Periplaneta americana*), cave crickets (*Ceuthophilus sp.)*, and *guabá* or whip spider (*Phrynus longipes*) were observed on the ceiling and walls of the cave. The presence of bats or guano was not detected.

In addition, as included in the Scientific Cave Inventory from (DNER, 2014) Las Cabachuelas Cave System was indentified about one (1) mile to the east of the western boundary of the property. (See **Figure 2: Aerial Photo**).

3.6.5. SOILS

According to the Arecibo Area, Puerto Rico Northern Part from the Natural Resources Conservation Services (NRCS) (Spatial: Version 3, Dec 19, 2013) there are several soil series classified at the property, which are depicted in **Figure 4**, Soils Map. Following is provided a brief description of the soils.

- **Soller cobbly clay (SpD)** – This soil is moderately deep, moderately steep (12 to 20 %) slopes and well drained. It is on small, undulating hills and side slopes. Included with this soil in mapping are small areas of Soller soils where the subsoil is exposed at the surface and small areas of Colinas soils. Also included are areas off exposed limestone bedrock. The permeability of this Soller soil is moderate and the available water capacity is low. Runoff is rapid and natural fertility is medium. Reaction in the surface layer and subsoil is moderately alkaline. The subsoil has a high shrink-well potential.
- **Soller-Rock outcrop complex (SrF) –** This complex consists of sloping to very steep (5 to 60 % slopes), well drained soils and areas of exposed limestone bedrock. This complex is on ridgetops and side slopes. Included with this complex in mapping are small areas of Colinas, San German, Espinosa, and Almirante soils. The Soller soils have moderate permeability and low available water capacity. Runoff is moderate to very rapid. Natural fertility is medium to high. Reaction in the surface layer and subsoil is neutral to mid alkaline.
- **Moca clay (MoC2)** - This soil is deep, gently sloping (2 to 12% slopes, eroded) and moderately well drained. It is located on low, rolling hills in the humid volcanic areas. Included with this soil are small areas of Vega Alta soils. The permeability of this Moca soil is moderately slow, and the availability of water capacity is high. Runoff is rapid and natural fertility is medium. Reaction throughout the soil is very strong acid. The subsoil has a high shrink-swell potential.
- **Espinosa clay (EcB)** – This soil is deep, gently sloping (2 to 5% slopes) and well drained. It is in small valleys between limestone hills and on the coastal plains. Included with this soil in mapping are small areas of Almirante soils and exposed bedrock. Permeability is moderate. Runoff and fertility are medium and available of water capacity is high.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS)[9] as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation[10].

The three (3) essential characteristics of wetlands are hydrophytic vegetation, **hydric soils**[11], and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

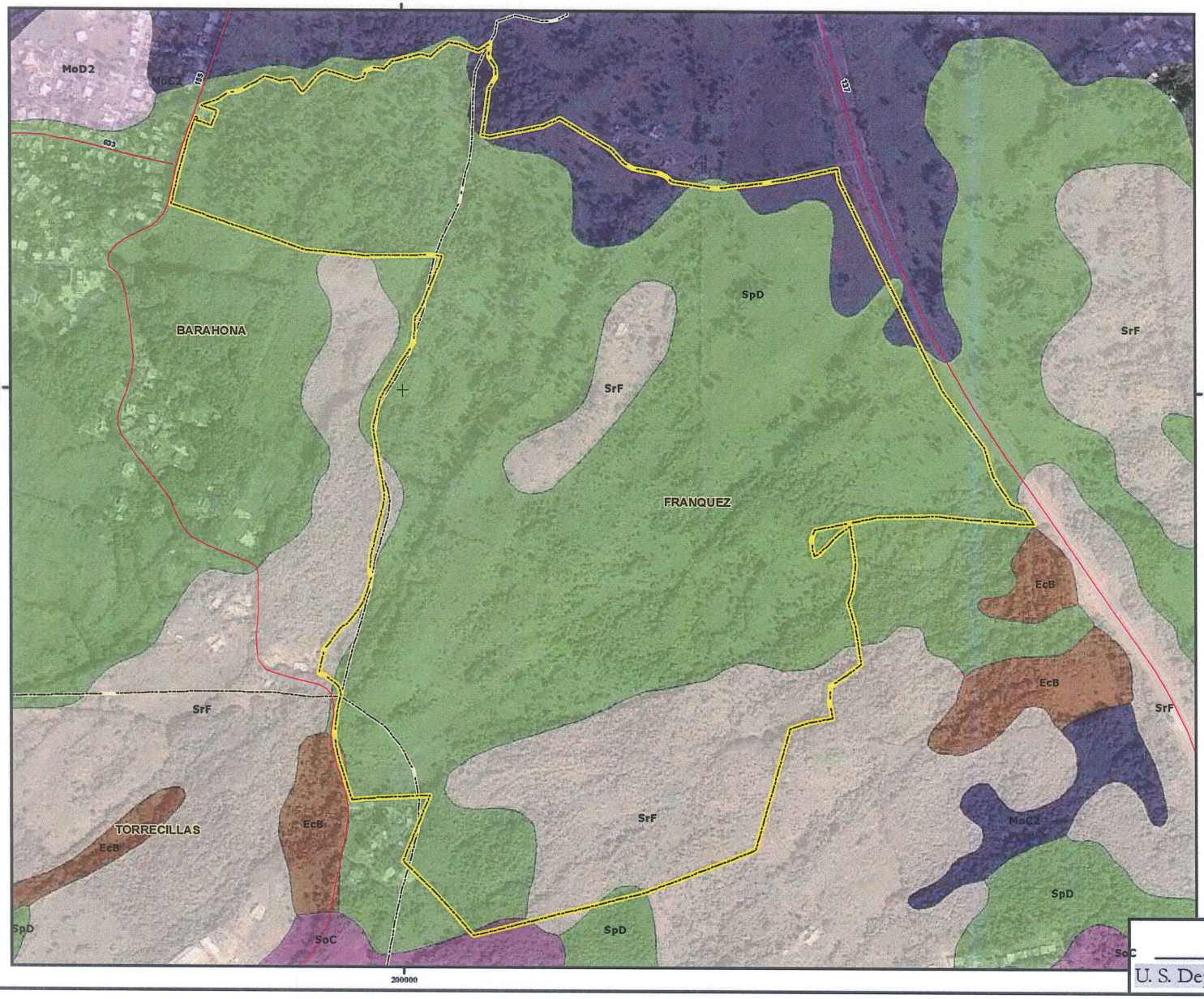
According to the NRCS Caribbean Area, **none** of these soils have been classified as hydric[12].

[9] http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/pr/soils/?cid=nrcs141p2_037283

[10] 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 (USACE 2011). http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/reg_supp/caribbean_v2.pdf; http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf

[11] If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006). http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_036967.pdf

[12] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pr/soils/?cid=nrcs141p2_037261



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Meters

Legend:

- Main Roads[1]
- Property Limit
- Ward Limit[2]

Soils

- EcB, Espinosa clay, 2 to 5 percent slopes
- MoC2, Moca clay, 2 to 12 percent slopes, eroded
- MoD2, Moca clay, 12 to 20 percent slopes, eroded
- SoC, Soller clay, 5 to 12 percent slopes
- SpD, Soller cobbly clay, 12 to 20 percent slopes
- SrF, Soller-Rock outcrop complex, 5 to 60 percent slopes

Sources:
1. Puerto Rico Highway and Transportation Authority (ACT by it acronym in Spanish), June 2006
2. Information provided by the Puerto Rico Planning Board
3. U.S. Department of Agriculture, Natural Resources Conservation Service. National Soil Information System (NASIS) data base for Arecibo area, 2006.
4. Ortho images provided by - UPR-Graduate School of Planning, Puerto Rico Planning Board (PRPB). VITO Belgium, FugroEarth Data Inc, October 2009 - January 2010

Coordinate System: State Plane NAD83 Puerto Rico & Virgin Islands FIPS 5200 (Meters)

Figure 5: Soils Map

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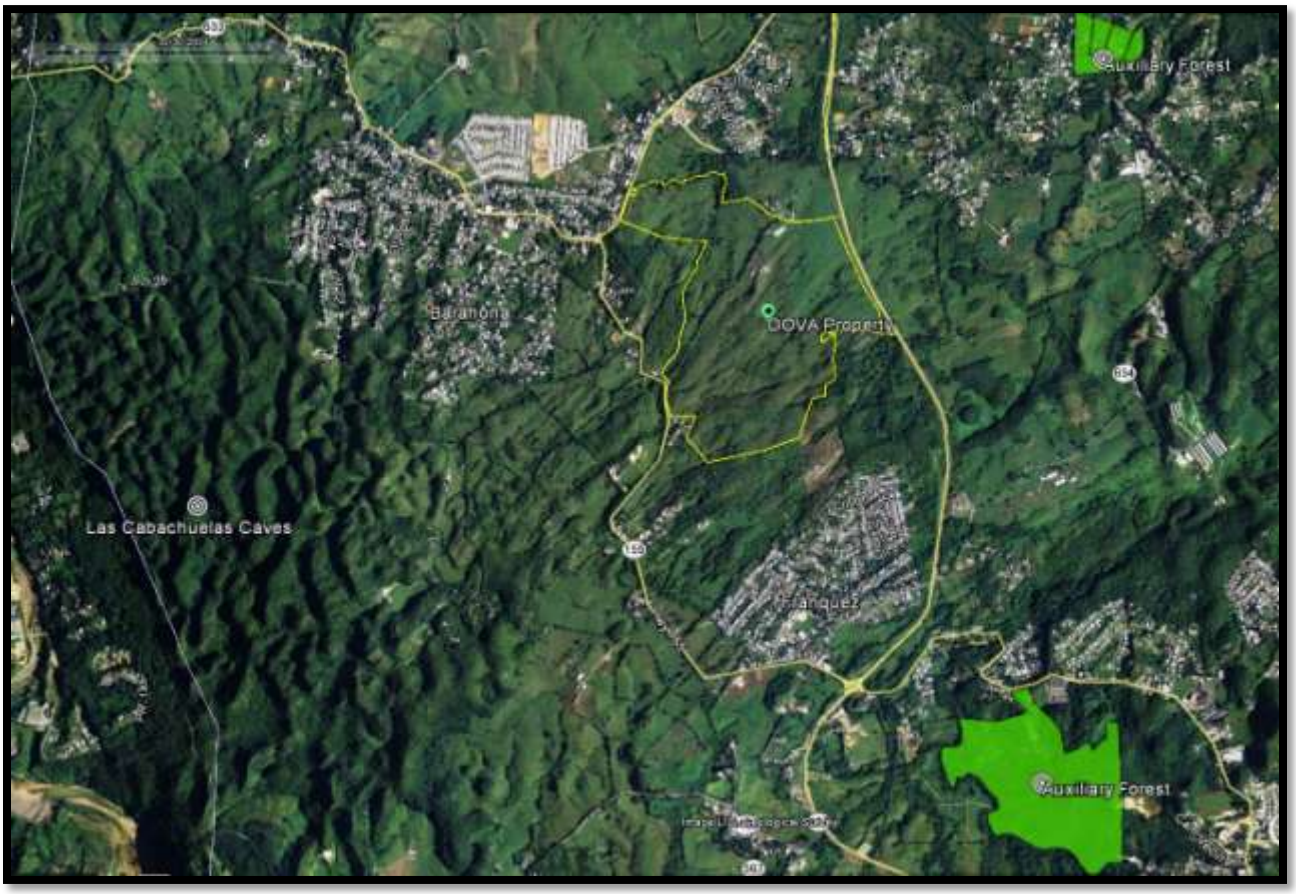
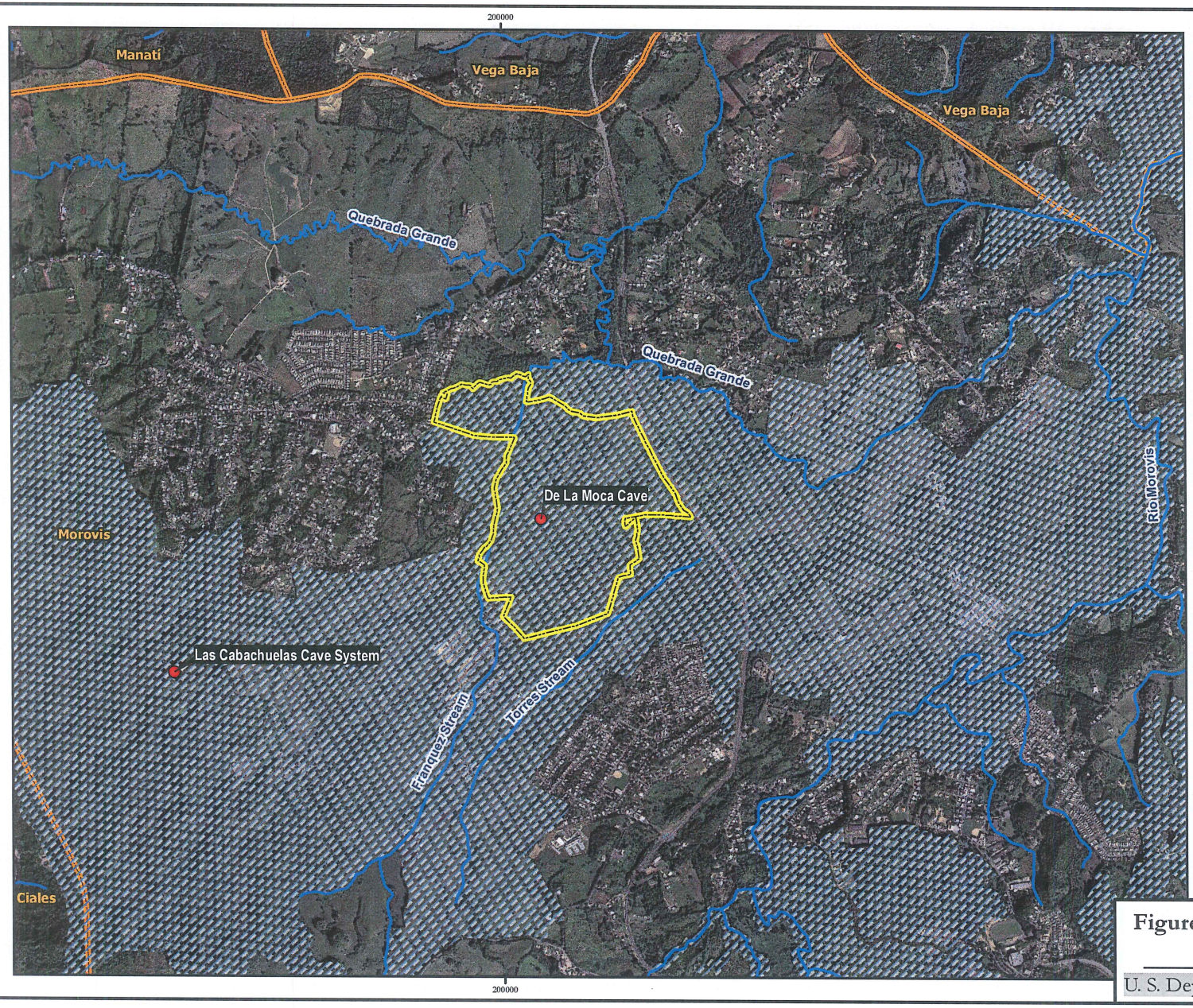
3.7. Protected Natural Lands, State Forests and Reserves within the Region

According to the DNER (Natural Heritage Division) database, no Natural State Lands, State Forest or Natural Reserves occur within or contiguous to the property limits. The nearest natural reserve (Las Cabachuelas) is located about one (1) mile from the western property boundary. The acquisition of private lands within Las Cabachuelas is undergoing by the DNER. Two (2) Auxiliary Forests[13] (private lands) have been recorded at 0.86 mile (northeast) and 1-mile (southeast) from the eastern property boundaries, respectively.



The property also occurs within the Restricted Karst Special Planning Area (*Área de Planificación Especial Restringida del Carso*), which is locally regulated by the DNER under the Karst Special Planning Area Regulation (2014) (PRAPEC, by its Spanish acronym). This was established based on the DNER's Karst Study (DNER, 2008) and Act Number 292 from August 21, 1999 (Law for the Protection and Conservation of Karstic Physiography of Puerto Rico). (**Figure 6: Natural Ecosystems and Sensitive Areas**).

[13] Voluntary program established by the DNER where private owners can registered their track of lands and obtain tax exemptions. Auxiliary Forests are those forested areas on private lands certified by the Secretary of DNER at the request of the land owner. Private owners with track of lands over five (5) acres can participate in the program (these must be dedicated to the conservation and development of forest products).



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Scale: 1:20,000

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Legend:

- Cave
- Hydrography[4]
- Property Limit
- Priority Conservation Areas
- Karst Restricted Zone[2,3]
- Municipal Limit[1]

Note:
1. Location is approximate.

Sources:
1. Information provided by the Puerto Rico. Planning Board
2. National Oceanic and Atmospheric Administration (NOAA, by english acronym), Environmental Sensitivity Index for Puerto Rico, Map number 27, may, 2000. United States Environmental Protection Agency (EPA by english acronym), Departament of Natural and Environmental Resoures of Puerto Rico, US Coast Guard and U.S. Department of the Interior
3. Ortho images provided by - UPR-Graduate School of Planning, Puerto Rico Planning Board (PRPB), VITO Belgium, FugroEarth Data Inc, October 2009 - January 2010

Coordinate System:
State Plane NAD83 Puerto Rico
& Virgin Islands FIPS 5200 (Meters)

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Figure 6: ESI Natural Ecosystems and Sensitive Areas

U. S. Dept. of Veterans Affairs, Morovis, PR

4.0 STUDY METHODOLOGY

This section describes the procedure used to conduct the flora and fauna assessment and the selection criteria for the observation points. The investigations were performed according to the procedures accepted by the DNER and the USFWS, including field assessments along the entire property.

4.1. Literature and Maps Revision from the Natural Heritage Division of the Department of Natural and Environmental Resources

Prior to the field work for the Flora and Fauna Study, a review of relevant and available scientific literature was performed. Also the database for Endangered and Critical Flora and Fauna Species at the DNER Natural Heritage Division was reviewed and discussed with the agency representatives. The database review included an inventory of all recorded species protected by state and federal laws, and other species of special concerns due to low density populations or that are associated to limited or sensitive habitats within Puerto Rico. The information was corroborated through field visits to the property performed by CSA biologists.

Scientific data review included the Critical Wildlife Areas of Puerto Rico Study (DRNA, 2005), the Puerto Rico Breeding Bird Atlas Project (SOPI, unpublished), PR-GAP Project (2007), National Oceanic & Atmospheric Administration (NOAA), Environmental Sensitivity Index Maps (ESI), and USFWS National Wetland Inventory (NWI), among others. This information was analyzed using a geographic information system (GIS) tool that allows, among other capacities, to capture, analyze, and graphically display referenced geographic data and information providing a better understanding of the current conditions of property.

4.2. Field Work

The study comprises a track of land covering a total area of approximately 247 acres (254 *cuerdas*). The field work begins with a series of preliminary reconnaissance visits during May 2015 in order to get familiar with the natural features of the area and property boundaries. This also served to validate some of the information obtained during the literature review stage, begin collecting flora and fauna species, and to establish transects and plots (observation points) for the identification of the flora and fauna species, and the different habitats.

In addition to general footwalks and reconnaissance, **36 plots** (observation point) were established (see **Figure 2: Aerial Photo**). All flora and fauna species were recorded and classified. Flora samples were collected and photographed for those species not identified in the field.

The plots methodology was implemented in addition to the general footwalk reconnaissance, due to the size and the extension of the study area. During the footwalks efforts from plot to plot, additional observations were performed recording additional flora and fauna species. This technique provides a more accurate vegetative composition and assessment of the different habitat within the property. After all the field data gathering, a comprehensive analysis was completed and a list of flora and fauna species was completed.

In addition, an avian survey was conducted at dawn and dusk, between 6:00 and 9:00 am and 4:00 pm - 6:00 pm, respectively. Special consideration was taken for forested areas, pasturelands (open areas) and the Fránquez creek. Wunderle method (1994) was implemented in order to determine the diversity of birds.

To identify the amphibians and reptiles a search was implemented in those areas that could represent suitable habitat such as, under logs and debris, crevices, moist or wet soils, suspected sinkholes, and creek. Fixed-point observations were performed at creek and suspected sinkholes to obtain a description of the species observed in those areas. Reptiles and amphibians searches at the study area were performed according to the Rivero (1998) methodology.

4.3. Data Analysis

Field data was analyzed using GIS tools and scientific techniques. The identification of plants and animals was validated using field guides and scientific references, such as Little, Woodbury and Wadsworth (1974), Liogier (1985, 1988, 1991, 1995, 1997), Acevedo-Rodríguez and Woodbury (1985), Proctor (1989), García-More and Molinari (2006), Raffaele et al. (1998), Rivero (1998), Little and Wadsworth (1999) and Acevedo-Rodríguez (2003), Acevedo-Rodriguez and Strong (2005), Acevedo-Rodriguez (1996) and Axelrod (2011).

5.0 RESULTS AND DISCUSSION

5.1. FLORA

At the property the different habitats (associations of vegetation) were identified. Also, some area within the property includes residential developments and access roads. The property shows characteristics of previous impacts by different activities, such as agriculture, cattle grazing and human activities. Five (5) main vegetation associations (habitats) have been identified within the property:

Table 4: Main Vegetation Associations (Habitats)

	Habitats	Acres	*Cuerdas*	Percentage
1.	Pastureland and shrub areas	46	47.4	19%
2.	Forestland (relative dense hardwood areas)	183	188	74%
3.	Urbanized areas	2	2.1	1%
4.	Riverine area (Fránquez creek)	2	2.1	1%
5.	Suspected Sinkhole areas	14	14.4	5%
	TOTAL	**247**	**254**	**100%**

These associations were evaluated applying GIS tools and during the field visits. As part of this study a total of **353** plant species belonging to **83** different families. A total of **237** (**67%**) of the **353** recorded species are native, and **116** (**33%**) are exotics. **Appendix 1** includes a detailed classification for each of the observed species.

Table 5: Observed Plant Species per Plant Type

Group	Number of Species
Herb	128
Tree	86
Shrub	49
Palm	3
Vine	36
Sedges	9
Parasitic Plants	1
Grasses	29
Fern	12
TOTAL	**353**

5.1.1. Shrubs and Pastures Association

This type of habitat comprises approximately **46 acres** (**47.4 *cuerdas***) of the property or 19% of available habitat. It is mainly associated to those areas subject to cattle grazing and former livestock activities. Pasturelands are relatively unused, however horses were observed at the area. Grasses and sedges dominate this type of habitat. Approximately **215** species including herbs, sedges and grasses were recorded identified through the property, where **29** species were grasses and **9** species were sedges. In regards to shrubs, **49** species were observed; including Guajava (*Psidium guajava*), Cariaquillo (*Lantana camara*), Mimosa (*Mimosa pigra*) and Higuillo limón (*Piper amalago*). Some of the herbs and vines species observed through the area include: Man-better-man (*Achyranthes aspera*), Shepherd's needle (*Bidens alba*), Florida tasselflower (*Emilia fosbergii*), *Cleoserrata speciosa*, French weed (*Commelina elegans*), Wild balsam apple (*Mormodica charanthia*), *Merremia quinquefolia* and *Euphorbia heterophylla,* among others.

Some scattered trees were observed along this habitat. The most common species were African tulip tree (*Spathodea campanulata*), Guará (*Cupania americana*), Espino rubial (*Zanthoxylum martinicesis*), Guaraguao (*Guarea guidonea*), Moca (*Andira inermis*), Royal poinciana (*Delonix regia*), Cabo de hacha (*Trichilia hirta*), Guano (*Ochroma pyramidale*), Yagrumo (*Cecropia peltata*) and Cafeillo (*Casearia guianensis*), among others. All these species were observed highly scattered through the pasturelands. Also, in some of these transition areas less common species like Staghorn clubmoss (*Lycopodiella cernua*) and Southern ladies'-tresses (*Spiranthes torta*) were observed in open grass areas.

5.1.2. Forestland Association (Secondary Forest)

This habitat comprises approximately 74% or **183 acres** (**188 *cuerdas***) of the property, distributed in several clusters or non-contiguous areas with variable density. Scattered trees previously recorded within Pastureland and Shrubs Association was also observed through the forested areas. Forested areas are commonly observed through depression and rolling hills. Based on field observations forested areas mainly consist of secondary type forests that have been recently developed or originally modified in the past due to previous land use. Based on aerial images review from different years, hardwood areas were not the most dominant habitat within the property.

The understory species observed include shrubs and young trees, as well as a variety of terrestrial and epiphytic ferns. Epiphytic species include bromeliads (*Bromeliaceae*) and anthuriums (*Araceae*). Other species observed include climbing vines such as Cat claw (*Pisonia aculeata*), False guaco (*Mikania congesta*), Ipomoea (*Ipomoea setifera*) and Pringamoza (*Tragia volubilis*).

5.1.3. Urbanized areas

This habitat comprised approximately 1% or **2 acres** (**2.1 *cuerdas***) of the property. These areas have been impacted by the construction of internal access roads, residences and infrastructure over the years. Most of the flora species observed through the urban areas are of secondary succession trees, aggressive vines and some remains of ornamentals and fruit plantings. Some of the more common species are: Espino rubial (*Zanthoxylum martinicensis*), African tulip (*Spathodea campanulata*) Cabo de hacha (*Trichilia hirta*), Moca (*Andira inermis*). Ornamental species include Traveler's tree (*Ravenala madagascarensis*), White oak (*Tabebuia heterophylla*) and West Indies mahogany (*Swietenia mahogany*), among others. There are also some ferns such as *Nephrolepis biserrata* and garden plants such as the Heartthrob day (*Cestrum diurnum*), Guava (*Psidium guajava*), Allamanda (*Allamanda cathartica*) and Trinity (*Bougainvillea spectabilis*). Vines are covering portions of the structures and the surroundings including trees. Some of the vines are the golden pottos (*Epipremnum pinnatum*), arrow-head vine (*Syngodium podophyllum*), lions paw (*Monstera deliciosa*). Some tall trees were observed along the access road, including Guará (*Cupania americana*), Espino rubial (*Zanthoxylum martinicesis*), Guaraguao (*Guarea guidonea*), Moca (*Andira inermis*), Royal poinciana (*Delonix regia*), Cabo de hacha (*Trichilia hirta*), Guano (*Ochroma pyramidale*), Yagrumo (*Cecropia peltata*) and Cafeillo (*Casearia guianensis*).

5.1.4. Riverine Area (Fránquez creek)

This are include the stream bed, the banks and a five (5) meter setback from the top-of-bank. It covers and area of approximately two (2) acres (2.1 cuerdas) and represents 1% of the entire property. The stream banks are covered with the same species described in Forestlands Association (see **Section 5.1.2**). A stream crossing (existing conduits within stream bed) of approximately eith (8) to 10 feet wide and six (6) to eigth (8) feet is located near the southern property access and is part of the existing internal access. The creek channel is well defined with an approximate width varying from five (5) to 20 feet and mostly covered with rocks. The heigh of the banks varies from five (5) to 50 feet.

5.1.5. Suspected Sinkholes Areas

These areas are covered with scattered trees and grasses similar to the vegetation composition described in **Section 5.1.1 (Pasturelands and Shrub Areas).** Trees are mostly observed along the edge of suspected sinkholes. Combined, it has a total area of 14 acres (14.4 *cuerdas*).

5.1.6. Protected Species

In terms of flora, **no** threatened or/and endangered species were observed during the field visits.

Appendix 1 includes a list of the species of flora identified at the property. In summary, none of the species observed are classified as critical elements, threatened or endangered under the state or federal regulations and laws.

5.2. FAUNA

The fauna includes a total of **73** vertebrates species, of which **51** are birds, two (**2**) fish, **15** are reptiles and five (**5**) amphibians. **Appendix 1** contains the list of observed species and classification. The following table presents the species classification for each group observed during the field visits.

Table 6: Observed Species at the Property

Group	Endemics	Exotics	Migratory	Native	Total
Birds	5	8	7	31	51
Reptiles/Amphibians	9	3	0	3	15
Mammals	0	3	0	2	5
Fish	0	2	0	0	2
TOTAL	**14**	**16**	**7**	**36**	**73**

The most common avian species within the property were the cattle egrets (*Bubulcus ibis*), domestic pigeons (*Columba livia*), great egrets (*Ardea alba*), zenaida doves (*Zenaida aurita*), Puerto Rican orioles (*Icterus portoricensis*), shiny cowbirds (*Molothrus bonariensis*), and the gay kingbirds (*Tyrannus dominicensis*). Several species of warblers and sparrows were observed, as well as three (**3**) species of swallows. Endemic birds species such as the Puerto Rican woodpecker (*Melanerpes portoricensis*), and the Puerto Rican emerald (*Chlorostilbon maugaeus*) were observed during the site visits. These species are common and widely distributed throughout island. Please refer to **Appendix 1** for a detailed list of the recorded fauna within the property.

At the Fránquez creek, the Common gallinule (*Gallinula galeata*), and Black-necked stilt (*Himantopus mexicanus*) and various species of egrets were observed through that riverine area.

Other migratory birds were observed flying through the area including the Osprey (*Pandion haliaetus*), Red-tailed hawk (*Buteo jamaicensis*), Killdeer (*Charadrius vociferous*) and Black-necked stilt (*Himantopus mexicanus*).

5.2.1. Protected Species

In terms of fauna, the Puerto Rican Boa (*Epicrates inornatus*) was the only federally and locally protected species observed within the property, near the Fránquez creek area (Riparian association). However is not discarded the presence of this species in other portions of the property. The USFWS / DNER Protection Protocol must be implemented during earth work activities. Please refer to **Appendix 2**.

6.0 HABITAT CATEGORIZATION

This section describes the categorization for the different habitats within the property. This was done in accordance to Law No. 241. This establishes the procedures and dispositions of the DNER Regulation No. 6765 (Regulation to Govern the Conservation and Management of Wildlife, Exotic Species and Hunting within the Commonwealth of Puerto Rico), and the requirements for habitat assessment, categorization and mitigation. Based on the flora and fauna inventory, vegetation association can be grouped in three (3) natural habitat categories:

1. Category 4[14] (including Forestland, riverine and sinkhole areas)
2. Category 5[15] (Pastureland and shrub areas)
2. Category 6[16] (Urbanized areas, internal access roads and PREPA ROWs)

According to Regulation No. 6765, impacts over natural habitats Category 4 would requires a 1:1 compensatory mitigation, consisting on protecting habitat of the same or higher ecological value (e.g. land acquisition, conservation eastment). However, the **PRAPEC** establishes that for Restricted Karst Special Planning Area, habitat compensation (mitigation) of the same or higher ecological value must occur in a **1:1 ratio** based on the footprint of a proposed action, without limiting to a natural habitat designation of Category 4. Natural Habitats Categorization Designation and Details are included in the following tables.

Table 7: Natural Habitats Categorization Designation

Categories		Property		Compensation Requirements as per Regulation No.6765
Category	**M^2**	**Acres**	***Cuerdas***	
# 4	805,327.6	199	204.9	Category requires avoidance, minimization and/or mitigation of impacts. Unavoidable impacts are quantified in terms of area and can be mitigated by land acquisition and donation to the DNER ("land swap") with equal or greater ecological value. (Compensation Ratio: 1:1)
# 5		46	47.4	For both habitats, mitigation is required through the implementation of protection measures or the improvements of wildlife valuable habitat within the property. In addition, it requires compliance with the DNER Joint Regulation (Chapter 47: Tree Cutting, Pruning and Reforestation)[17].
# 6		2	2.1	
TOTAL		247	254	--

[14] Natural Habitat with Ecological Value
[15] Natural Habitat with Great Potential to Become Essential Habitat, High Ecological Value or of Ecological Value
[16] Natural Habitat with Low Potential to Become Essential Habitat, High Ecological Value or of Ecological Value
[17] OGPe Joint Permit Regulation applicability (exemption) – Rule 3.4: "These provisions shall not apply to any improvement or authorized public acquisition, or other mode undertaken exclusively by the Government of the United States."

The criteria used for the habitat categorization are included in the following table.

Table 8: DNER Habitat Characterization Criteria

HABITATS	DESCRIPTION	DNER CRITERIA
• **Category No. 4**[18]	• Is characterized by a high density and diversity of wildlife species (native) that are not restricted to a specific physiography of the region.	• Have an index of biological characterization equal or greater than 4 and a distribution of wildlife species no specific to the type of habitat or region. • Have a high density of wildlife species (native) which distribution is not specific to the area or its region.
• **Category No. 5**[19]	• Does not meet the characteristics of the previous categories and could be considered with great potential to become a habitat with high ecological value.	• This type of habitat is characterized by connectivity with a value equal or greater than 4. • The term connectivity is obtained only as a functional value to provide the information necessary for the evaluation of the track of land and not to evaluate ecological connectivity • The connectivity criterion is estimated using the percentage of natural habitat in a buffer zone of 500 meters around the area to be modified. • The proximity of natural communities and the presence of hydrology on a buffer zone of 100 meters of habitat are evaluated in the study area.
• **Category No. 6**[20]	• Does not meet the characteristics of the previous categories and is characterized by having a lower connectivity. Also, is considered a natural habitat with low potential to become a habitat with high ecological value.	• To determine connectivity under this habitat category is necessary to use the criteria previously discussed.

[18] Natural Habitat with Ecological Value
[19] Natural Habitat with Great Potential to Become Essential Habitat, High Ecological Value or of Ecological Value
[20] Natural Habitat with Low Potential to Become Essential Habitat, High Ecological Value or of Ecological Value

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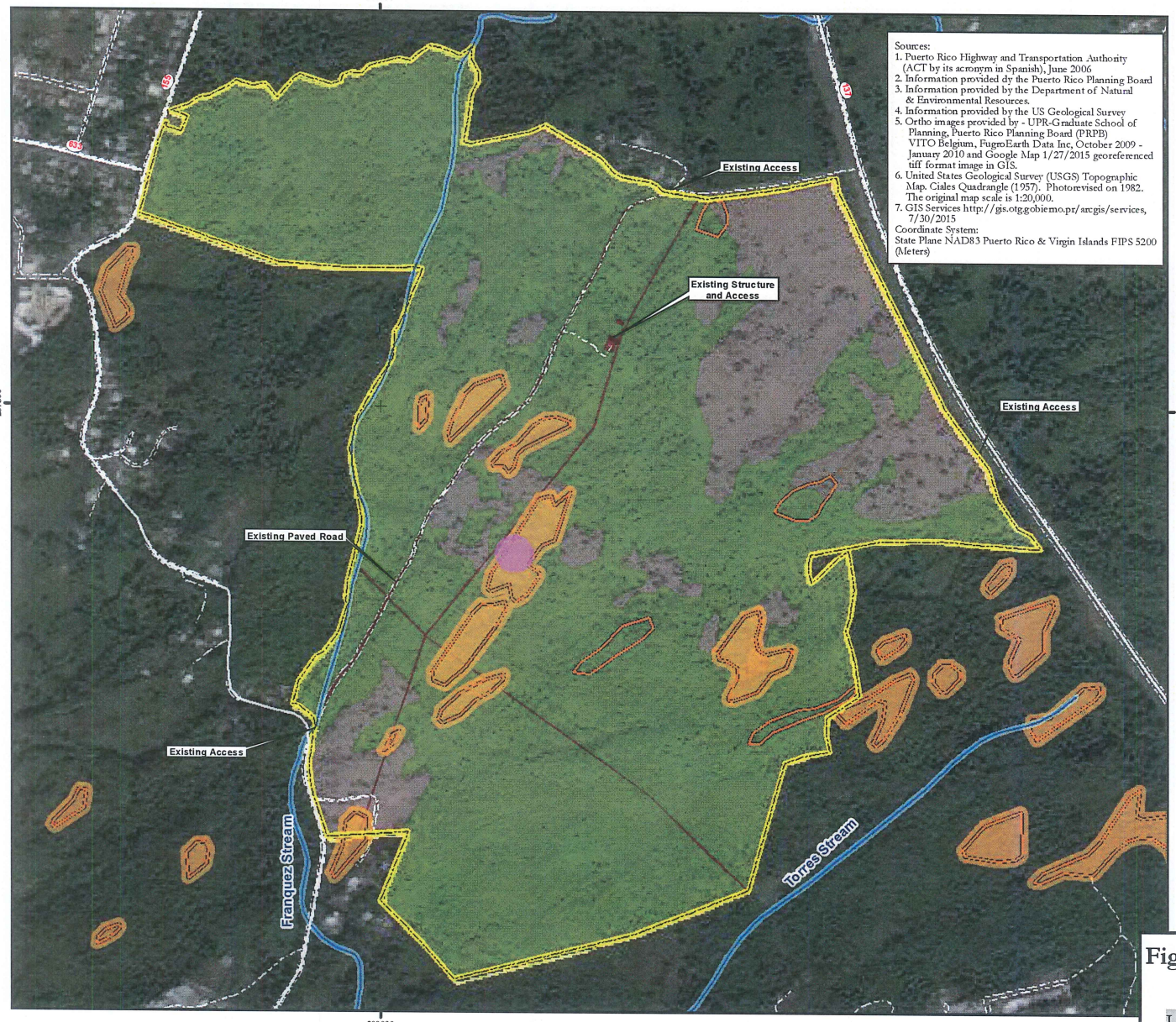

Sources:
1. Puerto Rico Highway and Transportation Authority (ACT by its acronym in Spanish), June 2006
2. Information provided dy the Puerto Rico Planning Board
3. Information provided by the Department of Natural & Environmental Resources.
4. Information provided by the US Geological Survey
5. Ortho images provided by - UPR-Graduate School of Planning, Puerto Rico Planning Board (PRPB) VITO Belgium, FugroEarth Data Inc, October 2009 - January 2010 and Google Map 1/27/2015 georeferenced tiff format image in GIS.
6. United States Geological Survey (USGS) Topographic Map. Ciales Quadrangle (1957). Photorevised on 1982. The original map scale is 1:20,000.
7. GIS Services http://gis.otg.gobierno.pr/arcgis/services, 7/30/2015

Coordinate System:
State Plane NAD83 Puerto Rico & Virgin Islands FIPS 5200 (Meters)

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Scale: 1:6,000

0 50 100 200 Meters

Legend:

- Access Roads[7]
- Main Roads[1]
- Suspected Sinkholes[2]
- Suspected Sinkholes DNER Preliminary Buffer (10m)
- Hydrography[4]
- Hydrography DNER Preliminary Buffer (5m)
- De La Moca Cave Preliminary Buffer (30 M radius)
- Property Limit

Habitat Categories:

- Category 4 — *Natural Habitat with Ecological Value - Forested Land Association*
- Category 5 — *Natural Habitat with Great Potential to Became Essential Habitat, High Ecological Value or of Ecological Value – Shrub and Pasture Association*
- Category 6 — *Natural Habitat with Low Potential to Became Essential Habitat, High Ecological Value or of Ecological Value – Urban Areas Association*

Habitat Categories Area Summary

Category	Square Meters	Acres	Cuerdas
4	802961.3	198.4	204.3
5	188717.9	46.6	48.0
6	9883.6	2.4	2.5
Total	1001562.8	247.5	254.8

Notes:
1. Habitat Categorization was perform in accordance to "Procedimiento para evaluar y determinar la categoría de un hábitat natural de acuerdo a la Nueva Ley de Vida Silvestre de Puerto Rico" (DRNA, 2008). DNER Organic Law, Law No. 23 from June 20, 1972, as amended and New Wildlife Law, Law No. 241 from August 15 of 1999, as amended.
2. Field Visit perform during the month of July 2015.
3. Field conditions were evaluated by field biologists and technical personnel taking in consideration the actual conditions of the site.
4. Delineation of the areas are approximately using the available GPS information and recent aerial photographs of the Project right of way.
5. Location of the Project was in accordance to data provided by DVA.

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Figure 7: Natural Habitat Categorization for the Project Right of Way

U. S. Dept. of Veterans Affairs, Morovis, PR

7.0 POTENTIAL IMPACTS

Overall, the property shows evidence of previous impacts associated to agriculture, livestock, internal access roads, residences, and infrastructure right-of-ways, among others. Also a section of the Fránquez creek has an existing crossin (pipe). Approximately and preliminarily, it is understood that future use of the property would impact forestlands and pasturelands. Best engineering and management practices shall be implemented to minimize impacts outside the property and project footprint limits**.**

It is anticipated that the most noticeable impact would be caused by the removal of the habitats as result of a proposed action (land use). Best Management Practices (BMPs) must be implemented to avoid and/or minimize the environmental impacts to their maximum extent, and to promote the recovery of the flora and fauna species in the vicinity. The effects of a project within this environment will require mitigation. Also after completion of the proposed action restoration of areas temporarily impacted, must be conducted; in this way it is anticipated that the seed bank will be re-activated promoting the re-colonization and allowing the vegetation communities be reestablished in certain areas.

It is also expected that construction activities would cause local displacement of the wildlife associated to the habitats identified as part of this study. Some of these species can be established in adjacent undisturbed habitats or remaining portions of the track of land that will not be impacted.

Effects can be mitigated by the implementation of the proper measures, which may include habitat reforestation, restoration, creation and conservation.

8.0 MITIGATION MEASURES AND RECOMMENDATIONS

Impacts must be considered whether or not are significant. Applicable mitigation actions should consider the following:

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

The specific mitigation actions should be identified in coordination with the USFWS and DNER based on the natural habitats categorization designation and the PRAPEC. Following is included mitigation measures and best management practices to minimize impacts, conserve and mitigate unavoidable impacts. These measures should be implemented as part of the proposed action:

- Establish and maintain a ten (10) meters buffer (set back), as a minimum, from the edge of sinkholes.
- Establish and maintain a five (5) meters buffer (set back), as a minimum, from the top of bank of the Fránquez creek.
- It is recommended to establish and maintain a 30-meters buffer (raduis), as a minimum, around De La Moca cave.
- Implementation of the Protection Protocol for the Puerto Rican boa as accepted by the DNER and USFWS. This should be implemented during the construction phase. Please refer to **Appendix 2**.
- The final design should consider natural drainage patterns and its alignments, maintaining the natural configuration to the maximum extent practicable.
- Installation of temporary protective barriers between the impact area and those areas designated to be preserved. All construction activity must be maintained within the property limits. This will reduce any impacts to areas that are outside of the construction activities.
- Design the Project to limit and reduce the earth movement, always taking into consideration the location of existing sinkholes, zanjones, caves, cavities and topographic contours.
- The design should promote wildlife connectivity and maintain natural corridors.
- Provide treatment for stormwater runoff to be generated.

- Temporary protective barriers should be installed along the perimeter of the construction limits. This will help in reducing impact to areas that are outside of the construction works such as forested lands, streams, cave formations, well defined *zanjones* and sinkholes.
- Best management practices implementation during construction and operation is necessary to minimize impacts that may affect nearby water bodies. Sedimentation barriers must be inspected regularly to prevent sediment discharges to the nearest water bodies and stop or minimize any prolonged exposure of mechanized cleared soil areas. A Stormwater Pollution Prevention Plan (SWPPP) should be prepared.
- An evaluation of designated staging areas must be conducted to discard the potential presence of protected species. The selected areas to be used as material staging and lay down areas, as well as the identification of access roads, should always be providing protection to any sensitive area. Staging areas must be located within the property and away from surface waters.
- Coordination with the United States Corps of Engineers (USACE) for any work over jurisdictional areas, as per the Clean Water Act.

9.0 REFERENCES

Acevedo-Rodríguez, P., y R. O. Woodbury. 1985. Los Bejucos de Puerto Rico. Volumen 1. General Technical Report SO-58. United States Department of Agriculture, New Orleans, LA. 331 pp.

Acevedo-Rodríguez, P. 1996. Flora of St. John: U.S. Virgin Islands, Memoirs of the New York Botanical Garden Vol. 78., New York Botanical Garden Press, Bronx, NY. 581 pp.

Acevedo-Rodríguez, P. 2003. Bejucos y Plantas Trepadoras de Puerto Rico e Islas Vírgenes. Sheridan Press, Hanover, PA. 491 pp.

Acevedo-Rodríguez, P and M.T. Strong. 2005. Monocotyledons and Gymnosperms of Puerto Rico and the Virgin Islands. National Museum of Natural History, Smithsonian Institution, Washington, DC. 415 pp.

Axelrod, F. 2011. A Systematic Vademecum to the Vascular Plants of Puerto Rico. Center for Applied Tropical Ecology and Conservation of the University of Puerto Rico – Río Piedras. National Science Foundation and Botanical Research Institute of Texas. 431 pp.

Berryhill, H.L. 1965. Geologic Map of the Ciales Quadrangle. U.S. Geological Survey. Bulletin 1184. Plate 1.

Boccheciamp, R. A. 1979. Soil Survey of Arecibo Area of Puerto Rico. United States Department of Agriculture, Soil Conservation Service, in cooperation with the University of Puerto Rico, Agricultural Experimental station. 154 pp.

Department of Natural and Environmental Resources. 2005. Puerto Rico Critical Wildlife Areas. Commonwealth of Puerto Rico. Bureau of Fish and Wildlife, Terrestrial Resources Division, San Juan, PR 385 pp.

Ewel, J. J. and J. L. Whitmore. 1973. The Ecological Life Zones of Puerto Rico and the United States Virgin Islands. Research Paper ITF-18. United States Department of Agriculture, Forest Service, Institute of Tropical Forestry, Río Piedras, PR.

GMTS, PSC. 2015. Geomorphologic Study Report Risk Analysis of Karst Environments for Puerto Rico National Cemetery, Morovis, PR. Job No. G151258.

Liogier, H. A and L. F. Martorell. 1999. Flora of Puerto Rico and Adjacent Islands: a Systematic Synopsis. 2nd Ed. Editorial Universidad de Puerto Rico, Río Piedras, PR. 382 pp.

Liogier, H. A. 1985. Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. I. Editorial Universidad de Puerto Rico, Río Piedras, PR. 357 pp.

Liogier, H. A. 1988. Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. II. Editorial Universidad de Puerto Rico, Río Piedras, PR. 481 pp.

Liogier, H. A. 1991. Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. III. Editorial Universidad de Puerto Rico, Río Piedras, PR. 461 pp.

Liogier, H. A. 1995. Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. IV. Editorial Universidad de Puerto Rico, Río Piedras, PR. 617 pp.

Liogier, H. A. 1997. Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. V. Editorial Universidad de Puerto Rico, Río Piedras, PR. 436 pp.

Little, E. L., and F. H. Wadsworth. 1999. Common Trees of Puerto Rico and the Virgin Islands. A private reprinting by the authors from Forest Service U.S. Department of Agriculture Handbook No. 249. Río Piedras, PR. 556 pp.

Little, E. L., R. O. Woodbury and F. H. Wadsworth. 1974. Trees of Puerto Rico and the Virgin Islands. Second Volume. United States Department of Agriculture Handbook No. 449-S. Washington, DC. 1024 pp.

Más, E., y O. García-Molinari. 2006. Guía Ilustrada de Yerbas Comunes de Puerto Rico. Servicio de Extensión Agrícola de la Universidad de Puerto Rico. McGraw Hill Publishing Company, New York, NY. 103 pp.

Monroe, W. H. 1980. The Karst Landforms of Puerto Rico. U.S. Geological Survey. Professional Paper 899. Plate 1.

Oficina de Patrimonio Natural de Puerto Rico. 2008. Lista de Elementos Críticos de la División de Patrimonio Natural. Departamento de Recursos Naturales y Ambientales, San Juan, PR.

Proctor, G. R. 1989. Ferns of Puerto Rico and the Virgin Islands. Memoirs of the New York Botanical Garden Vol. 53. Bronx, NY. 387 pp.

Quiñones, F. and Torres, S. 2005. Las Cuencas Principales de Puerto Rico.

Raffaele, H. A., J. Wiley, O. Garrido, A. Keith y J. Raffaele. 1998. A guide to the birds of the West Indies. Princeton University Press, Princeton, New Jersey. 411 pp.

Rivero, J. 1998. Los Anfibios y Reptiles de Puerto Rico. Segunda Edición Revisada. Editorial Universidad de Puerto Rico, Río Piedras, PR. 510 pp.

Sociedad Ornitológica Puertorriqueña, Inc. (Sin publicar). Atlas de las Aves de Puerto Rico.

United States Geological Survey. 2007. PR-GAP: Puerto Rico Gap Analysis Project, Assessing Biodiversity and Conservation in Puerto Rico. Final Deport and Data. U. S. Department of Interior. Digital Version.

Wunderle, J. M. 1994. Census Methods for Caribbean Land Birds. General Technical Report SO-100. U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, New Orleans, LA.

10.0 APPENDICES

Appendix 1 – Flora and Fauna Inventories

Appendix 2 – Puerto Rican Boa (*Epicrates inornatus*) Protocol

APPENDIX 1: Flora and Fauna Inventory

Table 9: Flora Inventory

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
MAGNOLIOPHYTA				
Acanthaceae				
Ruellia tuberosa L.	-	Many-roots	Native	herb
Thumbergia alata Bojer	Flor de poeta	Black-eye Susan	Native	herb
Agavaceae				
Furcraea tuberosa (Mill.) W.T.	Maguey criollo	-	Native	herb
Aizoaceae				
Mellugo verticillata L.	Alfombra	Carpet weed	Native	herb
Amaranthaceae				
Achyranthes aspera L. var. *aspera*	Rabo de gato	Man-better-man	Native	herb
Amaranthus dubius Mart.	Bledo	Amaranth	Native	herb
Amaranthus spinosus L.	Blero espinoso	Spiny amaranth	Native	herb
Celosia nitida Vahl.	-	-	Native	herb
Amaryllidaceae				
Hippeastrum puniceum (Lam,) Kuntze	Lirio Rojo	-	Native	herb
Hymenocallis speciosa (L.f. ex Salisb.) Salisb.	-	-	Exotic	herb
Anacardiaceae				
Comocladia glabra (Schultes) Spreng.	Carrasco	Poison ash	Native	tree
Mangifera indica L.	Mangó	Mango	Exotic	tree
Spondias monbin L.	Jobo	Yellow monbin	Exotic	tree
Spondias purpurea L.	Jobillo	-	Exotic	tree
Annonaceae				
Annona muricata L.	Guanabana	-	Native	tree
Annona reticulata L.	Corazón	Custard apple	Native	tree
Apocynaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Allamanda cathartica L.	Canario	Allamanda	Exotic	shrub
Araceae				
Anthurium crenatum	Flor de culebra	-	Native	herb
Caladium bicolor (Ait.) Vent.	Cara de caballo	Garden caladium	Exotic	herb
Colocasia esculenta (L.) Schott	Malanga	-	Native	herb
Diefenbachia seguine (Jacq.) Schott	Rábano cimarrón	Dumb cane	Native	herb
Monstera adansonii Schott.	-	-	Exotic	herb
Monstera deliciosa Liebm.	-	-	Exotic	herb
Philodendrum ornatum Schott.	-	-	Exotic	herb
Syngonium podophyllum Schott	Malanga trepadora	Arrow-head vine	Native	herb
Araliaceae				
Epipremnum pinnatum (L.)	-	-	Exotic	herb
Schefflera morototoni (Aubl.) Maguire, Stemyerm & Frodin	Yagrumo Macho	-	Exotic	tree
Xanthosoma undipes (K. Koch & C.D. Bouché)	Yautia rascosa	-	Exotic	herb
Arecaceae				
Cocos nucifera L.	Palma de Coco	Coconut Palm	Exotic	palm
Coccothrinax barbadensis (Lodd. Ex. Mart.) Becc.	Palma de abanico	Puerto Rico Silver Palm	Native	palm
Roystonea borinquena O. F. Cook.	Palma Real	Royal palm	Native	palm
Veitchia merrillii (Becc.) H.A. Moore	Palma de Adonidia	Christmas Palm	Exotic	palm
Asclepiadaceae				
Asclepias curassavica L.	Yerba de mariposa	Red milkweed	Exotic	herb
Asteraceae				
Bidens alba (L.) DC. var. *radiata*	Margarita silvestre	Shepherd's needle	Native	herb
Chromolaena odorata (L.)	Cariaquilo de Santa Maria	-	Native	herb
Conyza canadensis (L.) Cronq.	Mil hojas	Horseweed	Exotic	herb
Cyanthillium cinereum (L.) H. Rob.	Yerba socialista	-	Exotic	herb

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Eclipta postrata (L.)	Eclipta blanca	-	Native	herb
Elephantopus mollis Kunth.	Lengua de vaca	-	Exotic	herb
Emilia fosbergii Nicolson	Clavelito colorado	Florida tasselflower	Native	herb
Emilia sonchifolia (L.) DC.	Yerba socialista	Lilac tasselflower	Exotic	herb
Mikania congesta DC	Guaco Falso	-	Native	herb
Mikania micrantha Kunth in Humbolt	Guaco Falso	-	Native	herb
Parthenium hysterophorus L.	Yerba amarga	Feverfew	Exotic	herb
Pectis linearis La Llave	-	-	Native	herb
Pluchea odorata (L.) Cass.	Salvia	-	Native	shrub
Pseudoelephantopus spicatus (Juss.) C. F. Baker	Lengua de vaca	-	Native	herb
Sphagneticola trilobata (L.) Pruski in Acevedo Rodriguez	Margarita amarilla	-	Native	herb
Synedrella nodiflora (L.) Gaertn.	Serbatana	Nodeweed	Native	herb
Wedelia calcyna Rich in Persoon	Margarita de las rocas	-	Native	herb
Youngia japonica (L.) DC.	-	-	Exotic	herb
Balsaminaceae				
Impatiens walleriana Hook. F. in Oliver	Miramelindas	-	Exotic	herb
Bignoniaceae				
Crescentia cujete L.	Higüero	Calabash tree	Native	tree
Spathodea campanulata Beav.	Tulipán africano	African tulip	Exotic	tree
Tabebuia aurea (Silva Manso) Benth & Hook	Roble amarillo	-	Native	tree
Tabebuia heterophylla (DC.) Britt	Roble blanco	White cedar	Native	tree
Tecoma stans (L.) Juss. Ex Kunth in Humboldt	Sauco amarillo	-	Exotic	tree
Bixaceae				
Bixa orellana L.	Achiote	Bija	Exotic	tree
Cochlospermum vitifolium (Willd.) Spreng.	Rosa imperial	-	Exotic	tree
Boraginaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Cordia polycephalla (Lam.) I. M. Johnst.	Basora prieta	Black sage	Native	shrub
Heliotropium angiospermum Murray	Cotorrilla	Scorpion tail	Native	herb
Tournefortia hirsutissima L.	Nigua	Chiggery grapes	Native	herb
Brassicaceae				
Leptidium virginicum L.	Lentejilla	Wild pepper grass	Exotic	herb
Bromeliaceae				
Bromelia pinguin (L.) Sp. Pl.	Maya	-	Native	herb
Pitcairnia agustifolia Alton var. *augustifolia* Hort.	Piña cortadora	-	Native	herb
Tillandsia polystachia(L.) L.	Parasita	-	Native	herb
Tillandsia recurvata (L.) L.	Nidos de gungulén	Bunch moss	Native	herb
Tillandsia usneoides (L.) L.	-	-	Native	herb
Cactaceae				
Hylocereus trigonus (Haw.) Safford	Pitahaya	Night-blooming cereus	Native	shrub
Cannaceae				
Canna indica L.	Maraca roja	-	Native	herb
Canna jaergeriana L.	Maraca montuna	-	Native	herb
Caryophyllaceae				
Drymaria cordata (L.) Willd.	Yerba de estrella	Drymaria	Native	herb
Celastraceae				
Schaefferia frutescens Jacq.	Jibá	Florida boxwood	Native	shrub
Cleomaceae				
Arivela viscosa (L.) Raf. Sylva Tellur	-	-	Exotic	herb
Cleoserrata speciosa (Raf.) Iltis	Volantines preciosos	-	Exotic	herb
Tarenaya spinosa (Jacq.) Raf.	Aromo	-	Native	herb
Clusiaceae				
Camophyllum antillanum Britton in Britton & Wilson	Santa Maria	Calaba	Native	tree

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Clusia rosea Jacq.	Cupey	Balsam fig	Native	tree
Combretaceae				
Bucida buceras L.	Ucar	Oxhorn bucida	Native	tree
Terminalia catappa L.	Almendro	Indian almond	Exotic	tree
Commelinaceae				
Callisia repens (Jacq.) L.	-		Native	herb
Commelina diffusa Burm. f.	Cojitre	French weed	Native	herb
Commelina erecta L.	Cohitre azul	Blue day-flower	Native	herb
Trascadenia zebrina Hort. ex Bosse, Vollst. Handb.	Cohitre morado	-	Native	herb
Convolvulaceae				
Ipomoea setifera Poir.	Bejuco de puerco	-	Native	vine
Ipomoea tiliacea (Willd.) Choisy	Bejuco de puerco	-	Native	vine
Ipomoea triloba L.	Bejuquillo de puerco	-	Native	vine
Ipomea alba L.	Bejuco de puerco	-	Native	vine
Jacquemontia pentanthos (Jacq.) G. Don	Aguinaldo azul	-	Native	vine
Merremia quinquefolia (L.) Hallier	Batatilla blanca	-	Native	vine
Merremia umbellata (L.) Hallier f.	Aguinaldo amarillo	-	Native	vine
Costaceae				
Costus scaber Ruiz & Pav.	-	-	Exotic	herb
Crassulaceae				
Kalanchoe pinnata(Lam.) Pers.	Yerba de Bruja	-	Native	herb
Cucurbitaceae				
Cucumis anguria L.	Pepinillo silvestre	-	Native	vine
Curcubita moschata Duchesne	Calabaza	-	Native	vine
Melothria pendula L.	Pepinito	-	Native	vine
Momordica charantia L.	Cundeamor	Wild balsam apple	Exotic	vine

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Cyperaceae				
Abildgaaardia ovata (Burm f.) Kral.	-	-	Native	sedges
Cyperus compressus L.	-	-	Exotic	sedges
Cyperus esculentus L.	Chufas	-	Native	sedges
Cyperus odoratus L.	-	-	Native	sedges
Cyperus sphacelatus Rottb.	-	-	Native	sedges
Cyperus surinamensis Rothb.	-		Native	sedges
Eleocharis geniculata (L.) Roem & Schultz	-	Canada spikesedge	Native	sedges
Fimbristylis cymosa R. Br.	-	-	Native	sedges
*Fimbristylis dichotoma*L. Vahl	Junquito	-	Native	sedges
Kyllinga brevifolia Rottb.	-	Mullunbimby couch	Native	sedges
Rhynchospora colorata (L.) H. Pfeiff	-	Starrush whitetop	Native	sedges
Dioscoreaceae				
Dioscorea alata L.	Ñame de agua	-	Exotic	vine
Dioscorea bulbifera L.	Gunda	-	Exotic	vine
Erythroxylaceae				
Erythroxylum brevipes DC.	-	Brisselet	Native	tree
Euphorbiaceae				
Adelia ricinella L.	Cotorro	Ricinella	Native	herb
Astraea lobata (L.) Klotzsch	Croton lobulado	-	Native	herb
Codiaeum variegatum (L.)	Crotón de jardín	-	Exotic	shrub
Croton humilis L.	Yerba bellaca	Pepper bush	Native	shrub
Euphorbia heterophylla L.	Lechecilla	-	Native	herb
Euphorbia hirta (L.)	Lechecillo	-	Native	herb
Euphorbia hypericifolia L.	Yerba niña	-	Native	herb
Euphorbia hyssopifolia (L.)	Lechera	-	Native	herb

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Gymnanthes lucida Sw.	Yaiti	-	Native	tree
Hura crepitans L.	Molinillo	Sandbox tree	Native	tree
Jatropha gossypifolia L.	-	-	Native	shrub
Jatropha hernandiifolia Vent.	Tabaiba	-	Native	shrub
Phyllanthus niruri L.	Quinino del pobre	Gale of the wind	Native	herb
Ricinus communis L.	Higuereta	Castor bean	Exotic	shrub
Tragia volubilis L.	Pringamoza	Poison ash	Native	herb
Fabaceae				
Abrus precatorius L.	Peronía	Crab's eye	Native	tree
Albizia lebbeck (L.) Benth.	Acacia amarilla	Siris tree	Exotic	tree
Albizia procera (Roxb.) Benth.	Albicia	Tall albizia	Exotic	tree
Alysicarpus vaginalis (L.) DC.	Yerba de contrabando	False moneywort	Exotic	herb
Andira inermis (W. Wr.) DC.	Moca	Angeline tree	Native	tree
Cajanus cajan (L.) Millsp.	Gandules	-	Native	shrub
Caspareopsis monandra (Kurz) Britton & Rose	Palo de orquideas	-	Exotic	tree
Centrosema pubescens Benth.	Flor de conchitas	Butterfly pea	Native	vine
Centrosema virginianum (L.) Benth.	Conchita de Virginia	-	Native	vine
Chamaecrista nictitans ssp. *nictitans* var. *glabrata* (Vogel) Irwin & Barneby	Moriviví bobo	-	Native	herb
Clitoria ternatea L.	Flor de conchitas	Asian pigeonwings	Exotic	vine
Crotalaria pallida Aiton	-	-	Exotic	herb
Crotalaria retusa L.	Cascabelillo	Rattleweed	Exotic	herb
Dalbergia monetaria L.	Membrillo	Money-bush	Native	shrub
Delonix regia (Bojer *ex* Hook.) Raf.	Flamboyán	Flamboyant	Exotic	tree
Desmanthus virgatus (L.) Willd.	Desmanto	-	Native	herb
*Desmodium incanum*DC.	Cadillo	-	Native	herb
Desmodium tortuosum (Sw.) DC.	Zarzabarbacoa tortuosa	-	Native	herb

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Desmodium triflorum (L.) DC..	-	-	Native	herb
Erythrina berteroana Urb.	Machete	-	Native	tree
Gliricidia sepium (Jacq.)Kunth	Mata raton	Quickstick	Native	tree
Hymenaea courbaril L.	Algarrobo	Guapirol	Exotic	tree
Indigofera suffruticosa Miller	Añil	Indigo	Native	herb
Inga laurina (Sw.)Willd.	Guamá	Sacky sac bean	Native	tree
Inga vera Willd.	Guaba	River koko	Native	tree
Leucaena leucocephala (Lam.) DeWit	Tamarindillo	Wild tamarind	Exotic	tree
Macroptilidium lathyroides (L.) Urb.	Habichuela parada	Wild bush bean	Exotic	herb
Mimosa casta L.	Zarza	Graceful mimosa	Exotic	shrub
Mimosa ceratonia L.	Zarza	Black ambret	Native	shrub
Mimosa pigra L.	-	-	Native	shrub
Mimosa pudica L.	Moriviví	Sensitive plant	Native	herb
Mucuna pruriens (L) DC.	Pica-pica	Cowitch	Exotic	vine
Neptunia plena (L.) Benth.	Desmanto amarillo	Water neptunia	Native	herb
Peltophorum pterocarpum (DC.) Back. & Heyne	Flamboyán amarillo	Yellow flamboyant	Exotic	tree
Pithecelobium dulce (Roxb.) Benth.	Guamá americano	Madras thorn	Exotic	tree
Pueraria phaseoloides (Roxb.) Benth., J. Linn Soc.	Kudzu Tropical	Troipical kudzu	Exotic	vine
Senna alata (L.) Roxb.	Talan-talan	-	Exotic	herb
Senna hirsuta(L.) H.S. Irwin & Barneby	-	Wolly senna	Exotic	herb
Senna obtusifolia (L.) Irwin & Barneby	Dormidera	-	Exotic	herb
Senna occidentalis (L.) Link	Hedionda	Coffee senna	Exotic	herb
Senna siamea (Lam.) Irwin & Barneby	Casia amarilla	Siamese casia	Exotic	tree
Sesbania sesban (L.) Merr.	Sesbania	-	Exotic	shrub
Stilosanthes hamata (L.) Tabú.	Zarzabacoa enana	Pencil flower	Native	herb
Tamarindus indica L.	Tamarindo	Tamarind	Exotic	tree
Tephrosia cinerea (L.) Pers.	Añil cenizo	-	Native	herb

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Vigna hosei (Craib) Backer ex K. Heyne	-	Sarawak	Native	vine
Vigna luteola (Jacq.) Benth.	Frijol silvestre	Hairypod cowpea	Native	vine
Vigna vexillata(L.) A. Rich.	Frijol cimarrón	Zombi pea	Native	vine
Flacourtiaceae				
Casearia aculeata Jacq.	Cambrón	-	Native	tree
Casearia decandra Jacquin	Caracolillo	Wild honey tree	Native	tree
Casearia guianensis (Aub.) Urb.	Cafeíllo	Wild coffee	Native	tree
Casearia sylvestris Sw. Fl. Ind.	Cafeíllo	Wild coffee	Native	tree
Heliconiaceae				
Heliconia bihai (L.) L	-	-	Native	shrub
Heliconia caribaea Lam.	Platano de indio	-	Native	shrub
Heliconia psittacorum L.f.	-	Parakeetflower	Exotic	shrub
Lamiaceae				
Clerodendron chinense (Osbeck) Mabb.	Flor de muerto	-	Exotic	herb
Clerodendron x speciosum Dombrain	-	-	Exotic	herb
Hyptis verticillata Jacq.	-	-	Native	herb
Leonotis nepetifolia (L.) R. Br.	Botón de cadete	Lion's ear	Exotic	herb
Nectandra coriacea (Sw.) Griseb.	Avispillo	-	Native	shrub
Ocotea leucoxylon (Sw.) Laness	Cacaillo	-	Native	tree
Tectona grandis L.f.	Teca	Teca	Exotic	tree
*Persea americana*Mill.	Aguacate	Avocado	Exotic	tree
Loranthaceae				
Dendropemon caribeus Krug & Urb.	Capitana	-	Native	parasitic
Lythraceae				
Cuphea strigulosa Kunth in Humboldt, Bonpland & Kunth	-	-	Native	herb
*Lagerstroemia speciosa (*L.) Pers.	Reina de las flores	Queen of flowers	Exotic	tree

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Malpighiaceae				
Bunchosia glandulosa (Cav.) L.C. Rich	Café forastero		Native	shrub
Heteropterys laurifolia (L.) A. Juss.	Bejuco de Buey	-	Native	vine
Malpighia emarginata Sessé & Mociño	Acerola	West Indian cherry	Native	shrub
Stigmaphyllon floribundum (DC.) C. Anders	Bejuco de San Pedro	-	Native	vine
Malvaceae				
Malachra urens Poit. Ex Ledeb. In Ledebour & Alderstam	Malvavisco	-	Native	herb
Malvastrum americanum (L.) Torr. *in* Emory	Malva silvestre	False mallow	Native	herb
Melochia pyramidata L.	Bretónica piramidal	-	Native	herb
Ochroma lagopus(Cav. Ex Lam.) Urb.	Balsa	West Indian balsa	Native	tree
Pavonia spinifex L.	Cadillo espinoso	-	Native	herb
Sida acuta Burm f.	Escoba blanca	Wire weed	Native	herb
Sida rhombifolia L.	Escoba colorada		Native	herb
Sidastrum multiflorum (Jacq.) Fryxell	-	-	Native	herb
Thespesia grandiflora DC.	Maga	Maga wood	Native	tree
Triumfetta semitriloba Jacq.	Cadillo de perro	-	Native	herb
Urena lobata L.	Cadillo	Bur	Native	herb
Urena sinuata L.	Cadillo pata de perro	Bur	Native	herb
Waltheria indica L.	Malvabisco	-	Native	herb
Melastomataceae				
Clidemia hirta (L.) D. Don, Mem Wern. Nat Hist.	Camasey peludo	-	Native	shrub
Clidermia eggersii (Cong.) F.S. Axelrod	Camasey colorado	-	Native	shrub
Heterotis rotundifolia (Sm.) Jacques-Fél	-	-	Exotic	herb
Miconia impetiolaris (Sw.) D. Don ex D.C.	Camasey de costilla	-	Native	tree
Miconia prasina (Sw.) DC.	Camasey blanco	-	Native	tree
Meliaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Guarea guidonia (L.) Sleumer	Guaraguao	Muskwood	Native	tree
Melia azedarach L.	Alelailo	China berry	Exotic	tree
Swietenia mahogany L. Jacq.	Caoba dominicana	West Indies mahogany	Exotic	tree
Trichilia hirta L.	Cabo de hacha	Broomstick	Native	tree
Menispermaceae				
Cissampelos pareira L.	Bejuco de Mona	Velvet leaf	Native	vine
Moraceae				
Artocarpus altilis (S. Park.) Fosb.	Pana	Breadfruit	Exotic	tree
Ficus benjamina L.	Laurel Benjamín	Benjamin fig	Exotic	tree
Ficus citrifolia P. Mill.	Jagüey macho	-	Native	tree
Ficus stahlii Warb. *in* Urb.	Jagüey	-	Native	tree
Ficus trigonata L.	Jagüey	Wild fig	Native	tree
Musaceae				
Musa x paradisiaca L. (pro sp.)	Guineo	Banana	Exotic	tree
Mutingiaceae				
*Muntingia calabura*L.	Capulin	-	Native	tree
Myrsinaceae				
Ardisia elliptica Thumb.	-	Shoebutton ardisia	Exotic	tree
Ardisia obovata Desv.	Mameyuelo	-	Native	tree
Myrtaceae				
Eugenia biflora (L.) DC.	Hoja menuda	Black rod-wood	Native	shrub
Eugenia monticola (Sw.) DC.	Birijí	Black berry	Native	shrub
Psidium guajava L.	Guayaba	Guava	Exotic	shrub
Syzygium jambos (L.)	Pomarrosa	Pomarrose	Exotic	tree
Syzygium malaccense (L.)	Pomarrosa malaya	-	Exotic	tree
Nyctaginaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Bougainvillea spectabilis Willd.	Trinitaria	Bougainvillea	Exotic	shrub
Guapira discolor (Spreng.) Little	Barrehorno	-	Native	tree
Guapira fragrans (Dum.-Cours) Little	Corcho	Black mampoo	Native	tree
*Pisonia aculeata*L.	Uña de gato	Cat's claw	Native	vine
Oleaceae				
Jasminum fluminense Vell.	Jazmín oloroso	-	Exotic	vine
Onagranaceae				
Ludwigia octovalvis (Jacq.) Raven	Yerba de clavo	Primerose willow	Native	herb
Orchidaceae				
Ionopsis utricularoides (Sw.) Lindl.	Angelitos	-	Native	herb
Oeceoclades maculata (Lindl.) Lindl.	-	-	Exotic	herb
Polystachia concreta (Jacq.) Garay & H.R. Sweet	Parasitica	-	Native	herb
Spiranthes torta (Thumb.) Garay & H.R. Sweet in Howard	Ibis	-	Native	herb
Cranichis muscosa Sw.	-	Cypress-knee helmet orchid	Native	herb
Oxalidaceae				
Averrhoa carambola L.	Carambola	-	Exotic	tree
Oxalis latifolia Kunth in Humboldt	Violeta de monte	-	Native	herb
Papaveraceae				
Argemone mexicana L.	Cardo santo	Mexican poppy	Exotic	herb
Passifloraceae				
Passiflora edulis Sims	Parcha	Passion fruit	Exotic	vine
Passiflora suberosa L.	Flor de pasión	Passion flower	Native	vine
Phytolaccaceae				
Petiveria alliacea L.	Anamú	Garlicweed	Native	herb
Rivina humilis L.	Carmín	Cat's blood	Native	herb
Trichostigma octandrum (L.) H. Walt.	Bejuco de palma	Basket wiss	Native	vine

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Piperaceae				
Peperomia rotundifolia (L.) Kunth in Humbolt Bondpland & Kunth	Yerba de medio real	-	Native	herb
Piper aduncum L.	Higuillo	-	Native	shrub
Piper amalago L.	Higuillo de Limón	-	Native	shrub
Piper hispidum Sw.	Higuillo	Jamaican pepper	Native	shrub
Piper jacquemontianum Kunth.	-	-	Native	shrub
Piper marginatum (Miq.) C. DC.	Higuillo oloroso	-	Native	shrub
Piper peltatum L.	Baquiña	-	Native	shrub
Plantaginaceae				
Plantago major L.	Llantén	-	Exotic	herb
Poaceae				
Axonopus compresus (Sw.) P. Beauv.	-	-	Native	grasses
Bambusa vulgaris Schrad.	Bambú	Bambu	Exotic	grasses
Cenchrus echinatus L.	Abrojo	Bur grass	Native	grasses
Chloris barbata Sw.	Paragüita	Mexican blue grass	Native	grasses
Chloris radiata (L.) Sw.	Grama de costa	Plush-grass	Native	grasses
Cynodon dactylon (L.) Pers.	Bermuda común	Bermuda gras	Exotic	grasses
Cynodon nlemfuensis Vanderhyst	Yerba de estrella	-	Exotic	grasses
Dactyloctenium aegyptium (L.) Beauv.	Egipcia	-	Exotic	grasses
Digitaria cillaris (Retz) Koeler	-	-	Native	grasses
Digitaria eriantha Steud	Pangola	Pangola grass	Exotic	grasses
Digitaria horizontalis Willd.	-	-	Native	grasses
Digitaria setigera Roth.	Pendejuelo	-	Exotic	grasses
Echinocloa colona (L.) Link	Arrocillo	Jungle rice	Native	grasses
Eleusine indica (L.) Gaertn.	Pata de gallina	Goose grass	Exotic	grasses
Eragrostis ciliaris (L.) R & Br.	-	-	Exotic	grasses

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Megathyrsus maximus (Jacq.) B.K. Simon & S.W.L.	Yerba de guinea	Guinea grass	Exotic	grasses
Laciasis divaricata (L.) A.S. Hitch.	Bambuílla	Small Cane	Native	grasses
Paspalum conjugatum Berg.	Horquetilla		Exotic	grasses
Paspalum conjugatum Berg.	-	-	Exotic	grasses
Paspalum fimbriatum HBK.	-	-	Native	grasses
Paspalum millegrana Schrad.	-	-	Native	grasses
Paspalum notatum Flügge	Yerba bahía	-	Native	grasses
Saccharum spontaneum L.	Caña de azúcar silvestre	Wild sugar cane	Exotic	grasses
Setaria parviflora (Poir.)	Arrocillo	Yellow foxtail	Native	grasses
Sorghum halapense (L.) Pers.	Yerba Johnson	Johnson grass	Exotic	grasses
Sorghum saccharatum (L.) Moench	Millo	Sorghum	Exotic	grasses
Sporobolus jacquemontii Kunth	-	-	Native	grasses
Sporobolus jacquemontii Kunth	-		Native	grasses
Sporolobus tenuissimus (Schrank) Kuntze	-	-	Native	grasses
Urochloa distachya (L.) T.Q. Nguyen	Gramita	-	Exotic	grasses
Urochloa mutica (Forssk.) Nguyen.	Malojillo	-	Exotic	grasses
Polygalaceae				
Securidaca virgata Sw.	-	-	Exotic	vine
Polygonaceae				
Antigonon leptopus Hook. & Arn.	Coral	Love-chain	Exotic	vine
Polygonum punctatum Elliot	Yerba de jicotea	-	Native	herb
Portulacaceae				
Portulaca oleracea L.	Verdolaga	Purslane	Native	herb
Rubiaceae				
Coffea arabica L.	Café	Coffee tree	Exotic	shrub
Diodella sarmentosa Sw. Bacigalupo & E.L. Cabral	-	-	Native	shrub

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Faramea occidentalis (L.) A. Rich Mem. Soc. Hist. Nat.	Cafeillo	-	Native	shrub
Ixora coccinea L.	Cruz de Malta	Burning love	Exotic	shrub
Palicourea crocea (Sw.) Schultz.in Roemer and Schultes	Cachimbo	-	Native	shrub
Psychotria nervosa Sw.	Bálsamo	-	Native	shrub
Randia aculeata L.	Tintillo	Box brier	Native	shrub
Spermacoce confusa Rendle & Gillis	Hierva de hierro	Iron grass	Native	herb
Spermacoce ovalifolia (M. Martens & Galeotti)	Botoncillo	-	Native	herb
Spermacoce verticillata L.	Botón blanco	-	Native	herb
Ruscaceae				
Dracaena fragrans (L.) Ker Gawl.	Drecina	Indian cane	Exotic	herb
Sansevieria hyacinthoides (L.) Druce	Lengua de vaca	Sweet sansevieria	Exotic	herb
Rutaceae				
Citrus reticulata Blanco	Mandarina	Mandarin Orange	Exotic	tree
Citrus x limon (L.) Burm f. (pro. sp.)	Limón	Lemon	Exotic	tree
Citrus x paradisi Macfad. (pro sp.)	Toronja	Grapefruit	Exotic	tree
Citrus x sinensis (L.) Oesbeck (pro sp.)	China dulce	Orange	Exotic	tree
Zanthoxylum caribaeum Lam.	Espino rubial	-	Native	tree
Zanthoxylum martinicense (Lam.) DC.	Espino	Prickly ash	Native	tree
Salicaceae				
Casearia guianensis (Aubl.) Urb., Symb. Antill.	Cafeillo	-	Native	tree
Santalaceae				
Eubrachion ambiguum (Hook & Arn.)	-	-	Native	parasitic
Sapindaceae				
Cupania americana L.	Guara	-	Native	tree
Meliococcus bijugatus Jacq.	Quenepa	Genip	Exotic	tree
Serjania polyphylla (L.) Radlkofer	Bejuco de canastas	Basket wood	Native	vine

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Thouinia striata Radlk.	Serrasuela	-	Native	tree
Sapotaceae				
Chrysophyllum argenteum Jacq.	Caimito verde	-	Native	tree
Scrophulariaceae				
Capraria biflora L.	Té del país	Goat-weed	Native	herb
Mecardonia procumbens (Mill.) Small	Yerba de culebra amarilla	-	Native	herb
Scoparia dulcis L.	Escoba amarga	Licorice weed	Native	herb
Simaroubaceae				
Bursera simaruba (l.) Spreng.	Almácigo	Turpentine tree	Native	tree
Solanaceae				
Brugmansia suaveolens (Humb. & Bonpl. Ex. Willd.) Bercht & C. Presl	Campana	Angel's tears	Exotic	shrub
Cestrum citrifolium Retz. In Hoffmann	Galán de monte	-	Native	shrub
Cestrum diurnum L.	Galán de día	Day cestrum	Native	shrub
Physalis angulata L.	Sacabuche	Ground cherry	Exotic	herb
Solanum americanum Mill.	Yerba mora	Black night shade	Exotic	shrub
Solanum torvum Sw.	Berenjena cimarrona	Turkey berry	Exotic	shrub
Solanum viarum Dunal	-	Tropical soda apple	Exotic	shrub
Sterculiaceae				
Melochia pyramidata L.	Bretónica piramidal	-	Native	herb
Waltheria indica L.	Malvabisco	-	Native	herb
Typhaceae				
Typha dominguensis Pers.	Yerba de eneas	-	Native	herb
Urticaceae				
Cecropia schreberiana Miq.	Yagrumo hembra	Trumpet tree	Native	tree
Pilea microphylla (L.) Liebm.	Madreperla	Artillery plant	Native	herb
Verbenaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Cithrarexylum fruticosum L.	Péndula	Florida fiddlewood	Native	tree
Lantana camara L. var. *camara*	Cariaquillo	Yellow sage	Native	shrub
Lantana strigocamara R.W. Sanders	-	-	Native	shrub
Priva lappulacea (L.) Pers.	Abrojo	Bur vervain	Native	herb
Stachytarpeta jamaicensis (L.) Vahl.	Bretónica	-	Native	herb
Vitaceae				
Cissus trifoliata L.	Bejuco de caro	-	Native	vine
Cissus verticillata (L.) Nicholson & Jarvis	Bejuco de caro	Pudding vine	Native	vine
Xanthorrhoeaceae				
Aloe vera (L.) Burm. F.	Sábila	Aloe	Exotic	herb
Zingiberaceae				
Alpinia zerumbet (Pers.)	Boca de Dragón	-	Exotic	herb
Hedychium coronarium J. Koenig in Retz.	-	-	Exotic	herb
Renealmia jamaicensis(Gaertn.) Horan	Narciso colorado	-	Exotic	herb
PTERIDIOPHYTA				
Blechenaceae				
Blechnum occidentale L.	-	Hammock fern	Native	fern
Cyatheaceae				
Cyathea arborea (L.) Sm.	Helecho arboreo	-	Native	fern
Gleicheniaceae				
Sticherus bifidus (Willd.) Ching.	-	Mat forming Fern	Native	fern
Polypodiaceae				
Campyloneurum phyllitidis (L.) C. Presl.	-	-	Native	fern
Microgramma lycopodioides (L.) Copel.	-	-	Native	fern
Phlebodium pseudoaureum (Cav.) Lellinger	-	-	Native	fern
Pteridaceae				

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS	TYPE
Adianthum tenerum Sw.	Culantrillo de pozo	Maidenhair fern	Native	fern
Blechum occidentale L.	-	-	Native	fern
Cyclopetis semicordata (Sw.) J Sm.	-	-	Native	fern
Nephrolepis biserrata (Sw.) Schott	-	-	Exotic	fern
Nephrolepis rivularis (Vahl) Mattanus	-	-	Native	fern
Phlebodium aureum (L.) J. Sm.	Calaguala	-	Native	fern
Pteris longifolia L.	-	-	Native	fern
Telypteridaceae				
Thelypteris dentata (Forskal) E. St. John	-	-	Native	fern
LYCOPODIOPHYTA				
Selaginellaceae				
Selaginella plana (Desv. Ex Poir.)	Selaginella	Selaginella	Native	herb
Lycopodiella cernua (L.) Pic.	Azufre vegetal	-	Native	herb

Table 10: Fauna Inventory

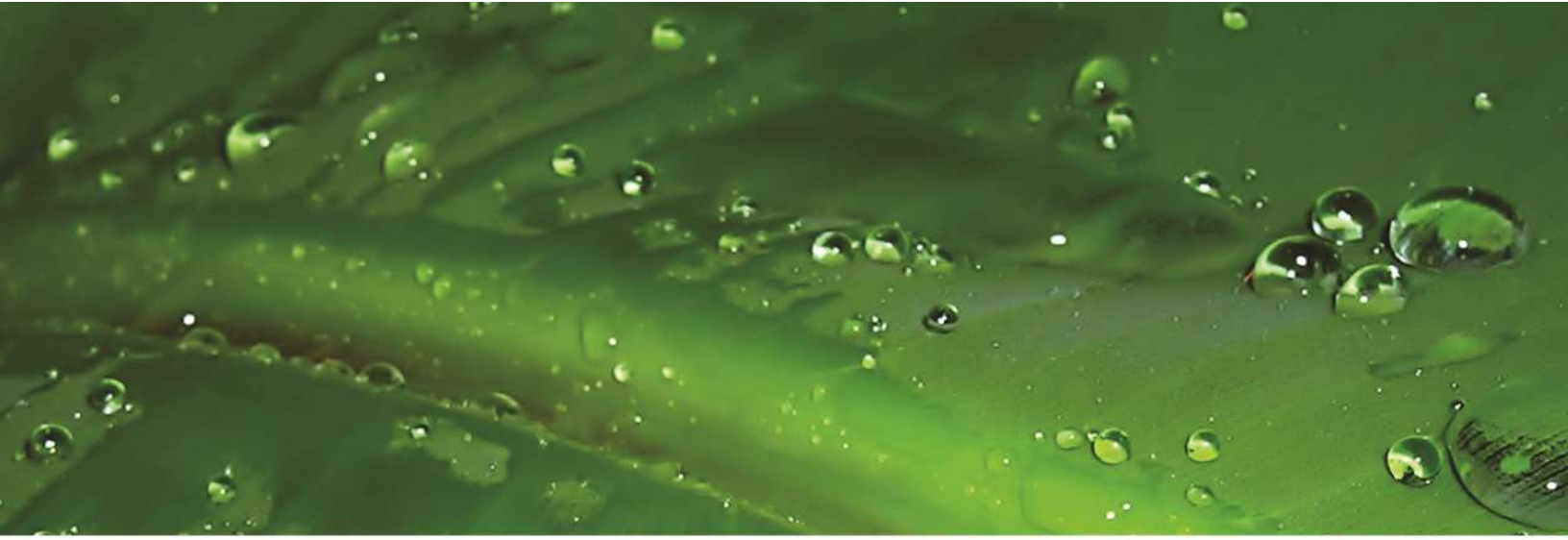
SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS
AVES			
ARDEIDAE			
Ardea alba	Garza Real	Great Egret	Native
Egretta thula	Garza Blanca	Snowy Egret	Native
Egretta caerulea	Garza Azul	Little Blue Heron	Native
Bubulcus ibis ibis	Garza Ganadera	Cattle Egret	Native
Butorides virescens	Martinete	Green Heron	Native
Nycticotorax nycticotorax	Yaboa Real	Black-crowned Night-Heron	Native
Nyctanassa violacea	Yaboa Común	Yellow-crowned Night-Heron	Native
ACCIPITRIDAE			
Pandion haliaetus	Águila Pescadora	Osprey	Native-Migratory
Buteo jamaicensis	Guaraguao Colirrojo	Red-tailed Hawk	Native-Migratory
RALLIDAE			
Gallinula galeata	Gallareta Común	Common Gallinule	Native
CHARADRIIDAE			
Charadrius vociferus	Chorlito Sabanero	Killdeer	Native-Migratory
RECURVIROSTRIDAE			
Himantopus mexicanus	Viuda	Black-necked Stilt	Native-Migratory
COLUMBIDAE			
Columba livia	Paloma Doméstica (Silvestre)	Rock Pigeon	Exotic
Patagioenas squamosa	Paloma Turca	Scaly-naped Pigeon	Native
Streptopelia roseogrisea	Tórtola Collarina	African Collared-Dove	Native
Zenaida asiatica	Tórtola Aliblanca	White-winged Dove	Native
Zenaida aurita	Tórtola Cardosantera	Zenaida Dove	Native
Zenaida macroura	Tórtola Rabilarga o Rabiche	Mourning Dove	Native
Columbina passerina	Rolita	Common Ground-Dove	Native
CUCULIDAE			
Coccyzus minor	Pájaro Bobo Menor	Mangrove Cuckoo	Native
Crotophaga ani	Garrapatero o Judío	Smooth-billed Ani	Native
STRIGIDAE			
Asio flammeus	Múcaro Real	Short-eared Owl	Native

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS
CAPRIMULGIDAE			
Chordeiles gundlachii	Querequequé	Antillean Nighthawk	Native
TROCHILIDAE			
Anthracothorax dominicus	Zumbador Dorado	Antillean Mango	Native
Chlorostilbon maugeaus	Zumbadorcito	Puerto Rican Emerald	Endemic
PICIDAE			
Melanerpes portoricensis	Carpintero de Puerto Rico	Puerto Rican Woodpecker	Native-Endemic
FALCONIDAE			
Falco sparverius	Falcón Común	American Kestrel	Native
TYRANNIDAE			
Tyrannus dominicensis	Pitirre	Gray Kingbird	Native
HIRUNDINIDAE			
Progne dominicensis	Golondrina de Iglesias	Caribbean Martin	Native-Migratory
Petrochelidon fulva	Golondrina de Cuevas	Cave Swallow	Native
Hirundo rustica	Golondrina Horquillada	Barn Swallow	Native-Migratory
TURDIDAE			
Turdus plumbeus	Zorzal Patirrojo	Red-legged Thrush	Native
MIMIDAE			
Mimus polyglottos	Ruiseñor	Northern Mockingbird	Native
Margarops fuscatus	Zorzal Pardo	Pearly-eyed Thrasher	Native
PARULIDAE			
Setophaga americana	Reinita Pechidorada	Northern Parula	Native-Migratory
Setophaga adelaidae	Reinita Mariposera	Adelaide's Warbler	Native-Endemic
COEREBIDAE			
Coereba flaveola	Reinita Común	Bananaquit	Native
THRAUPIDAE			
Spindalis portoricensis	Reina Mora	Puerto Rican Spindalis	Native

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS
EMBERIZIDAE			
Loxigilla portoricensis	Comeñame	Puerto Rican Bullfinch	Native-Endemic
Tiaris olivaceus	Gorrión Barba Amarilla	Yellow-faced Grassquit	Native
Tiaris bicolor	Gorrión Negro	Black-faced Grassquit	Native
ICTERIDAE			
Quiscalus niger	Mozambique	Greater Antillean Grackle	Native
Molothrus bonariensis	Tordo Lustroso	Shiny Cowbird	Native
Icterus portoricensis	Calandria	Puerto Rican Oriole	Native-Endemic
Icterus icterus	Turpial	Venezuelan Troupial	Exotic
PASSERIDAE			
Passer domesticus	Gorrión Doméstico	House Sparrow	Exotic
PLOCEIDAE			
Euplectes franciscanus	Obispo Anaranjado	Orange Bishop	Exotic
ESTRILDIDAE			
Estrilda melpoda	Veterano	Orange-cheeked Waxbill	Exotic
Lonchura cucullata	Diablito o Pandillero	Bronze Mannikin	Exotic
Lonchura punctulata	Gorrión Canela	Nutmeg Mannikin	Exotic
VIDUINAE			
Vidua macroura	Viuda Colicinta	Pin-tailed Whydah	Exotic
AMPHIBIA			
BUFONIDAE			
Bufo marinus	Sapo Común	Cane Toad	Exotic
LEPTODACTYLIDAE			
Eleutherodactylus antillensis	Coquí Churí	-	Native-Endemic
Eleutherodactylus coqui	Coquí Común	-	Native-Endemic
Leptodactylus albilabris	Ranita de Labio Blanco	White-lipped Frog	Native-Endemic
REPTILIA			
HYLIDAE			
Osteopilus septentrionalis	Rana Platanera	-	Exotic
EMYDIDAE			

SCIENTIFIC NAME	SPANISH COMMON NAME	COMMON NAME	STATUS
Trachemys stejnegeri	Jicotea de Puerto Rico	Puerto Rican Slider	Native-Endemic
IGUANIDAE			
Iguana iguana	Iguana Verde	Green Iguana	Exotic
POLYCHROTIDAE			
Ctenonotus cristatellus	Lagartijo Común	Common Anole	Native-Endemic
Ctenonotus pulchellus	Lagartijo de Jardín	Grass Anole	Native
Ctenonotus gundlachi	Lagartijo Barba Amarilla	Yellow-bearded Anole	Native-Endemic
Ctenonotus stratulus	Lagartijo Manchado	Barred Anole	Native
Ctenonotus evermanni	Lagartijo Verde	Green Anole	Native-Endemic
Xiphosurus cuvieri	Lagartijo Gigante de PR	Puerto Rican Giant Anole	Native-Endemic
TEIIDAE			
Ameiva exsul	Siguana Común	Puerto Rican Common Ameiva	Native-Endemic
GECKONIDAE			
Sphaerodactylus macrolepis	Salamanquita Común	Common Puerto Rican Gecko	Native
MAMMALIA			
MOLOSSIDAE			
Molossus molossus	Murciélago de Techos	Velvety Free-tailed Bat	Native
PHYLLOSTOMIDAE			
Artibeus jamaicensis	Murciélago Frutero	Jamiacan Fruit Bat	Native
MURIDAE			
Rattus norvegicus	Rata	Brown Rat	Exotic
Mus musculus	Jarriero	House Mouse	Exotic
MUSTELIDAE			
Herpestes auropunctatus	Mangosta	Indian Mongoose	Exotic
OSTEICHTHYES			
POECILIIDAE			
Poecilia reticulata	Gupi	Guppy	Exotic
CENTRARCHIDAE			
Micropterus salmoides	Lobina Negra	Largemouth Bass	Exotic

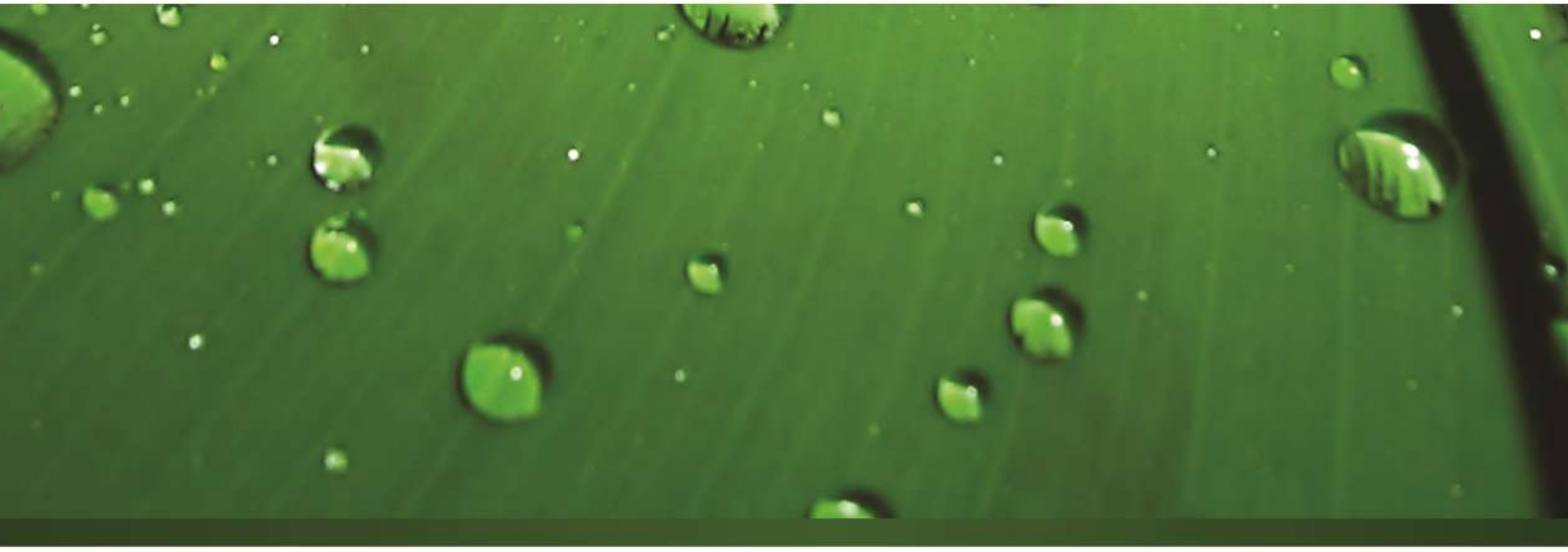
APPENDIX 2: Puerto Rican Boa Protection Protocol



Appendix 2: *Protection Protocol for Search, Capture and Relocation of Puerto Rican Boa (Epicrates inornatus)*

U.S. Department of Veterans Affairs

Municipality of Morovis, Puerto Rico



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1. INTRODUCTION

The Puerto Rican Boa is only known from Puerto Rico (endemic), where it has been recorded throughout the Island, being most common in moist and wet forests, most common in haystack hills (*mogotes*) of northern and north-western Puerto Rico (Pérez-Rivera and Vélez, 1978). Some individuals have also been found in dryer areas near the coasts. The species appears to be more abundant than previously thought. The Puerto Rican Boa (*Epicrates inornatus*) is the largest snake in the Island, measuring up to 2.2 meters Snout-Vent Length (SVL).

In 1970, the species was designated as endangered and was legally protected by the Endangered Species Act of 1973, as amended. Since then the boa still is listed as an endangered species by local, federal, and International Conservation Agencies. The decreasing boa population is attributed predominantly to human impact. Habitat loss, mongoose predation, poaching for oil extraction, and killing because of innate fear, religious prejudice, or ignorance are the main factors affecting the species. The secretive habits and cryptic coloration of this species, and the rough terrain and dense forest of its habitat, make it difficult to study individuals for extended periods. More recently, there is an indication that the boa has recovered somewhat in recent years, although not to the degree that protective measures can be dropped.

It is possible that the species suffered from the effects of the extensive deforestation early in the 20th Century. The industrialization of the Puerto Rican economy and the subsequent establishment of secondary forests may have provided suitable habitat, permitting the species to increase its population size. There are no reliable data to assess the total population of Puerto Rican Boas (USFWS, 1986a).

1.1 Species Background

Historic records, some dating back to the 18th century, indicate that during the first few centuries of Spanish colonization in Puerto Rico the boa was relatively abundant, and oil produced from the snake's fat was utilized extensively as an export. Impacts to the boa resulting from the oil trade were undoubtedly heightened by a concurrent reduction of habitat. Deforestation of the island began during this period and continued until, by the early 20th century, very little natural forest remained. When an expedition from the U.S. Natural Museum visited Puerto Rico in 1900, the boa had become so rare that no specimens could be collected. Predation by the mongoose, introduced into Puerto Rico in the 20th century, has been postulated as a further cause for the boa's present status, but there is no direct evidence to support this idea. There is an indication that the boa has recovered somewhat in recent years, although not to the degree that protective measures can be dropped.

The Recovery Plan prepared by the U.S. Fish & Wildlife Service (USFWS) for the Puerto Rican Boa can be found at http://ecos.fws.gov/docs/recovery_plan/PR%20boa%20recov%20plan.pdf.

2. SPECIES DESCRIPTION

2.1 General Information

Their coloration is plain, but variable, ranging from light to dark brown to gray or black (Schwartz and Henderson, 1991). Sometimes, individuals may exhibit a series of dark spots or bars along the dorsal side (Rivero, 1998). Maximum size is approximately 6.5 feet. Young Puerto Rican boas prey upon invertebrates, lizards, and frogs, shifting toward warm-blooded organisms when mature. Most of the reproductive cycle commences in the rainy season and females gestate for a period of 152-193 days giving live birth to 15 to 32 young.

Rodriguez and Reagan (1984) report bat predation by the Puerto Rican boa. The boa feeds by seizing the prey in its jaws, wrapping several coils around the victim, and then constricting until the prey has suffocated. The prey is then swallowed head first. The feeding habits of the very young are unknown.

2.2 Geographic range

The Puerto Rican boa is endemic to the island of Puerto Rico. However, the boa is most often encountered in the northern limestone karst belt or Puerto Rico that extends from Carolina (west) to Aguadilla (Pere-Rivera & Velez, 1978).

2.3 Feeding Behavior

The boa feeds by seizing the prey in its jaws, wrapping several coils around the victim, and then constricting until the prey has suffocated. The prey is then swallowed head first. The feeding habits of the very young are unknown. However, locals claim they eat small lizards, other small vertebrates and some insects.

Since the karst region in which the Puerto Rican boa lives usually has many caves, the boa has the opportunity to feed on bats. It was previously unknown how the boa managed to capture the bats in flight. Observations revealed that boas hang at the opening of the cave, waiting until bats fly out of it. Then they grab a bat with their jaws before killing it via constriction.

3. BOA PROTECTION PROTOCOL

If a snake is sighted **DO NOT HARASS, HARM, CAPTURE, KEEP, INJURE OR KILL** the species; and stand back, observe it and contact the designated Field Biologist. Snakes don't purposefully position themselves to frighten people. They would much rather avoid encounters and usually will flee.

There is no good reason to kill a snake except in the unlikely situation of a poisonous snake posing immediate danger to people or pets. Snakes usually bite people only if they are molested; it's their only means of self-defense. Even a poisonous snake in the woods or crossing the road poses no threat and should be left alone.

Snakes can only be removed by qualified personnel from working areas without harming the species through the use of funnel or similar traps. The frequent sighting of snakes near dwellings or out-buildings may indicate the presence of rodents. Removal of brush, lumber or other debris accumulations will discourage both rodents and snakes.

Prior to any construction activity, including the earth and vegetation removal, the following activities must be done:

- A site meeting shall be held with the resident engineer, contractor, subcontractors, management personnel and construction workers associated with this Project, in which biologists from the Department of Natural and Environmental Resources (DNER), U. S. Fish & Wildlife Service (USFWS), or any authorized expert on this matter will discuss the biology, importance, habitat, legal status and consequences of harming or taking the Puerto Rican Boa.
- A field biologist shall be assigned permanently to the Project area for surveying Puerto Rican boas during the construction (land clearing; clearing and grubbing) phase. The field biologist shall request a DNER[1] Collection Permit.

The resident engineer, in coordination with the field biologist will be responsible to implement the procedures in the event that an individual of this species is found. The biologist will be available for each working shift during land clearing operations.

The survey must be scheduled according to the contractors plan. Daily changes in these work plans shall be taken into account for planning the surveys and protection protocol. The field biologist, in coordination with the resident engineer, shall evaluate the proposed area prior to clearing to determine the amount of time required for the field inspection. Surveys shall be conducted early in the morning, prior to the use of machinery in the area. The machinery shall also be closely inspected for the presence of boas.

[1] Department of Natural & Environmental Resources

The methodology to be implemented for the Puerto Rican Boa surveys at the Project site must be as follows:

- The designated biologist and/or other authorized personnel shall conduct surveys early in the morning, prior to the use of machinery in the area. Special attention or effort must be dedicated within the areas where machinery, equipment or vehicles will be working.
- Boas must be searched on the canopy, stems, trees and palms axils, understory vegetation, ground, roads and trails, crevices in rocks and wood, under rocks and woody debris and within any old structures.
- Boas must be also searched within the machinery, heavy equipment and vehicles that stay overnight in the Project area.

The Project construction areas shall be flagged and a security fence shall be placed along or around any sensitive area, to protect the habitat of the species and to delineate the construction limit. Also, signs shall be posted to preclude construction activities from taking place in these areas.

If a snake that resembles a Puerto Rican Boa is found, the following steps shall be taken:

1. Any construction activity around a 50 feet radius from the snake must stop.
2. Any persons shall not injure, harm harass or kill this species.
3. One person must keep watch on the snake while another contacts the field biologist.
4. Depending on the location of the snake (on the ground, in a tree, in a hole, depression or crevice), the biologist should bring a burlap sack, tarp, or a large box by the snake. If it is possible to do so without harming the specimen, the snake can be placed in the burlap sack. The snake's natural tendency would be to crawl into a dark place, such as the sack or box. Once captured, the snake must be taken to a quiet cool place within the area and wait for DNER personnel. If the snake does not crawl into the sack or box, it may be covered by the tarp and watched there until the DNER personnel arrive.
5. Once the snake is removed from the Project site, construction activities may resume. The specimen must be released in a suitable habitat, in coordination with the DNER.
6. After the approved personnel has removed the snake, the biologist shall be responsible for preparing a complete report of the incident, including, but not limited to the following major points:
    a. Exact location of the snake;
    b. Circumstances of the sighting;
    c. Order and timing of procedures followed after the sighting;
    d. Personnel involved in each step of the procedures;
    e. Perceived conditions of the snake at the time of sighting, behavior, and conditions of the

snake when removed by the approved person; and

f. The name, time of contact and time of arrival of the approved person.

The resident engineer must review each report. All the reports shall be consolidated on a final report which must be sent to the DNER and the USFWS once the land clearing activities are completed.

The contact agencies or personnel are the following:

Name	Agency	Phone Number
Sgt. Ángel E. Atienza	DNER, Law Enforcement Division	(787) 815-1575 / 502-2278
Miguel García	DNER, Fish & Wildlife Bureau	(787) 999-2200
Ramón L. Rivera Lebrón	DNER, Land Resources Division	(787) 999-2200, (787) 772-2028
Alberto Puente	UPR-Arecibo, Biology Department	(787) 871-1240

4. REFERENCE LITERATURE

Bird-Pico, F.J. 1994. Final Report on *Epicrates inornatus* survey throughout Puerto Rico. Cooperative Agreement between U.S. Department of Interior, Fish & Wildlife Service and the Department of Biology, University of Puerto Rico, Mayaguez Campus.

Joglar, R. L., A. O. Álvarez, T. M. Aide, D. Barber, P. A. Burrowes, M. A. García, A.B León Cardona, A. V. Longo, N. Pérez-Buitrago, A. Puente, N. Ríos-López and P. J. Tolson. 2007. Conserving the Puerto Rican Herpetofauna. Applied Herpetology 4: 327-345.

Moreno, J. A. 1991. Accounts of those species considered to be concern. *In* Status y Distribución de los reptiles y anfibios de la región de Puerto Rico, ed. J. A. Moreno, 9-10. Puerto Rico: Miscellaneous Scientific Publication No. 1 DNER of Puerto Rico.

Pérez-Rivera, R. A., and M. J. Vélez. 1978. Notas sobre algunas culebras de Puerto Rico. Science-Ciencia 6(1):68-73.

Reagan, D. P., and C. P. Zucca. 1982. Inventory of the Puerto Rican boa (*Epicrates inornatus*) in the Caribbean National Forest. CEER T-136, 42 pp.

Reagan, D. P. 1984. Ecology of the Puerto Rican Boa (*Epicrates inornatus*) in the Luquillo Mountains of Puerto Rico. Caribbean Journal of Science. 20 (3-4):119-126.

Rivero, J. A. 1998. Los anfibios y reptiles de Puerto Rico. Editorial Universitaria. San Juan, Puerto Rico, 152 pp.

Tolson, P. J., and Herdenson, R. W. 1993. The Natural History of the West Indies Boas. R and A Publishing Limited, Somerset, England.

U.S. Fish and Wildlife Service. 1970. Conservation of Endangered Species and other fish and wildlife: Appendix D: United States List of Endangered Native Fish and Wildlife Federal Register 35, No. 199, October 23, 1970. Chapter I – Bureau of Sport Fisheries and Wildlife, Department of Interior.

U.S. Fish and Wildlife Service. 1990. Endangered and threatened species of the Southeastern United States (The Red Book). Division of Endangered Species. Region 4. November 1990.

U.S. Fish and Wildlife Service. 2000. *Endangered Species List (Puerto Rico/Virgin Islands)*. Division of Endangered Species.

Proposed Puerto Rico National Cemetery Phase 1 Construction Emissions Calculations

Calculation of Fugitive Dust from General Construction

Area Description	Area	Exposed Area	Duration	EF TSP	Control Efficiency	Estimated Emissions
	(Acres)	(Acres)	(months)	(ton/acre/mo	(%)	(tons/year)
Total Area, Each Alternative	67	50		1.2	80	144.0

http://www.epa .gov/ttnc hie1/ap42/ch13/fina l/c13s02-3.pdf

Emission factor Section 13.2.3 "Heavy Construction Operations" (dated 1/95), of AP-42, "Compilation of Air Pollutant Emission Factors", 5th Edition, U.S. EPA, Research Triangle Park, NC, 1998

Assumed Total Operational Hours for Construction Equipment

Equipment Type	number	hours/da	total days	total hours
grader	2	8		10448
backhoe	6	8		31344
bulldozer	2	8		10448

SCAB Fleet Average Emission Factors (Diesel)

	ROG	CO	NOx	SOx	PM	CO2	CH4
	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
graders	0.1197	0.5883	0.8866	0.0015	0.0441	133.0000	0.0108
Tractors/Loaders/Backhoes	0.0610	0.3689	0.4070	0.0008	0.0258	66.7979	0.0055
Rubber Tired Dozers	0.2591	0.9834	2.0891	0.0025	0.0858	239.0905	0.0234

http://www.aqmd. gov/home/regulations/ceqa /air-qua lity-analysis-ha ndbook/off-road-mobile-source-emission-factors

Emission factor year 2016. Composite emission factor used.

Calculation of Criteria Pollutant Emissions from Nonroad Construction Vehicles

		ROG	ROG	CO	CO	NOx	NOx	SOx	SOx	PM	PM
Equipment	hours	(lb/hr)	total pounds	(lb/hr)	total pounds	(lb/hr)	total	(lb/hr)	total pounds	(lb/hr)	total pounds
graders	10448	0.1197	1250.63	0.5883	6146.56	0.8866	9263.19	0.0015	15.67	0.0441	460.76
Tractors/Loaders/Backhoes	31344	0.0610	1912.41	0.3689	11563.52	0.4070	12756.36	0.0008	24.29	0.0258	809.02
Rubber Tired Dozers	10448	0.2591	2707.14	0.9834	10274.43	2.0891	21827.17	0.0025	25.61	0.0858	896.79
Total Pounds			5870.17		27984.51		43846.72		65.58		2166.56
Total Tons			2.9351		13.9923		21.9234		0.0328		1.0833

Non-Road Emissions in Tons

Pollutant	VOC	CO	NOx	SOx	PM
Annual Emissions (tons/year)	1.1731	5.5926	8.7626	0.0131	0.4330

Proposed Puerto Rico National Cemetery Phase 1 Construction Emissions Calculations
Haul Truck Calculations

Amount of Excavation Material from Each Phase, cubic yards	Phase 1 (30 months)	1,326,178	<---Enter cubic yards
Total Excavation Material, cubic yards		1,326,178	
Amount of cubic yards one truck can handle		16	
Number of Truck Trips Required		82,886	
Miles per trip		60	

Heavy Duty Diesel Vehicle (HDDV) Average Emission Factors (grams/mile)

HDDV	Multiplier (1 gram = 0.00220462 lbs, then multiplied by total miles)	VOC	CO	Nox	SO2	PM10	PM2.5	PM total
Emissions, grams/mile	1	0.3250	0.8320	2.8170	0.0120	0.1100	0.0830	0.19
Emissions, lbs over 30 months	10,963.94	3,563.3	9,122.0	30,885.4	131.6	1,206.0	910.0	2,116.04
Emissions, tons over 30 months		1.782	4.561	15.443	0.066	0.603	0.455	1.058
Emissions per YEAR,		0.713	1.824	6.177	0.026	0.241	0.182	0.423

Notes:
1. Emission Estimation Method for Hauling Excavation Materials and Construction Supplies: United States Air Force (USAF) Institute for
2. Emissions factors for all pollutants are from USAF IERA 2013.

Assumptions:
1. Haul trucks carry average of 16 cubic yards of material per trip.
2. The average distance from the project site to the materials source is estimated to be 30 miles; therefore, a haul truck will travel 60 miles round
3. Estimated number of trips required by haul trucks = total amount of material/16 cubic yards per truck.