EVALUACIÓN BIOLÓGICA

B

HIGHWAY PR-22 EXTENSION

Hatillo to Aguadilla

Biological Assessment Report

Prepared for:
Puerto Rico Department of Transportation and Public Works
Highway and Transportation Authority

Prepared by:
URS Corporation Southern
7650 West Courtney Campbell Causeway
Tampa, Florida 33607

February 2007

TABLE OF CONTENTS

List of Appendices

TABLE OF CONTENTS (continued)

List of Figures

List of Tables

1.0 INTRODUCTION

The Puerto Rico Department of Transportation and Public Works, through its Highway and Transportation Authority (PRHTA), is evaluating alternatives for extension of Highway PR-22 (PR-22). The build alternatives include construction of either a new controlled access toll road, improvement of existing Highway PR-2 (PR-2), or a combination of both through the Municipalities of Hatillo, Camuy, Quebradillas, Isabela, Aguadilla and Moca (Figure 1-1). The proposed PR-22 extension project will provide a high vehicular capacity roadway for users and will reduce travel time between municipalities along the northwest coast of Puerto Rico.

There are three build alternatives and one no-build alternative under study for the PR-22 extension:

- Alternative A: Construction of a new cross-country route extension of PR-22 (José de Diego Highway) located south of PR-2 (Figure 1-2). Alternative A would begin about 700 meters (2,300 feet) south of the existing PR-22 Hatillo Toll Plaza. It will end where it joins existing PR-2, about 300 meters (985 feet) south of the existing interchange of PR-2 and Highway PR-111 (PR-111). Three highway connectors are also included in Alternative A, connecting proposed PR-22 with existing PR-2. These are located at the Camuy/Quebradillas municipality boundary, in the municipality of Isabela, and in the municipality of Aguadilla.

- Alternative B: The conversion of PR-2 to an expressway (Figure 1-3). Alternative B will begin at the intersection of existing PR-22 and PR-2 in the municipality of Hatillo and end about 300 meters (985 feet) south of the intersection of PR-2 and PR-111 in Aguadilla.

- Alternative C: A combination of Alternatives A and B (Figure 1-4). Alternative C would begin about 700 meters (2,300 feet) south of the existing PR-22 Hatillo Toll Plaza. It will end where it joins existing PR-2, about 300 meters (985 feet) south of the existing interchange of PR-2 and PR-111. One highway connector is also included at the Camuy/Quebradillas municipality boundary.

- Alternative D: No action (No-Build).

The purpose of this Biological Assessment (BA) is to evaluate the effects each alternative may have on Federal and Commonwealth listed species and their habitats. In addition, this BA presents conservation measures and construction guidelines that will be used to off-set potential effects to listed species. This BA was conducted as part of the Section 7 Consultation Process of the Federal Endangered Species Act of 1973, as amended.

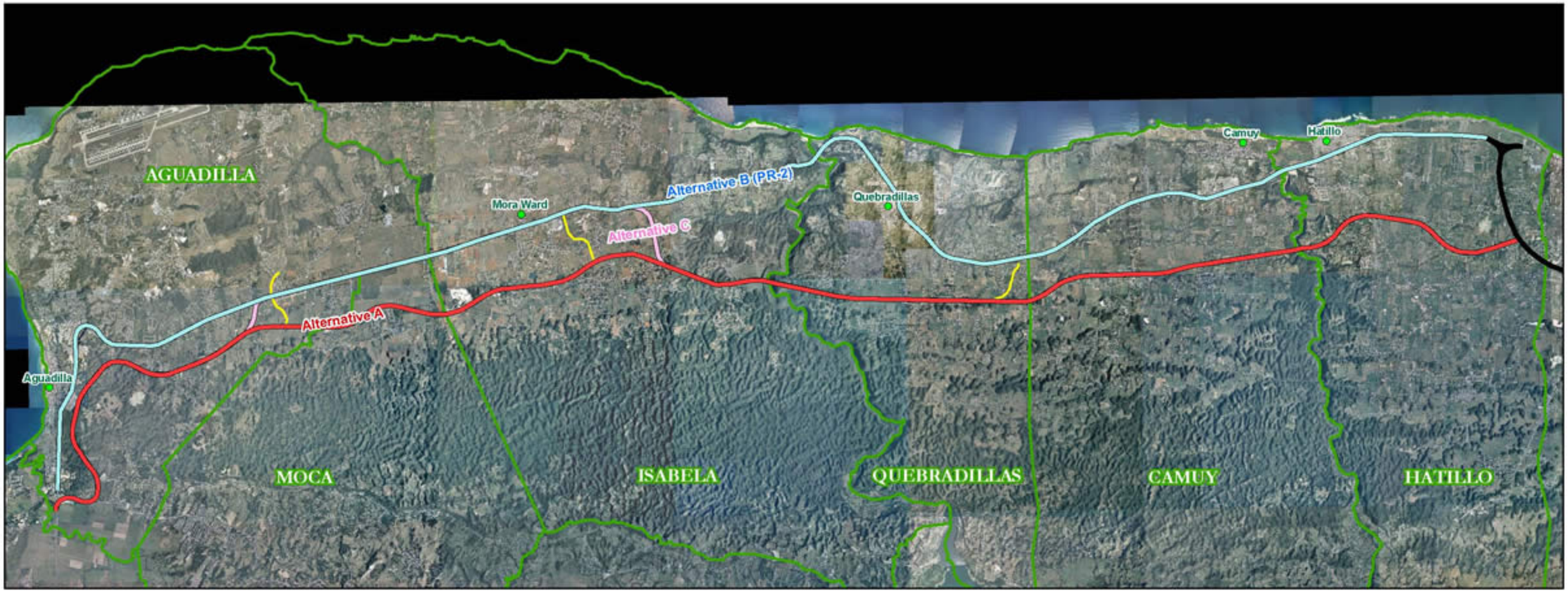


Figure 1-1

PR-22 Extension

Alternatives A, B, & C

Hatillo To Aguadilla

- Alternative A Center Line
- Alternative B Center Line (PR-2)
- Alternative C Center Line
- Alternative A Connectors
- Municipality Boundaries
- Jose de Deigo Highway (PR-22)
- Major Cities

N W E S

Kilometers
0 1.5 3 6

Miles
0 1.5 3 6

Data Source: Guillermety, Ortiz & Associates

Orthophoto Mosaic derived from CRIM Basemap 1996-1998

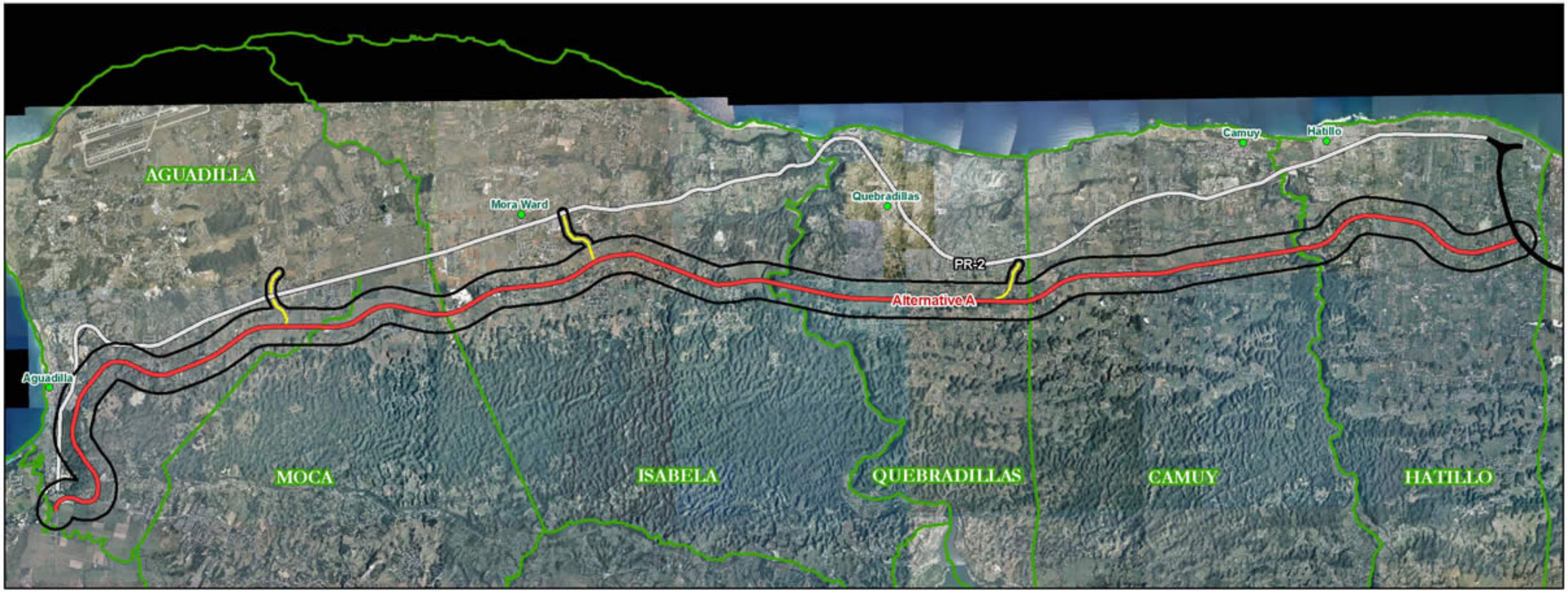


Figure 1-2

PR-22 Extension

Alternative A

Hatillo To Aguadilla

- Alternative A Center Line
- Alternative A Study Corridor
- Highway PR-2 (Existing)
- Alternative A Connectors
- Municipality Boundaries
- Jose de Deigo Highway (PR-22)
- Major Cities

N W E S

Kilometers
0 1.5 3 6

Miles
0 1 2 4

Data Source: Guillermety, Ortiz & Associates

Orthophoto Mosaic derived from CRIM Basemap 1996-1998

H:\projects\12005276_PR22\Applic\abs\mxd\Alternative_A_loc.mxd

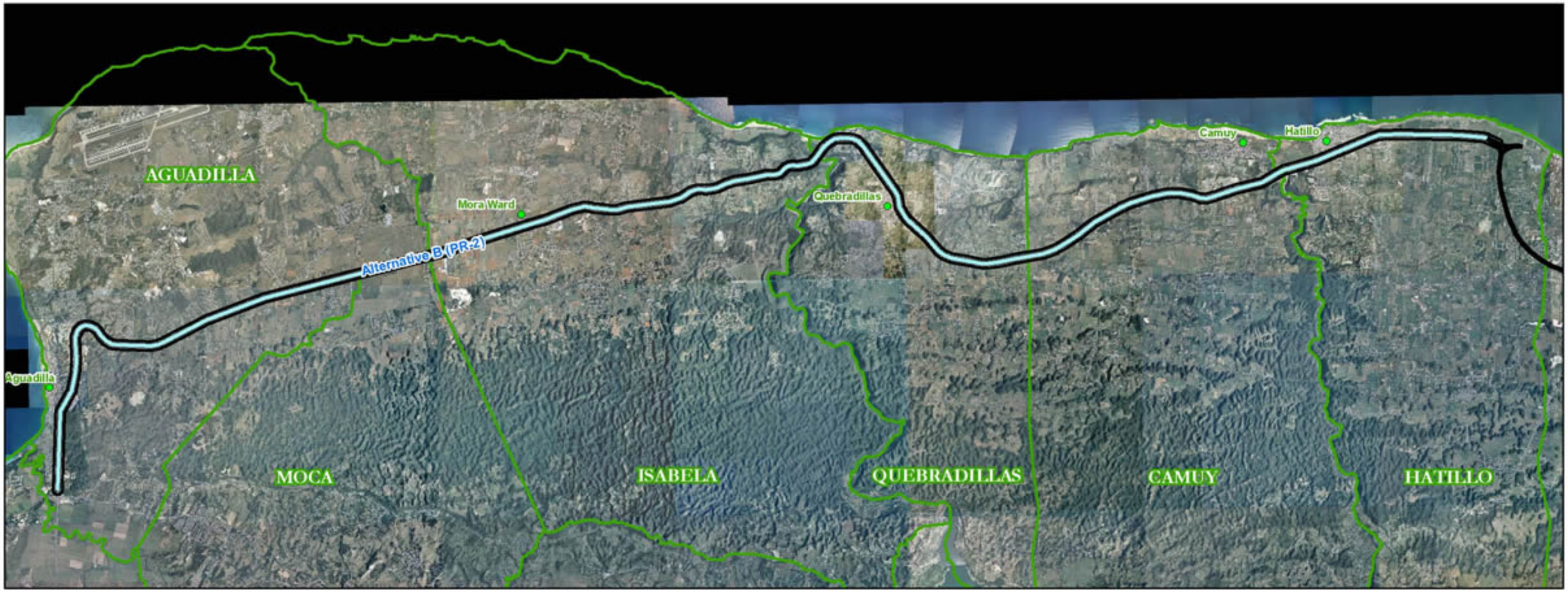


Figure 1-3

PR-22 Extension

Alternative B

Hatillo To Aguadilla

Alternative B Center Line
(Highway PR-2)
Alternative B 250m Study Corridor
Municipality Boundaries
Jose de Deigo Highway (PR-22)
Major Cities

N
W E
S

Kilometers
0 1.5 3 6

Miles
0 1.5 3 6

Data Source: Guillermety, Ortiz & Associates

Orthophoto Mosaic derived from CRIM Basemap 1996-1998

H:\projects\12005276_PR22\Applications\mxd\Alternative_B_loc.mxd

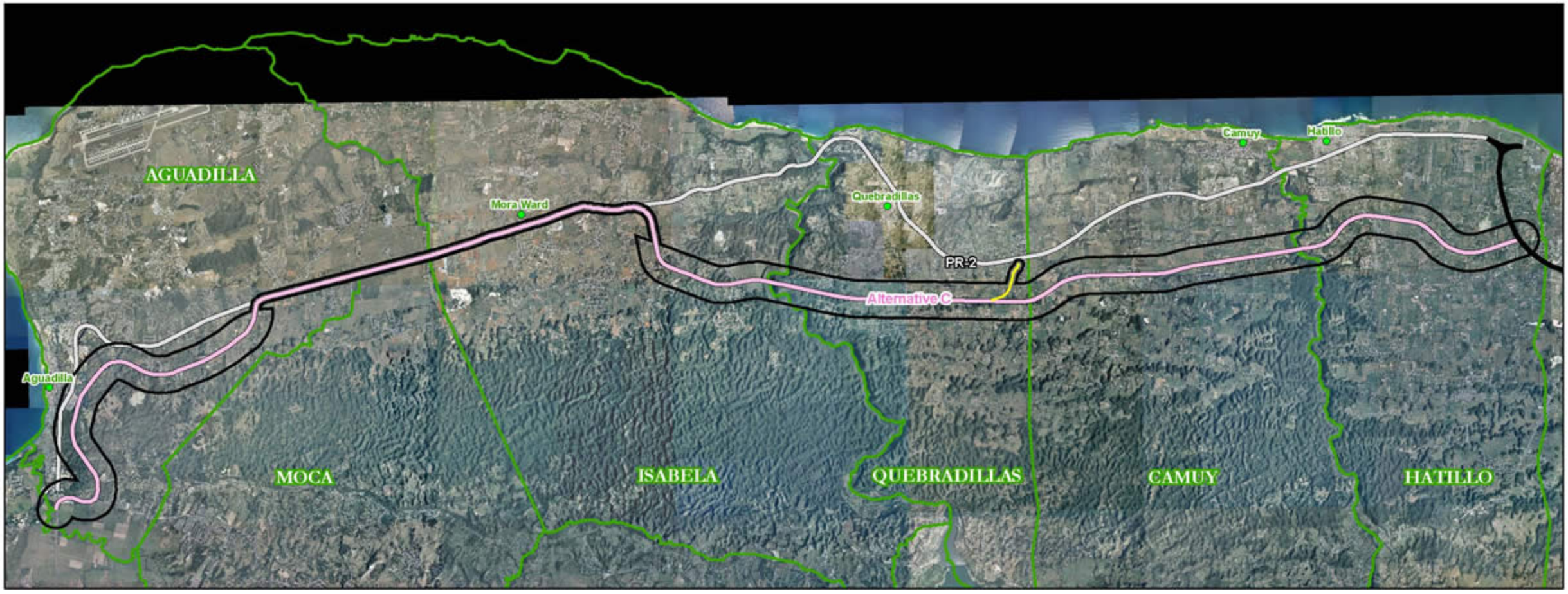


Figure 1-4

PR-22 Extension

Alternative C

Hatillo To Aguadilla

Alternative C Center Line
Highway PR-2 (Existing)
Alternative C Study Corridor
Alternative A Connectors
Municipality Boundaries
Jose de Deigo Highway (PR-22)
Major Cities

N
W
E
S

Kilometers
0 1.5 3 6

Miles
0 1.5 3 6

Data Source: Guillermety, Ortiz & Associates

Orthophoto Mosaic derived from CRIM Basemap 1996-1998

I:\projects\12005276_PR22\Applications\mxd\Alternative_C_loc.mxd

1.1 Description of Alternatives

1.1.1 Alternative A (Preferred Alternative)

Alternative A proposes the construction of a new east-west expressway with a minimum of two lanes in each direction, exterior and interior shoulders, and a median with the provision for possible future internal expansion of one additional lane in each direction. This alternative is an extension of the existing José de Diego Expressway (PR-22) through the rural areas of Hatillo, Camuy, Quebradillas, Isabela, Moca, and Aguadilla municipalities. The proposed alignment is located south of existing PR-2, with the exception of the final segment (in Aguadilla) which is located west of PR-2. There are three highway connectors from the proposed Alternative A corridor to existing PR-2. One occurs in Isabela near station 272+00, a second in Quebradillas approximately at station 150+00, and the last in Aguadilla near station 365+00. The approximate length of Alternative A is 46 kilometers (28.6 miles) and the right-of-way's minimum width is 90 meters (295 feet), or 45 meters (148 feet) from each side of the centerline. Including the three connectors, the total area of the Alternative A right-of way is 451 hectares (1,113 acres).

Alternative A was proposed by the PRHTA as the preferred alternative after review of the community and economic impacts associated with each action alternative. Alternative A would require right-of-way acquisition and construction of a new roadway. It would divide, relocate, or lead to the acquisition of dairy and agricultural farms located in the path of the right-of-way corridor. Alternative A will improve the road system to allow transport of goods and services and connect the island's northwest area municipalities with the metropolitan region of San Juan. Alternative A would also allow for two major routes (the proposed corridor and existing PR-2) to traverse northwestern Puerto Rico, resulting in redistributed traffic and an alternate route when future road or bridge repairs are required.

1.1.2 ALTERNATIVE B

Existing PR-2 is the principal highway from Hatillo to Aguadilla. Currently, PR-2 lacks controlled access and has numerous intersections both with and without traffic lights. Alternative B consists of converting PR-2 to a limited access expressway. The conversion would provide the number of lanes necessary to maintain acceptable operational conditions (i.e., a minimum level of service C) along the expressway with fully controlled access. One- and two-way marginal streets would be provided to direct and move traffic at new overpasses. The approximate length of Alternate B is 47 kilometers (29.2 miles) with a minimum right-of-way width of 90 meters (295 feet), or 45 meters (148 feet) from each side of the centerline. The total area of the Alternative B right-of-way is 443 hectares (1,093 acres).

1.1.3 ALTERNATIVE C

Alternative C consists of a combination of Alternative A and a segment of existing PR-2 within Alternative B. Segments of Alternative A included within Alternative C are; (1) from Hatillo to Isabela, and (2) that portion within the municipality of Aguadilla. These two segments would

consist of a tolled expressway, a minimum of two lanes and exterior shoulders in each direction, and a median with provision for future interior lane and shoulder expansion.

The segment of existing PR-2 within Alternative C is that portion from the western half of the municipality of Isabela through the east side of the municipality of Aguadilla. This segment would consist of a non-tolled expressway, two or three lanes in each direction with exterior shoulders, one- or two-way marginal streets, and median barriers.

The approximate length of Alternative C is 48 kilometers (29.8 miles), with a minimum right-of-way width of 90 meters (295 feet), or 45 meters (148 feet) from each side of the centerline. The total area of the Alternative C right-of-way is 446 hectares (1,102 acres).

1.1.4 ALTERNATIVE D (NO ACTION ALTERNATIVE)

Alternative D is the "No Action" alternative. With this alternative the existing PR-2 would continue to be the principal roadway connecting the six contiguous municipalities from Hatillo to Aguadilla in the northwestern region of Puerto Rico. PR-2 would continue to undergo routine roadway maintenance and minor improvements. It would remain a multiple lane highway with over 30 signalized intersections and no access control where operational conditions have a high potential for overuse as development in the area continues and the residential population grows.

2.0 METHODOLOGY

2.1 Study Corridors

For this BA, a study area (study corridor) was established for each of the three build alternatives as described below.

Alternative A Study Corridor – Alternative A consists of a new alignment and the final design has not been determined, therefore, its study area consists of a one-kilometer-wide corridor centered along the proposed roadway alignment.

Alternative B Study Corridor – Alternative B consists of converting existing PR-2 to a limited access expressway. Because this alternative would follow the existing highway, its study area consists of a 250-meter wide corridor centered along existing PR-2.

Alternative C Study Corridor – Alternative C consists of a combination of Alternatives A and a segment of existing PR-2, therefore, its study corridor is a combination of the study corridors for Alternatives A and B (i.e., one-kilometer wide along the Alternative A segments and 250 meters wide along the Alternative B segment).

Lengths and areas of the study corridors for each of the three build alternatives are provided in Table 2-1 below.

Table 2-1
Alternative Study Corridor Length and Area

Study Corridor	Length		Area	
	Kilometers	Miles	Hectares	Acres
A	46.0	28.6	4,689.9	11,588.8
B	47.0	29.2	1,221.7	3,018.9
C	48.0	29.8	3,886.2	9,602.6

Each alternative study corridor is shown on Figures 1-2 through 1-4, for Alternatives A through C, respectively.

2.2 Agency Coordination

Prior to performing field reviews, letters were sent to the USFWS and the DNER requesting information on occurrences of listed species in the vicinity of the project study corridors. Copies of agency correspondence are provided in Appendix A. In two letters dated June 28, 2001 and July 25, 2003, the USFWS responded with a listing of threatened and endangered species potentially occurring in the vicinity of the project study corridors. The USFWS also provided suggestions for construction guidelines during construction of the project. The DNER responded with two letters (October 18, 2001 and November 15, 2004), pointing out the potential for environmental impacts associated with the proposed action.

On August 28, 2003, an inter-agency presentation and discussion was conducted for public agencies and municipalities. The USFWS requested that a BA be completed, as the proposed project alternatives are all considered major construction activities. Subsequent meetings took place for the purpose of information and discussion about the proposed action. These meetings occurred on the following dates: public participation meetings on December 2, December 4, December 9, and December 11, 2003; a presentation for interest groups on October 23, 2003; and a meeting with interest groups on April 16, 2004.

2.3 Preliminary Data Collection

Prior to field reviews, the following documents and information sources were reviewed as part of a preliminary assessment of land features, habitats and vegetative cover, and determine Federal and DNER listed species potentially occurring within each alternative study corridor:

- U.S. Geological Survey (USGS) 7.5 minute quadrangle maps: Aguadilla Quadrangle (1960), Moca Quadrangle (1964), Quebradillas Quadrangle (1972), and Camuy Quadrangle (1972, revised 1982);

- Color aerial photographs (scale 1:40,000), 2006;

- U.S. Fish and Wildlife Service (USFWS), Threatened and Endangered Species System (TESS), http://ecos.fws.gov/tess_public/StartTESS.do, June 2006; and

- Puerto Rico Department of Natural and Environmental Resources (DNER), Natural Heritage Program Species Location Maps, 2002 [hereafter cited as (DNER 2002)].

2.4 Field Survey Methodologies

Between February 13, 2005 and July 8, 2006, biologists from Reforesta, Inc. conducted field assessments of the three alternative study corridors to determine vegetation land cover/habitat boundaries and to assess for the presence of Federal and Commonwealth listed species. A total of 64 days were spent conducting surveys at seven locations within the Alternative A and C study corridors and along the entire length of the Alternative B study corridor (Figure 2-1). The field surveys within the Alternative C study corridor included segments of each of the six field study locations within Alternatives A and B. Detailed reports of each of the field studies are included in Appendix B.

The listed species surveys and vegetation land cover/habitat surveys were conducted concurrently during the five field studies. Representative areas of the vegetative habitats present within the alternative study corridors were monitored for the occurrence of listed species. At each location, transects three meters wide by 30 meters long were established and all woody plants $\geq$ 1 centimeter (0.4 inch) diameter at breast height (DBH) were identified. Basal area, density, and height of all woody plants within each transect was also recorded. In addition to inventorying plants along transects, the biologists walked the limestone hills (mogotes) found in each study corridor and recorded all encountered plants (woody and herbaceous) to develop a species list. Particular attention was given to forested areas and the Camuy and Guajataca River

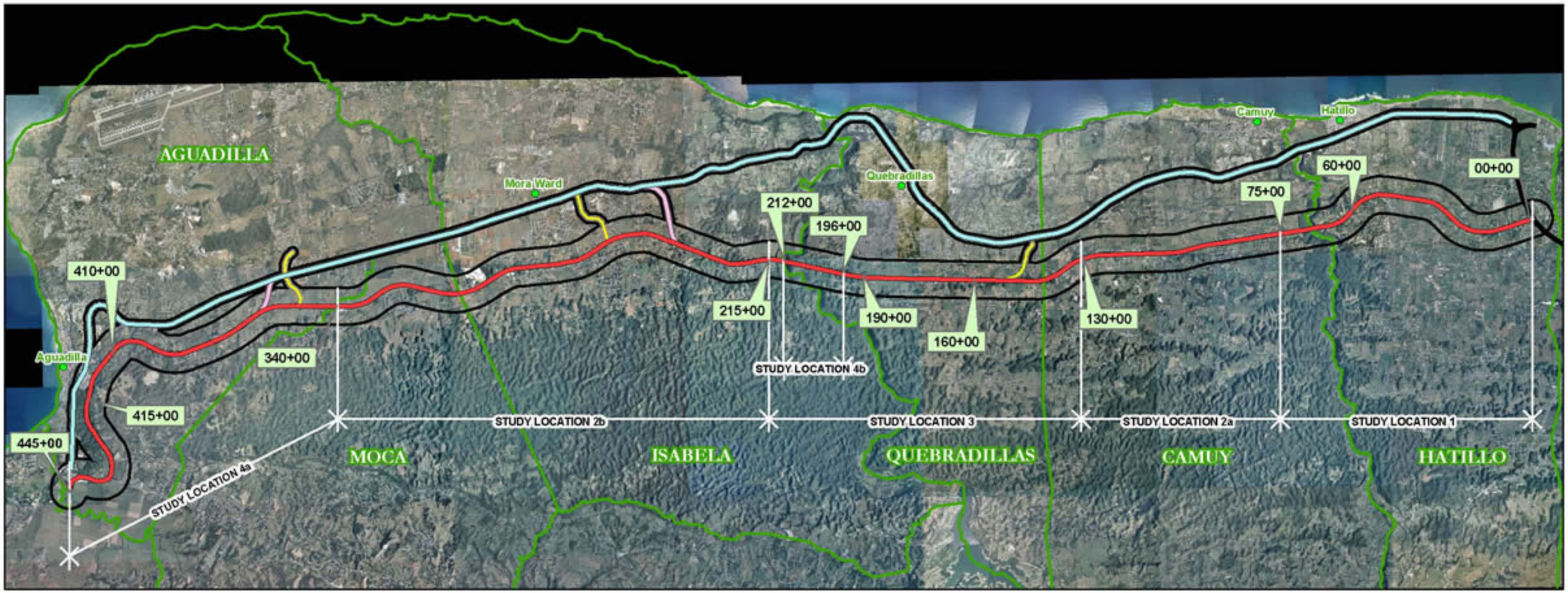


Figure 2-1

Alternative A & C

Study Locations

Stations: 00+00 to 445+00

- Alternative A Center Line
- Alternative B Center Line (PR-2)
- Alternative C Center Line
- Alternatives A, B & C Corridor
- Major Cities
- Jose de Deigo Highway (PR-22)
- 00+00 Station Locations
- Alternative Connectors

N W E S

Kilometers: 0 1.5 3 6

Miles: 0 1.5 3 6

Data Source: Guillermety, Ortiz & Associates

Orthophoto Mosaic derived from CRIM Basemap 1996-1998

H:\projects\12005276_PR27\Application\mxd\study_region_2-1_overview.mxd

Gorges. If any plant could not be identified in the field, a single specimen was collected for later identification at the University of Puerto Rico Herbarium. If Federal or Commonwealth listed species were found, concentrated species identification extending outside of the transect area was undertaken. Additional methods of observation and the locations of each of the field surveys are discussed below.

2.4.1 Alternative A and Alternative C

Study Location 1: Hatillo-Camuy Area from Station 00 + 00 to 75 + 00

This study was conducted from station 00+00 to 75+00 of the Alternative A and C study corridors (Figure 2-2). All plant species occurring within 125 meters (410 feet) of both sides of the proposed road's centerline were recorded. The locations of Federal and Commonwealth listed species were recorded using GPS and marked on a USGS topographical map. The presence of reptile and bird species was recorded during diurnal visual and acoustic censuses. Diurnal censuses were conducted between 0700 and 1630 hours. Eight and a half field days were spent at this study location.

Study Locations 2a and 2b: Study Area from Station 75+00 to 130+00 (2a) and 215+00 to 340+00 (2b)

This study was conducted from station 75+00 to 130+00 in the municipality of Camuy (Study 2a) (Figure 2-3) and station 215+00 to 340+00 in the municipalities of Isabela and Moca (Study 2b) (Figure 2-4). From station 75+00 to 130+00, all plant species occurring within 125 meters (410 feet) of both sides of the centerline of Alternative A were recorded. From station 215+00 to 340+00, all listed plant species occurring within 250 meters (820 feet) of both sides of the Alternative A centerline were recorded. The presence of reptile and bird species found in this study area was recorded during diurnal visual and acoustic censuses conducted between 0700 and 1630 hours. Eleven field days were spent at these study locations.

Study Location 3: Guajataca Gorge Area from Stations 130+00 to 215+00

This study was located between stations 130+00 and 215+00 of the Alternative A and C corridors and included the Guajataca River Gorge (Figure 2-5). The Arca de Noe Zoo is located within this segment. All plant species occurring within 250 meters (820 feet) of both sides of the proposed road's centerline were recorded. The locations of Federal and Commonwealth listed species were recorded using GPS and marked on a USGS topographical map. The presence of reptile and bird species found in this study area was recorded during diurnal visual and acoustic censuses conducted between 0700 and 1630 hours. Twenty-two field days were spent at this study location.

Study Locations 4a and 4b: Hatillo to Aguadilla, Northwestern Puerto Rico

Studies for Federal and Commonwealth listed species were conducted in all forested mogotes along the Alternative A and C study corridors. These surveys occurred between stations 340+00 and 445+00 in Aguadilla (Study 4a) (Figure 2-6) and stations 196+00 to 212+00 in Quebradillas

Major Cities
Municipality Boundaries
Alternatives A & C Center Line
Alternatives A & C Study Buffer
Alternatives A & C Corridor

Data Source: Guillermety, Ortiz & Associates - USGS Topographic Map: Hatillo

H:\projects\120005276_PR22\Applications\mxd\study_region_2-2_corridor.mxd

Figure 2-2

Alternatives A & C

Study Location 1

Stations: 00+00 to 75+00

N W E S

Kilometers
0 0.4 0.8 1.6

Miles
0 0.25 0.5 1

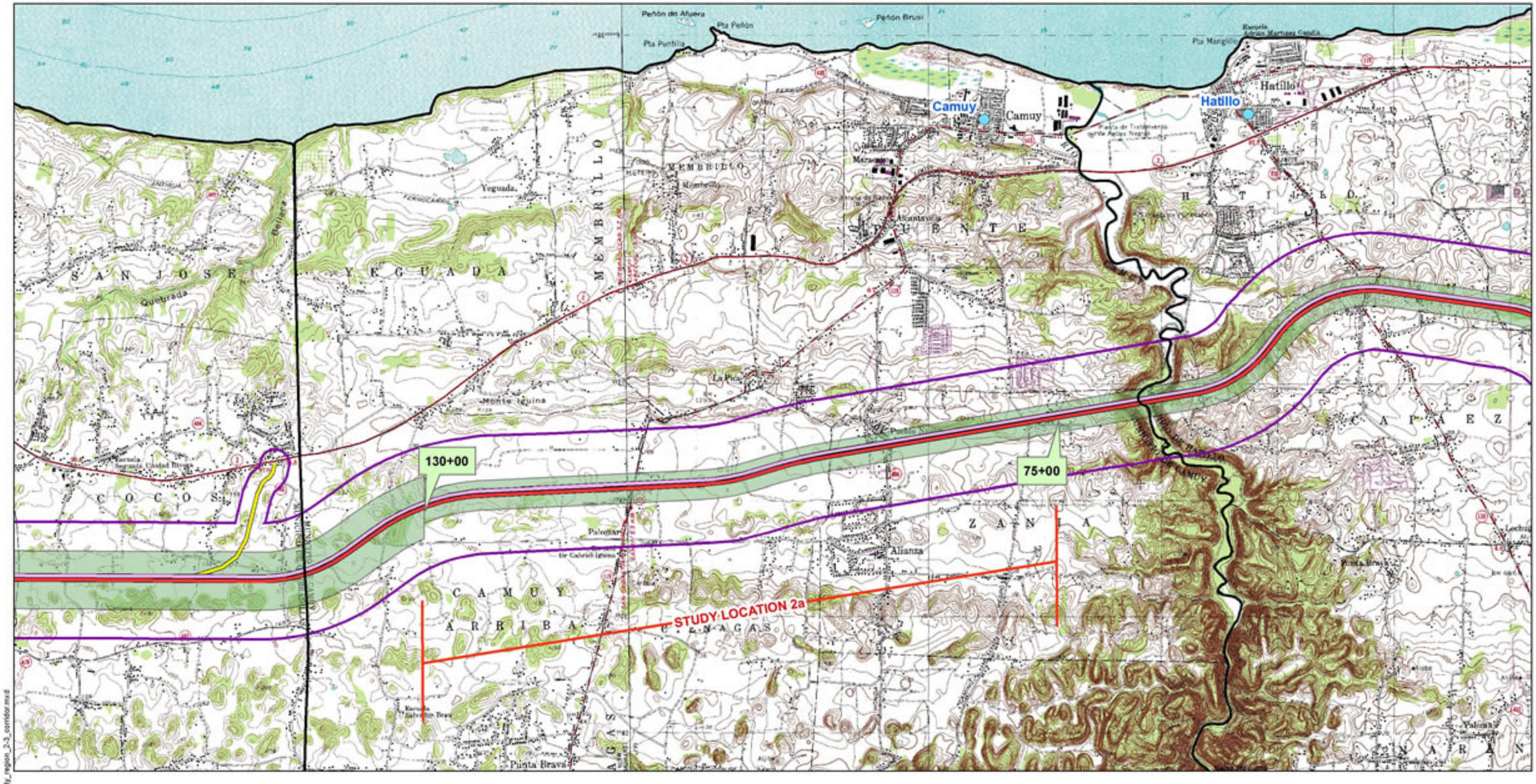


Figure 2-3

Alternatives A & C

Study Location 2a

Stations: 75+00 to 130+00

Data Source: Guillermety, Ortiz & Associates - USGS Topographic Map: Camuy

H:\projects\120052276_PR22\Applications\mxd\study_region_2-3_corridor.mxd

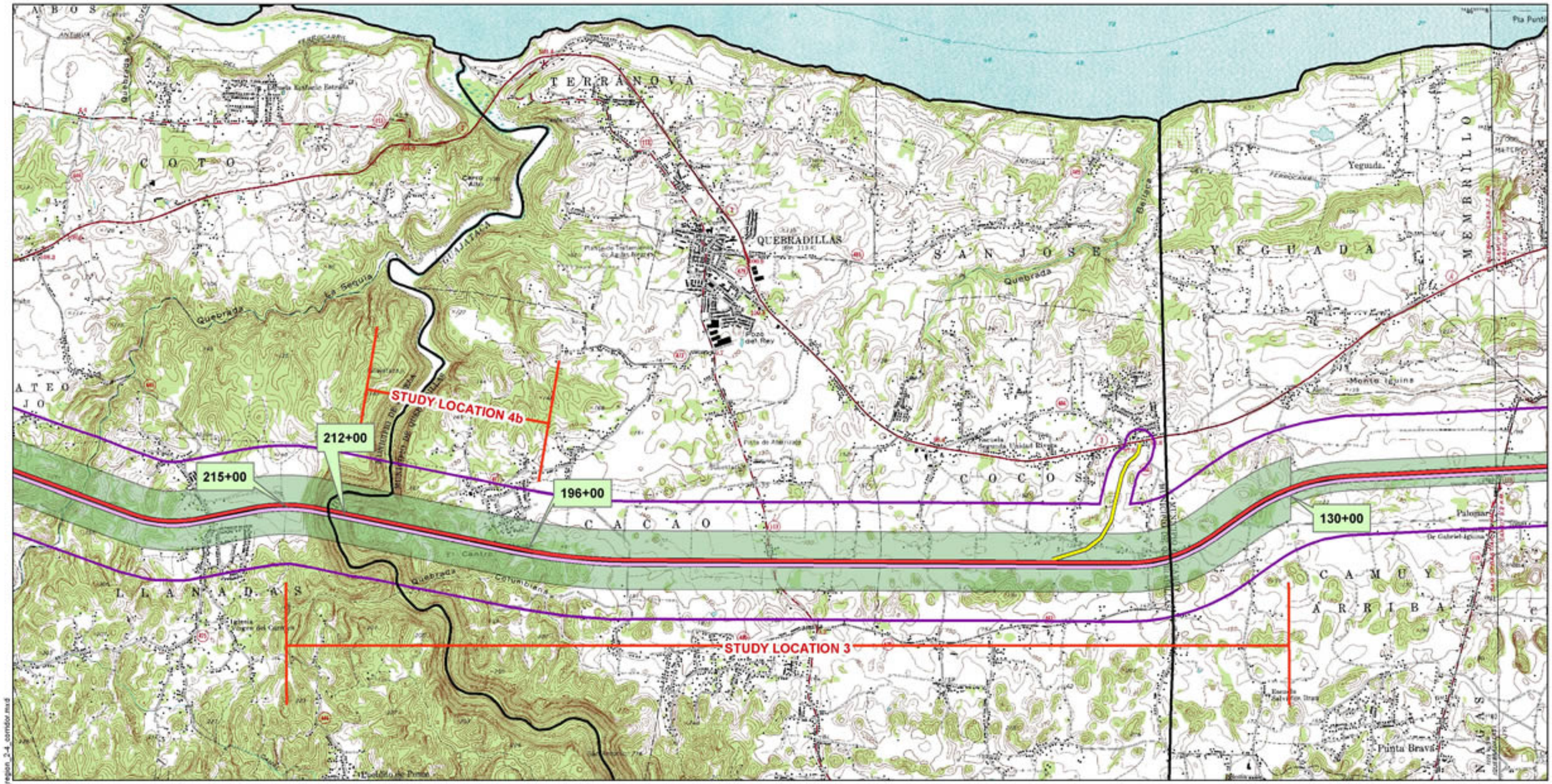


Figure 2-4

Alternatives A & C

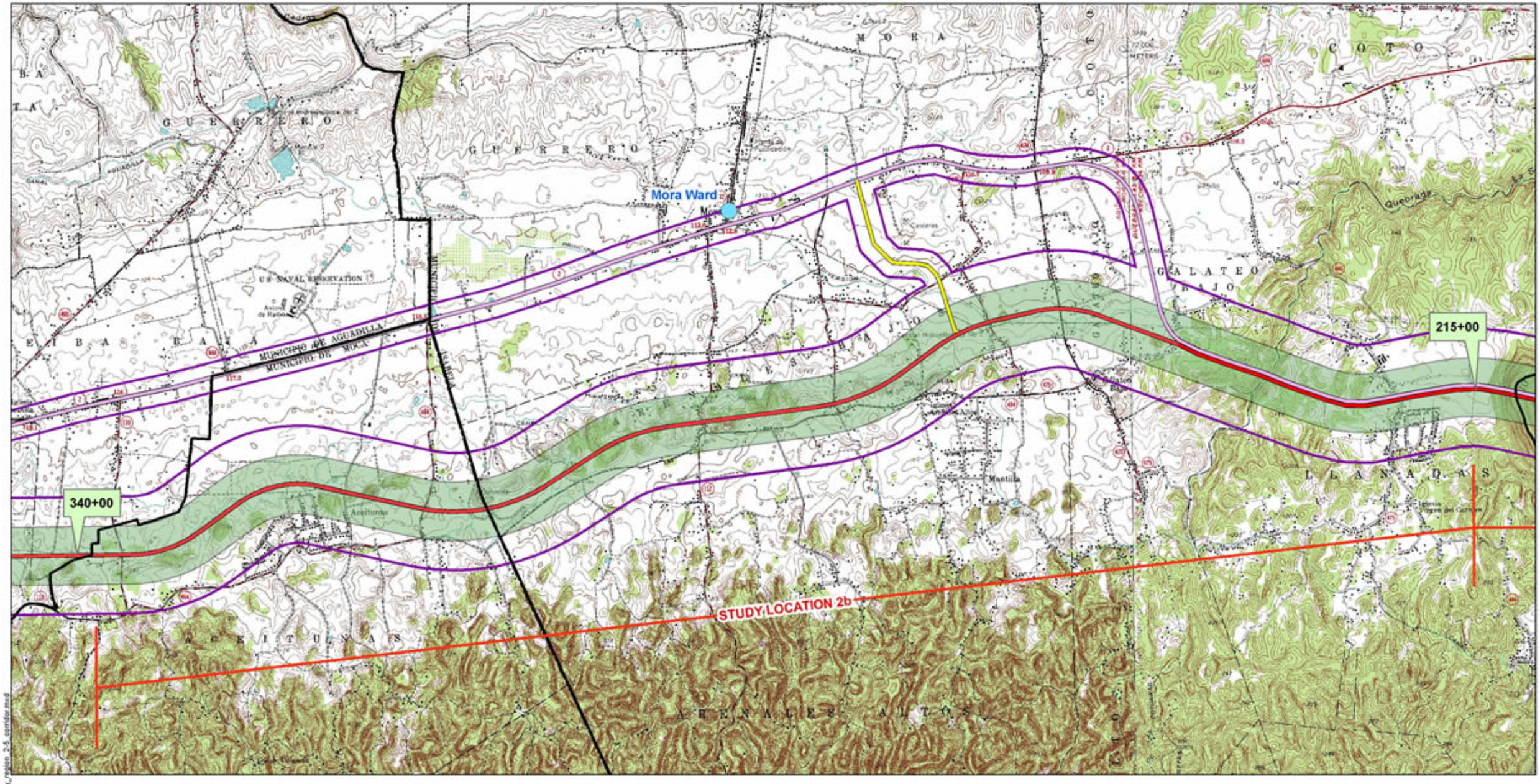
Study Locations 3 & 4b

Stations: 130+00 to 215+00

Stations: 196+00 to 212+00

Data Source: Guillermety, Ortiz & Associates - USGS Topographic Map: Quebradillas

H:\projects\152005276_PR22\Applications\mxd\study_region_2-4_corridor.mxd



- Alternative A Center Line
- Alternative C Center Line
- Alternative Connectors
- Municipality Boundaries
- Alternatives A & C Study Buffer
- Alternatives A & C Corridor
- Major Cities

Figure 2-5

Alternatives A & C

Study Location 2b

Stations: 215+00 to 340+00

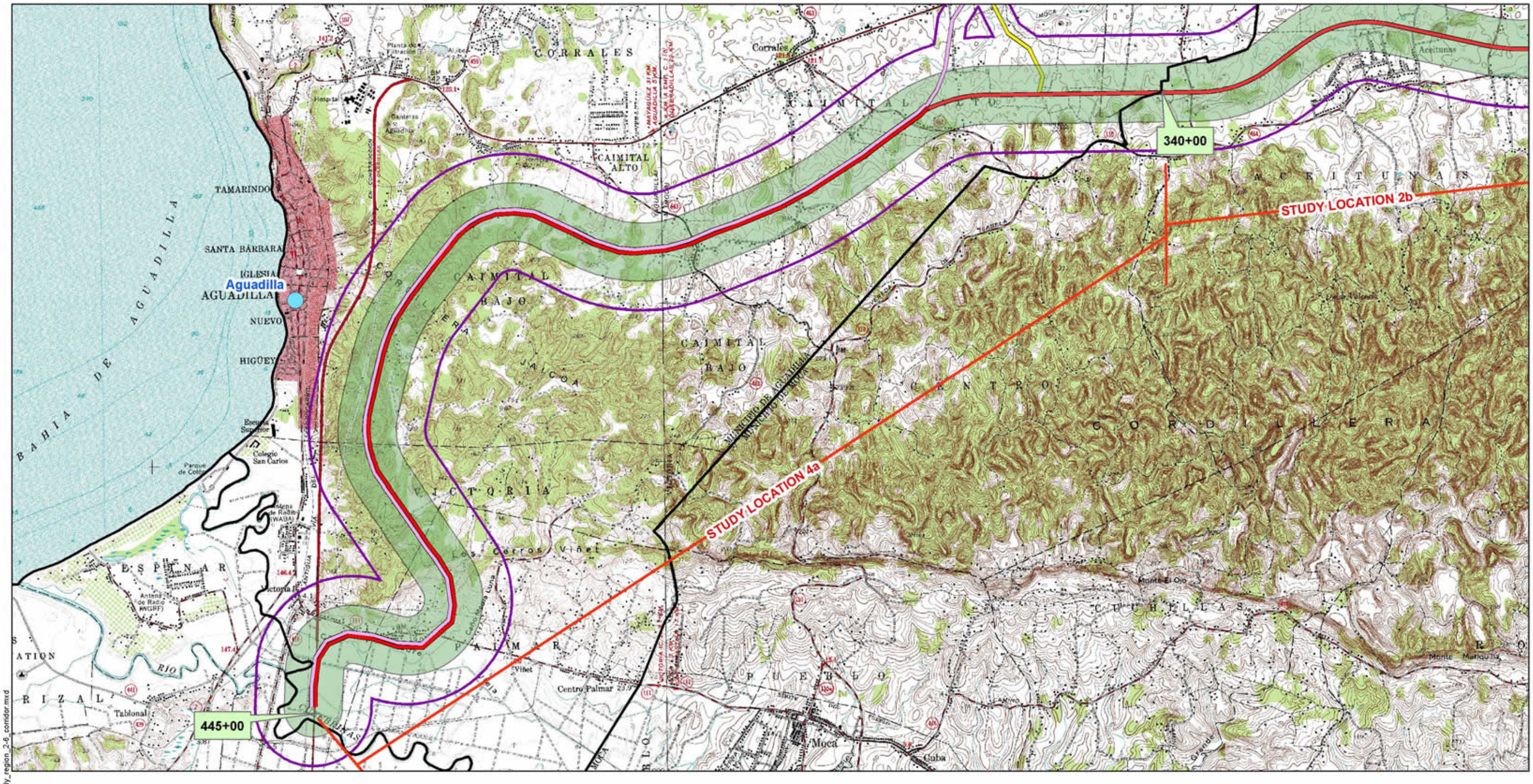
N W E S

Kilometers
0 0.4 0.8 1.6

Miles
0 0.25 0.5 1

Data Source: Guillermety, Ortiz & Associates - USGS Topographic Map: Isabella/Moca

H:\projects\120005276_PR2\Applications\mxd\study_region_2-5_corridor.mxd



Alternative A Center Line
Alternative C Center Line
Alternative Connectors
Municipality Boundaries
Alternatives A & C Study Buffer
Alternatives A & C Corridor
Major Cities

Figure 2-6

Alternatives A & C

Study Location 4a

Stations: 340+00 to 445+00

N
W E
S

Kilometers
0 0.4 0.8 1.6

Miles
0 0.25 0.5 1

Data Source: Guillermety, Ortiz & Associates - USGS Topographic Map: Aguadilla

H:\projects\120005276_PR22\Applications\mxd\study_region_2-6_corridor.mxd

(Study 4b) (Figure 2-5). Vegetative monitoring was conducted within 250 meters (820 feet) of both sides of the proposed Alternative A and C centerlines. The locations of Federal and Commonwealth listed species were recorded using GPS and marked on a USGS topographical map. The presence of reptile and bird species found in this study area was recorded during diurnal visual and acoustic censuses conducted between 0700 and 1630 hours. Nine and a half field days were spent at these study locations.

2.4.2 Alternative B and Alternative C

Study Location 5: PR-2 from Hatillo to Aguadilla

This study extended along the length of PR-2 from its intersection with PR-22 in Hatillo to approximately 300 meters (985 feet) south of the intersection of PR-2 and PR-111 in Aguadilla (see location of Alternative B on Figure 2-1). All plant species occurring within 50 meters (164 feet) of both sides of the existing road's shoulders in developed and non-wooded areas were recorded. In wooded areas, plant species within 100 meters (328 feet) of the existing shoulder were recorded. Locations of Federal and Commonwealth listed species were recorded using GPS and marked on a USGS topographical map. The presence of reptile and bird species was recorded by diurnal and nocturnal visual and acoustic census. Diurnal censuses were conducted between 0700 and 1300 hours and nocturnal census was conducted between 1830 and 0030 hours. In addition to the visual and acoustic census, nests, feathers, and feces were also used for species identification. Thirteen field days were spent in this study area.

2.5 Habitats and Land Cover Classification

A project-specific habitat and land-cover classification system was developed by integrating various habitat descriptions available within the scientific literature. The resulting classification system included vegetative-based upland and wetland habitats. All wetland and open-water habitats were also classified using the USFWS's wetland classification (Cowardin et al., 1979).

All habitat boundaries within each alternative study corridor were identified on color aerial photographs and verified by field observation. The resulting habitat boundary information was then entered into GIS format with an underlying aerial base. Results of the habitat and land cover mapping effort are presented in the following section.

3.0 EXISTING ENVIRONMENTAL CONDITIONS

3.1 Habitats and Land Cover

Based on collected field data and in-house reviews of aerial photographs, ten upland, three freshwater, and one estuarine habitat were found within the three alternative study corridors. General descriptions of these habitats are provided in the following subsections. The ten upland habitat/land cover types are Secondary Limestone Forest, Riparian Forest, Lowland Albizia Forest, Scrub Forest, Delonix Forest, Leucaena Forest, Herbaceous Vegetation, Pasture Land, Crop Land, and Developed Land. The three freshwater communities include Herbaceous Wetlands, Reservoirs, and Rivers and Streams. The one estuarine habitat is Coastal Forested Wetlands. Table 3-1 presents the area of each habitat type and land cover found in the alternative study corridors. The following figures, located in Appendix C, show the habitats and land cover mapped within each study corridor:

- Alternative Study Corridor A: Figures 3-A1 through 3-A14,
- Alternative Study Corridor B: Figures 3-B1 through 3-B15,
- Alternative Study Corridor C: Figures 3-C1 through 3-C14.

Table 3-1
Habitats and Vegetative Cover within the Alternative Study Corridors

Habitat/Vegetative Cover Types	Alternative A			Alternative B			Alternative C		
	Hectares	Acres	Percent of Total	Hectares	Acres	Percent of Total	Hectares	Acres	Percent of Total
Upland									
Secondary Limestone Forest	1,052.2	2,599.9	22.4	126.8	313.3	10.4	994.8	2,458.1	25.6
Riparian Forest	22.1	54.7	0.5	0.0	0.0	0.0	22.1	54.7	0.6
Lowland Albizia Forest	5.8	14.4	0.1	0.0	0.0	0.0	5.8	14.4	0.1
Scrub Forest	201.7	498.5	4.3	67.6	167.1	5.5	143.2	353.9	3.7
Delonix Forest	0.0	0.0	0.0	10.7	26.5	0.9	0.0	0.0	0.0
Luecaena Forest	0.0	0.0	0.0	4.7	11.7	0.4	0.0	0.0	0.0
Herbaceous Vegetation	15.1	37.3	0.3	5.2	12.9	0.4	11.4	28.1	0.3
Pasture Land	2,135.9	5,277.7	45.5	258.0	637.6	21.1	1,634.4	4,038.6	42.1
Crop Land	58.1	143.6	1.2	29.7	73.5	2.4	68.0	168.0	1.8
Developed Land	1,078.8	2,665.6	23.0	705.9	1,744.2	57.8	891.6	2,203.1	22.9
Subtotal	*4,569.7*	*11,291.7*	*97.4*	*1,208.6*	*2,986.8*	*99.0*	*3,771.3*	*9,319.0*	*97.1*
Freshwater Wetlands and Open Water									
Herbaceous Wetland	109.9	271.5	2.3	8.7	21.4	0.7	109.8	271.4	2.8
Reservoirs	6.1	15.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Rivers and Streams	4.2	10.5	0.1	1.3	3.2	0.1	5.0	12.3	0.1
Subtotal	*120.2*	*297.1*	*2.6*	*10.0*	*24.6*	*0.8*	*114.8*	*283.7*	*2.9*
Estuarine Wetland									
Coastal Forested Wetland	0.0	0.0	0.0	3.0	7.5	0.2	0.0	0.0	0.0
Total:	***4,690.0***	***11,588.8***	***100.0***	***1,221.7***	***3,018.9***	***100.0***	***3,886.2***	***9,602.6***	***100.0***

3.1.1 Upland Communities

Secondary Limestone Forest

Secondary Limestone Forest is thirty- to fifty-year-old forest occurring in limestone hills. This habitat type encompasses broader categorizations of vegetative cover typically reported in the literature, including evergreen, semi-evergreen, and dry forest types. The tree canopy is usually closed and averages about four meters (13 feet) in height. Limestone rock is exposed on outcroppings or vertical walls. Common tree species found in Secondary Limestone Forest are ironwood (*Krugiodendron ferreum*), pigeon-plum (*Coccoloba diversifolia*), and black cherry (*Eugenia monticola*). The understory is composed of tree seedlings and herbaceous plants such as *Anthurium crenatum* and *Scleria lithosperma.*

The Alternative A project study corridor contains 1,052.2 hectares (2,599.9 acres) of Secondary Limestone Forest. The largest areas of Secondary Limestone Forest in the Alternative A study corridor surround the Camuy River Gorge, Guajataca River Gorge, and the hills east of the city of Aguadilla. Smaller areas of Secondary Limestone Forest are scattered throughout the Alternative A study corridor.

The Alternative B study corridor contains 126.8 hectares (313.3 acres) of Secondary Limestone Forest, most of which is located along the western-most segment of the alignment.

The Alternative C study corridor contains 994.8 hectares (2,458.1 acres) of Secondary Limestone Forest. The largest portions of Secondary Limestone Forest in the Alternative C study corridor surround the Camuy River Gorge, Guajataca River Gorge, and the hills east of the city of Aguadilla. Other smaller areas of Secondary Limestone Forest are scattered throughout the Alternative C study corridor.

Riparian Forest

Riparian Forest is forest located adjacent to streams and rivers and are usually dominated by non-native shade or fruit trees such as the African tulip tree (*Spathodea campanulata*), breadfruit (*Artocarpus altilis*), and Indian almond (*Terminalia catappa*). Canopies may reach to 10-13 meters (32.8-46.7 feet) in height.

The Alternative A study corridor contains 22.1 hectares (54.7 acres) of Riparian Forest, all of which is located adjacent to the Camuy and Guajataca Rivers.

The Alternative B study corridor does not contain any habitat classified as Riparian Forest.

The Alternative C study corridor contains 22.1 hectares (54.7 acres) of Riparian Forest. The Riparian Forest in the Alternative C study corridor is found on the edges of the Camuy and Guajataca Rivers.

Lowland Albizia Forest

Lowland Albizia Forest is a forested community dominated by the exotic tree species tall Albizia (*Albizia procera*).

The Alternative A study corridor contains 5.8 hectares (14.4 acres) of Lowland Albizia Forest, all of which occurs southeast of the intersection of existing PR-2 and PR-111 near the western terminus of the corridor.

The Alternative B study corridor does not contain any Lowland Albizia Forest.

The Alternative C study corridor contains 5.8 hectares (14.4 acres) of Lowland Albizia Forest, all of which occurs southeast of the intersection of existing PR-2 and PR-111 near the western terminus of the corridor.

Scrub Forest

Scrub Forest is typically disturbed areas that are reverting back to forest by natural succession. However, mogotes with shallow soils are also known to naturally exhibit this type of vegetative cover. Ground cover ranges from 75 to 100 percent of the area depending on the amount of disturbance. Woody species average 2-2.5 meters (6.6-8.2 feet) in height and vines are abundant. Dominant species occurring in this habitat type are *Croton* spp., *Randia aculeata, Leucaena leucocephala, Tecoma stans,* and *Tabebuia heterophylla.*

The Alternative A study corridor contains 201.7 hectares (498.5 acres) of Scrub Forest. The Scrub Forest in Alternative A is found in small areas scattered throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

The Alternative B study corridor contains 67.6 hectares (167.1 acres) of Scrub Forest, most of which occurs in scattered patches throughout the eastern and middle portions of the alignment.

The Alternative C study corridor contains 143.2 hectares (353.9 acres) of Scrub Forest. The Scrub Forest in Alternative C is found in small areas scattered throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

Delonix Forest

Delonix Forest consists of stands of trees dominated by the exotic tree species royal poinciana (*Delonix regia*). This habitat type usually occurs along roadsides.

The Alternative A and C study corridors do not contain this type of habitat.

The Alternative B study corridor contains 10.7 hectares (26.5 acres) of Delonix Forest. The only areas of Delonix Forest in the Alternative B study corridor are found east of the Guajataca River near the town of Quebradillas.

Leucaena Forest

Leucaena Forest consists of recently abandoned road cuts or abandoned agricultural areas where the lead tree (*Leucaena leucocephala*) grows rapidly into mono-specific stands. Tree densities are high and canopies range from 2.5-5 meters (8.2-16.4 feet).

No Leucaena Forest is found within the Alternative A and C study corridors.

The Alternative B study corridor contains 4.7 hectares (11.7 acres) of Leucaena Forest, all of which occurs alongside existing PR-2 near the Camuy River crossing.

Herbaceous Vegetation

Herbaceous Vegetation is abandoned Pasture Land or deforested stream banks dominated by the following grasses: *Pennisetum purpureum, Saccharum spontaneum, Gynerium sagittatum, or Panicum maximum.*

The Alternative A study corridor contains 15.1 hectares (37.3 acres) of Herbaceous Vegetation, most of which is located along the Camuy River and in an abandoned pasture near Station 310+00.

The Alternative B study corridor contains 5.2 hectares (12.9 acres) of Herbaceous Vegetation, most of which is located along existing PR-2 east of Aguadilla.

The Alternative C study corridor contains 11.4 hectares (28.1 acres) of Herbaceous Vegetation, most of which is located along the Camuy River.

Pasture Land

Pasture Land is land actively used for cattle ranching. Dominant vegetation found in this habitat type is pangola grass (*Digitaria decumbens*) and guinea grass (*Panicum maximum*). Individual pastures commonly are separated by fence rows containing *Gliricidia sepium, Casearia guianensis,* and *Citharexylum fruticosum.*

Pasture Land is the most commonly occurring habitat type within the Alternative A and C study corridors. The Alternative A study corridor contains 2,135.9 hectares (5,277.7 acres) of Pasture Land. The Pasture Land in Alternative A is found throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

The Alternative B study corridor contains 258.0 hectares (637.6 acres) of Pasture Land scattered throughout the study corridor except for that portion of the study corridor adjacent to the city of Aquadilla.

The Alternative C study corridor contains 1,634.4 hectares (4,038.6 acres) of Pasture Land. The Pasture Land in Alternative C is found throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

Crop Land

Crop Land is cultivated land used for growing specific crops used for consumption and goods. The most common crops in northwest Puerto Rico are plantains, tubers, and seed production.

The Alternative A study corridor contains 58.1 hectares (143.6 acres) of Crop Land, most of which is found south of Mora Ward in the western section of the municipality of Isabela and in the south-central portion of the municipality of Aquadilla.

The Alternative B study corridor contains 29.7 hectares (73.5 acres) of Crop Land, all of which is located in the relatively flat area west of Mora Ward in the western section of the municipality of Isabela.

The Alternative C study corridor contains 68.0 hectares (168.0 acres) of Crop Land. The Crop Land in the Alternative C study corridor is found in the south-central portion of the municipality of Aguadilla and in the western section of the municipality of Isabela.

Developed Land

Developed Land consists of areas of intensive use with much of the land occupied by man-made structures such as roads, housing, rural dwellings, industrial, and commercial areas. Natural vegetative cover in these areas is minimal and exotic ornamental vegetation may be common.

The Alternative A study corridor contains 1,078.8 hectares (2,665.6 acres) of Developed Land. The Developed Land in Alternative A is found throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

Developed Land is the most common land cover type within the Alternative B study corridor. The Alternative B study corridor contains 705.9 hectares (1,744.2 acres) of Developed Land throughout the length of the study corridor.

The Alternative C study corridor contains 891.6 hectares (2,203.1 acres) of Developed Land. The Developed Land in Alternative C is found throughout the study corridor, with the exception of the areas directly surrounding the Camuy and Guajataca River gorges and east of the city of Aguadilla.

3.1.2 Freshwater Communities

Herbaceous Wetland
USFWS Classification: Palustrine, Emergent, Persistent, Seasonally or Permanently Flooded (PEM1C and PEM1H)

Herbaceous Wetland is seasonally or permanently flooded land dominated by herbaceous vegetation. The most common herbaceous species include cattails (*Typha domingensis*), para grass (*Brachiaria purpurascens*), and Venezuelan grass (*Paspalum fasciculatum*). Dasheen or taro (*Colocasia esculenta*) is also commonly found. Scattered shrubs such as *Aeschynomene sensitive* and *Mimosa pigra* may also occur.

The Alternative A study corridor contains 109.9 hectares (271.5 acres) of Herbaceous Wetland, most of which occurs at the western terminus of the corridor south of the city of Aguadilla.

The Alternative B study corridor contains 8.7 hectares (21.4 acres) of Herbaceous Wetland, almost all of which occurs at the western terminus of the corridor south of the city of Aguadilla.

The Alternative C study corridor contains 109.8 hectares (271.4 acres) of Herbaceous Wetland, most of which occurs at the western terminus of the corridor south of the city of Aquadilla.

Reservoirs
USFWS Classification: Palustrine, Open Water/Unknown Bottom, Artificially Flooded (POWK)

Reservoirs are artificial impoundments of water used for irrigation, flood control, municipal and rural water supplies, recreation or hydro-electric power generation.

The only reservoir within any of the three alternative study corridors is a 6.1 hectare (15.1 acre) impoundment located within the Alternative A study corridor near Mora Ward.

Rivers and Streams
USFWS Classification: Riverine, Upper Perennial, Rock Bottom or Unconsolidated Bottom (R3RB and R3UB)

This habitat type includes rivers, creeks, canals and other linear water bodies.

The Alternative A study corridor contains 4.2 hectares (10.5 acres) of Rivers and Streams. The Rivers and Streams in the Alternative A study corridor consists of the Camuy River, Guajataca River, Quebrada La Sequia (creek), and the Culebrinas River.

The Alternative B study corridor contains 1.3 hectares (3.2 acres) of Rivers and Streams. The Rivers and Streams in the Alternative B study corridor are the Camuy River, Guajataca River, Culebrinas River, and Principal Canal near Mora Ward in the western portion of the municipality of Isabela.

The Alternative C study corridor contains 5.0 hectares (12.3 acres) of Rivers and Streams. The Rivers and Streams in the Alternative C study corridor are the Camuy River, Guajataca River, Quebrada La Sequia (creek), Culebrinas River, and Principal Canal near Mora Ward in the western portion of the municipality of Isabela.

3.1.3 Estuarine Communities

Coastal Forested Wetlands
USFWS Classification: Estuarine, Intertidal, Forested, Broad-Leaved Evergreen (E2FO3)

Coastal Forested Wetlands occur near the coast, contain salt or brackish water, and are dominated by black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), red mangrove (*Rhizophora mangle*) and sea hibiscus (*Hibiscus pernambucensis*).

The Alternative A and C study corridors do not contain any Coastal Forested Wetlands.

The Alternative B study corridor contains 3.0 hectares (7.5 acres) of Coastal Forested Wetland near the mouth of the Rio Guajataca. This wetland is a brackish system dominated by sea hibiscus although white, black, and red mangroves are present at low densities (less than 10 percent cover).

3.2 Listed Species

Table 3-2 contains the Federal and Commonwealth listed plant and animal species which have a potential to occur within the three project study corridors. The probability of occurrence within the project study corridors is described as low, moderate, or high based on the habitat requirements of each species and the documented occurrence of the species within 1.6 kilometers (one mile) of the project corridors. A low listing indicates that potentially suitable habitat exists within the study corridors but no documented sightings have occurred within 1.6 kilometers (one mile) of the study corridors. A moderate listing indicates that suitable habitat exists within the study corridors and the species is documented to occur within 1.6 kilometers (one mile) of the study corridors. A high listing indicates that suitable habitat exists and the species was observed during field reviews within the study corridors.

Federally listed species have a status of either endangered or threatened. Commonwealth listed species are listed as critically endangered, endangered, vulnerable, or critical element. A critical element species can be defined by any of the following: a species of natural heritage importance; a species in decline or species whose habitat is in decline; a rare species; or a species classified as threatened, endangered, or critically endangered. For the purposes of this report, the critical element classification was used if the species is not otherwise classified as critically endangered, endangered, or vulnerable.

A total of 47 Federal and/or Commonwealth listed plant species and seven Federal and/or Commonwealth listed animal species have the potential to occur within one or more of the project study corridors. Descriptions of each of the species are provided in the following sub-sections. No designated Critical Habitat for any Federally listed species occurs within any of the alternative study corridors.

The figures and tables contained in Appendix D show the locations of listed plant and animal species reported by the DNER (2002) and observed during the field reviews performed as part of this BA in 2005 and 2006.

Table 3-2
Listed Species Potentially Occurring within Project Alternative Study Corridors

Plants

Species/Common Name	Designated Status[3]		Habitat Preference	Potential for Occurrence in Study Corridor[4]		
	USFWS[1]	DNER[2]		Alternative A	Alternative B	Alternative C
Adiantum vivesii Puerto Rico maiden hair	E	CR	One locality in a shaded hollow at base of a north-facing limestone cliff in Quebradillas	Low	Low	Low
Antirhea portoricensis Puerto Rico quina	None	EC	Moist limestone forests, northern Puerto Rico	High	High	High
Auerodendron pauciflorum No common name	E	CR	Semi-evergreen and evergreen seasonal forests of the limestone hills	Low	High	Low
Banara vanderbiltii Palo de Ramón	E	CR	Semi-evergreen forests of karst region of northern Puerto Rico. Two known sites.	Low	Low	Low
Bumelia bellonis Puerto Rico bully	None	EC	Forests, low to mid altitudes, northern hills	Low	High	Low
Buxus portoricensis No common name	None	EC	Serpentine soil in Maricao, Moca, and Susua, Puerto Rico	High	Moderate	High
Buxus vahlii Diablito de tres cuernos, Vahl's boxwood	E	EN	Two locations in Puerto Rico: 650 meters west of PR-2/Road #187 intersection and Hato Tejas	Low	Low	Low
Caesalpinia major Mauritius thorn, Mysore thorn	None	EC	Found in small forested canyon, subtropical moist forest	High	Low	High
Calyptronoma rivalis Palma de manaca	E	EN	Three wild locations: stream near San Sebastian, Camuy River, Guajataca River	Low	Low	Low
Campylocentrum pachyrrizum Leafless bentspur orchid	None	EC	Swamps and wet hammocks in the western mountains and limestone hills	Low	High	Low
Cedrela odorata Barbados cedar, Spanish cedar	None	EC	Found in small forested canyon, subtropical moist forest	High	Low	High
Chionanthus axilliflora Hueso	None	EC	Moist to dry limestone forests at lower elevations	Low	High	Low
Chionanthus ligustrina Cabra blanca	None	EC	Moist limestone forests in northwestern Puerto Rico	Moderate	High	Moderate
Cordia bellonis No common name	E	EN	Maricao and Susua in serpentine soils, road edges, river margins,	Low	Low	Low
Cornutia obovata Palo de nigua	E	CR	Semi-evergreen or evergreen seasonal forest of the subtropical moist forest	Low	Low	Low
Daphnopsis helleriana No common name	E	CR	Semi-evergreen or evergreen seasonal forest of the subtropical moist forest, restricted to limestone hills of northwestern coast	Low	High	Low
Dioclea hexandra Bejuco de mato	None	EC	Forest and hill thickets at lower and middle elevations	Low	High	Low
Diospyros sintenisii Guayabota, Múcaro, Tabeiba	None	EC	Found in small forested canyon, subtropical moist forest	High	High	High
Drypetes ilicifolia Rosewood	None	EC	Sand dunes and limestone hills of northern Puerto Rico	Low	High	Low
Drypetes lateriflora Guiana plum	None	EC	Wooded limestone hills of northern and western Puerto Rico	Moderate	High	Moderate
Eugenia underwoodii Underwood's stopper	None	EC	Forests on the southern slopes of central mountains	Low	High	Low
Gaussia attenuata Palma de lluvia	None	EC	Subtropical moist forest	Moderate	Low	Moderate
Goetzea elegans Mata buey, Beautiful goetzea	E	EN	Edge of a semi-evergreen seasonal forest at low elevation	High	High	High
Guapira obtusata Corcho, Corcho blanco	None	EC	Found in small forested canyon, subtropical moist forest	High	Low	High
Ilex urbaniana Cuero de sapo	None	EC	Forests near Utuado and in western areas of Puerto Rico.	High	Low	High

Table 3-2
Listed Species Potentially Occurring within Project Alternative Study Corridors

Plants

Species/Common Name	Designated Status[3]		Habitat Preference	Potential for Occurrence in Study Corridor[4]		
	USFWS[1]	DNER[2]		Alternative A	Alternative B	Alternative C
Jacquinia umbellata Chirriador, Chirre	None	EC	Found in small forested canyon, subtropical moist forest	High	Moderate	High
Mappia racemosa Palo de cana	None	EC	Moist limestone forests	Low	High	Low
Myrcia pagani No common name	E	CR	Limestone hills, semi-evergreen or evergreen seasonal forest of the subtropical moist forest	High	Low	High
Ottoschulzia rhodoxylon Palo de rosa	E	CR	Ranges from semi-evergreen, seasonal forest to semi-deciduous, dry forest to lower montane, semi-evergreen forest	High	High	High
Passiflora murucuja Virgin Island passionflower	None	EC	Thickets on limestone, near Quebradillas and Vega Alta	Low	High	Low
Peperomia wheeleri Wheeler's peperomia	E	EN	Andesitic tuff and lava intruded by diorite, weathered to round boulders	Low	Low	Low
Pereskia aculeata Barbados shrub	None	EC	Tropical climates	High	Low	High
Philodendron fragantissimum Shortstem philodendron	None	EC	Tropical moist forest, premontane wet forest, tropical wet forest	Moderate	Low	Moderate
Piper swartzianum Spanish elder	None	EC	Primaveral forests in central and western mountains of Puerto Rico	Moderate	Low	Moderate
Pleodendron macranthum Chupacallos	E	CR	Subtropical wet and subtropical montane wet forests of northern Puerto Rico, limestone hill region in semi-evergreen and evergreen seasonal forest	Low	Low	Low
Polygala cowellii Violet tree	None	EC	Limestone hills, subtropical moist forest	High	High	High
Pseudolmedia spuria False breadnut	None	EC	Moist limestone hills near northern coast of Puerto Rico	High	Low	High
Psidium amplexicaule Guayaba de monte, Mountain guava, Sperry guava	None	EC	Limestone hills, subtropical moist forest	High	High	High
Rollinia mucosa Wild sugar apple	None	EC	Forests in eastern and western mountains of Puerto Rico	Low	High	Low
Schoepfia arenaria No common name	T	EN	Low elevation evergreen & semi-evergreen forests in densely wooded limestone hills	Low	High	Low
Schoepfia schreberi No common name	None	EC	Found in small forested canyon, subtropical moist forest	High	Low	High
Sloanea amygdalina Motillo	None	EC	Secondary limestone forest, mid- to lower elevations, up to 700 meters (2,297 feet)	High	Low	High
Solanum drymophilum Erubia	E	EN	Tetas de Cayey in Sierra de Cayey in central Puerto Rico, evergreen forest remnants disturbed land in this location	Low	Low	Low
Tectaria estremerana Puerto Rico halberd fern	E	CR	Moist, shaded humus and around limestone boulders on wooded rocky hillsides, karst region of northwestern Puerto Rico	Low	Low	Low
Tetrazygia angustifolia Stinking fish	None	EC	Lower elevations in northeastern, southwestern, and northwestern Puerto Rico	Low	Moderate	Low

Table 3-2
Listed Species Potentially Occurring within Project Alternative Study Corridors

Plants

Species/Common Name	Designated Status		Habitat Preference	Potential for Occurrence in Study Corridor		
	USFWS	DNER		Alternative A	Alternative B	Alternative C
Thelypteris verecunda Barrio, Charcas maiden fern	E	CR	Moist, shaded limestone ledges at middle elevations of approximately 200 meters.	Low	Low	Low
Zanthoxylum thomasianum St. Thomas prickly ash	E	EN	Low stature vegetation, near summit of Piedras Chiquitas, Guajataca River in Isabela, Coamo	Low	High	Low

Animals

Species/Common Name	Designated Status		Habitat Preference	Potential for Occurrence in Study Corridor		
	USFWS	DNER		Alternative A	Alternative B	Alternative C
Accipiter striatus venator Puerto Rican sharp-shinned hawk	E	CR	Maricao forest in subtropical lower montane wet and subtropical wet forest types, Carite forest in the caimitillo-granadillo forest types, Toro Negro in the elfin woodland, sierra palm, caimitillo-granadillo, tabonuco forest types	Low	Low	Low
Amazona vittata Puerto Rican parrot	E	CR	Mature rain forest, large numbers of old *Cyrilla racemiflora*. Historically nested in holes in cliffs. Northern karst region identified as a future release site.	None	None	None
Amphisbaena bakeri Baker's worm lizard	None	EC	Dense woodland, thickets, caves.	Low	High	Low
Buteo platypterus brunnescens Puerto Rican broad-winged hawk	E	CR	Tabonuco, palo colorado, elfin, caimitillo, franadillo, slope, subtropical wet, and subtropical rain forest types	Low	Low	Low
Columba inornata wetmorei Puerto Rican plain pigeon	E	EN	Historical habitat includes lowland swamps and woodland, open woodland and cultivated land in mountains, limestone karst, and coffee plantations in upland hills. Presently in lower montane rainforest. Nests in hardwood canyons.	Low	Low	Low
Epicrates inornatus Puerto Rican boa	E	VU	Forested limestone hill areas.	High	High	High
Mabuya nitida Lucia, Slipperyback skink	None	VU	Isolated localities in Puerto Rico, rocky areas	Low	Moderate	Low
Peltophryne lemur Puerto Rican crested toad	T	CR	Small population believed to exist on northern coast near Isabela, Quebradillas, Arecibo, Berceloneta, Vega Baja, and Bayamon	Low	Low	Low

(1) USFWS = U.S. Fish and Wildlife Service
(2) DNER = Puerto Rico Department of Natural and Environmental Resources
(3) Designated Status
- T = Threatened (USFWS)
- E = Endangered (USFWS)
- EN = Endangered (DNER)
- CR = Critically Endangered (DNER)
- VU = Vulnerable (DNER)
- EC = Critical Element (DNER)

(4) Potential for Occurrence
- Low = Suitable habitat exists within Study Corridor, however no documented occurrence of species
- Moderate = Suitable habitat exists within Study Corridor and species has been reported within one mile of Study Corridor
- High = Suitable habitat exists and species was observed in Study Corridor during field review

3.2.1 Flora

The following 18 Federal and 47 Commonwealth listed plant species have the potential to occur within one or more of the project study corridors:

Adiantum vivesii **– (Puerto Rico maiden hair)**
Federal Status: Endangered
DNER Status: Critically Endangered

Puerto Rico maiden hair is a terrestrial fern with creeping 2.5 to 3 millimeter- (0.10 to 0.12 inch) thick rhizomes. The stalks are lustrous purple-black, 25 to 46 centimeters (10 to 18 inches) long, irregularly branched with hair-like scales. The frond blades are broad and irregular.

The species is found in the karst region of northwestern Puerto Rico. In Puerto Rico, it has been reported from only one locality in the limestone hills of the northern portion of the island. An estimated 1,000 plants have been reported in a shaded hollow at the base of a north-facing limestone cliff in the municipality of Quebradillas on privately-owned property. The species and Puerto Rico halberd fern (*Tectaria estremerana*) share habitat locales and characteristics. The most significant factors affecting this rare restricted fern are destruction and modification of its habitat and illegal harvesting by collectors. Puerto Rico maiden hair was Federally listed as endangered on June 9, 1993. The mogotes found in the Alternative A, B and C study corridors are considered suitable habitat for the species, but it was not found within any of the project alternative study corridors during the field studies performed for this BA. The species is considered to have a low potential to occur within the three alternatives.

Antirhea portoricensis **– (Puerto Rico quina)**
Federal Status: Not Listed
DNER Status: Critical Element

Puerto Rico quina is a rare endemic tree which grows to 6-9 meters (20-30 feet) tall and 10 centimeters (four inches) in trunk diameter. The leaves are opposite elliptic, 2.5-5 inches long, and 1-2.5 inches wide. They are dull and slightly thickened. The species flowers in clusters. The fruit is an elliptic drupe which is 6.5 millimeters (0.25 inch) long and 6.5 millimeters (0.25 inch) in diameter.

The species is found in the moist limestone forests of northern Puerto Rico between 61-122 meters (200-400 feet) in elevation. Almost all of the three study corridors lie below 61 meters (200 feet) in elevation. However, an unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest habitat types of the Alternative B study corridor (DNER 2002). During the field reviews for this BA, approximately ten individuals were found within Secondary Limestone Forest in Study Location 3, east of the Guajataca River Gorge in study corridors A and C. The species is considered to have a high potential for occurrence within the Alternative A, B and C study corridors.

***Auerodendron pauciflorum* - (No common name)**
Federal Status: Endangered
DNER Status: Critically Endangered

Auerodendron pauciflorum is an evergreen shrub or small tree which may reach five meters (16.5 feet) in height. The leaves are opposite or subopposite, glabrous, ovate to ovate-elliptic, 6 to 15 centimeters (2.5 to 6 inches) long and 3.5 to 6 centimeters (1.5 to 2.5 inches) wide with minute black glandular dots. Two to three flowers are borne in the leaf axils. Fruit has not been described and seedlings have not been observed in the field.

The species is found in the semi-evergreen and evergreen seasonal forests of the limestone hills of northwestern Puerto Rico. Only 19 individuals are known from four groups in the Coto Ward area of Isabela near the intersection of Road 113 and Road 2.

A. pauciflorum was Federally listed as endangered on March 2, 1994, due to habitat destruction. During the field surveys for this BA, two individuals of the species were found on a hillside northwest of the intersection of Highway PR-2 and Road Number 113 in Study Location 5. This area is within the Secondary Limestone Forest of the Alternative B corridor. The species is considered to have a high potential of occurrence in Alternative B and low potential for occurrence in the Alternative A and C corridors.

***Banara vanderbiltii* – (Palo de Ramón)**
Federal Status: Endangered
DNER Status: Critically Endangered

Palo de Ramón is an evergreen shrub or small tree reaching 10 meters (33 feet) in height and 12 centimeters (five inches) in diameter. The leaves alternate in a single plane, have a dentate margin, and are densely pubescent on both sides. Older leaves become rough with a sandpaper-like texture on the upper surface. The flowers are bisexual and borne solitary. They are noticeably yellow, more likely due to the mass of yellow stamens, about 13 millimeters (0.5-inch) in diameter and velvety in texture. The fruit was only recently discovered and consists of multi-seeded berries, deep red to purple in color, with an enlarged calyx and a long-pointed style. The species is known from the karst region of northern Puerto Rico and in one area in the central mountains. Specifically, Palo de Ramón is found in semi-evergreen forests on two privately-owned, northern Puerto Rico sites; one between Vega Baja and Bayamón, and one in the Tetas de Cayey in the municipality of Salinas (USFWS 1990). The two populations consist of six plants in the less than 16 square-meter (52 square feet) Vega Baja location, and five individuals on the Tetas de Cayey location.

The species was Federally listed as endangered on January 14, 1987. Each of the three study corridors contain suitable habitat for the species, but it was not found within any of the project alternative study corridors. The species is considered to have a low potential to occur within the three alternative study corridors.

***Bumelia bellonis* or *Sideroxylon portoricense* – (Puerto Rico bully)**
Federal Status: Not Listed
DNER Status: Critical Element

Puerto Rico bully is an endemic tree which grows to 25-30 meters (82-98 feet) tall. The leaves are elliptic or oblong-elliptic, 7-20 centimeters (3-8 inches) long, and 3-6 centimeters (1-2 inches) broad. The berries are ovoid, obovoid to broadly ellipsoid, and 1.6-2.5 centimeters (0.6-1 inch) long.

The species is commonly found in forests at lower to middle altitudes in the northern hills and at Utuado, Guajataca and Mayaguez, Puerto Rico. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest habitat of the Alternative B study corridor, on the mogotes west of the Guajataca River Gorge (DNER 2002). The species has high potential for occurrence in the Alternative B corridor and a low potential for occurrence in the Alternative A and C corridors.

***Buxus portoricensis* – (No common name)**
Federal Status: Not Listed
DNER Status: Critical Element

Buxus portoricensis is an endemic, 1-2 meter-tall (3.3-6.6 foot-tall) shrub with quadrangular twigs. The leaves are ovate to elliptic-ovate, 3-6 centimeters (1.2–2.4 inches) long, and 2-3 centimeters (0.8-1.2 inches) wide. The seed capsules are globose and hold the oblong, black 4-5 millimeter (1.6-2 inches) long seeds.

B. portoricensis is located on serpentine soil in Maricao, Moca, and Susua, Puerto Rico. During the field reviews for this BA, approximately 50 individuals of this plant were found in the Secondary Limestone Forest on a hill north of Road Number 483, west of the municipality boundary of Quebradillas and Camuy, at Study Location 3. This location is within the Alternative A and C study corridors and within 1.6 kilometers (one mile) of the Alternative B study corridor. The species is classified as having a high potential for occurrence in Alternatives A and C and a moderate potential for occurrence in Alternative B.

***Buxus vahlii* – (Diablito de tres cuernos, Vahl's Boxwood)**
Federal Status: Endangered
DNER Status: Endangered

Vahl's boxwood is an evergreen shrub or small tree which grows to 4.5 meters (15 feet) tall with a trunk to 13 centimeters (five inches) in diameter. The twigs have two characteristic grooves below each pair of leaves. The oblong leaves are simple, opposite, dark shiny green, and grow to 3-4 centimeters (1.2-1.6 inches) long and about two centimeters (0.75 inch) wide. The flower cluster is small, about 6-7 millimeters (0.25 inch) long, and is composed of a solitary female flower at the tip of several male flowers borne just below it. Flowering occurs from December to early April, producing shiny, black, 3-4 centimeter- (1.2-1.6 inches) long seeds in a horned capsule.

Vahl's boxwood was listed as Federally endangered on August 13, 1985. The species is known from two locations in Puerto Rico: the Nuclear Power Plant site owned by the Commonwealth of Puerto Rico at Punta Higuero, Rincón; and from Hato Tejas, Bayamón, near Highway Number 2 about 650 meters (2,130 feet) west of its intersection with Road Number 167 (on land owned by Pan American Investment, Inc.) (USFWS 1990).

Potential threats to Vahl's boxwood include destruction or modification of the plant's habitat, air and water pollution, and development. Overall vulnerability is increased by the small population size, easy access, low reproduction rate, and probable loss of genetic variation of the species throughout both locations. All three study corridors contain suitable habitat for the species, but it was not found within any of the alternative study corridors during the field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

***Caesalpinia major* – (Mauritius thorn, Mysore thorn)**

Federal Status: Not Listed
DNER Status: Critical Element

Caesalpinia major is a robust, thorny, evergreen shrub 2-4 meters (6.6-13 feet) high or climber up to 10 meters (32.8 feet) or higher. It often forms dense thickets. The stems are covered with minute golden-hair and the thorns are straight to hooked, numerous, and not in regular rows or confined to nodes. The leaves are dark green, paler beneath, not glossy, up to 300 millimeters (one foot) long and the leaflets are up to 8 millimeters (0.1 inch) wide. The flowers are pale yellow, in elongated, erect clusters 100-400 millimeters (4-15.7 inches) long. Fruits are brown, woody pods, flattened, unsegmented, smooth, sharply beaked at apex, and approximately 80 millimeters (3.1 inches) long.

The species generally occurs in disturbed areas, natural forests, planted forests, range/grasslands, and water courses. It is sometimes used as a hedge barrier or an ornamental plant. During the field reviews for this BA, *C. major* was found on a cliff edge of the Camuy River gorge at Study Location 1 as a vine encompassing 0.4-0.8 hectare (1-2 acres). This area is within the Alternative A and Alternative C study corridors. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and low potential for occurrence in Alternative B study corridor.

***Calyptronoma rivalis* – (Palma de manaca)**

Federal Status: Threatened
DNER Status: Endangered

Palma de manaca is a palm tree reaching about 8-10 meters (26- 33 feet) in height. Its trunk is smooth and may grow to 13-25 centimeters (5-10 inches) in diameter. The species has spineless, feather-shaped leaves which can reach up to 3-4 meters (10-13 feet) long with a 61-centimeter- (two-foot) long leaf stalk and a 61-centimeter- (two-foot) long sheath. Its large flowers are clustered, branched, and drooping. Borne on sunken pits, these flowers are arranged in triads of

two males and one female. The fruit, less than six millimeters (0.25 inch) wide, are imperfectly round and reddish when ripe.

The species was Federally designated as threatened on February 6, 1990. Three wild populations are known in Puerto Rico: (1) adjacent to Quebrada Collazo, a small stream near San Sebastian; (2) along the Camuy River, and; (3) along the Guajataca River (USFWS 1990). The combined population of these three sites is about 265 individuals. All three natural populations are located in the semi-evergreen, limestone forests of northwestern Puerto Rico at elevations between 100 to 150 meters (325 to 490 feet). In the southern portion of the Camuy River, some individuals are located at the bottom of deep canyons. Two populations have also been established from palm tree seedlings; one in the Puerto Rico Department of Natural Resources' Río Abajo Commonwealth Forest and the other at Camp Guajataca (owned by the Boy Scouts) (USFWS 1990).

Deforestation for development, flash floods (made worse by deforestation), and fires are the most serious threats to these plants. The three study corridors contain suitable habitat for the species, but it was not found within any of them during the field reviews for this BA. The species is considered to have a low potential to occur within the three study corridors.

***Campylocentrum pachyrrizum* – (Leafless bentspur orchid)**
Federal Status: Not Listed
DNER Status: Critical Element

Leafless bentspur orchid is a leafless monopodial epiphyte. The roots are gray-green, fascicled, and 2.5-5 millimeters (0.1-0.2 inch) wide when flattened against a substrate. The roots also have bronze-colored growing tips. The stems are hidden by roots. Inflorescences are densely flowered spikes with prominent reddish-brown bracts. The petals are creamy white with pink flush. Each bloom has a club-like spur which is large relative to the size of the flower. After the flowers are pollinated, they develop into short clusters of seed capsules. Capsules are brownish-orange, ellipsoid, 6-9 millimeters (0.25-0.35 inch) long, and 3-4 millimeters (0.11-0.16 inch) wide.

The species is found in swamps and wet hammocks in the western mountains and limestone hills of Puerto Rico at elevations between sea level and 1,400 meters (4,593 feet). An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor, on the mogotes west of the Guajataca River (DNER 2002). The species has a high potential for occurrence in the Alternative B corridor and a low potential for occurrence in the Alternative A and C corridors.

***Cedrela odorata* – (Barbados cedar, Cigar box cedar, Spanish cedar)**
Federal Status: Not Listed
DNER Status: Critical Element

Cedrela odorata is a tree up to 40 meters (131.2 feet) high with a diameter larger than two meters (6.6 feet); leaves up to 80 centimeters (1.3 feet) long, with 6-7 pairs of leaflets with a heavy odor of onions or garlic; leaflets ovate to lanceolate, acute to rounded at base, acute,

acuminate or obtuse at tip, 8-20 centimeters (3.2-7.9 inches) long, 2.5-5.5 centimeters (1-2.2 inches) broad, generally glabrous; flowers in clusters at the extremes of the branches, with a heavy malty odor, 6-9 millimeters (2.4-3.5 inches) long; petals greenish-cream in bud, opening white; fruit 2.5-4.5 centimeters (1-1.8 inches) long, septicidally 5-valved; seeds flat, chestnut-brown, about 25 millimeters (9.8 inches) long and 6-7 millimeters (2.4-2.8 inches) broad.

The species is found in agricultural areas, disturbed areas, roadsides, and pastures. It is almost always found on well-drained soils and often, but not exclusively, on limestone. It tolerates a long dry season but does not flourish in areas of rainfall greater than about 3000 millimeters (120 inches). During field reviews for this BA, one individual was found on a cliff edge of the Camuy River Gorge at Study Location 1. Less than 10 individuals were also found west of the Guajataca River Gorge in Study Location 3. These areas lay within the Alternative A and C study corridors. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

Chionanthus axilliflora **– (Hueso)**
Federal Status: Not Listed
DNER Status: Critical Element

Hueso is a shrub or small tree which grows to seven meters (23 feet) tall and 10 centimeters (four inches) in trunk diameter. The young twigs and inflorescences are often finely tomentulose or glabrate. The leaves are oblong to elliptic, 4-7 centimeters (1.6-2.8 inches) long, and 1.5-4 centimeters (0.6-1.6 inches) broad. The flowers are compact, up to three centimeters (1.2 inch) long and slightly lobed. The fruit is oblong to ovoid, about 13 millimeters (0.5 inch) long, and white.

The species occurs in moist or dry limestone forests at lower elevations, specifically at Guajataca Gorge and Guanica. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These were found on the mogotes west of the Guajataca River. The species has a high potential for occurrence in the Alternative B study corridor and a low potential for occurrence in the Alternative A and C study corridors.

Chionanthus ligustrina **– (Cabra blanca)**
Federal Status: Not Listed
DNER Status: Critical Element

Cabra blanca is a tree or shrub which grows to 12 meters (39 feet) tall and 15 centimeters (6 inches) in trunk diameter. The bark is gray, rough, and ridged. The twigs are slender and glabrous, with lenticels. The leaves are elliptic to lanceolate, 4-9 centimeters (1.6-3.5 inches) long 1.2-2.5 centimeters (0.5-1 inch) broad, and rounded to obtuse or obtusely acuminate at the apex. They are dark green and shiny on the upper surface and dull, gland-dotted, and paler beneath. The flowers are fragrant, with linear petals, and are 5-7 millimeters (2-2.8 inches) long. The species occurs in moist limestone forests in the northwestern districts of Puerto Rico. An unspecified number of individuals were reported by the DNER Natural Heritage Program within

the Alternative B study corridor (DNER 2002). These were found on the mogotes west of the Guajataca River and on the mogotes south of the intersection of PR-2 and Highway 459. This location is also within 1.6 kilometers (one mile) of the Alternatives A and C study corridors in the Secondary Limestone Forest habitat. The species has a moderate potential for occurrence within the Alternative A and C study corridors and a high potential for occurrence within the Alternative B study corridor.

***Cordia bellonis* – (No common name)**
Federal Status: Endangered
DNER Status: Endangered

Cordia bellonis is a shrub species known from only three public forests in Puerto Rico: Maricao, Susúa, and Río Abajo. An arching to erect shrub of 1-2 meters (3-6.5 feet) in height, it has very slender twigs with short hairs. The leaves are alternate, oblong to oblong-lanceolate, 2 to 6 centimeters (0.75-2.5 inches) long, and usually 2.5-3 times longer than wide. The corolla is white with four subcylindric lobes. The fruit, which appears from October through January, is a pointed, five millimeter- (0.25 inch-) long drupe. The dioecious plants produce white, axillary, unisexual flowers which have a thin, reduced corolla. The plants remain dense and shrubby in openly exposed habitats, but in closed vegetation the branches become divergent and form obtuse angles that hook the plant into the surrounding trees.

The species was Federally listed as endangered on January 10, 1997. It has been found in Maricao and Susúa in serpentine soils, at road edges, river margins, and on steep slopes at an elevation between 230-250 meters (750-820 feet) (Susúa) and 441-820 meters (1,450-2,700 feet) (Maricao) (USFWS 1990). In the Río Abajo Forest, the species was found either on sunny banks along dirt roads, growing in thickets of vegetation, or in open saddles between limestone hills. Unknown from this forest until 1994, approximately 118 individuals were found in 12 localities (USFWS 1990). Ninety-five of those plants were located along the construction route for a highway and were removed for possible future transplantation (USFWS 1990).

C. bellonis is threatened by habitat destruction and modification, certain forest management practices, and its restricted distribution. All three study corridors contain suitable habitat for the species, but it is not known to occur within any of the project alternative study corridors. For this reason, the species is considered to have a low potential to occur within the three alternative study corridors.

***Cornutia obovata* – (Palo de nigua)**
Federal Status: Endangered
DNER Status: Critically Endangered

Palo de nigua is an evergreen tree which reaches 10-15 meters (33-50 feet) in height and 25 centimeters (10 inches) in diameter. The leaves are opposite, simple, obovate, blunt or rounded at the apex and may be 5-14 centimeters (2-5.5 inches) long and 4-8 centimeters (1.5-3.2 inches) wide. Fine hairs cover the minute, golden, shiny glandular dots on the lower surface of the leaves. Twigs are four-sided, finely hairy and brownish when young. The flower cluster is a terminal panicle, 8-30 centimeters (3-12 inches) in length, perfect, and zygomorphic. The

corolla is bluish or purplish, finely hairy outside with long hairs inside. The fruit is a purplish drupe containing 3 to 4 seeds. Flowering has been observed between the months of May and July, and fruits are present in September and October.

The species is found in semi-evergreen or evergreen seasonal forest on limestone hills at elevations of 150-350 meters (490-1150 feet) and higher. Only seven Palo de Nigua trees are known to exist in three areas: five individuals from five different locations in the limestone hills of the Río Abajo Forest; one from the limestone hills near the Arecibo Observatory; and one from Barranquitas on Monte Torrecilla (USFWS 1990).

Federally listed as endangered on April 7, 1988, the species has historically been subjected to deforestation, selective cutting for agriculture, coffee production, grazing, production of charcoal, and logging. All three study corridors contain suitable habitat for the species, however it was not found within any of the alternative corridors during the field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

***Daphnopsis helleriana* – (No common name)**

Federal Status: Endangered
DNER Status: Critically Endangered

Daphnopsis helleriana is a small evergreen tree or shrub which reaches six meters (20 feet) in height and five centimeters (two inches) in diameter. The leaves (3-13 centimeters long and 1.5-6 centimeters wide) (1.2-5 inches long and 0.5-2.4 inches wide) are simple, alternate, elliptic to obovate, and blunt or rounded at the apex. The side veins are prominent and curved. Both leaves and twigs are golden hairy when young. The species is dioecious (male and female flowers borne on different plants) and flower clusters are borne at the ends of young branches between February and April. While both flowers are small, the male flowers are tubular with finely golden hairs outside and the female flowers are calyx bell-shaped and similarly hairy outside and inside. The fruit is an elliptic, one-seeded, white berry that is less than two centimeters (0.75 inches) long.

The species is found in the semi-evergreen or evergreen seasonal forest of the subtropical moist forest on limestone hills at elevations from 150 to 350 meters (490 to 1,150 feet). It is restricted to the limestone hills of the northwestern coast of the island. Only four populations are known to exist today, consisting of approximately 61 individuals in the area of Isabela/Quebradillas; seven individuals in the Río Lajas Hills of Toa Baja; about 50 plants in the Nevarez limestone hills; and seven trees on National Institute of Health land near Sabana Seca (USFWS 1990). Three of these sites are located on privately-owned land.

The species was Federally listed as endangered on June 23, 1988. Possibly always a rare species, its dioecious habit reduces the probability of successful reproduction. Individuals at presently known sites are threatened by urban, tourist, and industrial expansion, limestone quarrying, landfills, and forest clearing for agriculture. During the field reviews for this BA, thirty individuals were found west of the Guajataca River in Secondary Limestone Forest within the Alternative B study corridor. The species is considered to have a high potential for

occurrence within the Alternative B corridor and a low potential for occurrence within the Alternative A and C corridors.

***Dioclea hexandra* – (Bejuco de mato)**
Federal Status: Not Listed
DNER Status: Critical Element

Bejuco de mato is a thick-stemmed woody vine. It is typically eight meters (26 feet) long or longer. The twigs, petioles and inflorescences are long-pilose with brown hairs or glabrate. The leaflets are ovate to elliptic, 8-15 centimeters (3-6 inches) long, and 5-10 centimeters (2-4 inches) broad. The inforescences are reddish-tomentose and are longer than the leaves. The flower petals are purple, usually about 1.5 centimeters (0.6 inch) long, and are orbicular to obovate.

The species is found in forest and hillside thickets at lower and middle elevations in the southeastern and northeastern districts of Puerto Rico. An unknown number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found on the mogotes west of the Guajataca River. The species is considered to have a high potential for occurrence within the Alternative B corridor and low potential for occurrence within the Alternative A and C corridors.

***Diospyros sintenisii* – (Guayabota, Múcaro, Tabeiba)**
Federal Status: Not Listed
DNER Status: Critical Element

Diospyros sintenisii is an endemic tree which grows to 10-15 meters (23.8-49.2 feet) tall and 15 centimeters (six inches) in trunk diameter. The bark is dark gray and the leaves are oblong or narrowly elliptic, 5-15 centimeters (2-6 inches) long, and 2-5 centimeters (0.8-2 inches) wide. They are dark green in color and shiny above and dull light green in color beneath. The fruit is 2.5-3.5 centimeters (1-1.4 inches) in diameter and brown or dark red when mature.

The species is rare, but found in moist limestone forests as far east as Bayamon and at Susúa and Maricao forests in Puerto Rico. During field reviews for this BA, one individual was found on a cliff edge of the Camuy River Gorge in Study Location 1. One individual was also found on a hill south of Arca de Noé Zoo, between Highway PR-2 and Road Number 483 and west of the municipality line of Quebradillas and Camuy in Study Location 3. These locations are within the Alternative A and Alternative C corridors. Approximately 10 individuals were found west of the Guajataca River within the Alternative B study corridor. The species is classified as having a high potential for occurrence in the Alternative A, B and C study corridors.

***Drypetes ilicifolia* – (Rosewood)**
Federal Status: Not Listed
DNER Status: Critical Element

Rosewood is either a shrub which grows to 2-3 meters (6.6-9.8 feet) tall or a tree which grows to 10 meters (33 feet) tall. The twigs and leaves are glabrous. The leaves are broad, coarsely spinulose-dentate, and are acute or acuminate at the apex. The staminate flowers are greenish and there are usually 4-10 in an axillary fascicle.

The species is found on sand dunes and limestone hills of the northern districts of Puerto Rico. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found on the mogotes west of the Guajataca River. The species is considered to have a high potential for occurrence within the Alternative B corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Drypetes lateriflora* – (Guiana plum)**
Federal Status: Not Listed
DNER Status: Critical Element

Guiana plum is either a shrub which grows to 1-5 meters (3.3-16.4 feet) or a tree which grows to 13 meters (42.7 feet) tall. The trunk can sometimes reach up to 25 centimeters (10 inches) thick. The branches are drooping, with oblong or elliptic leaves. The leaves are 5-11 centimeters (2-4.3 inches) long, 2-6 centimeters (0.8-2.4 inches) broad, and acute or short-acuminate at the base. The fragrant flowers grow in dense axillary clusters. The seeds are solitary, growing 5-7 millimeters (0.2-0.3 inches) long in the orange-scarlet drupe.

The species is found in the wooded limestone hills of the northern and western districts of Puerto Rico. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found on the mogotes west of the Guajataca River. The species has a high potential for occurrence within the Alternative B study corridor. The species has a moderate potential for occurrence in the Alternatives A and C study corridors because it has been observed within 1.6 kilometers (one mile) of the study corridors. These individuals were found in the Secondary Limestone Forest on the west cliff of the Guajataca River Gorge (DNER 2002).

***Eugenia underwoodii* – (Underwood's stopper)**
Federal Status: Not Listed
DNER Status: Critical Element

Underwood's stopper is an endemic shrub which grows 2-3 meters (6.6-9.8 feet) tall. The shrub is very branched with slender gray twigs. The leaves are chartaceous, elliptic-lanceolate, 2-5 centimeters (0.8-2 inches) long, and 1.5-2 centimeters (0.6-0.8 inch) broad. They are slightly paler beneath than above and somewhat shiny. The flowers are found in a small, short-peduncled axillary. The berries are globose, 5-6 millimeters (0.2 inch) in diameter, and turn from green to red.

The species is found in forests on the southern slopes of the central mountains. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These

individuals were found on the mogotes west of the Guajataca River. The species has a high potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Gaussia attenuata* – (Palma de lluvia, Puerto Rico llume-palm)**

Federal Status: Not Listed
DNER Status: Critical Element

Gaussia attenuata is an endemic tall palm (usually to 12.2 meters (40 feet) in height) distinguished by the slender, tapering, smooth brown trunk with many prop roots at the base. The pinnate leaves are 1.2-1.8 meters (4-6 feet) long with a blade that is 61-76.2 centimeters (2-2.5 feet) across with many narrow long-pointed leaflets. The flowers are orange and green and scattered along slender branches of a curved axis about 0.9 meters (three feet) long. Numerous bright red or orange-red fleshy fruits are about 1.6 centimeter (5/8-inch) long and are nearly round or slightly pear-shaped.

This species is common on the rocky summits and cliffs of the moist limestone region and in the hills between San German and Lajas (USFWS 1990). During field reviews for this BA, five individuals were found within 1.6 kilometers of the Alternatives A and C study corridors in Secondary Limestone Forest habitat. The species is considered to have a moderate potential for occurrence in the Alternatives A and C study corridors and a low potential for occurrence within the Alternative B study corridor.

***Goetzea elegans* - (Mata buey or Beautiful goetzea)**

Federal Status: Endangered
DNER Status: Endangered

Beautiful goetzea is an evergreen shrub or small tree which measures to nine meters (30 feet) tall with stems to 13 centimeters (five inches) thick. The simple, alternating leaves may grow to 10 centimeters (four inches) long and to five centimeters (two inches) wide. The upper surface of the leaves is dark shiny green and the lower surface is pale green. The small, orange, funnel-shaped flowers are borne from the axils of leaves, typically singly. The two centimeter (0.75-inch) round fruit is orange in color and is usually seen between May and August, during the same period that the plant flowers.

The species was Federally listed as endangered on April 19, 1985. The species' habitat is at the edge of semi-evergreen seasonal forest on limestone below 200 meters (656 feet) and is presently found at several closely grouped sites on the northwestern part of Puerto Rico in the area of Quebradillas and Isabela (USFWS 1990). Approximately 40 to 50 plants are known from these sites. All sites but one is on privately-owned land with the exception being owned and managed by the Commonwealth Department of Transportation and Public Works. The Commonwealth-owned site alongside Road 113 is subject to trimming by road maintenance crews, as well as possible habitat destruction or modification in relation to the road. The privately-owned sites could be impacted by mining, grazing, potential take for landscaping purposes, and proposed construction of a resort development.

During the field reviews for this BA, twelve individuals were found on a hill north of Road 483 and west of the municipality line of Quebradillas and Camuy, in Study Location 3. These individuals occur within the Secondary Limestone Forest of the Alternative A and C study corridors. In addition, 38 individuals were found on the slope southwest of the intersection of PR-2 and Road 113. This area is within the Secondary Limestone Forest of the Alternative B corridor. The species is considered to have a high potential for occurrence in the Alternative A, B and C study corridors.

Guapira obtusata **– (Corcho, Corcho blanco, Corcho prieto)**
Federal Status: Not Listed
DNER Status: Critical Element

Guapira obtusata is a dioecious shrub or small tree which grows to 15 meters (49.2 feet) tall and 35 centimeters (1.2 feet) in diameter. The bark is gray or light brown and finely fissured. The leaves are elliptic to ovate, 6-13 centimeters (2.4-5.1 inches) long, 3-6 centimeters (1.2-2.4 inches) wide, and rounded to obtuse at the apex. The flowers are nearly sessile and the fruit is oblong, about 8-10 millimeters (3.2-3.9 inches) long, and fleshy and bright red.

The species occurs in the moist forests of western Puerto Rico, the Bahamas, and the Greater Antilles. During field reviews for this BA, two individuals were found on the cliff edge of the Camuy River Gorge in Study Location 1. This area lies within the Secondary Limestone Forest of the Alternative A and Alternative C corridors. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

Ilex urbaniana **– (Cuero de sapo)**
Federal Status: Not Listed
DNER Status: Critical Element

Ilex urbaniana is a shrub which grows to three meters (9.8 feet) tall, or a small tree which grows to 10 meters (32.8 feet) tall with a trunk diameter to 10 centimeters (3.9 inches). The twigs are slender and the leaves are elliptic, oval or oval-obovate, 3-8 centimeters (1.2-3.2 inches) long, an 3.5-4.5 centimeters (1.4-1.8 inches) wide.

Although the species is rare, it is found in forests near Utuado and in western areas of Puerto Rico. During field reviews for this BA, one individual was found on a cliff edge of the Camuy River gorge in Study Location 1. This area lies within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

Jacquinia umbellata **– (Chirriador, Chirre)**
Federal Status: Not Listed
DNER Status: Critical Element

Jacquinia umbellata is a shrub which grows to three meters (9.8 feet) in diameter and usually 30-40 centimeters (11.8-15.8 inches) tall. The twigs are slender and stiff and 5-12 millimeters (0.2-0.5 inches) broad. The corolla is orange or orange-purple, about five millimeters (0.2 inches) long and has rounded lobes. The berries are ellipsoid or obovoid, orange, 8-12 millimeters (0.3-0.5 inches) long and six millimeters (0.25 inches) in diameter.

This species is found on hillsides and in thickets in the southern, western and northern districts of Puerto Rico at lower and middle elevations. During field reviews for this BA, three individuals were found on a cliff edge of the Camuy River Gorge in Study Location 1. Approximately 25 individuals were also found on a hill south of PR-2 and east of the municipality line of Quebradillas and Camuy in Study Location 3. This area also lies within the Secondary Limestone Forest of the Alternative A and C corridors. The individual plants found in Study Location 3 are within 1.6 kilometers (one mile) of the Alternative B study corridor. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and a moderate potential of occurrence in the Alternative B study corridor.

***Mappia racemosa* – (Palo de cana)**
Federal Status: Not Listed
DNER Status: Critical Element

Palo de cana is a large shrub or small tree which can grow to 11 meters (36 feet) tall and 30 centimeters (11.8 inches) in trunk diameter. The leaves are 10 to 19 centimeters (3.9-7.5 inches) long and 3-5 centimeters (1.2-2 inches) broad. The species may have few to many flowers. The petals are cream-colored, lanceolate to oblong, and 3-5 millimeters (0.1-0.2 inch) long. The fruits are ellipsoidal, 1.4-1.6 centimeters (0.6 inches) long and are a dull brick-red with a yellow-green tinge.

The species is rare and found in moist limestone forests from Quebradillas to Fajardo. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found on the mogotes west of the Guajataca River. No individuals of this species were found during field surveys for this BA. The species has a high potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Myrcia pagani* - (No common name)**
Federal Status: Endangered
DNER Status: Critically Endangered

Myrcia pagani is an evergreen tree which may grow to nine meters (30 feet) in height and 13 centimeters (five inches) in diameter. The bark is mottled and flaky with an orange-brown inner bark. Young twigs are flattened and have numerous soft brownish hairs. The leaves are opposite, simple, entire, coriaceous, aromatic, and glandular punctate below. The leaf blade is elliptic-oblong, 10-16 centimeters (4-6.5 inches) long and 4-9 centimeters (1.5-3.5 inches) wide. The fruit and flowers have not been described.

M. pagani was Federally listed as endangered on February 18, 1994. It is found in the semi-evergreen or evergreen seasonal forest on limestone hills at elevations from 150-350 meters (490-1,150 feet). All known localities of the species are on private land in the limestone hills of northwestern Puerto Rico. Eight individuals of *M. pagani* were reported from three localities in the Biáfara-Arrozal area south of Arecibo and in Quebradillas (USFWS 1990).

During the field reviews for this BA, two individuals were found on the hills bordering the east side of the Guajataca River Gorge at Study Location 3. This area lies within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors. The species is considered to have a high potential for occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

***Ottoschulzia rhodoxylon* - (Palo de rosa)**

Federal Status: Endangered
DNER Status: Critically Endangered

O. rhodoxylon is a small evergreen tree reaching 4-5 meters (13-16.5 feet) in height. Its smooth, alternate leaves have an elliptic to ovate shape with rounded apex and thick, leathery bases. The species' flowers are bisexual and can be found at the leaf bases singly or in clusters. The fruit is a thin-covered drupe and seem to be produced irregularly throughout the year, much like the flowers.

The species was Federally listed as endangered on April 10, 1990. Approximately 200 individuals are known from 17 populations in the following areas of Puerto Rico: Guaynabo; Quebradillas/Isabela; Cambalache Forest; Guánica Forest; Cabo Rojo; and near the Río Abajo Forest. Habitat types range from semi-evergreen, seasonal forest around 100 meters (328 feet) in the Bayamon site, to low elevation, semi-deciduous, dry forest on limestone in the southwestern coast Guánica Forest. A single tree in Maricao Forest survives in a lower montane, semi-evergreen forest on serpentine outcrops around 600 meters (1,970 feet) in elevation (USFWS 1990).

O. rhodoxylon was found on a cliff and hills bordering the east side of the Guajataca River Gorge at Study Location 3. Four individuals were found on a hill north of Road Number 483, west of the municipality line of Quebradillas and Camuy in the same study location. On the cliff edges of the Camuy River Gorge, 106 individuals and recently germinated seedlings were found at Study Location 1. These areas lie within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors. Twelve individuals were also found on the hillside northwest of the intersection of Highway PR-2 and Road Number 113 and on the slope southeast of that intersection at Study Location 5. In the same survey, one individual was found on a hill north of Highway PR-2 and Highway 459. This area lies within the Secondary Limestone Forest of the Alternative B study corridor. The species is considered to have a high potential for occurrence in the Alternative A, B and C study corridors.

***Passiflora murucuja* – (Virgin Island passionflower)**
Federal Status: Not Listed
DNER Status: Critical Element

Virgin Island passionflower is a glabrous vine with angular stems. The leaves are variable and transversely linear-oblong to obdeltoid. They grow up to four centimeters (1.6 inches) broad with rounded to obtuse lobes. The flowers are red to purple, 5-7 millimeters long, with linear-oblong petals. The fruit is globose, 1-1.5 centimeters (0.4-0.6 inch) in diameter, and green.

The species is found in thickets on limestone, near Quebradillas and Vega Alta. An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found on the mogotes west of the Guajataca River. No individuals of this species were found during the field studies for this BA. The species is considered to have a high potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Peperomia wheeleri* – (Wheeler's peperomia)**
Federal Status: Endangered
DNER Status: Endangered

Wheeler's peperomia is an evergreen, fleshy herb which may reach one meter (3.28 feet) in height. It has opposite, entire, fleshy, elliptic leaves with inconspicuously black-punctated lower sides. Inflorescences are spikes, 10-16 centimeters (4-6.5 inches) long which are borne solitary and opposite the leaves or at the leaf axils. Flowers are minute, approximately 0.5 millimeters (0.01 inch) in diameter.

The species was listed as Federally endangered on January 14, 1987. The species is only known with certainty from Culebra, a small island approximately 27 kilometers (17 miles) east of Puerto Rico. It is found only on grano-diorite boulders in the north slope semi-evergreen seasonal open forest (USFWS 1990). Several hundred plants may be present in an area of approximately 0.2 hectare (0.5 acre), and many are scattered throughout a larger area. Although a suspect population of *Peperomia* was found in Quebradillas in northwest Puerto Rico, it remains to be confirmed whether or not it is *P. wheeleri* (USFWS 1990). During field reviews for this BA *Peperomia* species was found in Study Location 3, specifically in the hills southwest of Arca de Noe Zoo at the municipality boundary of Quebradillas and Camuy. The species was collected for identification at a herbarium and was verified as not being *P. wheeleri*. The study corridors contain suitable habitat for the species, but it was not found within any of the project alternative study corridors during field reviews for this BA. The species is considered to have a low potential to occur within the three study corridors.

***Pereskia aculeata* – (Barbados shrub)**
Federal Status: Not Listed
DNER Status: Critical Element

Barbados shrub is a slender vine which climbs on shrubs, trees or rocks. It is 3-10 meters (10-33 feet) long with spines on older stems. The leaves are short-petiolate, 3-10 centimeters (1.2-3.9 inches) long, and acute obtuse or rounded at the base. The flowers are white, pale yellow, or tinged with pink. The fruit is light yellow, 1.5-2 centimeters (0.6-0.8 inches) in diameter and smooth at maturity. The seeds are black, somewhat flattened, and 4-5 millimeters (0.2 inch) in diameter.

The species is a native of tropical America. It is widely distributed in Florida, the West Indies, Mexico, Central America, and tropical South America. It grows spontaneously around Puerto Rico after cultivation. An unknown number of individuals were reported by the DNER Natural Heritage Program within the Secondary limestone Forest of the Alternative A and C study corridors (DNER 2002). These individuals were found on mogotes east of the Camuy River Gorge. The species is considered to have a high potential for occurrence within the Alternative A and C study corridors and a low potential for occurrence within the Alternative B study corridor.

***Philodendron fragantissimum* – (Shortstem philodendron)**

Federal Status: Not Listed
DNER Status: Critical Element

Shortstem philodendron is distinguished by its short internodes, a tendency to produce slender, whip-like branches from near the apex, persistent, reddish brown cataphyll fibers, more or less D-shaped petioles with somewhat elevated, lateral margins, ovate to ovate-triangular, cordate blades (about equal to the petioles in length), and colorful inflorescences with bright red spathes on the tube and white on the blade.

The species is found near sea level to 1000 meters (3281 feet) elevation in tropical moist or wet forest. An unknown number of individuals were reported by the DNER Natural Heritage Program within 1.6 kilometers (one mile) of the Alternatives A and C study corridors in Secondary Limestone Forest habitat (DNER 2002). These individuals were found on the mogotes west of the Guajataca River Gorge. No individuals of this species were found during the field studies for this BA. The species has a moderate potential of occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

***Piper swartzianum* – (Spanish elder)**

Federal Status: Not Listed
DNER Status: Critical Element

Spanish elder is a shrub which grows 3-5 meters (9.8-16.4 feet) tall. The leaf blades are oblong to lanceolate, 11-24 centimeters (4.3-9.5 inches) long, and 3-7 centimeters (1.2-2.8 inches) broad. Spikes grow to 11 centimeters (4.3 inches) long and four millimeters (0.2 inch) thick. The berries are tetragonous and glabrous.

The species is found in primaveral forests in the central and western mountains of Puerto Rico. An unknown number of individuals were found by DNER within 1.6 kilometers (one mile) of the

Alternatives A and C study corridors in the Secondary Limestone Forest habitat type (DNER 2002). These individuals were found on the mogotes west of the Guajataca River Gorge. No individuals of this species were found during the field studies for this BA. The species has a moderate potential of occurrence in the Alternative A and C study corridors and a low potential for occurrence in the Alternative B study corridor.

***Pleodendron macranthum* – (Chupacallos)**

Federal Status: Endangered
DNER Status: Critically Endangered

Chupacallos is an evergreen tree reaching 10 meters (33 feet) in height. The leaves are leathery, alternate, and simple, about 8.5-12.5 centimeters (3-5 inches) long and 4.5-5 centimeters (1.5-2 inches) wide. The blades are elliptic with the upper surface dark, shiny green in color and the midvein sunken. The lower surface is pale green with a prominent mid-vein and fine, parallel side veins. The leaf stalks are about seven millimeters (0.25 inch) long. The whitish bisexual flowers are solitary and axillary, two centimeters (0.75 inch) wide with a 2.5-centimeter- (one-inch-) long flower stalk. The aromatic purplish-black fruit measures two centimeters (0.75 inch) in diameter and contains many seeds.

Chupacallos was Federally listed as endangered on September 9, 1994. The species has fewer than 50 presently-known individuals in seven localities of the subtropical wet and subtropical montane wet forests of northern and eastern Puerto Rico (USFWS 1990). Three localities are within the Caribbean National Forest and four are within the Río Abajo Forest. The species is found in the semi-evergreen or evergreen seasonal forest of the subtropical moist forest on limestone hills at elevations from 150-350 meters (490-1,150 feet).

Each of the three study corridors contain suitable habitat for the species, but it was not found within any corridor during the field reviews for this BA. The species is considered to have a low potential for occurrence within the three study corridors.

***Polygala cowellii* – (Violet tree)**

Federal Status: Not Listed
DNER Status: Critical Element

Polygala cowellii is an endemic tree which grows to 20 meters (65.6 feet) tall, with a trunk growing to 20 centimeters (7.9 inches) in diameter. The bark is gray, smooth or slightly fissured, with slender twigs which are puberulous to glabrous. The leaves are elliptic to ovate, 5-15 centimeters (2-6 inches) long, 2.5-8 centimeters (1-3.1 inches) broad, with many straight lateral veins. The purple flowers appear either before the leaves of the season sprout or before the leaves of the previous year have fallen.

The species is found in forests on hillsides and arroyos, mostly in the southern coastal regions, and in moist limestone hills of the northern coast. During the field reviews for this BA, five individuals were found on the cliff edges of the Camuy River Gorge at Study Location 1. One individual was also found east of the Guajataca River Gorge at Study Location 3. These areas lie within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors.

One individual was also found between PR-2 and the railroad track by Aguadilla and five individuals were found on a hill northwest of PR-2 and Road 113 (see report in Appendix B). These locations are within the Secondary Limestone Forest of the Alternative B study corridor. The species is considered to have a high potential for occurrence in the Alternative A, B and C study corridors.

***Pseudolmedia spuria* – (False breadnut)**
Federal Status: Not Listed
DNER Status: Critical Element

False breadnut is a tree which grows 8-20 meters (26.2-65.6 feet) tall. The leaves are lance-oblong to oblong-elliptic, 8-16 centimeters (3.1-6.3 inches) long, and 2.8-6 centimeters (1.1-2.4 inches) broad. The base of the leaf is obtuse to rounded or acute. It is pale and reticulate underneath. The flowers are ovoid, about two millimeters (0.08 inch) long, and softly puberulent. The drupes are broadly ovoid, fleshy, 1-1.5 centimeters (0.4-0.6 inch) long, and turn bright red at maturity.

The species is found in the moist limestone hills near the northern coast of Puerto Rico. During the field reviews for this BA, one individual was found at Study Location 2 within the Secondary Limestone Forest of the Alternative A and C study corridors. This individual was found on the mogotes west of the Guajataca River Gorge. The species has a high potential for occurrence within the Alternative A and C study corridors and a low potential for occurrence within the Alternative B study corridor.

***Psidium amplexicaule* – (Guavaba de monte, Mountain guava, Sperry guava)**
Federal Status: Not Listed
DNER Status: Critical Element

Psidium amplexicaule is a shrub or tree which grows to 12 meters (39.4 feet) tall and 30 centimeters (one foot) in trunk diameter. The bark is a mottled tan-gray color which peels off in plates. The twigs are gray, slender, suborbicular or ovate-orbicular, 4-11 centimeters (1.6-4.3 inches) long, and 3-8 centimeters (1.2-3.1 inches) wide. Flowers are white and four centimeters (1.6 inches) long. The fruit is subglobose or ellipsoid, green in color, and about two centimeters (0.8 inches) in diameter.

This species is found in moist forests on limestone in northern and central Puerto Rico at lower to middle elevations. During the field reviews for this BA, 10 individuals were found on a hill northwest of PR-2 and Road 113. This location is within the Secondary Limestone Forest of the Alternative B study corridor. Ten individuals were also found east of the Guajataca River Gorge. These locations lie within the Secondary Limestone Forest of the Alternatives A and C study corridors. The species is considered to have a high potential for occurrence in the Alternative A, B and C study corridors.

***Rollinia mucosa* – (Wild sugar apple)**
Federal Status: Not Listed
DNER Status: Critical Element

Wild sugar apple is a medium sized tree, growing to 9 meters (30 feet) tall, with open, spreading branches. The leaves are alternate, glossy green and large, 10-36 centimeters (4-14 inches) in length and 5-12.5 centimeters (2-5 inches) wide. The leaf blade is soft and pliable, and has prominent veins, sunken on the adaxial (upper) surface. The flowers are perfect, whitish, have a three lobed triangular form and occur singly or in pairs in the leaf axils. The fruits are spherical and large, around 2-6 inches (5-15 centimeters) in diameter, yellowish, and with slight or very prominent protuberances. The pulp is whitish, juicy, aromatic and flavorful, with a creamy texture and a delicious sweet-sour balance. Seeds are shiny, brown and elliptical, about 1.3 centimeters (0.5 inch) long.

The species is found in forests in the eastern and western mountains of Puerto Rico at elevations between 150-160 meters (500-2,000 feet). An unspecified number of individuals were reported by the DNER Natural Heritage Program within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). These individuals were found in the mogotes west of the Guajataca River. No individuals of this species were found during the field reviews for this BA. The species is considered to have a high potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Schoepfia arenaria* - (No common name)**

Federal Status:	Threatened throughout its range
DNER Status:	Endangered

Schoepfia arenaria is an evergreen shrub or small tree that may grow to six meters (19.7 feet) tall. The species has several trunks from the base reaching 10 centimeters (four inches) in diameter. The simple, alternating leaves are green on the upper surface and light green on the lower surface. The wood is light brown and hard. The species flowers mainly in spring and fall, usually with two or three light yellow, tubular-shaped flowers on the end of the stalk. The fruit, occurring during summer and winter, is elliptic, one-seeded, shiny red, and 12 millimeters (0.5 inch) in diameter.

The species was Federally listed as threatened throughout its range on April 19, 1991. *S. arenaria* is known in four locations: Isabela, Piñones, Fajardo, and Río Abajo Forest (USFWS 1990). Approximately 100 individuals of all size classes are known in the Isabela area, from the wooded upper slopes of the hills to west of the mouth of Guajataca Gorge (USFWS 1990). The species is found in low elevation evergreen and semi-evergreen forests of the densely wooded portions of limestone hills in northern Puerto Rico between the elevations of 150 to 350 meters (490 to 1,150 feet).

Factors which have historically restricted the distribution of this plant species are deforestation and destruction of limestone hills for construction materials, agriculture, grazing, and development such as urban, industrial, or tourist developments. During field reviews for this BA, 90 individuals were found on the hillside northwest of the intersection of Highway PR-2 and Road 113 and on a slope south/southeast of the same intersection at Study Location 5. These areas lie within the Secondary Limestone Forest of the Alternative B corridor. The species has

been classified as having a high potential for occurrence in the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Schoepfia schreberi* – (No common name)**
Federal Status: Not Listed
DNER Status: Critical Element

Shoepfia schreberi is a shrub or small tree which grows to nine meters (29.5 feet) tall. The branches are whitish and angular, while the leaves are ovate to ovate-lanceolate. The leaves are 3-8 centimeters (1.2-3.2 inches) long and 1.5-4.8 centimeters (0.6-1.9 inches) broad. The red flowers are sessile.

The species is found on hills in dry coastal and seasonal forests in Puerto Rico. During field reviews for this BA, five individuals were found on cliff edges of the Camuy River Gorge in Study Location 1. This area lies within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors. The species is considered to have a high potential for occurrence within the Alternatives A and C study corridors and a low potential for occurrence within the Alternative B study corridor.

***Sloanea amygdalina* – (Motillo)**
Federal Status: Not Listed
DNER Status: Critical Element

Motillo is a large tree which grows to 30 meters (98.4 feet) in height with a narrow crown. The leaves are elliptic, obtuse to emarginated at both ends, 6-15 centimeters (2.4-5.9 inches) long, and 4-9 centimeters (1.6-3.5 inches) broad. The leaves have a slightly undulate margin and are glabrous. The flowers are axillary with four ovate sepals. The seed capsules are yellowish green, densely covered with slender spines, and open by four valves.

The species occurs in forests at lower and middle elevations to 700 meters (2,297 feet) in western Puerto Rico. During field reviews for this BA, one individual was found east of the Guajataca River Gorge in Study Location 3. This area lies within the Secondary Limestone Forest of the Alternative A and Alternative C corridors. The species is considered to have a high potential for occurrence within Alternatives A and C study corridors and a low potential for occurrence within the Alternative B study corridor.

***Solanum drymophilum* – (Erubia)**
Federal Status: Endangered
DNER Status: Endangered

Erubia is an evergreen shrub with sharp, yellow spines. It can grow to 5.5 meters (18 feet) in height as it branches from the base, although it can grow from a single stem. The spines are almost 13 millimeters (0.5 inch) long and are located along the mid-vein of the leaves. Mature shrubs have minute, whitish, star-shaped hairs on their leaves and petioles. These hairs are longer and appear on the twigs and flowers of younger shrubs. The lanceolate to lanceolate-

oblong shaped leaves are alternate and its white, bisexual flowers are five-lobed and fan-shaped. Erubia seems to flower and produce round, shiny, black berries throughout the year.

Erubia was Federally listed as endangered on August 26, 1988. The only site where Erubia is still known to exist is the two-acre Tetas de Cayey in Sierra de Cayey in central Puerto Rico. About 100 to 150 plants exist on this privately-owned land, situated at 840 meters (2,760 feet) in elevation and speckled with volcanic outcrops. The Tetas de Cayey is a combination of cleared home sites, pastures, coffee plantations, and native evergreen forest remnants. Most of the remaining Erubia population is found in a pasture on the area's southern hill, surrounded by lots which are undergoing residential and commercial development (USFWS 1990). The species typically takes hold easily in moderately disturbed sites, but the severe deforestation and clearing of its only habitat has contributed greatly to its decline. In addition, grazing, coffee and charcoal production, and residential and commercial construction have reduced the number of population sites to only one. Farmers also regard the species as a nuisance and threat to their grazing livestock because of the sharp spines on immature shrubs, thus uprooting them whenever possible.

Each of the three study corridors contain suitable habitat for the species, but it was not found within any of them during field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

***Tectaria estremerana* – (Puerto Rico halberd fern)**

Federal Status: Endangered
DNER Status: Critically Endangered

Puerto Rico halberd fern is a terrestrial fern with woody 10-15 millimeter- (0.5-0.7 inch-) thick rhizomes. It has several loosely bundled 65-80 centimeter- (25-32 inch-) long fronds. The light orange-brown stipes are slightly shorter than the blades and are covered with pale jointed hairs. Significant factors affecting this rare, restricted fern are destruction, modification of its habitat, and illegal harvesting by collectors. Halberd Fern was Federally listed as endangered on June 9, 1993.

The species is found in the karst region of northwestern Puerto Rico and in portions of the US Virgin Islands. In Puerto Rico it has been recorded in two locales; the first is in moist, shaded humus on and around limestone boulders on a wooded rocky hillside between 250-300 meters (820-985 feet) elevation in the municipality of Arecibo. This location is within the property of the Arecibo Radio Telescope and held approximately 23 individual plants when recorded. The second location is in the Río Abajo Ward in the municipality of Florida where it was observed in 1994 (USFWS 1990). The species and Puerto Rico maiden hair (*Adiantum vivesii*) share habitat locales and characteristics. Each of the three study corridors contain suitable habitat for the species, but it was not found within study corridor during the field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

***Tetrazygia angustifolia* – (Stinking fish)**

Federal Status: Not listed
DNER Status: Critical Element

Stinking fish is a small tree which commonly grows up to seven meters (23 feet) tall and 10 centimeters (4 inches) in trunk diameter. The leaves are linear-lanceolate, 3-8 centimeters (1.2-3.2 inches) long, and 4-15 millimeters (1.6-5.9 inches) broad. They are glabrous above and grayish-woolly beneath with minute stellate hairs. The flowers are short-pedicelled. The four petals are yellowish or rosy and obovate. The berries are bluish-black, glubose, and about five millimeters (0.2 inch) in diameter.

The species is local and scattered at lower elevations in the northeastern, southwestern, and northwestern districts of Puerto Rico. An unspecified number of individuals were reported by the DNER Natural Heritage Program within 1.6 kilometers (one mile) of the Alternative B study corridor in the Secondary Limestone Forest habitat (DNER 2002). These individuals were found north of PR-2, approximately halfway between Mora Ward and the town of Aguadilla. No individuals of this species were found during the field reviews for this BA. The species has a moderate potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Thelypteris verecunda* – (Barrio Charcas maiden fern)**

Federal Status: Endangered
DNER Status: Critically Endangered

Thelypteris verecunda is a terrestrial fern with creeping 2-3 millimeter- (0.75-1.2 inches-) thick rhizomes. Its dimorphic fronds are covered with star-shaped hairs and numerous longer, simple hairs. The sterile blades are oblongate, 2.5-4 centimeters (1-1.6 inches-) long to 1.5-2 centimeters (0.6-0.8 inch-) broad, truncated at the base, and rounded at the broadly-lobed apex, which also had brown scales. The fertile blades are linear to attenuate, 13 to 15 centimeters (5-6 inches) long, 1.2-1.8 centimeters (0.5-0.7-inch) broad, truncated at the base, and the rachis bears a minute, proliferous bud below the apex. The small and erect sori have a tuft of long, white, simple hair.

The species was Federally listed as endangered throughout its range on July 2, 1993. Because of its rarity, the species is extremely vulnerable to the loss of any individual. Factors which affect the species are clearing and development of its habitat.

The species has been collected from Barrio Charcas in the municipality of Quebradillas (USFWS 1990). Other localities known for the species include: Barrio Bayaney, Hatillo, and Barrio Cidral in the municipality of San Sebastian (USFWS 1990). Each of these three sites occur on private land. In Quebradillas and San Sebastian, only one individual has been collected from each locality (USFWS 1990). In Barrio Bayaney, about 20 plants are known (USFWS 1990). It is found on moist, shaded limestone ledges at middle elevations of 200 meters (656 feet). All three study corridors contain suitable habitat for the species, but it was not found within any study corridor during the field reviews for this BA. The species is considered to have a low potential to occur within the three study corridors.

***Zanthoxylum thomasianum* - (St. Thomas prickly ash)**
Federal Status: Endangered
DNER Status: Endangered

St. Thomas prickly ash is an evergreen shrub or small tree which grows to six meters (20 feet) tall. The spiny trunk reaches up to 10 centimeters (four inches) in diameter. The bark, leaves, and fruit are aromatic. The five-inch long, alternate, pinnate leaves are divided into 5 to 13 leaflets. The leaflets are 1.25-2.5 centimeter- (0.5-1inch-) long and have one or two six millimeter- (0.25 inch-) long spines at their base. The leaflet upper surface is shiny green and the lower surface is pale green with two or three spines along the mid-vein. The dioecious plants produce small, three-petal flowers. The fruit is a dry capsule with a shiny black seed about six millimeters (0.25 inch) long.

The species was Federally listed as endangered on December 20, 1985. The species has been found in Puerto Rico and the Virgin Islands at six different locations. Puerto Rico's three sites include one near the summit of Piedras Chiquitas, one at Guajataca in the municipality of Isabela, and one in Coamo (USFWS 1990). The areas in which the plant grows are distinguished by the low stature of the vegetation and by more than 50 percent of the species losing their leaves during the dry season. Plants at the Guajataca site may be threatened by farming, limestone mining, or proposed resort development. All of the known sites are on private land. Hurricane winds may have destroyed the population found on the summit at Piedras Chiquitas (USFWS 1990). The most serious threats to St. Thomas prickly-ash seem to be modification and destruction of habitat.

During field reviews for this BA, five individuals were found on the hillside northwest of the intersection of Highway PR-2 and Road 113 in Study Location 5. This area lies within the Secondary Limestone Forest of the Alternative B corridor. The species is considered to have a high potential for occurrence within the Alternative B study corridor and low potential for occurrence within the Alternative A and C study corridors.

3.2.2 Fauna

The following eight Federal and 10 Commonwealth listed animal species have the potential to occur within one or more of the project study corridors:

Amphibians

***Peltophryne lemur* – (Puerto Rican crested toad)**
Federal Status: Threatened
DNER Status: Critically Endangered

The Puerto Rican crested toad is a medium-sized toad, 64-120 millimeters (2.5-5 inches) in snout-vent length, yellowish-olive to blackish-brown in color, with prominent supraorbital crests and a distinctive long, upturned snout. Males are considerably smaller than females and exhibit less prominent crests. Although not documented, these toads are believed to be opportunistic feeders that primarily consume insects and other invertebrates. Breeding appears to be sporadic

and highly dependent upon occasional heavy rains. When rainfall and surface water are adequate, more than one breeding event may occur in a single season. The breeding period is short and within a few weeks the toadlets metamorphose and quickly disperse. Adults toads are semifossorial and widely dispersed when not breeding. Because of this cryptic behavior, the location or even presence of adult toads when not breeding is difficult to detect.

Currently, crested toads are known to exist only on the main island of Puerto Rico at low elevations (below 200 meters) (656 feet). A single large population is known from the southwest coast in the Guánica Forest, and a small population is believed to survive on the north coast. It has also been collected on the southern coastal plain near Coamo (USFWS 1990). Northern coastal plain collections have been made near Isabela, Quebradillas, Arecibo, Barceloneta, Vega Baja, and Bayamon. While the Guánica Forest population is relatively stable and consists of approximately 1,500 to 2,000 individuals, the northern population consists of only 25 individuals.

The Puerto Rican crested toad was Federally listed as threatened on August 4, 1987. Primary contributing factors to this listing include loss of habitat from filling and drainage of breeding sites for construction, cultivation and mosquito control. Secondary factors include possibly heavy predation on dispersing toadlets, particularly from wading birds, reproduction may be relying on climatic events (sometimes one or more years apart at irregular intervals), and extremes in sex ratios. All three study corridors contain suitable habitat for the species, however it was not found within any of the project alternative study corridors during field reviews for this BA. The species is considered to have a low potential to occur within the three alternatives study corridors.

Reptiles

***Amphisbaena bakeri* – (Baker's Worm Lizard)**

Federal Status: Not Listed
DNER Status: Critical Element

Baker's worm lizard is a snake-like reptile with rings of scales encircling the body and tail. There are no external ear openings. Except for their size, they are similar in appearance to earthworms. Their eyes and ears are covered by skin. Most are about 30 centimeters (one foot) long. Members of many species of worm lizard remain underground most of their lives, feeding on earthworms, spiders, and insects. Worm lizards are found in tropical and warm temperate areas.

Baker's worm lizard lives in dense woodlands, thickets and caves in Puerto Rico. It can be found burrowing under logs, rocks, old tree stumps, and under termite and ant nests. An unspecified number of individuals were reported by the DNER Natural Heritage Program northwest of Mora Ward within the Secondary Limestone Forest of the Alternative B study corridor (DNER 2002). No individuals of this species were found during the field reviews for this BA. The species has a high potential for occurrence within the Alternative B study corridor and a low potential for occurrence within the Alternative A and C study corridors.

***Epicrates inornatus* - (Puerto Rican boa)**
Federal Status: Endangered throughout its range
DNER Status: Vulnerable

The Puerto Rican boa's color is somewhat variable, but usually ranges from pale to dark brown, sometimes grayish, with 70 to 80 darker colored blotches along the back from neck to vent. These dorsal blotches are generally dark-bordered with the centers of a lighter hue. Maximum size of this snake is approximately two meters (6.5 feet). In captivity, the boa's diet consists of birds, small mammals, and lizards, and a similar diet is expected in the wild. 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.

This species exists only in Puerto Rico, however no population estimates are available. Their preferred habitat seems to be the forested limestone hill area. The boas utilize ground level retreats for sleeping during the day, and apparently hunt most of their prey in nearby trees at night. During a radiotelemetry study at the Mata de Platano Reserve, the average home range area for females was 7,800 square meters, whereas for males it was 5,000 square meters (USFWS 1990). The mean area used during nonreproductive period by females was 22,119 square meters and 1,326 square meters for males. During the reproductive period, all radio-tracked females used a mean area of 16,940 square meters and all males used 18,500 square meters.

The Puerto Rican boa was Federally listed as endangered on October 13, 1970. Oil produced from the snake's fat was a popular commodity and the snake's vulnerability was heightened by a concurrent reduction of habitat. Deforestation and illegal hunting continues to affect the snake's population. Predation by the mongoose, introduced into Puerto Rico in the 1900's, is possibly another contributor to the decline in numbers, but the idea has not yet been directly supported. During field reviews for this BA, two individuals were found around cliff edges of the Camuy River Gorge in Study Location 1. Two individuals were also found in the hills east of, and on the cliff overlooking, the Guajataca River Gorge in Study Location 3. These areas lie within the Secondary Limestone Forest of the Alternative A and Alternative C study corridors. Two individuals were found east of PR-2 by the city of Aguadilla, within each of the three alternative study corridors in Secondary Limestone Forest habitat. The species are considered to have a high potential for occurrence in the Alternative A, B and C study corridors.

***Mabuya mabouya sloani* – (Lucia, Slipperyback skink)**
Federal Status: Not Listed
DNER Status: Vulnerable

The lucia is a terrestrial skink with a bronzed-brown colored body. Stretching from the species/ nostrils to its back legs are two dark brown stripes on each side. These stripes are separated by cream-colored strips, also running the length of its body. It is approximately 40 millimeters (3.5 inches) long.

The species was once common in isolated localitites. In Puerto Rico, the species is abundant at the base of coconut trees, under the clusters of opuntia and in the cracks of rocks. It is also

known to enter houses. An unknown number of individuals were reported by the DNER Natural Heritage Program within 1.6 kilometers (one mile) of the Alternative B study corridor in the Secondary Limestone Forest habitat (DNER 2002). The individuals were found on mogotes east of the Guajataca River Gorge. No individuals of this species were found during the field reviews for this BA. The species has a moderate potential for occurrence within the Alternative B corridor and a low potential for occurrence within the Alternative A and C study corridors.

Birds

***Accipiter striatus venator* – (Puerto Rican sharp-shinned hawk)**

Federal Status: Endangered throughout its range
DNER Status: Critically Endangered

The Puerto Rican sharp-shinned hawk is a small hawk measuring approximately 28-33 centimeters (11-13 inches) in length. The dark, slate-gray upper parts and heavily barred rufous under parts of the adults are distinctive. Immature birds are brown above and heavily streaked below. It has a short, squared tail, often appearing notched when folded, and a small head and neck. When in flight, noticeable characteristics are the short, rounded wings and long, narrow tail. The hawks will nest in both natural and modified habitats, tending to select plantation and natural forest nest sites with similar vegetative structure and topography (closed canopies and dense stands).

Breeding populations have been located in the mountain forest of the Maricao Forest, Toro Negro Forest, Guilarte Forest, Carite Forest and Caribbean National Forest A 1992, 285.6 square-kilometer (178 square-mile) census yielded 82 sharp-shinned hawks; 40 in Maricao Forest, 30 in Toro Negro Forest, 10 in the Carite Forest and two in the Carribean National Forest. The center of sharp-shinned hawk courtship and territorial activities in Maricao Forest has been located in the north-central and eastern parts, within the subtropical lower montane wet forest and subtropical wet forest types. In the Carite Forest, territorial and courtship activities occurred in the northeastern and north-central parts, within the caimitillo-granadillo forest types. In Toro Negro, these activities took place in the elfin woodland, sierra palm, caimitillo-granadillo and tabonuco forest types. In the Caribbean National Forest, the only two sharp-shinned hawks sighted were detected in the south-central part of the forest, confined to the Palo Colorado forest type of the lower montane forest (USFWS 1990).

The species was Federally listed as endangered on September 9, 1994. Threats to the hawk include timber harvest and management practices in the forests, road construction, increase in numbers of recreational facilities, disturbance associated with public use, hurricane effects, and genetic variation issues. Low reproductive success, high desertion of eggs, and high nestling mortality due to parasitism by the warble fly (*Philornis* spp.) have also been reported. All three study corridors contain suitable habitat for the species, but it was not observed within any of the project alternative study corridors during field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

***Amazona vittata* – (Puerto Rican parrot)**
Federal Status: Endangered
DNER Status: Critically Endangered

The Puerto Rican parrot is bright green, about 30.5 centimeters (one foot) in length, with red forehead, blue primary wing feathers, and flesh-colored bill and feet. This bird feeds chiefly on wild fruits, particularly the sierra palm (*Prestoea montana*), but may also consume flowers and tender shoots. During October, when other fruits are scarce, the tabonuco fruit (*Dacryodes excelsa*) becomes an important food item. Observations around 1990 indicated that nesting is confined almost exclusively to natural cavities in Colorado trees (*Cyrilla racemiflora*). The parrots clean out the interior of the cavity but they do not add lining material. Nest height varies from about 7-15 meters (23-49 feet) above the ground. Mating begins in January and clutch size ranges from two to four eggs. The period from laying to fledging lasts about 13 weeks. An intensive management program began in 1973, greatly increasing fledging success rate.

Preferred habitat of the Puerto Rican parrot consists of mature rain forest located between about 396-829 meters (1,300-2,700 feet) in elevation. Dwarf forest at the higher elevations and second growth lowland forest are not used. The parrots are confined to areas having the largest number of old Colorado trees, which supply nesting cavities. Historically, the parrots nested in holes in cliffs as well, and occupied a more diversified habitat, particularly at lower elevations. The captive program of the Puerto Rican parrot was initiated in 1968 by collecting parrots already in captivity and from the wild. A captive flock is being maintained to increase the number of parrots; to maintain a second group of birds, particularly if there should occur a natural catastrophe; to provide and manipulate different genetic stock for trading with the wild flock; and to eventually provide stock to be reintroduced into the wild. Although the Caribbean National Forest contains over 26,000 acres, the parrots have concentrated in a small area of 3,000 acres in the western and west central part of the forest. The northern karst region has been identified as the release site for the Puerto Rican Parrot.

The species was Federally listed as endangered on March 11, 1967. The Puerto Rican parrot currently ranks as one of the world's most critically endangered species. The initial decline has been attributed to extensive deforestation. Contributing factors have included widespread hunting, devastating hurricanes, natural predation, and the taking of parrots for pets. The small size of the remaining population makes all adverse pressures very serious. The Recovery Plan for the Puerto Rican Parrot, *Amazona vittata*, approved in April 1987 (original approval: November 30, 1982), includes the following recommendations:

(1) Increase effective wild population at the Caribbean National Forest to a self sustaining level of 500 birds;
(2) Maximize production of Puerto Rican parrots in captivity for eventual release;
(3) Protect and improve present and potential parrot habitat within the Caribbean National Forest area and the Rio Abajo area;
(4) Establish and maintain a second effective wild population of at least 500 birds in the Rio Abajo area;
(5) Manage wild populations in the Caribbean National Forest and in the Rio Abajo area;

(6) Construct and operate a second aviary at Rio Abajo Forest to produce parrots for release; and,
(7) encourage research and recovery efforts by reputable members of the private sector. The second aviary at Rio Abajo Forest was constructed in 1993. However, this aviary is roughly 25 kilometers (15.5 miles) from the closest alternative corridor (Alternatives A and C).

No mature rainforests above elevation 396 meters (1,300 feet) exist within any of the three study corridors. In addition, the tree species preferred by the parrot were not found within any of the alternative corridors. The species is considered to have no potential to occur within any of the three alternative study corridors.

***Buteo platypterus brunnescens* – (Puerto Rican broad-winged hawk)**

Federal Status: Endangered throughout its range
DNER Status: Critically Endangered

The Puerto Rican broad-winged hawk is a small, dark chocolate brown hawk with a body length of approximately 39 centimeters (15 inches). This is the darkest subspecies of the broad-winged hawk. In adults, the tail, broadly banded with black and white, and the rufous breast are characteristic. Immature birds have dark bars on the breast and lack the distinctive tail bands of the adult. Broadwings flap more than the similar but larger red-tailed hawk. Prey types collected from a nest include centipedes, frogs, lizards, mice, rats, and birds.

The species is an uncommon and local resident. Existing populations are restricted to montane habitats of three forests: Rio Abajo Forest, Carite Forest, and Caribbean National Forest. A 206.4 square-kilometer (130 square-mile) census in the three forests in 1992 yielded 58 broad-winged hawks, or an estimated population of 124 individuals (USFWS 1990). Sightings of the species have been reported from other areas including Cayey (next to the Carite Forest), Utuado, Jayuya, Adjuntas, and Villalba. The hawks were more often seen in the eastern side of the Caribbean National Forest, and the tabonuco and palo colorado forest types were reported to be the preferred habitats for the species. A cluster of broad-winged hawks was reported in the north-central part of the Caribbean National Forest within subtropical wet forest and subtropical rain forest, where the tabonuco is the dominant forest type. In the Carite Forest the species has been reported from the elfin, caimitillo, granadillo, tabonuco, and slope forest types.

The species was Federally listed as endangered on September 9, 1994. Timber harvest, forest management practices, road construction, increase in numbers of recreational facilities, disturbance from public use, mortality and habitat destruction from hurricanes, and possible loss of genetic variation due to low population levels are all potential threats to the species. All three study corridors contain suitable habitat for the species, but it was not observed within any of the project study corridors during field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors

***Columba inornata wetmorei* – (Puerto Rican plain pigeon)**

Federal Status: Endangered throughout its range
DNER Status: Endangered

The Puerto Rican plain pigeon is about the size and shape of a domestic pigeon. At a distance the species appears pale blue-gray. The head, hindneck, breast, and the top central part of the folded wing are washed with a wine color. The wing coverts are margined with white, while legs and feet are dark red. A variety of fruits, seeds, and livestock feed makes up this species' diet. Breeding occurs throughout the year, but peaks in late winter and spring. Some nests are flimsy platforms of twigs, occasionally placed on unused rat nests or on an accumulation of litter in a tangle of vines. More typically, nests are built on a bare forking tree branch or near the top of a bamboo stalk. The pigeon lays only one egg, but a female has been documented to produce three broods in a year. Flocking can occur any time food is locally abundant. Adult pigeons congregate in small flocks for feeding during the breeding season.

As of 1990, there were a minimum of 204 individuals in the wild and 116 in captivity (USFWS 1990). Surveys conducted since 1973 indicate that the only existing population occurs in the lower montane forest and hardwood canyons near Cidra and surrounding municipalities, particularly Cayey. A few of the birds have also been reported at Gurabo and Utuado (USFWS 1990). Historical habitats reportedly used by this bird include lowland swamps and woodland, open woodland and cultivated land in the mountains, limestone karst, and coffee plantations in upland hills.

The Puerto Rican plain pigeon was Federally listed as endangered throughout its range on October 13, 1970. Extensive deforestation and over-hunting are major factors contributing to population decline. Habitat loss due to the rapid development of the Cidra area is the most serious threat to the species' existence. The majority of nest failures observed were also a result of human-caused disturbances. Establishment of new populations apparently has been limited by the bird's reluctance to colonize new areas. All three study corridors contain historically suitable habitat for the species (limestone karst), but it was not observed within any of the project alternative study corridors during field reviews for this BA. The species is considered to have a low potential to occur within the three alternative study corridors.

4.0 POTENTIAL IMPACTS

Section 3.0 of this BA identified the Federal and Commonwealth listed species known to occur or which have the potential to occur within each study corridor based on the presence of suitable habitat, documented studies, and project field reviews. This section discusses the direct, indirect and cumulative impacts that may result to listed plant and animal species known to occur or potentially occur within each study corridor as a result of construction and operation of each build alternative.

4.1 Direct and Indirect Effects

4.1.1 Alternative A

Plants

Table 4-1 lists the three Federal and 17 Commonwealth listed plant species known to occur within the Alternative A study corridor. Three of these (*Schoepfia schreberi, Caesalpinia major,* and *Jacquinia umbellata*) were observed within the proposed 90 meter wide right-of-way during the BA field studies. Construction of Alternative A may result in the loss of individual plants of each of these species during clearing of the right-of-way. Proposed conservation measures to off-set these potential losses of individual plants are presented in Section 5.0.

In addition, construction of Alternative A would result in the loss of suitable habitat for these plant species within the cleared right-of-way. As shown in Table 4-2, the area of suitable habitat for listed plant species that would be lost as a result of construction of Alternative A is approximately 122 hectares (301 acres). This area includes Secondary Limestone Forest, Riparian Forest, and Scrub Forest habitats.

Construction of Alternative A would also result in the loss of approximately 122 hectares (301 acres) of suitable habitat (Secondary Limestone Forest, Riparian Forest, and Scrub Forest) for species with a potential for occurrence within this study corridor (see Table 3-2 for a listing of these species). The potential for loss of individuals of each of these plants during construction is considered low since they are not known to occur within the Alternative A study corridor.

Animals

The only Federal and Commonwealth listed animal species known to occur within the Alternative A study corridor is the Puerto Rican boa. This species was also observed within the proposed 90 meter wide right-of-way during the BA field studies. The total area of suitable Puerto Rican boa habitat that would be lost as a result of construction of Alternative A is approximately 103 hectares (254 acres) of Secondary Limestone Forest (see Table 4-2). The size of the Puerto Rican boa population within this area is unknown. Construction activity and post-construction operation of the new highway could also result in the death of an unknown number of boas.

Table 4-1
Listed Plant and Animal Species Observed In Alternative A Study Corridor

Plant Species	Common Name	Source	Number of Individuals	Listing Status[4]	
				USFWS[2]	DNER[3]
Antirhea portoricensis	Puerto Rico quina	BA field studies	10	None	EC
Buxus portoricensis	No common name	BA field studies	50	None	EC
Caesalpinia major	Mauritius thorn, mysore thorn	BA field studies	Multiple	None	EC
Cedrela odorata	Barbados cedar, Spanish cedar	BA field studies	11	None	EC
Diospyros sintenisii	Guayabota, Múcaro, Tabeiba	BA field studies	2	None	EC
Goetzea elegans	Mata buey, Beautiful goetzea	BA field studies	12	E	EN
Guapira obtusata	Corcho, corcho blanco	BA field studies	2	None	EC
Ilex urbaniana	Cuero de sapo	BA field studies	1	None	EC
Jacquinia umbellata	Chirriador, chirre	BA field studies	28	None	EC
Myrcia pagani	No common name	BA field studies	2	E	CR
Ottoschulzia rhodoxylon	Palo de rosa	BA field studies	110	E	CR
Pereskia aculeata	Barbados shrub	DNER 2002	NR[1]	None	EC
Polygala cowellii	Violet tree	BA field studies	6	None	EC
Pseudolmedia spuria	False breadnut	BA field studies	1	None	EC
Psidium amplexicaule	Guayaba de monte, Mountain guava, Sperry guava	BA field studies	10	None	EC
Schoepfia schreberi	No common name	BA field studies	5	None	EC
Sloanea amygdalina	Motillo	BA field studies	1	None	EC
Animal Species					
Epicrates inornatus	Puerto Rican boa	BA field studies, DNER 2002	4	E	VU

(1) NR = Not reported
(2) USFWS = U.S. Fish and Wildlife Service
(3) DNER = Puerto Rico Department of Natural and Environmental Resources
(4) Designated Status
T = Threatened (USFWS)
E = Endangered (USFWS)
EN = Endangered (DNER)
CR = Critically Endangered (DNER)
EC = Critical Element (DNER)

Table 4-2
Listed Species Habitat within Alternative A Right-of-Way (ROW)
(Including Three Connectors)

Habitat/Land Use	Area within 90-Meter ROW		Potential Habitat for Listed Species[1] within ROW?
	Hectares	Acres	
Secondary Limestone Forest	102.8	254.1	Yes
Riparian Forest	1.0	2.6	Yes
Scrub Forest	18.0	44.5	Yes
Delonix Forest	0.0	0.0	NA
Luecaena Forest	0.0	0.0	NA
Herbaceous Vegetation	0.3	0.7	No
Pasture Land	234.2	578.6	No
Crop Land	8.3	20.6	No
Developed Land	77.6	191.7	No
Herbaceous Wetland	8.2	20.3	No
Lowland Albizia Forest	0.0	0.1	No
Total	450.5	1113.1	
Total area of potential habitat for listed species within Alternative A ROW = 121.8 hectares (301.2 acres)			

(1) Includes both plant and animal Federal and DNER listed species.
NA = Not applicable

Proposed conservation measures to off-set potential losses to Puerto Rican boas are presented in Section 5.0. Other animal species that have a potential to occur within the Alternative A study corridor include the Puerto Rican crested toad, Baker's worm lizard, slippery back skink, Puerto Rican sharp-shinned hawk, Puerto Rican broad-winged hawk, and Puerto Rican plain pigeon. Direct and indirect effects to these species as a result of construction and operation of Alternative A include potential loss of nesting, denning, roosting, and foraging habitat and increased roadkill potential. The potential for loss of individuals of each of these animals during construction and operation of Alternative A is considered low since they are not known to occur within the Alternative A study corridor.

4.1.2 Alternative B

Plants

Table 4-3 lists the six Federal and 23 Commonwealth listed plant species known to occur within the Alternative B study corridor. Two of these (*Scheopfia* arenaria and *Ottoschulzia rhodoxylon*) were observed within the proposed 90 meter wide right-of-way during the BA field studies. Construction of Alternative B may result in the loss of individual plants of each of these species during clearing of right-of-way. However, the potential loss of listed plants resulting from construction of Alternative B is considered low since most of the right-of-way for Alternative B would be within the existing PR-2 right-of-way.

Table 4-3
Listed Plant and Animal Species Observed in Alternative B Study Corridor

Species	Common Name	Source	Number of Individuals	Listing Status[4]	
				USFWS[2]	DNER[3]
Antirhea portoricensis	Puerto Rico quina	DNER 2002	NR[1]	None	EC
Auerodendron pauciflorum	No common name	BA Field Studies, DNER 2002	2	E	CR
Bumelia bellonis	Puerto Rico bully	DNER 2002	NR	None	EC
Campylocentrum pachyrrizum	Leafless bentspur orchid	DNER 2002	NR	None	EC
Chionanthus axilliflora	Hueso	DNER 2002	NR	None	EC
Chionanthus ligustrina	Cabra blanca	DNER 2002	NR	None	EC
Daphnopsis helleriana	None	DNER 2002	NR	E	CR
Dioclea hexandra	Bejuco de mato	DNER 2002	NR	None	EC
Diospyros sintenisii	Guayabota, Mucaro, Tabeibe	BA Field Studies	10	None	EC
Drypetes ilicifolia	Rosewood	DNER 2002	NR	None	EC
Drypetes lateriflora	Guiana plum	DNER 2002	NR	None	EC
Eugenia underwoodii	Underwood's stopper	DNER 2002	NR	None	EC
Goetzea elegans	Mata buey, Beautiful goetzea	BA Field Studies, DNER 2002	20	E	EN
Jacquinia umbellata	Chirriador, chirre	BA Field Studies	25	None	EC
Mappia racemosa	Palo de cana	DNER 2002	NR	None	EC
Ottoschulzia rhodoxylon	Palo de rosa	BA Field Studies, DNER 2002	13	E	CR
Passiflora murucuja	Virgin Island passionflower	DNER 2002	NR	None	EC
Polygala cowellii	Violet tree	BA Field Studies	6	None	EC
Psidium amplexicaule	Guayaba de monte, Mountain guava, Sperry guava	BA Field Studies	10	None	EC
Rollinia mucosa	Wild sugar apple	DNER 2002	NR	None	EC
Schoepfia arenaria	No common name	BA Field Studies, DNER 2002	84	T	EN
Zanthoxylum thomasianum	St. Thomas prickly ash	BA Field Studies, DNER 2002	5	E	EN
Animal Species					
Amphisbaena bakeri	Baker's worm lizard	DNER 2002	NR	None	EC
Epicrates inornatus	Puerto Rican boa	BA Field Studies	1	E	VU

(1) NR = Not reported
(2) USFWS = U.S. Fish and Wildlife Service
(3) DNER = Puerto Rico Department of Natural and Environmental Resources
(4) Designated Status
T = Threatened (USFWS)
E = Endangered (USFWS)
EN = Endangered (DNER)
CR = Critically Endangered (DNER)
EC = Critical Element (DNER)

Construction of Alternative B would also result in the potential loss of up to 49 hectares (121 acres) of suitable habitat for each of these plant species (Table 4-4). However, the actual loss of suitable habitat for listed species as a result of construction of Alternative B would be minimal since most of the right-of-way for Alternative B would be within the existing PR-2 roadway alignment.

Animals

The only Federal and Commonwealth listed animal species known to occur within the Alternative B study corridor is the Puerto Rican boa and Baker's worm lizard (see Table 4-3). Both of these species share similar habitats (i.e., dense woodlands). The total area of suitable Puerto Rican boa and Baker's worm lizard habitat that could be lost as a result of construction of Alternative B is approximately 49 hectares (121 acres) of Secondary Limestone Forest and Scrub Forest (see Table 4-4 for impacts to listed species habitat within the right-of-way). However, the actual loss of suitable habitat for the Puerto Rican boa and Baker's worm lizard as a result of construction of Alternative B would likely be minimal since most of the right-of-way for Alternative B would be within the existing PR-2 right-of-way.

Table 4-4
Listed Species Habitat within Alternative B Right-of-Way (ROW)

Habitat/Land Use	Area within 90-Meter ROW		Potential Habitat for Listed Species(1) within ROW?
	Hectares	Acres	
Secondary Limestone Forest	29.5	72.7	Yes
Scrub Forest	19.4	47.9	Yes
Riparian Forest	0.0	0.0	NA
Delonix Forest	2.3	5.6	No
Luecaena Forest	2.2	5.5	No
Herbaceous Vegetation	1.4	3.5	No
Pasture Land	53.2	131.5	No
Crop Land	7.4	18.3	No
Developed Land	324.6	802.0	No
Herbaceous Wetland	2.0	5.0	No
Lowland Albizia Forest	0.0	0.0	NA
Coastal Forested Wetland	0.5	1.3	No
Total	442.5	1093.4	
Total area of potential habitat for listed species within Alternative B ROW = 48.8 hectares (120.6 acres)			

(1) Includes both plant and animal Federal and DNER listed species
NA = Not applicable

4.1.3 Alternative C

Plants

Table 4-5 lists the three Federal and 17 Commonwealth listed plant species known to occur within the Alternative C study corridor. Three of these (*Schoepfia schreberi, Caesalpinia major,* and *Jacquinia umbellata*) were observed within the proposed 90 meter wide right-of-way during the BA field studies. Construction of Alternative C may result in the loss of individual plants of each of these species during clearing of the right-of-way. Proposed conservation measures to off-set these potential losses of individual plants are presented in Section 5.0.

Table 4-5
Listed Plant and Animal Species Observed in Alternative C Study Corridor

Plant Species	Common Name	Source	Number of Individuals	Listing Status[4]	
				USFWS[2]	DNER[3]
Antirhea portoricensis	Puerto Rico quina	BA Field Studies	10	None	EC
Buxus portoricensis	No common name	BA Field Studies	50	None	EC
Caesalpinia major	Mauritius thorn, Mysore thorn	BA Field Studies	vine	None	EC
Cedrela odorata	Barbados cedar, Spanish cedar	BA Field Studies	11	None	EC
Diospyros sintenisii	Guayabota, Múcaro, Tabeiba	BA Field Studies	2	None	EC
Goetzea elegans	Mata buey, Beautiful goetzea	BA Field Studies	12	None	E
Guapira obtusata	Corcho, corcho blanco	BA Field Studies	2	E	E
Ilex urbaniana	Cuero de sapo	BA Field Studies	1	None	EC
Jacquinia umbellata	Chirriador, chirre	BA Field Studies	28	None	EC
Myrica pagani	No common name	BA Field Studies	2	E	CR
Ottoschulzia rhodoxylon	Palo de rosa	BA Field Studies	110	E	CR
Pereskia aculeata	Barbados shrub	DNER 2002	NR[1]	None	EC
Polygala cowellii	Violet tree	BA Field Studies	6	None	EC
Pseudolmedia spuria	False breadnut	BA Field Studies	1	None	EC
Psidium amplexicaule	Guayaba de monte, Sperry quava	BA Field Studies	NR	None	EC
Schoepfia schreberi	No common name	BA Field Studies	5	None	EC
Sloanea amygdalina	Motillo	BA Field Studies	1	None	EC
Animal Species					
Epicrates inornatus	Puerto Rican boa	BA Field Studies, DNER 2002	4	E	VU

(1) NR = Not reported
(2) USFWS = U.S. Fish and Wildlife Service
(3) DNER = Puerto Rico Department of Natural and Environmental Resources
(4) Designated Status
T = Threatened (USFWS)
E = Endangered (USFWS)
EN = Endangered (DNER)
CR = Critically Endangered (DNER)
EC = Critical Element (DNER)

Construction of Alternative C would also result in the loss of suitable habitat for each of these plant species within the cleared right-of-way. As shown in Table 4-6, the area of suitable habitat for listed plant species that would be lost as a result of construction of Alternative C is approximately 108 hectares (266 acres). This area includes Secondary Limestone Forest, Riparian Forest, and Scrub Forest habitats.

Table 4-6
Listed Species Habitat within Alternative C Right-of-Way (ROW)
(Including Connector)

Habitat/Land Use	Area within 90-Meter ROW		Potential Habitat for Listed Species(1) within ROW?
	Hectares	Acres	
Secondary Limestone Forest	96.7	238.9	Yes
Riparian Forest	6.6	2.6	Yes
Scrub Forest	10.0	24.8	Yes
Delonix Forest	0.0	0.0	NA
Luecanea Forest	0.0	0.0	NA
Herbaceous Vegetation	0.2	0.4	No
Pasture Land	191.0	471.8	No
Crop Land	12.2	44.0	No
Developed Land	121.3	299.7	No
Herbaceous Wetland	8.2	20.2	No
Lowland Albizia Forest	0.0	0.1	NA
Coastal Forested Wetland	0.0	0.0	NA
Total	446.2	1102.5	
Total area of potential habitat for listed species within Alternative C ROW = 107.8 hectares (266.3 acres)			

(1) Includes both plant and animal Federal and DNER listed species
NA = Not applicable

Construction of Alternative C would also result in the loss of approximately 108 hectares (266 acres) of suitable habitat for species with a potential for occurrence within this study corridor (see Table 3-2 for a listing of these species). The potential for loss of individuals of each of these plants during construction is considered low since they are not known to occur within the Alternative C study corridor.

Animals

The only Federal and Commonwealth listed animal species known to occur within the Alternative C study corridor is the Puerto Rican boa. This species was also observed within the proposed 90 meter wide right-of-way during the BA field studies. The total area of suitable Puerto Rican boa habitat that would be lost as a result of construction of Alternative C is approximately 97 hectares (239 acres) of Secondary Limestone Forest (Table 4-6). The size of the Puerto Rican boa population within this area is unknown. Construction activity and post-

construction operation of the new highway could also result in the death of an unknown number of boas.

Proposed conservation measures to off-set these potential losses are presented in Section 5.0. Other animal species that have a potential to occur within the Alternative C study corridor include the Puerto Rican crested toad, Baker's worm lizard, slipperyback skink, Puerto Rican sharp-shinned hawk, Puerto Rican broad-winged hawk, and Puerto Rican plain pigeon. Direct and indirect effects to these species as a result of construction and operation of Alternative A include potential loss of nesting, denning, roosting, and foraging habitat and increased roadkill potential. The potential for loss of individuals of each of these animals during construction and operation of Alternative C is considered low since they are not known to occur within the Alternative C study corridor.

4.2 Cumulative Effects

Cumulative effects include the effects of future Commonwealth, local, or private actions that have or are reasonably certain to occur in the study areas considered in this BA. Future Federal actions that are unrelated to the proposed action are not considered in this section since they require separate consultation pursuant to Section 7 of the Endangered Species Act.

Several possible future development projects in northwestern Puerto Rico have been identified, including passive parks, a school, firehouse, police station, stone crusher, asphalt plant, and an industrial park; however, these proposed actions are located in existing urban or agricultural areas and would have little or no effect on existing habitat suitable for listed species. The City of Aguadilla is attempting to integrate Alternative A in future expansion planning. However, since Alternative A would be a limited access highway, it would not provide direct access to private land adjacent to the highway. Likewise, Alternatives B and C would also provide a limited access highway, and therefore would not provide direct access to private land adjacent to the highway.

5.0 CONSERVATION MEASURES

In order to prevent jeopardizing the continued existence of the listed plant and animal species potentially affected by construction and operation of the three build alternatives, the following conservation measures will be implemented by the PRHTA.

5.1 Plants

Unless otherwise limited by size (e.g., large trees), all listed plant species found within the right-of-way will be relocated to the Guajataca or Río Abajo Forests or other publicly-held property where their long-term protection is assured. The recipient site for the transplanted plants will be selected jointly by the PRHTA, USFWS (for Federal listed species), DNER, and site manager. The site characteristics of the recipient site (soils, geology, associated vegetation, etc.) will be similar to those of the affected site.

Relocation methodologies may include transplantation, seed propagation, and cuttings. Seed propagation and cuttings may be more appropriate for woody species since transplantation of woody species often is not successful. Seeds and cuttings will be taken from all affected individuals to the maximum extent possible.

Prior to any construction activities, detailed vegetative surveys of the right-of-way will be performed by a professional botanist. The purpose of this survey is to identify and mark all Federal and Commonwealth listed plant species for relocation. Following this survey, the PRHTA will submit species-specific relocation procedures to the USFWS (for Federal listed species) or DNER (for Commonwealth listed species) for review and approval. These procedures will be developed or compiled by professional botanists or horticulturalists. The relocation methodology for tree transplants shall be prepared by an International Society of Arboriculture Certified Arborist and shall comply with ANSI 300 "Transplanting Standards."

Once the relocation procedure is accomplished, the PRHTA will also provide funding to the DNER for long-term monitoring and maintenance of the relocated plant populations.

5.2 Animals

Puerto Rican Boa

The proposed conservation measures for the Puerto Rican boa include education of project personnel, pre-construction surveys and relocation of individuals to protected areas. These conservation measures are as follows:

(1) All construction personnel will be required to attend an instructional meeting regarding the Puerto Rican boa. Information to be presented in this meeting include a description of the Puerto Rican boa, listing status, penalties for disturbance, and the capture and relocation procedures described below.

(2) During the period of right-of-way clearing and grading, two field biologists will conduct daily field surveys for the Puerto Rican boa in each construction area prior to commencement of work. These surveys will focus on rock and ground crevices and in trees that could be used by the species. Heavy equipment will also be checked for boas that may have crawled onto the equipment overnight. Surveys will be scheduled according to the contractor's work plan; daily changes in these work plans will be taken into account for planning site surveys. The surveys will be performed between 5 a.m. and 7:30 a.m. the day heavy equipment is scheduled to enter the work area.

In the event of a positive identification, the protocol presented below for capture and relocation of boas will be implemented. If any snake is spotted by construction personnel in the working area, all machine work within 50 feet of the snake will cease and the resident engineer notified. An authorized project biologist will capture the snake for relocation according to the protocol presented below. Construction activities may resume once the snake has been removed.

(3) All captured snakes will be relocated to the Guajataca or Rio Abajo Forests or other publicly-held property in an area of similar habitat from which it was captured.

(4) Monthly reports summarizing survey results and capture and relocation activities for boas will be prepared and submitted to the USFWS and DNER.

Protocol for Capture and Relocation of Puerto Rican Boas

The resident project biologists are responsible for implementing the following procedure in the event a snake is found within the right-of-way during construction. At least one resident project biologist will be on-site during all work hours. In the event a snake is spotted the following steps will be taken:

(a) Workers within 50 feet of the snake will stop all work.

(b) One person will keep watch of the snake while another contacts the resident engineer or project biologist.

(c) The project biologist will capture the snake with a snake stick or other suitable instrument without inflicting harm to the snake. The snake will be placed in a burlap sack or box and placed in a cool, dark place inside project facilities to await transport to the relocation site.

(d) If the snake is positively identified as a Puerto Rican boa, it will be transported to and released in the Guajataca or Rio Abajo Forests or other publicly-held property in an area of similar habitat from which it was captured. All other snake species will be released at the edge of the right-of-way at the end of the work day.

(e) After the snake has been released, the project biologist will be responsible for ensuring that a report of the incident is completed. This report is to contain the following information:

(1) Exact location of the snake at time of sighting and circumstances of the sighting.

(2) Order and timing of procedures followed after sighting.

(3) Personnel involved in each step of procedures.

(4) Perceived condition of snake at time of sighting and condition of snake when removed by approved person.

(5) The species of the snake if known.

(6) Time and location of where the snake was released.

(7) Any photographs of the snake that may have been taken.

(f) The report is to be signed by the project biologist and included in the monthly report submitted to the USFWS and DNER.

(g) In the event an observed snake cannot be captured, work within 50 feet of the snake may resume only after the snake has left the right-of-way.

(h) In the event a dead snake is discovered within the right-of-way, its carcass will be placed in a sealed plastic bag and placed on ice or within a freezer until positive identification of the snake is made. If the snake is identified as any species other than a Puerto Rican boa its carcass can be discarded. If the snake is identified as a Puerto Rican boa, the carcass shall remain frozen and the USFWS and DNER are to be contacted for further instruction.

Baker's worm lizard, Slipperyback skink, and Puerto Rican crested toad

The Baker's worm lizard, slipperyback skink, and Puerto Rican crested toad are, by their small size and secretive habits, difficult to detect. However, due to the potential occurrence of these species within the project right-of-way for each of the build alternatives, the following conservation measures will be implemented:

(1) During the period of right-of-way clearing and grading, two field biologists will conduct daily field surveys for the Baker's worm lizard, slipperyback skink, and Puerto Rican crested toad in each construction area prior to commencement of work. These surveys will be performed concurrently with the daily Puerto Rican boa surveys described above and will focus on rock and ground crevices and in trees that

could be used by the species. Surveys will be scheduled according to the contractor's work plan; daily changes in these work plans will be taken into account for planning site surveys. The surveys will be performed between 5 a.m. and 7:30 a.m. the day heavy equipment is scheduled to enter the work area.

In the event of a positive identification, the protocol presented below for capture and relocation of the target species will be implemented. If any of the target species are spotted by construction personnel in the working area, all machine work within 50 feet of the specimen will cease and the resident engineer notified. An authorized project biologist will attempt to capture the specimen for relocation according to the protocol presented below. Construction activities may resume once the specimen has been removed.

(2) All captured specimens will be relocated to the Guajataca or Rio Abajo Forests or other publicly-held property in an area of similar habitat from which it was captured.

(3) Monthly reports will be prepared and submitted to the USFWS (for Federal listed species) or DNER (for Commonwealth listed species) summarizing survey results and capture and relocation activities for all specimens.

Protocol for Capture and Relocation of Baker's worm lizard, Slipperyback skink, and Puerto Rican crested toad

The resident project biologists are responsible for implementing the following procedure in the event one of the above species is found within the right-of-way during construction. At least one project biologist will be on-site during all work hours. In the event a specimen is spotted the following steps are to be taken:

(a) Workers within 50 feet of the specimen will stop all work.

(b) One person will keep watch of the specimen while another contacts the resident engineer or project biologist.

(c) The project biologist will capture the specimen without inflicting harm to the specimen. The specimen will be placed in a burlap sack or box and placed in a cool, dark place inside project facilities to await transport to the relocation site.

(d) The specimen will transported to and released in the Guajataca or Rio Abajo Forests or other publicly-held property in an area of similar habitat from which it was captured.

(e) After the specimen has been released, the project biologist will be responsible for ensuring that a report of the incident is completed. This report is to contain the following information:

(1) Exact location of the specimen at time of sighting and circumstances of the sighting.

(2) Order and timing of procedures followed after sighting.

(3) Personnel involved in each step of procedures.

(4) Perceived condition of the specimen at time of sighting and condition of specimen when removed by approved person.

(5) Time and location of where the specimen was released.

(6) Any photographs of the specimen that may have been taken.

(f) The report is to be signed by the project biologist and included in the monthly report submitted to the USFWS (for Federal listed species) or DNER (for Commonwealth listed species).

(g) In the event an observed specimen cannot be captured, work within 50 feet of the specimen may resume only after the specimen has left the right-of-way.

Puerto Rican broad-winged hawk, Puerto Rican sharp-shinned hawk, and Puerto Rican plain pigeon

The Puerto Rican broad-winged hawk, Puerto Rican sharp-shinned hawk, and Puerto Rican plain pigeon have a low potential for occurrence within the three alternative study corridors, therefore, it is unlikely that any individuals of these species will be encountered within the project right-of-way. However, because there is a potential for individuals of these species to exist within the three alternative study corridors, the following conservation measures will be implemented during project construction.

(1) Surveys will be performed within the project right-of-way during the breeding season and prior to the scheduled start of right-of-way clearing. The purpose of these surveys will be to locate any nest sites used by these species. The PRHTA will submit the names and qualifications of the personnel selected to perform these surveys to the USFWS and DNER for their approval prior to performing the surveys.

(2) In the event a positive nest identification is made or breeding behavior by any of these species is observed, the nest or observed species location will be recorded and the USFWS and DNER will be notified.

(3) Additional monitoring protocol and conservation measures will be developed in coordination with the USFWS and DNER for any positively identified Puerto Rican broad-winged hawk, Puerto Rican sharp-shinned hawk, and Puerto Rican plain pigeon and their nests within the project right-of-way.

6.0 DETERMINATION

6.1 Federal Listed Species

Table 6-1 presents the effect determination for each Federal listed species with the potential to occur within each of the three alternative study corridors. These determinations indicate the overall effect that construction and operation of each alternative may have to Federal listed species and are supported by the information presented previously in this BA.

All Federal listed plant and animal species that are known to occur or otherwise have the potential to occur within an alternative study corridor were assigned a determination of "may affect, is not likely to adversely affect." The known presence or potential presence of the species within the study corridor is the basis for the "may affect" determination. The basis for the "is not likely to adversely affect" modifier is the implementation of the proposed conservation measures presented in Section 5.0.

6.2 Critical Habitat

No designated critical habitat for any Federal listed species occurs within any of the three alternative study corridors. Therefore, the determination for critical habitat is "No Effect" as shown in Table 6-2 below.

Table 6-2
Effect Determination for Designated Critical Habitat

Build Alternative	Effect Determination
Alternative A	No Effect
Alternative B	No Effect
Alternative C	No Effect

6.3 Commonwealth Listed Species

All individuals of Commonwealth listed plant and animal species that have the potential to occur within each of the three alternative study corridors, or which are known to occur within the alternative study corridors, may be affected by construction and operation of the project (see Table 6-3 for a listing of these species). Without the implementation of the conservation measures proposed in Section 5.0 of this BA, this effect may include taking of individual specimens. However, with the implementation of the proposed conservation measures presented in Section 5.0, there should be no net adverse effect to Commonwealth listed species within the project right-of-way.

Table 6-1
Effect Determinations for Federal Listed Species

Species/Common Name	USFWS Status[1]	Effect Determination			Comments
		Alternative A	Alternative B	Alternative C	
Adiantum vivesii Puerto Rico maiden hair	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Auerodendron pauciflorum No common name	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Banara vanderbilti Palo de ramón	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Buxus vahlii Diablito de tres cuernos, Vahl's boxwood	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Calyptronoma rivalis Palma de manaca	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Cordia bellonis No common name	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Cornutia obovata Palo de nigua	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Daphnopsis helleriana No common name	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Goetzea elegans Mata buey, Beautiful goetzea	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Myrcia paganii No common name	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Ottoschulzia rhodoxylon Palo de Rosa	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Peperomia wheeleri Wheeler's peperomia	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Pleodendron macranthum Chupacallos	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Schoepfia arenaria No common name	T	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Solanum drymophilum Erubia	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Tectaria estremerana Puerto Rico halberd fern	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Thelypteris verecunda Barrio Charcas maiden fern	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Zanthoxylum thomasianum St. Thomas prickly ash	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Accipiter striatus venator Puerto Rican sharp-shinned hawk	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Buteo platypterus brunnescens Puerto Rican broad-winged hawk	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Columba inornata wetmorei Puerto Rican plain pigeon	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Epicrates inornatus Puerto Rican boa	E	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Peltophryne lemur Puerto Rican crested toad	T	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	May affect, is not likely to adversely affect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.

(1) USFWS = U.S. Fish and Wildlife Service listed status
T = Threatened
E = Endangered

Table 6-3
Effects to Commonwealth Listed Species

Species/Common Name	DNER Status[1]	Effect Determination			Comments
		Alternative A	Alternative B	Alternative C	
Adiantum vivesii Puerto Rico maiden hair	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Antirhea portoricensis Puerto Rico quina	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Auerodendron pauciflorum No common name	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Banara vanderbiltii Palo de ramón	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Bumelia bellonis Puerto Rico bully	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Buxus portoricensis No common name	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Buxus vahlii Diablito de tres cuernos, Vahl's boxwood	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Caesalpinia major Mauritius thorn, Mysore thorn	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Calyptronoma rivalis Palma de manaca	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Campylocentrum pachyrrizum Leafless bentspur orchid	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Cedrela odorata Barbados cedar, Spanish cedar	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Chionanthus axilliflora Hueso	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Chionanthus ligustrina Cabra blanca	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Cordia bellonis No common name	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Cornutia obovata Palo de nigua	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Daphnopsis helleriana No common name	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Dioclea hexandra Bejuco de mato	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Diospyros sintenisii Guayabota, Múcaro, Tabeiba	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Drypetes ilicifolia Rosewood	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Drypetes lateriflora Guiana plum	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Eugenia underwoodii Underwood's stopper	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Gaussia attenuata Palma de lluvia	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Goetzea elegans Mata buey, Beautiful goetzea	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Guapira obtusata Corcho, Corcho blanco	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.

Table 6-3 Continued
Effects to Commonwealth Listed Species

Species/Common Name	DNER Status[1]	Effect Determination			Comments
		Alternative A	Alternative B	Alternative C	
Ilex urbaniana Cuero de sapo	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Jacquinia umbellate Chirriador, Chirre	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Mappia racemosa Palo de cana	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Myrcia pagani No common name	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Ottoschulzia rhodoxylon Palo de rosa	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Passiflora murucuja Virgin Island passionflower	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Peperomia wheeleri Wheeler's peperomia	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Pereskia aculeata Barbados shrub	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Philodendron fragantissimum Shortstem philodendron	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Piper swartzianum Spanish elder	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Pleodendron macranthum Chupacallos	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Polygala cowellii Violet tree	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Pseudolmedia spuria False breadnut	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Psidium amplexicaule Guayaba de monte, Mountain guava, Sperry guava	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Rollinia mucosa Wild sugar apple	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Schoepfia arenaria No common name	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Schoepfia schreberi No common name	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Sloanea amygdalina Motillo	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Solanum drymophilum Erubia	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Tectaria estremerana Puerto Rico halberd fern	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Tetrazygia angustifolia Stinking fish	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Thelypteris verecunda Barrio Charcas maiden fern	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Zanthoxylum thomasianum St. Thomas prickly ash	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.

Table 6-3 Continued
Effects to Commonwealth Listed Species

Species/Common Name	DNER Status[1]	Effect Determination			Comments
		Alternative A	Alternative B	Alternative C	
Accipiter striatus venator Puerto Rican sharp-shinned hawk	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Amphisbaena bakeri Baker's worm lizard	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Buteo platypterus brunnescens Puerto Rican broad-winged hawk	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Columba inornata wetmorei Puerto Rican plain pigeon	EN	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Epicrates inornatus Puerto Rican boa	VU	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Mabuya mabouya sloanei Lucia, Slipperyback skink	EC	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.
Peltophryne lemur Puerto Rican crested toad	CR	No net adverse effect	No net adverse effect	No net adverse effect	Contingent upon implementation of conservation measures. See Section 5.0 of BA.

(1) Puerto Rico Department of Natural and Environmental Resources designated status:
T = Threatened
EN = Endangered
CR = Critically Endangered
VU = Vulnerable
EC = Critical element

7.0 REFERENCES

Cowardin, Lewis M., V. Carter, F. C. Golet, and E.T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States" FWS/OBS-79/31. U.S. Fish and Wildlife Service. 131 pp.

Liogier, H.A. 1985. Descriptive Flora of Puerto Rico and Adjacent Islands, Spermatophyta: Volume I, Casuarinaceae to Connaraceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico. 352 pp.

Liogier, H.A. 1988. Descriptive Flora of Puerto Rico and Adjacent Islands, Spermatophyta: Volume II, Leguminosae to Anacardiaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico. 481 pp.

Liogier, H.A. 1994. Descriptive Flora of Puerto Rico and Adjacent Islands, Spermatophyta: Volume III, Cyrillaceae to Myrtaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico. 461 pp.

Liogier, H.A. 1995. Descriptive Flora of Puerto Rico and Adjacent Islands, Spermatophyta: Volume IV, Melastomatacea to Lentibulariaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico. 617 pp.

Little, Jr. E.L., R.O. Woodbury and F.H. Wadsworth. 1974. Trees of Puerto Rico and the Virgin Islands, Volume 2. U.S. Department of Agriculture, Washington, D.C. 1024 pp.

Lugo, A.E., L.M Castro, A. Vale, T.M. Lopez, E.H. Prieto, A.G. Martino, A.R. Puente Rolon, A.G. Tossas, D.A. McFarlane, T. Miller, A. Rodriguez, J. Lundberg, J.Thomlinson, J. Colon, J.H. Schellekens, O. Ramos, and E. Helmer. 2001. Puerto Rican Karst – A Vital Resource, General Technical Report WO-65. United State Department of Agriculture.

Puerto Rico Department of Natural and Environmental Resources. 2002. DNER Natural Heritage Program Protected Species Maps.

Puerto Rico Department of Transportation and Public Works. 1994. Biological Assessment: Relocation of PR-10, Utuado, Puerto Rico.

United States Department of Agriculture, Natural Resources Conservation Service. 1982. Soil Survey of Arecibo Area of Northern Puerto Rico.

United States Department of Agriculture, Natural Resources Conservation Service. 1975. Soil Survey of Mayaguez Area of Western Puerto Rico.

United States Fish and Wildlife Service (USFWS), Division of Endangered Species, 1990 and 1993. Endangered and Threatened Species of the Southeastern United States (The Red Book) FWS Region 4. Internet: http://ecos.fws.gov/tess_public/StateListingAndOccurrence.do?state=PR