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# CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52 PUERTO RICO

## DRAFT ENVIRONMENTAL IMPACT STATEMENT

Prepared by
UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION (FHWA)

and the
GOVERNMENT OF PUERTO RICO
DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS (DTPW)
PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY (PRHTA)

Cooperating Agencies:
Environmental Protection Agency, State Historic Preservation Office, US Fish and Wildlife Service, US Army Corps of Engineers

Submitted Pursuant to:
National Environmental Policy Act of 1969 as amended (42 U.S.C. 4332) and Puerto Rico Environmental Public Policy Law as amended

For PRHTA: _____ Date: 11/9/10
Rubén A. Hernández Gregorat, MEM, PE
Secretary, Department of Transportation and Public Works

For FHWA: _____ Date: 11-2[illegible]-2[illegible]
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## Abstract

This Draft Environmental Impact Statement (DEIS) for the Cidra Corridor project describes the transportation, environmental, social, and economic impacts of a No-Action Alternative and five Build Alternatives to improve the mobility from the municipality of Cidra to the Puerto Rico Strategic Highway Network (PRSHN). The five alignments for a new road were defined by studying a corridor with a minimum width of 120 meters. This DEIS describes the new road alignments, conceptual design, and costs. It also evaluates the alternatives' potential impacts and mitigation for impacts to the natural environment including water resources, biotic ecosystems, air quality, noise and energy; the social environment including traffic, community and economics; and the cultural environment including archaeological resources. The Preferred Alternative is Build Alternative C-5 and consists of a 7.24 kilometer four lane road extending from Industria Street, located 1[illegible] m north of PR-7733, in the municipality of Cidra to PR-52 access ramps at PR-[illegible]34 in the municipality of Caye[illegible].

This DEIS was prepared in accordance with 40 Code of Federal Regulations (CFR) Part 1500 Council on Environmental Quality Regulations for Implementing the Procedural Requirements of the National Environmental Policy Act of 1969 as amended; 23 CFR Part 771 Federal Highway Administration (FHWA) Environmental Impact and Related Procedures; and the Puerto Rico Environmental Public Policy Act as amended.

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# Executive Summary

The Puerto Rico Highway and Transportation Authority (PRHTA) is evaluating alternatives to improve mobility from the municipality of Cidra to the Puerto Rico Strategic Highway Network, specifically, to improve the connectivity with expressway PR-52. The PRHTA, in cooperation with the Federal Highway Administration, prepared this to This DEIS was prepared in accordance with the as amended, and its implementing regulations, as well as the as amended.

**Report Organization**

The DEIS is organized into the chapters summarized below:

- Chapter 1: Introduction – Introductory description of the DEIS and its components.
- Chapter 2: Purpose of and Need for Action – General description of the transportation system and socioeconomic characteristics, identifies existing and future transportation problems, summarizes planning studies performed and community participation.
- Chapter 3: Alternatives – Summarizes project history, discusses the broad range of alternatives considered, describes the reasonable alternatives evaluated in detail, and summarizes the studies and analyses performed to define them. Engineering characteristics are evaluated and Conceptual Design Drawings are also discussed.
- Chapter 4: Transportation Studies - Summarizes traffic studies and the traffic impacts associated with the No Action Alternative and the five Build Alternatives.
- Chapter 5: Affected Environment – Describes environmental, social, cultural and economic conditions in the project area, and the methodology used to identify and define resources.
- Chapter 6: Environmental Consequences and Mitigation Measures – Describes potential environmental, social, and economic impacts of each alternative under consideration, including both construction and cumulative impacts. Proposed mitigation measures are identified.
- Chapter 7: Alternatives Evaluation – Evaluates alternatives pursuant to criteria including traffic, environmental, social, cultural, economics and engineering aspects, as the basis for identifying the Preferred Alternative.

- Chapter 8 Coordination – Summarizes coordination performed with cooperating and participating government agencies and the community. Coordination was performed in accordance with Section 6002 of Public Law 109-59, "Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users", ( ).
- Chapter 9 List of Prepares – Lists personnel responsible for preparing the DEIS and supporting studies.
- Chapter 10 Distribution List – Lists the entities receiving a copy of the DEIS.

An index is also provided, and six additional separate technical appendixes contain copies of supporting studies plus documentation of coordination with government agencies and the community.

**Environmental Setting**

Puerto Rico is a Caribbean Island measuring approximately 3,500 square miles, has a population of over 3.8 million people, and is located about 1,000 miles southeast of Miami, Florida. The two principal municipalities affected by the proposed action are Cidra and Cayey, both located in the central-east region of Puerto Rico and designated as part of the Metro South Region as defined in the Puerto Rico 2030 Long Range Transportation Plan prepared by the PRHTA.

The Municipality of Cidra has deficient vehicular transportation linkages with adjacent municipalities and the PR-52 expressway which provides rapid vehicular transport to both the south and north coastal areas, including the San Juan metropolitan area. Private vehicles are the principal mode of transportation in the Metro South Region including the municipality of Cidra. The lack of a mass transportation system in the Metro South Region requires residents and businesses to depend on private vehicles for their transportation needs. Figure ES-1 shows the principal access roads to the Cidra Central Business District (CBD).

The current main access to Cidra is along PR-172, a secondary road which connects to PR-52 in Caguas. This is an undivided roadway and has sections of both two and four lanes, without shoulders, having steep slopes, small radius horizontal curves, drainage problems, and some sections with poor pavement markings. Numerous residences and commercial and institutional buildings such schools and churches have direct access to the road. Landslides are common along PR-172 and in some instances road lanes are closed to repair landslides.

Other access to Cidra is along the secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD; and tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD; and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. These are two lane rural roads (one narrow lane in each direction without shoulders) with poor geometric characteristics and residences, commercial and institutional buildings close to both sides of the roads.

The poor geometric conditions of the access roads to Cidra contribute to unsafe conditions, and is exacerbated when heavy freight traffic is utilizing the road. Community and government agencies concur that existing roads used to access Cidra CBD are unsafe, and the Puerto Rico Safety Transit Commission classified PR-172 as one of the most dangerous roads in Puerto Rico, averaging over 3 fatalities per year since 2000.

Traffic congestion is common along Cidra rural access roads due to their poor geometric characteristics and the proximity of residences, commercial and institutional buildings to both sides of the roads. Intersections are also deficient, and for year 2018 projected conditions, 9 or 17 intersections (both signaled and unsignaled) have Level of Service of "D" or worse in either the AM, PM or both.

**Socio-economic Characteristics and Growth**

The Puerto Rico Planning Board (PRPB) identifies Cidra as one of the municipalities with the highest rates of population growth, at 1.2 % annual (Table 1). Several new residential developments are in the planning or permitting process. Between year 2000 and 2007 the number of registered cars with the PRDTPW in Cidra grew at an annual growth rate of 5.1%, which is higher than Puerto Rico's average annual growth rate of 3.0%. About 90% of Cidra workers use their cars to go to work and 56 % of its residents work outside of municipal boundaries. All of these factors increase the demand for highway transportation.

**Table 1: Summary Income Characteristics.**

| Geographic Area | Population Year 2000 | Population Density (persons/mi$^2$) | Projected Population Year 2012 | Year 2012 Density (persons/mi$^2$) | Growth Rate (%) |
|---|---|---|---|---|---|
| Cidra | 42,753 | 1,179 | 49,220 | 1,363 | 1.2 |
| Cayey | 47,370 | 913 | 48,711 | 939 | 0.2 |
| Puerto Rico | 3,808,610 | 1,111 | 4,051,566 | 1,182 | 0.5 |

Source: Puerto Rico Planning Board and 2000 Census.

Data from the PR Department of Labor (PRDL) indicate that employment in Cidra grew steadily from 1997 to 2007, although there was a slight decline in 2007. Manufacturing and services are the largest employers in Cidra accounting for 37% and 30% of all jobs, respectively. Over the past twelve years Cidra has experienced a net gain in manufacturing openings. Cayey has per capita and family income levels lower than Cidra's, and both municipalities have lower levels than the island-wide average (Table 2). Despite economic growth as of 2000, Cidra and Cayey had nearly 47% and 50% respectively of their population below poverty level.

**Table 2: Summary Income Characteristics.**

| Geographic Area | Per Capita Income | | Median Family Income | |
|---|---|---|---|---|
| | 2000 | 2012 | 2000 | 2012 |
| Cidra | $7,027 | $20,084 | $17,262 | $33,136 |
| Cayey | $7,877 | $16,467 | $15,939 | $29,692 |
| Puerto Rico | $8,185 | $18,349 | $16,543 | $30,309 |

**Existing Environment**

The Municipality of Cidra occupies an area of hilly to mountainous topography underlain by volcanic rocks and crossed by numerous small streams. Cidra has a moist tropical environment, cooled by its higher elevations and the approximately 70 inches of rainfall per year. Cidra reservoir, is located adjacent to the Town of Cidra, to which it provides drinking water after filtration. This is the most sensitive and important water resource in the municipality, though other streams in the municipality drain to water supply intakes further downstream in other municipalities.

Until the mid-20th century the predominant land use in the study area was agricultural, with tobacco being the primary cash crop. As the tobacco industry declined following the 1940s, tobacco and other farms were converted into pasture, returned to secondary forest, or converted to rural residential and urban land uses. Current land uses along the new road corridors are predominately rural residential, secondary forest, and pasture.

Cidra has significant areas of forest recognized as habitat for the endangered Puerto Rican Plain Pigeon. Although this species was not observed during studies performed for this DEIS, the pigeon is presumed to inhabit forested areas within the study area. Agriculture is limited to cattle grazing, and the Tres Monjitas dairy farm is located in the area of the proposed new road alignments.

**Alternatives Considered**

A broad range of alternatives to improve the mobility from the Municipality of Cidra were considered including: Six of these alternatives were subject to detailed study in the DEIS: “No Action” and “Construction of a New Road” along five possible alignments (identified through the document as Build Alternatives). A comprehensive assessment of the positive and negative environmental, social, and economic impacts associated with these six alternatives, as well as impact avoidance and minimization measures, is also included.

The DEIS summarizes the analysis and studies performed and identifies the Preferred Alternative to improve the mobility between Cidra and the expressway, PR-52. This DEIS includes the transportation system, natural and social environment, cultural resources, economics, and engineering considerations for the study area.

**Transportation System Management Alternative**

Transportation System Management focuses on improving the operational characteristics of the existing transportation system using low cost approaches such as High Occupancy Vehicle (HOV), ridesharing, exclusive lanes on existing roadways, and traffic signal timing optimization. These options are usually implemented in urbanized areas with a population over 200,000 people. No viable Transportation System Management options were identified due to impediments such as the predominately rural configuration of the area and physical limitations of the existing roads. Because these options would not adequately address the project purpose and need, a detailed analysis of the Transportation System Management alternative was not performed in the DEIS.

**Mass Transit Alternative**

The Mass Transit Alternative was also not considered feasible, again due to the predominately rural characteristics of the area and the lack of an existing effective mass transportation system such as buses. A few private cars do provide public transportation service, but based on an irregular schedule to meet the level of passenger demand. For this reason, a detailed analysis of the mass transit alternative was not conducted in the DEIS.

**Build Alternatives (New Road Construction)**

A total of 5 different New Road alignments were considered, each selected with the objective of optimizing design conditions while minimizing environmental impacts. The New Road alignments are identified through the document as Build Alternatives. The Build Alternatives analyzed are illustrated in Figure ES-2. For the purpose of preliminary environmental analysis a 400 m wide corridor was identified for each build alternative, and a conceptual design was then prepared for these alternatives for the development of more detailed engineering data and for better quantification of environmental impacts.

Traffic study results indicated that a roadway section of one lane in each direction and the inclusion of climbing lanes would adequately handle some of the projected traffic for the horizon year of 2028. Conceptual Design Drawings were initially prepared using a R-6 road typical section (two lanes, one in each direction) with climbing lanes when needed. However, results indicate that at least 63% of the road length would need three or four lanes, with 90% of one of the build alternatives needing three or four lanes. In addition, the engineering and construction effort to build an R-6 road with climbing lanes would be similar to that required to build a four lane road. Therefore the build alternatives have four lanes, two in each direction. A road Type R-5 as defined by the PRHTA Highway Design Manual was used to develop the design parameters for

each of five build alternatives. Table 3 summarizes major engineering characteristics of the five proposed build alternatives, of which C-3 was identified as the preferred alternative.

**Table 3: Major Engineering Characteristics of New Road Alternatives.**

| Parameter | Alternatives | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Length (km) | 7.06 | 7.59 | 7.04 | 6.9 | 7.31 |
| Cut Volume (m3) a/ | 2,728,973 | 2,480,896 | 2,602,692 | 3,268,673 | 3,281,010 |
| Fill Volume (m3) a/ | 1,411,368 | 1,606,744 | 936,874 | 617,060 | 648,477 |
| Surplus (m3) b/ | 1,317,605 | 874,152 | 1,665,818 | 2,651,568 | 2,632,533 |
| Bridges over Water Bodies | 2 | 1 | 0 | 2 | 3 |
| Water Crossings (Culverts) | 23 | 30 | 27 | 16 | 15 |
| Bridges over Existing Roads | 2 | 2 | 2 | 1 | 1 |
| Bridges at Existing Roads | 1 | 2 | 3 | 3 | 2 |
| Corridor (cdas) | 225 | 235 | | 214 | 233 |
| Conceptual Design Drawing ROW (cdas) | 124 | 129 | | 112 | 118 |

a/ Without shrinkage or expansion factor.
b/ Surplus material could be reduced during final design when more detailed information is available.

Table 4 shows the Capital cost of each of the proposed Build Alternatives, estimated using Conceptual Design Drawings including others studies performed as part of environmental evaluation process.

**Table 4: Implementation Cost for New Road Alternatives.**

| Component | Cost of Each Alternative ($ Millions) | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Construction | 93.7 | 88.6 | 74.8 | 90.9 | 98.9 |
| Mitigation a/ | 23.4 | 25.1 | 22.5 | 18.9 | 21.6 |
| Acquisition b/ | 22.1 | 20.8 | 20.4 | 21.7 | 20.9 |
| Total Cost | 139.2 | 134.5 | | 131.5 | 141.4 |

a/ Activities required to mitigate environmental impacts.
b/ Includes Acquisition and Relocation Cost.

**Environmental impacts**

The total area of wetlands potentially impacted under each build alternative is summarized in Table 5. Impacts could be further reduced during the design stage when the selected alternative

may be adjusted to further minimize impacts to wetlands. Not all impacts can be avoided, and it is planned that unavoidable wetland impacts be mitigated through the creation of a forested wetland in a single parcel with, on a preliminary basis, a 3:1 (Creation: Impacted Wetland) ratio (Table 5). The wetland mitigation site will be evaluated and selected in accordance with criteria concerning land availability in the project vicinity, proximity to a reliable water source to establish the required wetland hydrology, site topography, and construction feasibility. Other mitigation alternatives, such as wetland banking, will be evaluated during subsequent project phases.

**Table 5: Potential Wetlands Impacted by New Road Alternatives (acres).**

| | C-1 | C-2 | C-3 | C-4 | C-5 |
|---|---|---|---|---|---|
| Impact Area | 5.77 | 5.13 | | 11.93 | 13.02 |
| Mitigation Area | 17.31 | 15.39 | | 35.79 | 39.06 |

**Threatened or Endangered Species**

The only endangered species reported in the study area by both the Puerto Rico Department of Natural Resources and the U.S. Fish and Wildlife Service is the Puerto Rican plain pigeon (Paloma Sabanera), *Patagioenas inornata wetmorei*, previously known as *Columba inornata*. This species was not observed during the field survey but has been reported from the area. It is likely that the plain pigeon uses some of the gallery and secondary forest along the rivers and creeks for foraging or nesting sites, particularly those areas closer to Cidra reservoir at the western portion of the study area, were sightings have been reported.

Direct and Indirect potential impacts to Puerto Rican plain pigeon were evaluated in the Biological Assessment prepared for the project, which focused on the impacts to potential pigeon habitat. Direct impact areas are those associated with the build alternatives corridors, and indirect impact areas fall between the corridor and the limit of the 400 m study belt.

Land cover categories along a study belt 400 m wide were presented in Chapter 5. Of these, the Gallery Forest, Secondary Forest and Bamboo have the potential to be Puerto Rican plain pigeon habitat. Table 6 summarizes the potential impacts to PR Plain Pigeon habitat.

**Table 6: Direct, Indirect and Total Impacts to PR Plain Pigeon Habitat (acres).**

| Alternative | Direct Impact | Indirect Impact | Total Impact |
|---|---|---|---|
| C-1 | 100.79 | 196.05 | 296.84 |
| C-2 | 111.23 | 224.33 | 335.56 |
| C-3 | 119.39 | 229.91 | |
| C-4 | 100.67 | 163.58 | 264.25 |
| C-5 | 101.08 | 170.60 | 272.40 |

a/ Does not included Rivers;
b/ PR Plain Pigeon Potentail Habitat Includes Gallery Forest, Secondary Forest and Bamboo.

All build alternatives cross potential habitat for the Puerto Rico Plain Pigeon. Impacts can be mitigated by planting trees associated within the Plain Pigeon habitat along wildlife corridors such as river banks. This tree planting could also meet the mitigation requirements established by P.R. Dept. of Natural and Environmental Resources (PRDNER) Regulation 25.

**Forest Impacts Under Regulation #25**

Forest impacts, as defined under PRDNER Regulation 25, are summarized in Table 7.

**Table 7: Potential Forest Impacted per New Road Alternatives.**

| Alternative | Forested Areas (acres) | Trees |
|---|---|---|
| C-1 | 117.01 | 171,771 |
| C-2 | 126.34 | 185,467 |
| C-3 | | |
| C-4 | 87.35 | 128,230 |
| C-5 | 99.91 | 146,668 |

**Cultural Resources and Impacts**

Phase 1A and 1B Cultural Resource studies were undertaken within the corridors associated with each of the five build alternatives under consideration. Both pre-Columbian and colonial resources were identified.

Preliminarily, no historic resources eligible to be included in the National Register of Historic Places (NRHP) were identified in any build alternative corridors. However, both pre-Columbian and colonial archaeological resources were identified during Phase 1A and Phase 1B archaeological studies. Phase II studies will be conducted if an archaeological site will be affected by the preferred alternative, and the consultation process pursuant to Section 36 CFR, Part 800 will be completed prior to completion of the National Environmental Policy Act process.

**Affected Land Uses**

The land use affected by each of the build alternatives was determined by reference to aerial photography with ground truthing, and is summarized in Table 8.

**Table 8: Land Use Cover in each Corridor**

| Cover | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Gallery Forest | 25.3 | 11.7 | 23.1 | 10.0 | 33.5 | 15.5 | 20.4 | 9.9 | 20.4 | 8.9 |
| Secondary Forest | 72.6 | 33.6 | 85.2 | 37.0 | 85.3 | 39.4 | 78.1 | 38.1 | 76.7 | 33.7 |
| Pine Forest | 8.2 | 3.8 | 8.2 | 4.0 | 8.2 | 3.8 | 7.7 | 3.7 | 8.2 | 3.6 |
| Scrubland | 16.3 | 7.6 | 19.6 | 8.6 | 21.4 | 9.9 | 38.3 | 18.7 | 41.7 | 18.3 |

| Cover | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Grassland | 47.8 | 22.1 | 48.3 | 21.1 | 51.2 | 23.7 | 35.1 | 16.2 | 59.2 | 25.9 |
| Cropland | 0.0 | 0.0 | 0.4 | 0.2 | 0.4 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pastureland | 26.2 | 12.1 | 26.1 | 11.0 | 0.0 | 0.0 | 3.5 | 1.7 | 0.0 | 0.0 |
| Wetland a/ | 0.0 | 0.0 | 0.03 | 0.01 | 0.04 | 0.01 | 0.09 | 0.05 | 0.09 | 0.04 |
| Urban | 16.5 | 7.7 | 16.0 | 7.0 | 15.6 | 7.2 | 21.6 | 10.5 | 17.8 | 7.8 |
| Bamboo | 2.9 | 1.4 | 2.9 | 1.0 | 0.6 | 0.3 | 2.2 | 1.1 | 4.0 | 1.7 |

a/ Excluding rivers.

**Water Resource Impacts**

None of the build alternatives is anticipated to have an appreciable impact on either ground or surface water resources, assuming environmental controls are responsibly implemented, particularly during the construction stage. However, there is a significant difference in the number and magnitude of the stream crossings among the different alternatives, as summarized in Table 9. Build Alternative C-3 is the only one not requiring bridge construction, although the number of culverts is the second-highest among the routes.

**Table 9: Stream Crossings for each New Road Alternative.**

| Alternative | Culverts | Bridges |
|---|---|---|
| C-1 | 23 | 2 (Río Sabana / Río Clavijo) |
| C-2 | 30 | 1 (Río Sabana) |
| C-3 | 27 | |
| C-4 | 16 | 2 (Unnamed Creek / Quebrada Beatriz) |
| C-5 | 14 | 3 (Unnamed Creek / Quebrada Beatriz / Río Guavate) |

**Noise Impacts**

A noise impact analysis was performed for each of the new roads alternatives following the criteria established in the "Development and Operation of Transportation Projects Policy", which was prepared to comply with the requirements set forth in CFR Title 23, Part 772 and the noise related requirements of the National Environmental Policy Act.

Noise impacts were analyzed for each alternative. The receptors that would require mitigation measures were identified assuming that mitigation will be provided only for those receptors within 1 dBA or exceeding the established Noise Abatement Criteria (Table 10).

**Table 10: Receptors that would Require Noise Mitigation Measures.**

| Build Alternative | Receptors |
|---|---|
| C-1 | 1-1, 1-2 (2 residences) |
| C-2 | 2-1, 2-2 (2 residences) |
| C-3 | |
| C-4 | 4-2, 4-5, 4-11 (4 residences) |
| C-5 | 5-2, 5-5, 5-10, 5-11 (8 residences) |

**Relocation Impact Assessment**

A "Properties Inventory and Probable Acquisition Cost Study" was prepared to estimate the number of properties that would be impacted and the estimated cost associated with each build alternative, along with the impacted structures. These results are summarized in Table 11 and Table 12.

**Table 11: Properties that would be Impacted and Acquisition Cost.**

| Alternative | Properties | Acquisition Cost |
|---|---|---|
| C-1 | 133 | $19,361,000 |
| C-2 | 125 | $19,231,000 |
| C-3 | 133 | $ |
| C-4 | 122 | $20,343,000 |
| C-5 | 116 | $19,571,000 |

**Table 12: Residential and Commercial Structures that would be Totally Acquired and Acquisition Cost.**

| Alternative | Properties | Acquisition Cost |
|---|---|---|
| C-1 | 69 (7) | $9,848,000 ($1,644,000) |
| C-2 | 56 (7) | $9,292,000 ($1,644,000) |
| C-3 | 54 (7) | $ |
| C-4 | 56 (0) | $10,149,000 (0) |
| C-5 | 55 (1) | $9,882,000 ($175,000) |

a/ Residential (Commercial)

**Cumulative Impact Assessment**

No cumulative environmental impacts are assigned to the “No Action” alternative, although some additional development may nevertheless occur in the absence of transportation improvements. However, all build alternatives will support additional development that would impact natural systems. Several public and private development initiatives are proposed for the municipality of Cidra, and in conjunction with construction of a new road, these will promote the further development of Cidra and will exert pressure on existing resources.

**Selection of Preferred Alternative**

The information compiled and studies undertaken were used to compare the various alternatives, and to prepare a matrix of characteristics and impacts of each alternative as presented in Chapter 7 of the DEIS.

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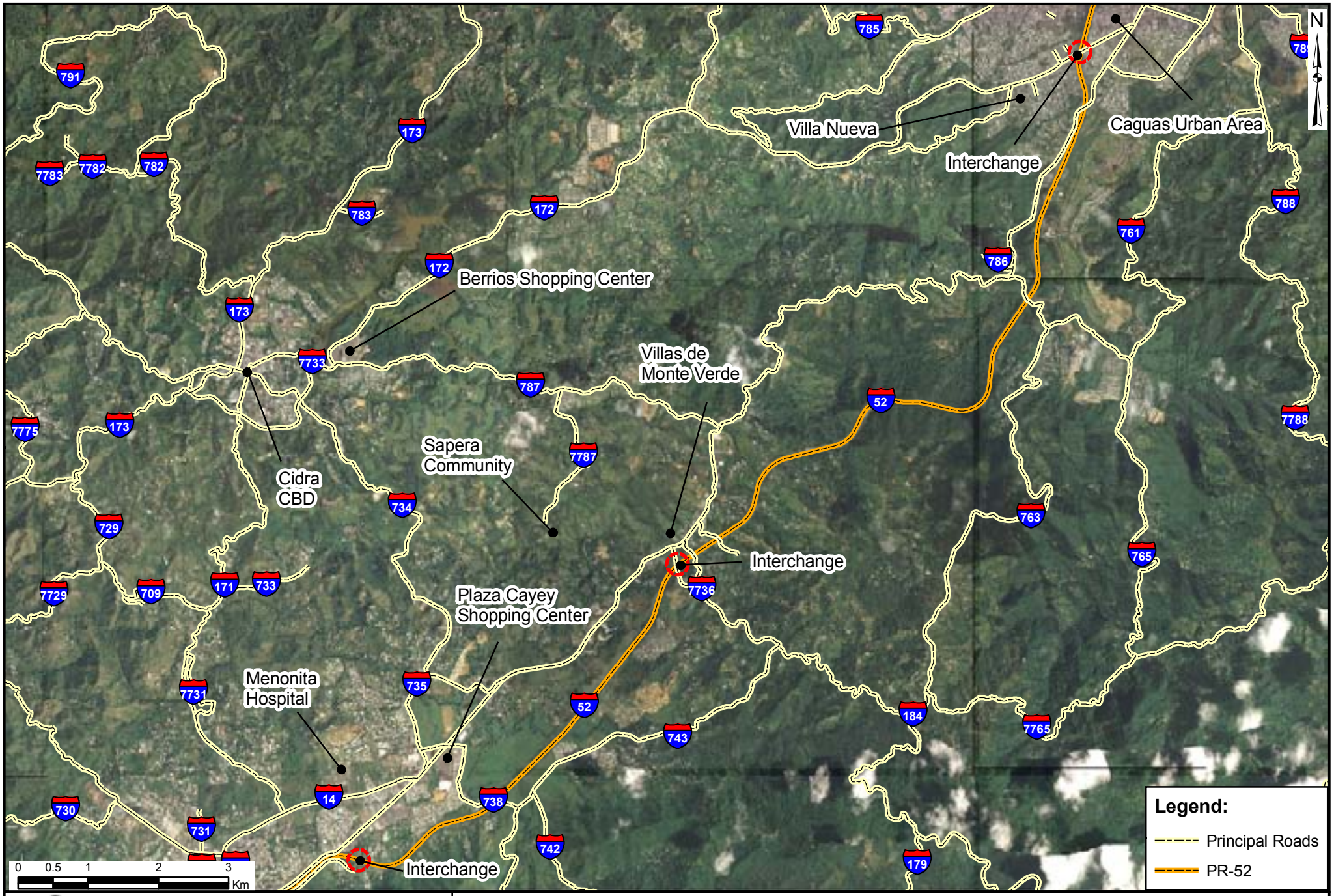


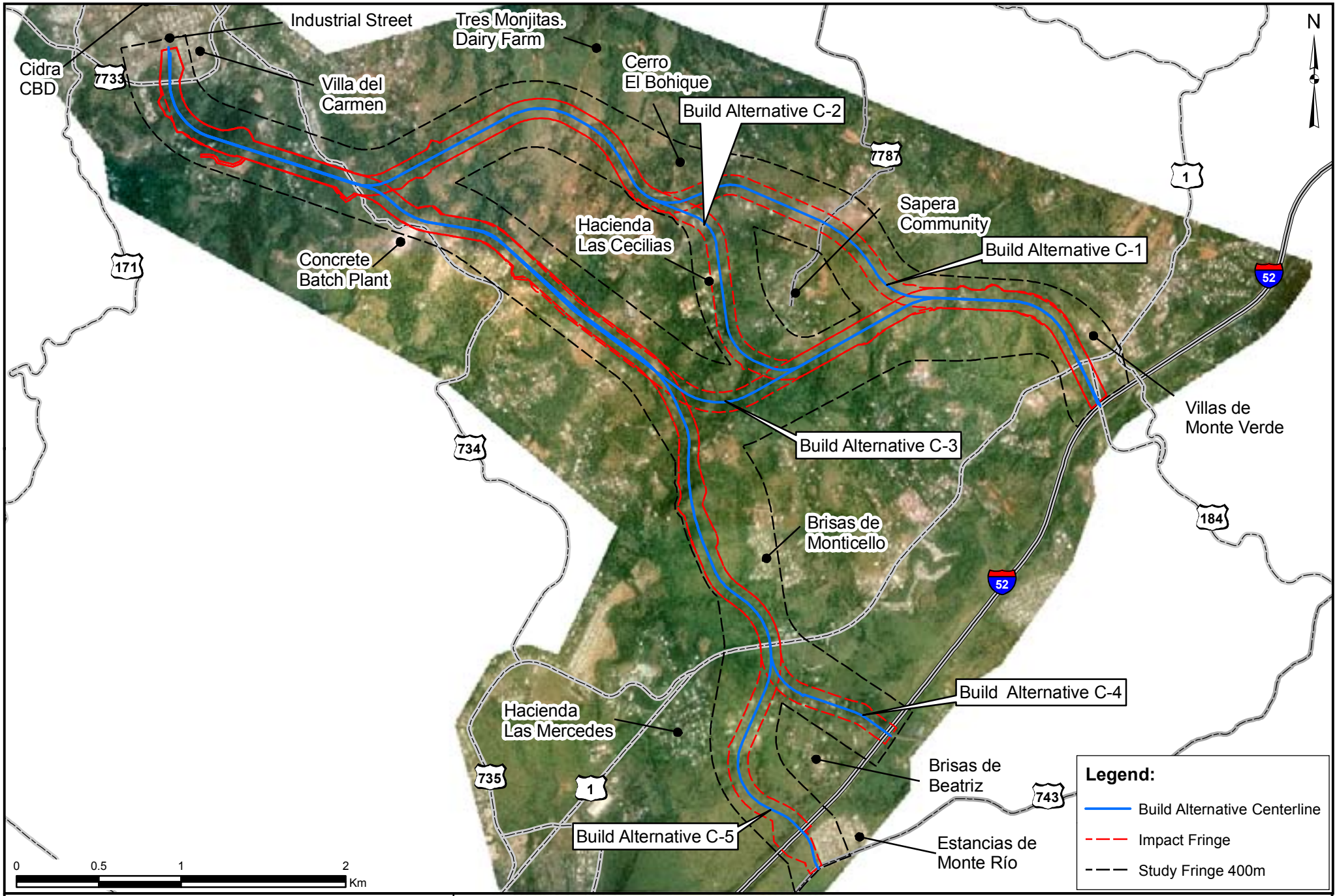

XIII

U.S. Department of Transportation
Federal Highway Administration

ES-1. Existing Cidra CBD Access Roads from PR-52.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRHTA






US Department of Transportation
Federal Highway Administration

ES-2. Location of Build Alternatives Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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| | |
|---|---|
| ADT | Average Daily Traffic |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACPH | Advisory Council on Historic Preservation |
| B/C | Benefit/Cost |
| BFE | Base Flood Elevation |
| BMPs | Best Management Practices |
| CAA | Clean Air Act |
| CBD | Central Business District |
| CDD | Conceptual Design Drawings |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| CL | Center Line |
| CM | Cidra Municipality |
| CO | Carbon Monoxide |
| CWA | Clean Water Act |
| DEIS | Draft Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| EPIP-ERAR | "Evaluación Preliminar para el Informe Preliminar del Estudio de Reconocimiento y Alternativas de Ruta" |
| ERAR | "Estudio de Reconocimiento y Alternativas de Ruta" |
| IP-ERAR | "Informe Preliminar del Estudio de Reconocimiento y Alternativas de Ruta" |
| FEMA | Federal Emergency Management Agency |
| FHWA | Federal Highway Administration |
| GME | Gregory L. Morris Engineering |
| HOV | High Occupancy Vehicle |
| LOS | Level of Service |
| NAAQS | National Ambient Air Quality Standards |
| NAC | Noise Abatement Criteria |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NPDES | National Pollutant Discharge Elimination System |
| NPV | Net Present Value |
| NRHP | National Register of Historic Places |
| NWI | National Wetland Inventory |
| MSA | Mass Transit Alternative |
| MOT | Maintenance of Traffic |
| PA | Preferred Alternative |
| PHT | Peak Hour Traffic |
| PMO | Permit Management Office |
| POT | "Plan Ordenamiento Municipal" |

| | |
|---|---|
| PRA | Preferred Route Alternative |
| PCDD | Preliminary Conceptual Design Drawings |
| PR | Puerto Rico |
| PRAD | Puerto Rico Agriculture Department |
| PRASA | Puerto Rico Aqueduct and Sewer Authority |
| PRCI | Puerto Rico Culture Institute |
| PRDL | Puerto Rico Department of Labor |
| PRDNER | Puerto Rico Department of Natural and Environmental Resources |
| PRDTPW | Puerto Rico Department of Transportation and Public Works |
| PREPA | Puerto Rico Electrical and Power Authority |
| PREQB | Puerto Rico Environmental Quality Board |
| PRHD | Puerto Rico Health Department |
| PRHTA | Puerto Rico Highway and Transportation Authority |
| PRLA | Puerto Rico Land Authority |
| PRLRTP | Puerto Rico 2030 Long Range Transportation Plan |
| PRMTC | Puerto Rico Municipal Tax Center (CRIM by Spanish acronym) |
| PRPRA | Puerto Rico Permits and Regulation Administration |
| PRPB | Puerto Rico Planning Board |
| PRSJTP | Puerto Rico San Juan Transportation Plan |
| PRSTC | Puerto Rico Safety Transit Commission |
| PRSHN | Puerto Rico Strategic Highway Network |
| PRSWA | Puerto Rico Solid Waste Authority |
| PRTC | Puerto Rico Telephone Company |
| PR-RRAS | Preliminary Report of the Recognition and Route Alternatives Study |
| RRAS | Recognition and Route Alternatives Study |
| ROW | Right of Way |
| SAFETEA-LU | Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users |
| SHPO | State Historic Preservation Office |
| SIP | State Implementation Plan |
| STA | Station |
| TNM | Traffic Noise Model |
| TPLCMP | Transportation Project-Level Carbon Monoxide Protocol |
| TSM | Transportation System Management |
| USACE | United State Army Corps of Engineers |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VOT | Value of Time |
| WET | Wetland Evaluation Techniques |

# ABBREVIATIONS FOR UNITS OF MEASURE

| | |
|---|---|
| ac | acre |
| cds | cuerdas (1 cuerda = 0.97 acres) |
| cm | centimeter |
| dB | decibel |
| ft | foot |
| $ft^2$ | square foot |
| $ft^3$ | cubic foot |
| $ft^3/s$ | cubic foot per second |
| ha | hectare (1 hectare = 2.47 acres) |
| in | inches |
| kg | kilogram |
| Km | kilometer |
| lb | pound |
| m | meter |
| $m^2$ | square meter |
| $m^3$ | cubic meter |
| $m^3/s$ | cubic meter per second |
| mi | mile |
| sec | second |
| F | Fahrenheit |
| MGD | Millions Gallons per Day |

# 1. INTRODUCTION

The Puerto Rico Highway and Transportation Authority (PRHTA) is evaluating alternatives to improve mobility from the municipality of Cidra to the Puerto Rico Strategic Highway Network (PRSHN). The PRHTA, in cooperation with the Federal Highway Administration, prepared this Draft Environmental Impact Statement (DEIS) to evaluate the alternatives and their environmental, social, and economic impacts. This DEIS was prepared in accordance with the National Environmental Policy Act (NEPA), as amended and its implementing regulations, as well as the as amended.

Puerto Rico is a Caribbean Island measuring approximately 3,500 square miles, has a population of over 3.8 million people, and is located approximately 1,000 miles southeast of Miami, Florida. Figure 1 shows the location of Puerto Rico. Cidra municipality is located in the central-east region of Puerto Rico (see Figure 2) and is part of the Metro South Region as defined in the Puerto Rico 2030 Long Range Transportation Plan (PRLRTP) prepared by the PRHTA. Figure 3 shows the location of Cidra and the PRSHN in the Metro South Region.

A broad range of alternatives to improve the mobility from the municipality of Cidra were considered including: (1) No Action, (2) Expansion or Improvement to Existing Roads, (3) Transportation System Management (TSM), (4) Mass Transit Alternative (MSA), and (5) Construction of a New Road (along one of five possible alignments). From these alternatives six were carried forward for a detailed study in the DEIS. The alternatives evaluated in detail are the No Action and five Build Alternatives (Construction of a New Road along five possible alignments). A comprehensive assessment of the positive and negative environmental, social, and economic impacts associated with these six alternatives, as well as impact avoidance and minimization measures, is also included.

The DEIS summarizes the analysis and studies performed evaluating the possible alternatives to improve the mobility from the municipality of Cidra. The DEIS identifies the Preferred Alternative (PA) to improve the mobility from the municipality of Cidra to the PRSHN. This DEIS includes the transportation system, natural and social environment, cultural resources, economics, and engineering consideration for the study area.

The DEIS is organized into 10 chapters as summarized below:

Chapter 1: Introduction – This chapter provides an introductory description of the DEIS and its components.

Chapter 2: Purpose of and Need for Action – This chapter provides a general description of the transportation system and socioeconomic characteristics, identifies existing and future transportation problems, summarizes the planning studies performed by government agencies related to the project, and summarizes community participation.

Chapter 3: Alternatives – This chapter summarizes the project history, discusses the broad range of alternatives considered, describes the reasonable alternatives evaluated in detail, and summarizes the studies and analyses performed to define them. Engineering characteristics are evaluated and Conceptual Design Drawings are also discussed.

Chapter 4: Transportation Studies - This chapter summarizes the traffic studies prepared for the DEIS. Origin and destination travel pattern and traffic for existing and forecast (year 2018 and 2028) conditions are discussed. Impacts in traffic due to the No Action Alternative and construction of Build Alternatives (new road along five possible alignments) are also discussed.

Chapter 5: Affected Environment – This chapter describes environmental, social, cultural and economic conditions in the project area. It also describes the methodology used to identify and define resources.

Chapter 6: Environmental Consequences and Mitigation Measures – This chapter describes the potential environmental, social, and economic impacts of each of the alternatives under consideration. The construction and cumulative impacts of each alternative are also described. This chapter also describes the measures proposed to mitigate adverse impacts.

Chapter 7: Alternatives Evaluation – This chapter evaluates the alternatives pursuant to several criteria including traffic, environmental, social, cultural, economics and engineering aspects. This evaluation forms the basis for the identification of the Preferred Alternative.

Chapter 8 Coordination – Chapter 8 summarizes the coordination performed with cooperating and participating government agencies and the community. Coordination was performed in accordance with Section 6002 of Public Law 109-59, “Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users”, (SAFETEA-LU).

Chapter 9 List of Prepares – This chapter lists the personnel responsible for preparing the DEIS and for performing the environmental studies.

Chapter 10 List of Agencies, Organizations, and Persons to Whom Copies of the DEIS are Sent - Provides the entities receiving a copy of the DEIS.

Index – provides an index to the document as required by 40 CFR 1502.10.

Additional Information: Six separate documents containing appendices accompany this DEIS. The first document contains the Build Alternatives Conceptual Design Drawings. The second contains the technical appendices consisting of Cost-Benefit and Economic Impact Analyses, Origin and Destiny Study and Traffic Study. The third contains the Socio-Economic Profile for Cayey and Cidra Connector, Geology and Geotechnical Study, Traffic Noise Analysis and Archaeological Studies Phase 1A and 1B. The fourth contains the Wetland Jurisdictional Determination, Biological Assessment Study, Trees Inventory, Energy Assessment, Air Quality Assessment and Environmental Hydrology Study. The fifth contains the Properties Inventory and Probable Acquisition Cost Study. The sixth document contains the Conceptual Relocation Plan and information demonstrating coordination with government agencies and community.

# 2. PURPOSE OF AND NEED FOR ACTION

This chapter provides a general description of the existing and future transportation system. It identifies existing and anticipated transportation problems and illustrates the purpose and need of the proposed project.

## 2.1. Need for Transportation System Improvement

### 2.1.1. Existing Transportation System

Private cars are the principal mode of transportation in the Metro South Region including the municipality of Cidra. The lack of a mass transportation system in the Metro South Region requires residents to depend on cars for their transportation needs. Roads are the only infrastructure used to move people and goods to and from Cidra. Figure 4 shows the principal access roads to the Cidra Central Business District (CBD).

Main access to Cidra from the PRSHN is along secondary road PR-172 which connects PR-52 (in the Caguas area) to Cidra CBD. This road is used by residents, visitors and heavy freight traffic. From PR-52 to La Sierra Sector (Cañaboncito ward in Caguas) is the PR-172, an undivided four lane road without shoulders characterized by steep slopes, small radius horizontal curves, drainage problems, and some sections with poor pavement markings. From La Sierra Sector (east of PR-172 and PR-785 intersection) to Cidra CBD, PR-172 is a two lane road with small radius horizontal curves. Along PR-172 are residences and commercial and institutional buildings such schools and churches with direct access to the road. Landslides are common along PR-172 and in some instances road lanes are closed to repair landslides.

Other access to Cidra is along the secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD; and tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD; and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. These are two lane rural roads (one narrow lane in each direction without shoulders) with poor geometric characteristics and residences, commercial and institutional buildings close to both sides of the roads.

The existing geometric conditions of the access roads to Cidra from the PRSHN are not favorable and in many cases unsafe for the drivers using them. The poor conditions are exacerbated when heavy freight traffic is utilizing the road.

Transportation System Safety

Community and government agencies concur that existing roads used to access Cidra CBD are unsafe. The Puerto Rico Safety Transit Commission (PRSTC) classified PR-172 as one of the most dangerous roads in Puerto Rico. Table 2.1-1 summarizes the fatal accidents on PR-172, PR-171, PR-787 and PR-734.

Table 2.1-1 Fatal accidents Along PR-172, PR-171, PR-787 and PR-734, 2000-2008.

| Year | Roads | | | |
|---|---|---|---|---|
| | PR-172 | PR-171 | PR-787 | PR-734 |
| 2000 | 3 | 2 | 0 | 0 |
| 2001 | 0 | 0 | 1 | 0 |
| 2002 | 3 | 1 | 0 | 2 |
| 2003 | 4 | 0 | 0 | 1 |
| 2004 | 3 | 1 | 0 | 0 |
| 2005 | 4 | 0 | 0 | 0 |
| 2006 | 8 | 0 | 1 | 1 |
| 2007 | 4 | 1 | 0 | 0 |
| 2008 | 3 | 0 | 0 | 1 |
| Total | 32 | 5 | 2 | 5 |

Source: Puerto Rico Safety Transit Commission

The geometric conditions along PR-172 combined with the high percentage of heavy freight traffic has forced the PRHTA to construct two gravel safety ramps to aid in stopping vehicles, especially heavy trucks, whose brakes system fail. However, fatal accidents still occur along PR-172.

Accident data shows that the existing accesses to Cidra from the PRSHN are inadequate and unsafe. Existing geometric conditions present a high risk for fatal traffic accidents. The forecasted increase in traffic in conjunction with the existing geometric conditions will likely produce an increase in the number of fatal accidents.

Traffic Congestion

Traffic congestion is common along the Cidra rural access roads by their poor geometric characteristics. Residences, commercial and institutional buildings are located close to both sides of the roads and have direct access to these roads. Drivers' maneuvers to enter or exit the roadside structures produce dangerous conditions and traffic delays. Traffic congestion was observed during the traffic assessment of the area at several sites along PR-172, including but not limited to: (1) a segment of 1.1 km in Caguas beginning from PR-52 where four traffic lights control traffic, (2) a segment of 1.8 km in the La Sierra Sector near PR-785 intersection where high concentration of restaurant and commercial buildings access the roadway, and (3) at the PR-7773 intersection.

An analysis of 2008 traffic conditions at sixteen signalized and unsignalized intersections indicated that seven of these intersections operate at Level of Service (LOS) E or worse during either the AM or PM peak hours. Of these seven intersections, two operated at LOS E or worse during both AM and PM peak hours. Forecasts indicate that by year 2018, the levels of service at the evaluated intersections will degrade with five intersections operating at LOS E or worst during

both AM and PM peak hours. By 2028 seven of the intersections will operate at LOS E or worse during either the AM or PM peak hours, and four of the intersections will operate at LOS E or worst during both AM and PM peak hours (see Table 2.1-2 and Table 2.1-3).

Table 2.1-2 No Action Alternative Intersections LOS (2018).

| Intersection | LOS / Average Delay per Vehicle (sec) | |
|---|---|---|
| | AM (LOS/Average Delay) | PM (LOS/Average Delay) |
| PR-1 with PR-184 | E (58.7) | E (68.9) |
| PR-1 with PR-14 | D (37.5) | D (42.4) |
| PR-7733 with PR-734 | F (361.5) | D (43.5) |
| PR-7733 with PR-171 | F (1080.7) | F (93.5) |
| PR-7733 with PR-172 | C (26.4) | B (16.6) |
| PR-171 with PR14 | F (203.1) | E (74.5) |
| PR-734 with PR-735 | B (13.5) | A (7.9) |
| PR-735(north) with PR-1 | A (5.5) | A (6.9) |
| PR735(south) with PR-1 | B (12.9) | C (22.9) |
| PR-1 with PR-738 | A (9.9) | B (15.9) |
| PR-172 with PR-787 | B (14.3) | C (20.8) |
| PR-1 with PR-787 | B (18.9) | A (7.2) |
| PR-743 with PR-742 | F (161.9) | A (9.9) |
| PR-184 with PR-52 NB | F (3895.2) | F (2536.2) |
| PR-184 with PR-52 SB | F (589.8) | D (41.3) |
| PR-7733 with Factory | F (79.2) | F (1950.6) |

Table 2.1-3 No Action Alternative Intersections LOS (2028).

| Intersection | LOS / Average Delay per Vehicle (sec) | |
|---|---|---|
| | AM (LOS/Average Delay) | PM (LOS/Average Delay) |
| PR-1 with PR-184 | F (80.0) | F (103.3) |
| PR-1 with PR-14 | D (48.6) | E (58.5) |
| PR-7733 with PR-734 | F (449.7) | E (65.8) |
| PR-7733 with PR-171 | F (1422.2) | F (171.9) |
| PR-7733 with PR-172 | C (24.2) | C (20.0) |
| PR-171 with PR14 | F (302.2) | F (117.7) |
| PR-734 with PR-735 | C (27.0) | B (11.8) |
| PR-735(north) with PR-1 | A (7.4) | B (13.6) |
| PR735(south) with PR-1 | D (45.6) | E (67.7) |
| PR-1 with PR-738 | C (30.6) | E (55.9) |
| PR-172 with PR-787 | B (16.1) | C (23.7) |
| PR-1 with PR-787 | C (32.4) | A (8.7) |
| PR-743 with PR-742 | F (302.4) | C (21.3) |
| PR-184 with PR-52 NB | F (4012.2) | F (2625.9) |
| PR-184 with PR-52 SB | F (637.6) | F (84.8) |
| PR-7733 with Factory | F (10000) a/ | F (2010.5) |

a/ - Value indicates complete oversaturation.

Existing roads from the PRSHN to Cidra cannot handle the existing and future travel demand. The analyses indicate that the LOS at intersections will deteriorate causing delays and inconvenience to travelers.

### 2.1.2. Socioeconomic Profile

Cidra has experienced considerable development and significant population growth within the urban and suburban township boundaries. This municipality has growing residential, industrial and commercial sectors. The Puerto Rico Planning Board (PRPB) identifies Cidra as one of the municipalities with the highest rates of population growth, with an annual growth rate of 1.2%. Residents from other neighboring municipalities find the natural landscape of Cidra attractive for living and several residential developments are under the planning and/or permitting process. This growing population will increase the demand for transportation.

Data from the PR Department of Labor (PRDL) indicate that employment in Cidra grew steadily from 1997 to 2007, although there was a slight decline in 2007. Manufacturing and services are the largest employers in Cidra accounting for 37% and 30% of all jobs, respectively. Over the

past twelve years Cidra has experienced a net gain in manufacturing openings (comparison of openings and closings). Currently, several industries are starting operations in Cidra. According to the Retail Census of Economic Activity (1997, 2002), Cidra has seen a decline in the number of retail establishment due to consolidation, and retail sales have grown at 8.8% annually.

Between year 2000 and 2007 the number of registered cars with the PRDTPW in Cidra grew at an annual growth rate of 5.1%, which is higher than Puerto Rico's average annual growth rate of 3.0%. About 90% of Cidra workers use their cars to go to work and 56% of its residents work outside of municipal boundaries.

Infrastructure improvements planned in the area by other agencies also support a scenario of future economic and population growth in this area. Although, the Puerto Rico Aqueduct and Sewer Authority (PRASA) and Puerto Rico Electrical and Power Authority (PREPA) have infrastructure which adequate serves the current population, PRASA recently started improvements to the Cayey Wastewater Treatment Plant which servers the municipalities of Cidra and Cayey to increase its treatment capacity from 4.28 MGD to 9.0 MGD.

Socioeconomic profiles and infrastructure availability indicate that Cidra has the potential to increase population and business. Natural beauty and pleasant climate promotes residential and tourist development. Adequate and safe access to Cidra would increase the potential and attractiveness for the establishment of new business since the location is midway on highway PR-52 that connects San Juan, the busiest metropolitan area in the north, with Ponce, the busiest metropolitan area in the south. The lack of adequate mobility from the PRSHN and Cidra constrains the economic development of Cidra.

## 2.2. Previous Studies and Evaluations

Government agencies recognize the necessity to improve mobility from the municipality of Cidra to the PRSHN. To evaluate alternatives for improvement several previous studies and evaluations were prepared in the past years 13 years which are summarized below.

### 2.2.1. Government Planning Studies

The Government of Puerto Rico and its municipalities have performed several transportation planning studies relevant to the area under study. These studies are summarized below.

Puerto Rico 2030 Long Range Transportation Plan (PRLRTP). This plan prepared by the Puerto Rico Department of Transportation and Public Works (PRDTPW) and PRHTA focused on the identification of possible solutions to existing and future transportation needs in Puerto Rico through the year 2030 to support economic development strategies. In this study the "Metro South Transportation Planning Region" was defined to include the municipalities of: Aguas Buenas, Aibonito, Barranquitas, Caguas, Cayey, Cidra, Comerio, Gurabo, Juncos and San Lorenzo. This study analyzed the transport needs between regions, and not the within-region transport needs.

Puerto Rico San Juan Transportation Plan (PRSJTP) (2004). The purpose of this report, prepared by the Puerto Rico Department of Transportation and Public Works (PRDTPW) and the PRHTA, was to integrate transportation planning with islandwide planning efforts, ensure intermodal efficiency, provide guidance on public policy, promote sustainability and land use compatibility, and update and expand the Interim San Juan 2025 Metropolitan Transportation Plan as a result of the new San Juan Transportation Management Area as defined by the 2000 Census.

The PRSJTP report identified a new road named: "Cidra East Connector from PR-52 to Intersection PR-7733, Phase 1" as a short term project.

Plan de Ordenamiento Territorial – Programa, Municipio de Cidra. This report suggests the construction of a new corridor between the PR-7733 and PR-52 under the General Projects Program in accordance with the Autonomous Municipal Law. The corridor would run from PR-7733 (south of the CBD) until reaching PR-1 at Las Cruces Sector in Beatriz Ward (near the PR-184 access to PR-52).

Plan de Ordenamiento Territorial – Programa, Municipio de Cayey. This report identified the construction of a new corridor between the PR-7733 and PR-52 under the Certified Projects Program in accordance with the Autonomous Municipal Law. The corridor would run from PR-7733 until reaching PR-52.

Cayey North By-Pass – Route Location Analysis (AC-020602). The PRHTA recently initiated analyses to define the preferred alternative for the Cayey North By-Pass. The by-pass would run from the intersection of PR-14 and project AC-020601 (PR-206 By-Pass) to PR-1 (about 150 m west of PR-1 and PR-738 intersection). It would serve as an alternative route to relieve PR-1 and PR-14 traffic congestion. Figure 5 shows the preliminary alternatives evaluated by the PRHTA. This project is independent of the Cidra-Cayey corridor and they do not intersect. The purpose of both projects is to facilitate traffic movement in the area.

PR-158 Connector. PRHTA is planning a connector between PR-1 and PR-52 in the municipality of Cayey. This connector starts at PR-1 approximately 400 meters north of PR-735 and runs southwest until reaching PR-52 about 360 meters southwest of the PR-52 bridge over Río Guavate. PR-158 runs along the fringe of the Build Alternative C-5 study corridor.

Cidra 2050 A Strategic Plan for the Municipality of Cidra PR. The Cidra 2050 Strategic Plan prepared in April 2008 establishes a long term plan for the municipality of Cidra. It promotes the preservation of the natural environment and consolidation and redevelopment of the urban center. It encourages higher density developments and calls for the restriction of sprawl, addressing social inequality, diversifying the economic base, and improving the existing infrastructure to accommodate the 2050 estimated population. The Plan includes several strategic initiatives for immediate and long-term implementation. As part of infrastructure improvement the plan suggests a new road from Cidra CBD to the intersection of PR-1 and PR-184.

### 2.2.2. Previous New Road Alternatives Studies

Alternatives to improve mobility from the municipality of Cidra to the PRSHN have been evaluated by the PRHTA and Cidra municipality prior to initiating the NEPA process. Evaluations began in 1997 and were focused on developing a new connector to link Cidra CBD with PR-52 at Cayey. Several studies and informative workshops were conducted to find a reasonable and prudent alternative for this connector. Documents and activities associated with the analysis and evaluations performed to identify a connector are summarized below.

Cidra Municipality Public Hearing (October 1997). In October 1997 the municipality of Cidra discussed with the community the municipality's intent to request funds to develop a new road between PR-7733 and PR-52. Most participants agreed with the development of a new road. Residents near the alignment of the proposed road requested access to the new road.

Route Study for Connector from Cidra Bypass (PR-7733) to the Intersection of PR-1 with PR-184 (January, 1999). In January 1999, the PRHTA presented the first Route Study of the Cidra New Corridor. This study evaluated four alternatives and identified as the Preferred Alternative an alignment which begins at road PR-7733, about 300 meters south the PR-734 intersection. The alternative then continues east bordering the south part of Santa Clara community and crossing several tributaries of the Sabana River. It then crosses the Tres Monjitas Farm and Clavijo River, and continues to the Sapera community where it turns southeast to protect a communication tower in the sector. After it passes the communication tower it turns northeast to end at PR-1 with a proposed new intersection. Figure 6 shows the alignment of the 1999 Route Study Preferred Alternative.

Route Study (1999) Informative Workshop. In December 6, 1999 the PRHTA held an informative workshop to discuss with the community the results and findings of the Route Study performed in January 1999. PRHTA discussed the project needs, benefits and impacts on the environment and the community.

Declaración de Impacto Ambiental Preliminar Conector Cidra – Cayey desde la PR-7733 hasta la Intersección de las Carretera PR-1 y PR-184" (June, 2000). In 2000 the PRHTA prepared a Draft Environmental Impact Statement to analyze in detail the alternatives studied in the 1999 Route Study. Alternatives were modified to incorporate comments expressed by the Sapera community in the 1999 Informative Workshop. Figure 6 shows the alignment of the 2000 DEIS Preferred Alternative.

Commonwealth of Puerto Rico Legislature Resolution # 27 (2001). In 2001 the Commonwealth of Puerto Rico Legislature issued a resolution ordering the Highway and Transportation Department to stop the planning of the Cidra-Cayey Corridor.

Conector Cidra – Cayey Estudio de Ruta Suplementario Final (November, 2005). Due to opposition to the 2000 DEIS, the PRHTA performed a new Route Study that considered the issues and opposition associated with previous studies. The study considered nine alternatives, three of them already evaluated by previous studies. Four of the Alternatives evaluated are shown in Figure 6.

Route Study (2006) Informative Workshop. On November 15, 2006, the PRHTA held an informative workshop to discuss with the community the results and findings of the Route Study performed in November, 2005.

## 2.3. Community Participation

During the last 13 years an improvement to the transportation system between Cidra and the PRSHN has been discussed between government agencies and the public. The PRHTA has held several informative workshops and public hearing in which the public has had opportunities to discuss studies and provided comments regarding to the potential alternatives.

A coordination plan as required by Section 6002 of Public Law 109-59, "Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users", ( ) was prepared as part of the preparation of this DEIS. As specified in the coordination plan, the public and government agencies have been included in the development of this DEIS. Two informative meetings were held in Cidra in which the community expressed their comments and suggestions.

The community concerns largely revolve around the alternative that should be selected.

# 3. ALTERNATIVES

This chapter discusses the broad range of alternatives considered, describes the reasonable alternatives evaluated in detail and those alternatives eliminated from detailed study, and summarizes the studies and analyses performed to evaluate the alternatives.

## 3.1. Evaluation and Selection of Reasonable Alternatives

Private cars are the principal mode of transportation in Metro South Region which includes Cidra. Roads are the only infrastructure used to move people and goods in Cidra and Cayey. Therefore the alternatives considered focused on improvement of the transportation system based on the context of the transportation system of the area.

Several alternatives were evaluated including: (1) No action, (2) Expansion or Improvement of Existing Roads, (3) Transportation System Management (TSM), (4) Mass Transit Alternative (MSA), and (5) Construction of a New Road (along one of five possible alignments).

### 3.1.1. No Action Alternative

The principal access routes to Cidra are PR-172, PR-734, PR-141 and PR-787, with PR-172 and PR-734 being the ones with highest use. Figure 4 shows existing access roads to Cidra CBD from PR-52.

The main access to Cidra from PRSHN is along secondary road PR-172 which connects PR-52 (in the Caguas area) to the Cidra Central Business Districts (CBD). This road is used by residents, visitors and heavy freight traffic. From PR-52 to La Sierra Sector (Cañaboncito ward in Caguas) PR-172 is an undivided four lane road without shoulders, and characterized by steep slopes, small radius horizontal curves, drainage problems, and some segments with poor pavement markings. From La Sierra Sector (east of PR-172 and PR-785 intersection) to Cidra CBD PR-172 is a two lane road with small-radius horizontal curves. Along PR-172 there are residences, commercial and institutional buildings such schools and churches close to and with direct access to the road. Improvements to the PR-172 and PR-7733 intersection were recently performed by PRHTA. Improvements include the construction of a new bridge over Cidra Lake and geometric changes to the intersection.

Other access routes to Cidra are along secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD, tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD, and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. These are rural 2-lane roads (one narrow lane in each direction, without shoulders) with poor geometric characteristics, and residences, commercial and institutional buildings close to the pavement on both sides of the road. Several municipal roads connect Cidra communities but

none of them has the capacity for large quantities of vehicles. PRHTA planning studies or strategic plans do not include improvements to the existing transportation system. Only regular maintenance like pavement repair, pavement marking and vegetation cutting are currently planned. The No Action Alternative is under consideration and is evaluated in the DEIS.

### 3.1.2. Expansion or Improvement of Existing Roads Alternative

Existing access roads to Cidra CBD are characterized by narrow surface pavement sections, poor geometry (steep slopes, small-radius horizontal curves), and high levels of development close to both sides of the road. Most structures along both sides of these roads have direct uncontrolled highway access. PR-172 and PR-734 are the roads with the highest percent of users, and run along sloping terrain which would require large amounts of earth movement to provide a safe and reliable road. PR-172 was constructed during the 1970's and PR-734 is an older rural road. Both roads do not comply with currently road safety standards. Figure 7 shows existing conditions of the PR-172 and PR-734.

PR-171 and PR-787 are rural roads characterized by narrow pavement section, poor geometry (steep slopes, small-radius horizontal curves), and structures close to the pavement on both sides of the road and which have direct access to the highway. Figure 8 shows existing condition of the PR-171 and PR-787.

The engineering and construction effort required to bring these existing roads into compliance with current road safety standard are comparable to the effort required to build a new road. Expansion, widening or improvement of existing road would require the acquisition of many residences, commercial and institutional structures. Structures not acquired would still maintain direct access to the roads. Community disruption would be extensive and traffic would be affected during construction. this alternative was not carried forward for detailed analysis in the DEIS.

### 3.1.3. Transportation System Management (TSM) Alternative

TSM focuses on improving the operational characteristics of the existing transportation system using low cost approaches that can be implemented addressing the transportation needs in the study area. Alternatives include use of These options are usually implemented in urbanized areas with a population over 200,000 people. PRLRTP and PRSJTP did not identify any TSM in the Metro South Region. Utilization of HOV is not a reasonable alternative because the existing roads are not prepared to handle this situation. Ride-sharing would require resident education and substantial change in travel habits, and its implementation is likely not feasible due to the rural configuration of the area. Traffic signal timing optimization would not improve the unsafe characteristics of existing roads and would not improve existing

traffic conditions. TSM would not adequately address the purpose and need. Therefore, the TSM Alternative was not carried forward for detailed analysis in the DEIS.

### 3.1.4. Mass Transit Alternative (MSA)

The Mass Transit Alternative was not considered in the PRSJTP for internal movements within the Metro South Region Area. Currently the region lacks of an effective mass transportation system such as buses. Only a few private public cars provide service, and they do not have a programmed schedule and their trip schedule is determined by passenger demand. This alternative is usually implemented in urbanized areas with a population over 200,000 people.

### 3.1.5. Construction of a New Road (Build Alternatives)

Construction of a new road was evaluated in detail. The PRHTA initially defined each alignment with a 400 m wide corridor (see Figure 9 and Figure 10). Environmental, cultural, social and engineering studies were performed in the 400 m corridor. Study results and public comments were used to prepare Conceptual Design Drawings (CDD) for each alternative. The following general criteria were used to develop to the Conceptual Design Drawings:

- Roads shall comply strictly with PRHTA and American Association of State Highway and Transportation Officials (AASHTO) design standards without modifications.
- Provide as possible an earth-balanced project. However, the build alternatives run across a mountainous area and an earth-balanced project is difficult to obtain without modification of design standards.
- Avoid as possible impacts to areas or properties that could qualify under Section 4(f) or have archaeological resources.
- Reduce the number of structures to be acquired for road construction.
- Minimize environmental and social impacts.
- Comply with government agency requirements expressed in preliminary consultations. For example, the Puerto Rico Energy and Power Authority (PREPA) requested a 100 ft setback measured from the existing 230 KW east right-of-way.

Traffic study results indicated that a roadway section of one lane in each direction and the inclusion of climbing lanes would adequately handle some of the projected traffic for the horizon year of 2028 (refer to Chapter 4). Conceptual Design Drawings (CDD) were initially prepared using a R-6 road typical section (two lanes, one in each direction) with climbing lanes when needed. However, results indicate that at least 63% of the road length would need three or four lanes, and 90% of one of the build alternatives would need three or four lanes. In addition, engineering and construction effort to build an R-6 road with climbing lanes would be similar to

that required to build a four lane road. Therefore the new road alternatives have four lanes, two in each direction.

A road Type R-5 as defined by the PRHTA Highway Design Manual was used to develop the design of each alternative. Figure 11 shows the principal design standards for an R-5 road. The main design considerations used for new road CDD are summarized in Table 3.1-1.

Table 3.1-1 Main Design Considerations used for Conceptual Design Drawings.

| Parameter | Consideration |
|---|---|
| Traffic | Traffic Studies performed for the project. |
| Design Class Code | R-5 |
| Functional Category | Rural Collector System (Major Collector Road) |
| Access Control | Full Control (between PR-7733 and PR-1) |
| Environmental | Alignments maximize the use of previous impacted areas and unavoidable impacts were minimized. |
| Road Elevations | Based on balanced earth movement (fill and cut) which minimize the overhaul distance. Regulatory Flood Levels as defined by Río Guavate Regulatory Flood Map. Crossings at existing roads, rivers and creeks. |
| Geotechnical | Geological end Geotechnical Evaluation prepared for the project. |
| Government Agencies | Requirements expressed by agencies. |
| Topography | Photogrammetric Survey performed for the project. |

Appendix A includes Conceptual Design Drawings for each build alternative. The CDD for each alternative were used to determine corridor alignments and widths. The minimum width of these corridors is 120 m but could increase to approximately 200 meters to account for stability requirements on steep slopes. Figure 12 and Figure 13 show the alignment of build alternatives corridors. Characteristics of these alternatives are summarized below.

**Build Alternative C1 – Construction of New Road**

Build Alternative C1 begins at the south end of the Industrial Street localized in Cidra Industrial Park. The alignment starts toward the south, about 170 m, until it reaches PR-7733 (km. 1.6), between the intersections with PR-171 and PR-734. A four leg signalized intersection is proposed that would allow access to Cidra Industrial Park located north of PR-7733. The intersection would require the closing of a municipal road that currently provides access to Cidra Industrial Park. The alignment continues southeast crossing various municipal roads that connect Los Pinos, Martinez and Quintas Gloria Sectors. Residences from these sectors separated from the existing transportation system by the new road could be accessed by a new municipal road parallel to the new road that could be accessed from PR-734 (km. 2.4), or a through a bridge at the new

connector that would allow the underpass of residents in these communities and eventual access to PR-734 (km.1.2).

Build Alternative C-1 continues southeast until it crosses PR-734 (km. 2.2), 400 m south the Arenas Elementary School, where a bridge is proposed at PR-734. It then turns northeast to cross Tres Monjitas Dairy, where a bridge is proposed over Sabana River that would be used as cattle crossing for the Dairy. In this segment the road crosses Río Clavijo. It continues southeast and crosses PR-7787 (km. 1.9) at Sapera community where a bridge is proposed. The alignment runs southwest of the Sapera Recreational Facilities (baseball field and a basketball court). It passes near a telephone communication towers until reaching the PR-1(km. 50) and PR-184 intersection, where a four leg signalized intersection is proposed. An interchange at this location was evaluated with the available information but several constraints complicate construction including drainage issues and the historic PR-1 bridge located 170 m northeast of the intersection. Geometric improvement or road realignment of PR-184 between PR-1 and PR-52 would be required as part of this alternative. Build Alternative C-1 ends at PR-52 (km. 32.1) access ramps located in PR-184 (km. 33.2). Build Alternative C1 is a reasonable alternative and is evaluated in detail in this DEIS.

**Build Alternative C2 – Construction of New Road**

The starting point for Build Alternative C2 is the same as in Build Alternative C1 and continues along the same alignment until reaching a point before it crosses Río Clavijo where it turns south to bypass the Sapera community. This alignment crosses PR-7787 where a bridge is proposed. After the PR-7787 crossing it turns northeast until meeting the C1 alignment about 500 m before reaching the PR-1 (km. 50) and PR-184 intersection, where the same intersection described in Build Alternative C1 is proposed. The ending point for Build Alternative C2 is the same as in Build Alternative C1. Build Alternative C2 is a reasonable alternative and is evaluated in detail in this DEIS.

**Build Alternative C3 – Construction of New Road**

The starting point for Build Alternative C3 is the same as in Build Alternative C1 and continues along the same alignment until it crosses PR-734, where it turns southeast crossing the south part of the Tres Monjitas Dairy. A bridge on the municipal road at Montichello sector is proposed under this alternative. The route continues southeast crossing several streams. It then turns northeast and crosses a municipal road that connects Sapera community with PR-734; a bridge is proposed in this location. Build Alternative C3 then continues northeast until it meets the Build Alternative C2 alignment. Build Alternative C3 is a reasonable alternative and is evaluated in detail in this DEIS.

**Build Alternative C4 – Construction of a New Road**

The starting point for Build Alternative C4 is the same as in Build Alternative C3 and continues along the same alignment until reaching a unnamed creek located south of Sapera community,

where it turns south crossing Quebrada Beatriz with a proposed bridge. North of the Quebrada Beatriz crossing the alignment traverses hilly terrain west of Brisas de Monticello residential area and the 230 kV power lines. The alignment continues southeast until it crosses PR-1 (km. 53.2) where two types of intersection could be constructed. One option is a Conventional Full Cloverleaf Interchange and the other option is a four-leg signalized intersection. The alignment runs southeast along Brisas de Beatriz community until reaching the PR-52 (km. 34.7) bridge over a municipal road where a Conventional Diamond Interchange is proposed. Previous evaluations determined that this interchange and the PR-184 and PR-52 interchange do not comply with minimum interchange spacing for rural highway recommended by AASHTO. Build Alternative C4 is a reasonable alternative and is evaluated in detail in this DEIS.

**Build Alternative C5 - Construction of a New Road**

The starting point for Build Alternative C5 is the same as in Build Alternative C4 and continues along the same alignment until it crosses PR-1 (km. 53.2), where it turns south. Two types of intersection could be constructed at the PR-1 crossing: a Conventional Full Cloverleaf Interchange or a four-leg signalized intersection. The alignment continues south, crossing Río Guavate where a bridge is proposed. After the Río Guavate bridge the alignment turns to the southeast until reaching a PR-52 (km. 35.5) bridge used as a cattle underpass. Due to a residential development located southeast of PR-52 and Río Guavate a Partial Cloverleaf interchange is proposed. Due to the proximity of PR-743 to PR-52, Build Alternative C5 would be extended until reaching PR-743 (km. 0.85) where a three-leg intersection is proposed. Build Alternative C5 is a reasonable alternative and is evaluated in detail in this DEIS. Table 3.1-2 summarizes major engineering characteristics of the five proposed build alternatives.

Table 3.1-2 New Road Alternatives Major Engineering Characteristics.

| Parameter | Build Alternatives | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Length (km) | 7.06 | 7.59 | 7.04 | 6.90 | 7.31 |
| Cut Volume (m3) a/ | 2,728,973 | 2,480,896 | 2,602,692 | 3,268,673 | 3,281,010 |
| Fill Volume (m3) a/ | 1,411,368 | 1,606,744 | 936,874 | 617,060 | 648,477 |
| Surplus (m3) b/ | 1,317,605 | 874,152 | 1,665,818 | 2,651,568 | 2,632,533 |
| Bridges over Water Bodies | 2 | 1 | 0 | 2 | 3 |
| Water Crossings (Culverts) | 23 | 30 | 27 | 16 | 15 |
| Bridges over Existing Roads | 2 | 2 | 2 | 1 | 1 |
| Bridges at Existing Roads | 1 | 2 | 3 | 3 | 2 |
| Corridor (cdas) | 225 | 235 | 219 | 214 | 233 |
| CDD ROW (cdas) | 124 | 129 | 119 | 112 | 118 |

a/ Without shrinkage or expansion factor.
b/ Surplus material could be reduced during final design when more detailed information is available.

## 3.2. Economic Analysis

### 3.2.1. Capital Cost of Build Alternatives

Table 3.2-1 shows the Capital cost of each of the proposed Build Alternatives. Build Alternatives costs were estimated using Conceptual Design Drawings including others studies performed as part of environmental evaluation process.

Table 3.2-1 New Road Alternatives Implementation Cost.

| Component | Alternatives Cost (Millions) | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Construction | 93.7 | 88.6 | 74.8 | 90.9 | 98.9 |
| Mitigation a/ | 23.4 | 25.1 | 22.5 | 18.9 | 21.6 |
| Acquisition b/ | 22.1 | 20.8 | 20.4 | 21.7 | 20.9 |
| Total Cost | 139.2 | 134.5 | 117.7 | 131.5 | 141.4 |

a/ Activities required to mitigate environmental impacts.
b/ Includes Acquisition and Relocation Cost.

### 3.2.2. Build Alternatives Economic Feasibility Analysis

Economic feasibility of Build Alternatives was compared based on Benefit and Cost ratio (B/C) analysis. The B/C analysis is a technique designed to determine the feasibility of a project or plan by a comparison of quantifiable costs and benefits. B/C translates the effects of an investment into current monetary terms, taking into consideration the fact that benefits generally accrue over a long period of time while capital costs are incurred primarily in the initial years.

A Cost/Benefit Model (C/B) was developed for the project and is included in Appendix B. The model was designed to measure, in real (non-inflated) dollars, the four primary categories of benefits resulting from each new road alternative. These categories of benefits are: Travel Time Savings, Vehicle Operating Cost Savings, Safety Benefits (Accident Cost Savings) and Emission Reductions. Project feasibility was evaluated using several parameters such as: Net present value and Benefit-cost ratio (benefits/costs). This analysis was performed over the life of the project (20 years). Table 3.2-2 summarizes the B/C and Net Present Value (NPV) comparison for the different Build Alternatives.

Table 3.2-2 Financial Analysis Results (millions).

| Build Alternative | Net Present Value | B/C |
|---|---|---|
| C-1 | $145.3 | 2.03 |
| C-2 | $172.2 | 2.26 |
| C-3 | $166.9 | |
| C-4 | $128.2 | 1.96 |
| C-5 | $98.8 | 1.69 |

### 3.2.3. Build Alternatives Economic Impacts

An inter-industry model was developed to asses the economic impacts of Build Alternatives (refer to Appendix B). The model quantifies the direct and indirect impacts of the Build Alternatives investments, during the construction phase, in terms of production (sales), compensation (wages), and employment. Additionally, the fiscal revenues for Cidra and Cayey municipalities are estimated. Table 3.2-3 summarizes the economic impacts for the different Build Alternatives.

Table 3.2-3 Economic Impact of Build Alternatives (millions).

| | Build Alternative | | | | |
|---|---|---|---|---|---|
| | C-1 | C-2 | C-3 | C-4 | C-5 |
| Investment | $139.2 | $134.5 | $117.7 | $131.5 | $141.4 |
| Sales a/ | $228.9 | $221.2 | $193.6 | $216.2 | $232.4 |
| Compensation a/ | $34.5 | $33.3 | $29.2 | $32.6 | $35.0 |
| Employment a/ | 1,479 | 1,429 | 1,252 | 1,397 | 1,502 |
| Potential Fiscal Revenues b/ | $5.6 | $5.4 | $4.7 | $5.3 | $5.7 |

a/ Direct and Indirect
b/ Construction Excise Taxes and Municipal Patent

# 4. TRANSPORTATION STUDIES

This chapter summarizes the traffic studies prepared for the project. Origin and destination travel patterns and existing and forecast (year 2018 and 2028) traffic characteristics are discussed. Impacts on traffic associated with the No Action alternative and the propose build alternatives are also discussed.

## 4.1. Origin and Destination Study

An Origin and Destination Traffic Study was prepared for the project (refer to Appendix C). Twelve zones were defined in the study as shown in Table 4.1-1. Figure 14 shows the approximate location of the Origin and Destination zones.

Table 4.1-1 Origin and Destination Zones.

| Zone Number | Zone Name | Description |
|---|---|---|
| 1 | Cidra | Internal trip to Cidra |
| 2 | Cayey | Trips originating or destined to Cayey |
| 3 | Caguas | Trips originating or destined to Caguas |
| 4 | San Lorenzo | Trips originating or destined to San Lorenzo |
| 5 | Gurabo | Trips originating or destined to Gurabo |
| 6 | Humacao | Trips originating or destined to all municipalities to the east of San Lorenzo and Gurabo |
| 7 | Guayama | Trips originating or destined to all municipalities to the south of Cayey |
| 8 | Aibonito | Trips originating or destined to all municipalities to the west of Cidra and Cayey |
| 9 | Bayamon | Trips originating or destined to all municipalities to the west of San Juan and north of Aguas Buenas |
| 10 | San Juan | Trips originating or destined to San Juan |
| 11 | Carolina | Trips originating or destined to all municipalities to the east of San Juan and north of Gurabo |
| 12 | Aguas Buenas | Trips originating or destined to Aguas Buenas |

### 4.1.1. Survey Methodology

A survey was performed during February 2008 using road-side interviews between the hours of 6:00 AM to 8:00 AM and 3:00 PM to 5:00 PM. Nine survey stations were set up at eight locations in the region. Figure 15 shows the location of the traffic survey stations.

The first location (STA1) was PR-1 intersection with PR-184 where Build Alternatives C1, C2 and C3 end. At this site drivers moving westbound on PR-184, from Guavate towards PR-1, and northbound on PR-1, from Cayey to Caguas, were surveyed. The second location (STA2) was PR-1 just north of the off ramps of PR-52; at this point traffic traveling northbound on PR-1, from Cayey to Caguas, was surveyed. The third location (STA 3) was the intersection of PR-7733 and PR-734; at this point traffic traveling northbound on PR-734, from Cayey to Cidra, was surveyed. The fourth location (STA4) was the intersection of PR-7733 and PR-171; at this location traffic traveling northbound on PR-171, from Cayey to Cidra, and traffic traveling eastbound on PR-7733, from the west towards PR-172, was interviewed. The fifth location was the intersection of PR-172 and PR-787; at this point traffic traveling westbound on PR-172 (STA8), from Caguas to Cidra, and traffic traveling westbound on PR-787 (STA5), from Cayey to Cidra, was interviewed. The sixth site (STA6) was the intersection of PR-735 and PR-734; at this location traffic traveling southbound on PR-734 was interviewed. The seventh site (STA7) was the intersection of PR-172 and Street #2 in Caguas; at this location traffic moving eastbound and westbound, from Caguas to Cidra and Cidra to Caguas, was interviewed. The eighth site (STA9) was the intersection of PR-171 and PR-14; at this location traffic traveling southbound on PR-171, from Cidra to Cayey, was interviewed.

A total of 3,410 vehicles were surveyed of the 26,526 vehicles counted during the study period, for a sample rate of 12.86%. Interviewed drivers were asked the origin, destination, and purpose of their trip. Additional questions were asked to determine the receptiveness of the drivers to change their usual route. Data on vehicle type and occupancy were also collected.

### 4.1.2. Survey Results

Passenger cars represented 94% of the total vehicles surveyed, buses represented 1.32%, 3-axle vehicles represented 2.61% and vehicles with four or more axles represented 2.08%. Average occupancy of surveyed vehicles was 1.59 persons per vehicle. A high percentage of those interviewed indicated they would change their travel pattern if a new route would reduce travel time.

**Regional Travel Pattern**

Survey results indicate that approximately 80% of the outgoing trips from the region originate in zones 1, 2 and 3, while 87% of the incoming trips have destinations in these same zones. The zone with the most origins is Cidra (Zone 1) with 43.64%, while Cayey (Zone 2) and Caguas (Zone 3) account for 26.42% and 10.47%, respectively. In terms of destinations, Cayey (Zone 2) accounts for 38.71% followed by Cidra (Zone 1) with 36.04% and Caguas (Zone 3) with a 12.49%. Table 4.1-2 summarizes the regional movements.

Table 4.1-2 Summary of Regional Movements

| Zone | Destination | | Origins | |
|---|---|---|---|---|
| | Total | Percent | Total | Percent |
| 1 | 1229 | 36.04 | 1488 | 43.64 |
| 2 | 1320 | 38.71 | 901 | 26.42 |
| 3 | 426 | 12.49 | 357 | 10.47 |
| 4 | 11 | 0.32 | 40 | 1.17 |
| 5 | 1 | 0.03 | 26 | 0.76 |
| 6 | 12 | 0.35 | 23 | 0.67 |
| 7 | 63 | 1.85 | 157 | 4.60 |
| 8 | 28 | 0.82 | 81 | 2.38 |
| 9 | 136 | 3.99 | 155 | 4.55 |
| 10 | 133 | 3.90 | 113 | 3.31 |
| 11 | 24 | 0.70 | 24 | 0.70 |
| 12 | 27 | 0.79 | 45 | 1.32 |
| Total | 3410 | | 3410 | |

Surveys indicate that vehicles with 3 axles or more preferred to use PR-172 as the Cidra access route. This highway exhibited the highest percentage in truck traffic, accounting for 9% of total vehicles. Regarding trip origins, of the 9% truck traffic, 24.52% originated in San Juan, Bayamón and Carolina, and 7.55% originated in Caguas. In term of trip destinations, 28.3% of truck trips have destinations in San Juan or Bayamón.

Travel to and from Cidra

Principal access roads to Cidra are PR-172, PR-734, PR-171 and PR-787. Survey results indicate that of the trips destined to Cidra, 36.9% use PR-172, 31.37% use PR-734, 18.82% use PR-171, and 12.9% use PR-787. When the trip originates in Cidra 37.8% use PR-734, 34.8% use PR-172, 19.9% use PR-171 and 7.46% use PR-787. PR-172 is the principal access route for trips to and from the Metropolitan Area of San Juan (Zones 9, 10, and 11), and PR-734 is the principal route between Cidra and Cayey.

Trip Purpose

Trip purpses were divided into six categories: home, work, business, shopping, school and personal business. Approximately 62% of travel originates from home and 24% at work. Routes PR-171, PR-787 and PR-734 have the highest percentage of home based trips, and PR-172 has the highest percentage of work based trips.

Destination trip purposes are 27% home and 35% work. Routes PR-172, PR-787 and PR-734 have the highest percentage of home based trips. The difference between these routes is not significant for the work category with an average of 32.2%.

## 4.2. Traffic Study

This section presents an analysis of existing and future traffic conditions under both the No Action and Build Alternatives. The Traffic Study prepared for this analysis performed the following evaluations:

- Determine existing traffic condition (year 2008) at the main intersections that connect PRSHN with Cidra CBD;
- Determine long-term traffic conditions (2018 and 2028) at intersections under the No Action and all five proposed build alternatives;
- Determine impacts on movement between Cidra and the PRSHN for all five proposed build alternatives.

A copy of the Traffic Study is included as Appendix D.

### 4.2.1. Data Collection

Current traffic data (2008), intersection geometric configuration and signal timing were obtained from field survey and data obtained from PRDTPW. Automated Traffic Count Stations were installed for one week (Sunday to Sunday) in the Study Area. Manual Traffic Counts were performed for 12 consecutive hours 6:00 AM to 6:00 PM. Figure 16 shows the traffic count station locations and station descriptions are included in Table 4.2-1 and Table 4.2-2.

Travel time and delay studies were conducted along routes that connect PRSHN to Cidra. Figure 17 shows the route alignments. Also, intersections and geometric configurations were field measured. Traffic signal timing and phasing were obtained from the Office of Traffic Regulation of the PRDTPW. Traffic projection factors for 2018 and 2028 were supplied by the PRHTA.

Table 4.2-1 Automated Traffic Count Stations.

| Station Number | Station Description | Station Number | Station Description |
|---|---|---|---|
| ATC-1 | PR-1 between PR-184 and PR-787 | ATC-9 | PR-172 west of PR-785 |
| ATC-2 | PR-738 between PR-1 and PR-735 | ATC-10 | PR-172 north of PR-787 |
| ATC-3 | PR-735 west of PR-734 | ATC-11 | PR-172 west of Street Num. 2 |
| ATC-4 | PR-734 south of PR-7733 | ATC-12 | PR-1 north of PR-787 |
| ATC-5 | PR-171 south of PR-7733 | ATC-13 | PR-787 west of PR-1 |
| ATC-6 | PR-172 south of PR-7733 | ATC-14 | PR-1 north of PR-52 ramps |
| ATC-7 | PR-171 north of PR-14 | ATC-15 | PR-184 between PR-1 and PR-52 |
| ATC-8 | PR14 east of PR-171 | ATC-16 | PR-743 north of PR-742 |

Table 4.2-2 Manual Traffic Count Stations.

| Station Number | Station Description | Station Number | Station Description |
|---|---|---|---|
| MTC-1 | PR-1 with PR-184 | MTC-9 | PR735 with PR-1 (south) |
| MTC-2 | PR-1 with PR-14 | MTC-10 | PR-735 with PR-738 |
| MTC-3 | PR-7733 with PR-734 | MTC-11 | PR-172 with PR-787 |
| MTC-4 | PR-7733 with PR-171 | MTC-12 | PR-1 with PR-787 |
| MTC-5 | PR-7733 with PR-172 | MTC-13 | PR-743 with PR-742 |
| MTC-6 | PR-171 with PR14 | MTC-14 | PR-184 with PR-52 NB Ramps |
| MTC-7 | PR-734 with PR-735 | MTC-15 | PR-184 with PR-52 SB Ramps |
| MTC-8 | PR-735 with PR-1 (north) | MTC-16 | PR-7733 with Factory Entrance |

Survey data were analyzed by computer programs utilized to simulate traffic conditions. Projected forecast scenarios (2018 and 2028) for the No Action and the five proposed build alternatives used projection factors developed by the PRHTA.

### 4.2.2. Simulation Methodology

Several traffic analyses were performed to evaluate existing and future conditions for the No Action and proposed Build Alternatives. The methodology used to simulate traffic conditions is summarized below.

Traffic Assignment Modeling

a traffic assignment model, was used to evaluate the capacity of each proposed build alternative to attract traffic from the existing network. The modeled network is described in Table 4.2-3. Figure 18 shows the road network configuration.

Table 4.2-3 Traffic Assignment Model Network.

| Road | Description |
|---|---|
| PR-1 | from the intersection with PR-172 to the intersection with PR-15 |
| PR-52 | from the ramps at the intersection with PR-172 to its cross over with PR-15 |
| PR-14 | between PR-1 and PR-15 |
| PR-171 | from PR-14 to PR-7733 |
| PR-734 | from PR-1 to PR-7733 |
| PR-787 | from PR-1 to PR-172 |
| PR-172 | from PR-1 to the entrance to Cidra |
| PR-15 | from PR-14 to the under pass with PR-52 |
| PR-7733 | between PR-171 and PR-172 |

New Road Geometric Configuration

The basic road section for the proposed build alternatives was determined using the Multi-lane module of Level of Service (LOS) was the criteria used to evaluate road sections, categorizing road operations into the following categories:

LOS A describes primarily free-flow operations. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream. Even at the maximum density, the average spacing between vehicles is about 528 ft which affords the motorist with a high level of comfort.

LOS B represents reasonably free flow, and speeds at the free-flow speed are generally maintained. The lowest average spacing between vehicles is about 330 ft. The ability to maneuver within the traffic stream is only slightly restricted, and the general level of comfort provided to drivers is still high.

LOS C provides for flow with speeds still at or near the free-flow speed of the freeway. Freedom to maneuver within the traffic stream is noticeably restricted at LOS C, and lane changes require more vigilance on the part of the driver. Minimum average spacing are in the range of 220 ft. Drivers experiences a noticeable increase in tension because of the additional vigilance required for safe operation.

LOS D is the level at which speeds begin to decline slightly with increasing flows. Density begins to deteriorate somewhat more quickly with increasing flow. Freedom to maneuver within the traffic stream is more noticeably limited, and the driver experiences reduced comfort levels. Vehicles are spaced at about 165 ft.

LOS E describes operations at capacity. Vehicles are spaced at approximately 100 ft, leaving little room to maneuver within the traffic stream at speeds that still exceed 50 mph. Maneuverability within the traffic stream is extremely limited, and the level of comfort is extremely poor.

LOS F describes breakdown in vehicular flow. Such conditions generally exist within queues forming behind breakdown points. Breakdown occurs when the ratio of arrival flow rate to actual capacity or the forecast flow rate to estimate capacity exceeds 1.00.

New intersection configurations were defined as part of Intersections Operational Analysis.

Intersections Operational Analysis

V7.0, a traffic simulation model based on the 2000 Highway Capacity Manual (HCM), was used to determine average intersection delay and Level of Service (LOS) for each signaled and unsignaled intersection. LOS represents intersection operating conditions as shown below:

LOS A describes intersection operation with very short delays, not exceeding 5 seconds per vehicle. This level of service occurs when signal progression is extremely favorable and most vehicles arrive during the green phase, and most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes intersection operation with delay between 5 and 10 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LOS C describes intersection operation with average delays between 15 and 25 seconds per vehicle. These higher delays may result from fair progression, longer cycle length, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes intersection operation with average delay between 25 and 40 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume to capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes intersection operation with average delay between 40 and 60 seconds per vehicle. This is considered by many agencies to be the upper limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high volume-to-capacity ratios. Individual cycle failures are frequent occurrences.

LOS F describes intersections operating with an average delay exceeding 60 seconds per vehicle. This level, considered to be unacceptable by most drivers, often occurs with

oversaturation, which occurs when the arrival flow rate exceeds the intersection capacity. It may also occur at volume-to-capacity ratios below 1.0 with many individual cycle failures. Poor progression and long cycle length may also be major factors contributing to long delays.

Several models were prepared to evaluate study area intersections for the existing and future condition for the No Action and proposed build alternatives. Intersections were assumed to operate in an isolated condition and both existing and future traffic conditions were evaluated.

Existing Traffic Conditions

The Existing Traffic Condition operational analysis was performed for the following intersections: PR-1 with PR-184, PR-1 with PR-14, PR-7733 with PR-734, PR-7733 with PR-171, PR-7733 with PR-172, PR-171 with PR14, PR-734 with PR-735, PR-735(North) with PR-1, PR-735 (South) with PR-1, PR-735 with PR-738, PR-172 with PR-787, and PR-1 with PR-787. Figure 19 shows the intersection locations. Survey data was used to evaluate existing traffic conditions.

Future Traffic Conditions

The Future Traffic Conditions operational analysis was performed for the same intersections evaluated for existing traffic conditions. For the proposed build alternatives the proposed new intersections and resultant traffic redistribution was incorporated into the analysis. Future condition analysis was performed for forecast years 2018 and 2028. PRHTA projection factors were used to forecast survey data used in the analyses.

### 4.2.3. Evaluation of Proposed Build Alternatives

Traffic Assignment Modeling

Surveyed traffic data, O/D study results, road characteristics, type of user, Value of Time (VOT), operational cost, and demand flow curves were the principal parameters used to define and calibrate the base network, which simulates existing traffic conditions. After calibration, the base network was modified to incorporate the proposed build alternatives. Modeling simulated both AM and PM peak hours for year 2008. Simulation results are summarized in Table 4.2-4 and Table 4.2-5, showing that the most attractive alternative in both directions is C5, followed by C4, C1 and C3, and C2.

Table 4.2-4 Traffic Assignment Results (AM Peak Hour).

| Road | Base | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|
| PR-172 | 429 (31)/ 259 (14) | 391 (29)/ 99 (5) | 406 (30)/ 99 (5) | 391 (29)/ 99 (5) | 434 (32)/ (231) 12 | 431 (32)/ 232 (12) |
| PR-787 | 203 (15)/ 368 (20) | 0 (0)/ 0 (0) | 0 (0)/ 0 (0) | 0 (0)/ 0 (0) | 199 (5)/ 118 (6) | 202 (15)/ 118 (6) |
| PR-734 | 489 (36)/ 716 (39) | 490 (36)/ 696 (37) | 490 (36)/ 696 (37) | 490 (36)/ 696 (37) | 200 (15)/ 377 (20) | 162 (12)/ 370 (20) |
| PR-171 | 242 (18)/ 516 (28) | 241 (18)/ 516 (28) | 242 (18)/ 516 (28) | 241 (18)/ 516 (28) | 235 (17)/ 516 (28) | 235 (17)/ 516 (28) |
| New Road | NA | 242 (18)/ 549 (30) | 227 (17)/ 431 (23) | 242 (18)/ 549 (30) | 296 (22)/ 619 (33) | 334 (25)/ 624 (34) |
| Total | 1364/1860 | 1364/1860 | 364/1860 | 1364/1860 | 364/1860 | 1364/1860 |

a/ - Entering Vehicles (Percent)/ /Exiting Vehicles (Percent)

Table 4.2-5 Traffic Assignment Results (PM Peak Hour).

| Road | Base | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|
| PR-172 | 353 (27)/ 288 (21) | 324 (24)/ 285 (21) | 334 (25)/ 285 (21) | 324 (24)/ 285 (21) | 331 (25)/ 288 (21) | 334 (25)/ 287 (21) |
| PR-787 | 282 (21)/ 122 (9) | 0 (0)/ 0 (0) | 27 (2)/ 50 (4) | 0 (0)/ 18 (1) | 31 (2)/ 53 (4) | 28 (2)/ 55 (4) |
| PR-734 | 500 (38)/ 576 (42) | 492 (37)/ 565 (42) | 492 (37)/ 565 (42) | 492 (37)/ 565 (42) | 379 (28)/ 456 (34) | 395 (30)/ 422 (31) |
| PR-171 | 195 (15)/ 374 (28) | 187 (14)/ 374 (28) | 187 (14)/ 374 (28) | 187 (14)/ 374 (28) | 184 (14)/ 374 (28) | 186 (14)/ 374 (28) |
| New Road | NA | 326 (25)/ 135 (10) | 289 (22)/ 86 (6) | 326 (25)/ 118 (9) | 405 (30)/ 188 (14) | 388 (29)/ 222 (16) |
| Total | 1330/1360 | 1330/1360 | 1330/1360 | 1330/1360 | 1330/1360 | 1330/1360 |

a/ - Entering Vehicles (Percent)/ /Exiting Vehicles (Percent)

Alternatives C5 and C4 have the ability to capture more vehicles mainly because of the intersection with PR-1 in Cayey, which attracts people traveling from Cayey to Cidra. From the field data it was calculated that the AM peak hour is approximately 8% of the average daily traffic; therefore, based on the above the projected average daily traffic for the new connector would be approximately 11,000 to 12,000 vehicles using 2008 volumes. Using PRHTA projection factors

the AADT for the new road are between 13,000 and 14,000 for projection year 2018, and between 15,000 and 16,000 for projection year 2028.

New Road Geometric Configuration

Projected AM and PM peak hour volumes, obtained from Traffic Assignment Modeling and PRHTA projection factors, were used to define the basic road section. Analysis indicated that a road with a two lane basic section (one in each direction) provides the capacity to handle some of the projected 2028 traffic with a LOS C. However, due to mountainous conditions of the area it is recommended that climbing lanes be provided for heavy vehicles. Due to anticipated slow truck traffic, the decision was made to provide 2-lanes in each direction, as explained in more detail in Section 3.1.5.

The proposed build alternatives would require new intersections at existing roads. For build alternatives C1, C2, and C3 modifications would be required to the intersection of PR-1 with PR-184 in Cayey and the intersection of PR-7733 and the industrial entrance in Cidra. Both intersections would be converted to four leg intersections. Build Alternative C4 would require three new intersections: PR-7733 with the new connector, PR-1 with the new connector, and PR-52 with the new connector. Build Alternative C5 would require four new intersections: PR-7733 with the new connector, PR-1 with the new connector, PR-52 with the new connector, and PR-743 with the new connector. For PR-1 intersections a four-leg intersection is recommended. To access PR-52 a diamond and partial cloverleaf interchanges are recommended for the C4 and C5 build alternatives, respectively. At PR-743 a T intersection is recommended.

### 4.2.4. Intersections Operational Analysis

An intersection operational analysis was performed to define existing and future traffic conditions. Twelve signaled and unsignaled intersections were evaluated.

Existing Traffic Conditions

For existing traffic conditions sixteen intersections were selected to perform existing condition operational analysis. Intersection information used to perform the analysis includes: geometric configuration, traffic signal cycle and phase, and traffic data surveyed. Table 4.2-6 shows the LOS under existing conditions. Analysis of 2008 existing traffic conditions indicated that seven of these intersections operate at Level of Service (LOS) of E or worse during either the AM or PM peak hours. Of these seven intersections, two operated at LOS E or worse during both AM and PM peak hours.

Table 4.2-6 Intersections Existing Level of Service (2008).

| Intersection | LOS / Average Delay per Vehicle (sec) | |
|---|---|---|
| | AM (LOS/Average Delay) | PM (LOS/Average Delay) |
| PR-1 with PR-184 | D (39.0) | D (38.6) |
| PR-1 with PR-14 | C (29.1) | C (31.9) |
| PR-7733 with PR-734 | F (287.2) | C (32.3) |
| PR-7733 with PR-171 | F (420.6) | D (52.5) |
| PR-7733 with PR-172 | C (29.9) | C (23.0) |
| PR-171 with PR14 | F (121.0) | E (63.0) |
| PR-734 with PR-735 | A (8.5) | A (7.5) |
| PR-735(north) with PR-1 | A (4.4) | A (4.6) |
| PR-735(south) with PR-1 | A (4.9) | A (6.3) |
| PR-1 with PR-738 | A (6.6) | A (7.5) |
| PR-172 with PR-787 | B (13.0) | C (23.8) |
| PR-1 with PR-787 | B (12.6) | A (6.3) |
| PR-743 with PR-742 | E (59.3) | A (6.4) |
| PR-184 with PR-52 NB | F (3764.2) | F (143.3) |
| PR-184 with PR-52 SB | E (61.7) | B (17.7) |
| PR-7733 with Factory | B (19.9) | F (174.1) |

Future Traffic Conditions

Operational analysis for forecast years 2018 and 2028 was prepared for the No Action alternative and each of the Build Alternatives. The No Action alternative includes existing intersections and information used during existing traffic conditions analysis, with future traffic forecast using PRHTA projection factors. Table 2.1-2 show the analysis results for the No Action alternative. Traffic forecasts indicate that under the No Action alternative, by the year 2018 the Level of Service at evaluated intersections will degrade, with five intersections operating at LOS E or worst during both AM and PM peak hours. During the 2028 scenario seven of the intersections will operate at Level of Service E or worse during either the AM or PM peak hours. Four of the intersections will operate at LOS E or worse during both AM and PM peak hours (refers to Table 2.1-3).

The operational analysis for proposed build alternatives focused on the new connector and its effect on the intersections along PR-7733, and includes the proposed intersections and traffic redistribution obtained during traffic assignment modeling. Operational analysis identified that the intersections of PR-171 with PR-7733, PR-734 with PR-7733, PR-184 with PR-52 SB Ramps and

PR-52 NB ramps presented unacceptable LOS. Geometric and signal improvements at these intersections are proposed.

The proposed PR-171/PR-7733 intersection improvement consists of the construction of a right turn lanes on PR-7773, and the construction of left turn lanes on PR-171. At the PR-734/PR-7733 intersection, the improvement consist of the construction of a right turn lane on the northbound approach on PR-734, the construction of a left and right turn lanes on the southbound approach of PR-734 and the construction of left turn lanes on PR-7733.

The proposed improvements at the intersection of PR-184 and the PR-52 southbound ramps consist of the installation of a traffic signal system. For the intersection of PR-184 with the PR-52 northbound ramps the proposed improvement consists of the construction of a northbound right turn lane and a southbound double left turn lane.

Table 4.2-7 and Table 4.2-8 show the LOS for forecast years 2018 and 2028, respectively. Under the proposed build alternatives, nearly all of the intersections adequately handle the projected traffic for forecast year 2028. However, the intersection of PR-1 with the new road under Build Alternative C-5 experiences service degradation. If Build Alternative C-5 is selected, an interchange may be necessary.

Table 4.2-7 Comparison 2018 Level of Service at Intersections.

| Intersection | LOS / Average Delay per Vehicle (sec) | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C1 | C2 | C3 | C4 | C5 |
| PR-171 with PR-7733 | F(1080.7)/ F(93.5) | F(181.0)/ D(45.3) | F(188.1)/ D(44.1) | F(200.7)/ D(45.0) | F(189.1)/ D(37.4) | F(272.9)/ D(53.7) |
| PR-7733 with new road | N/E | C(27.1)/ C(25.7) | B(12.4)/ C(25.1) | C(33.1)/ C(25.1) | B(15.4)/ C(33.2) | C(24.6)/ C(26.2) |
| PR-734 with PR-7733 | F(361.5)/ D(43.5) | F(539.6)/ F(453.0) | F(709.1)/ F(405.8) | F(561.6)/ F(447.4) | F(534.4)/ F(672.1) | F(324.6)/ F(712.7) |
| PR-172 with PR-7733 | C(26.4)/ B(16.6) | C(32.2)/ C(21.8) | B(14.9)/ C(22.7) | C(20.1)/ C(21.9) | B(16.7)/ B(17.0) | B(16.3)/ B(16.8) |
| PR-172 with PR-787 | B(14.3)/ B(20.8) | B(10.1)/ B(11.4) | A(9.0)/ B(12.1) | A(9.6)/ B(11.4) | A(9.2)/ A(9.5) | A(9.4)/ A(9.4) |
| PR-1 with PR-184/new road | E(58.7)/ E(68.9) | B(18.4)/ B(16.5) | B(17.0)/ B(16.4) | B(18.4)/ B(16.4) | N/E | N/E |
| PR-184 with PR-52 SB Ramp | F(589.8)/ D (41.3) | F(481.6)/ F(81.2) | F(481.6)/ E(75.5) | F(481.6)/ F(79.8) | N/S | N/S |
| PR-184 with PR-52 NB Ramp | F(3895.2)/ F(2539.2) | F(3217.7)/ F(2956.2) | F(3217.7)/ F(3018.8) | F(3217.7)/ F(2979.3) | N/S | N/S |
| PR-1 with new road | N/E | N/E | N/E | N/E | B(20.0)/ B(12.8) | C(29.6)/ C(21.4) |
| PR-743 with new road | N/E | N/E | N/E | N/E | NA | B(12.0)/ B(11.1) |
| PR-52 SB Ramps | N/E | N/E | N/E | N/E | A(7.0)/ A(7.0) | B(17.7)/ B(18.0) |
| PR-52 NB Ramps | N/E | N/E | N/E | N/E | A(7.2)/ A(7.2) | C(22.6)/ A(9.7) |

a/ LOS (Average Delay) AM/ LOS (Average Delay) PM; N/E – Not Exist, means that intersection would not exist under this alternative ; N/S – Not Significant, means that intersection was not evaluated because is not significant to alternative traffic performance.

Table 4.2-8 Comparison 2028 Level of Service at Intersections.

| Intersection | LOS / Average Delay per Vehicle (sec) | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C1 | C2 | C3 | C4 | C5 |
| PR-171 with PR-7733 | F(1422.2)/ F(171.9) | F(89.7)/ B(25.9) | D(52.9)/ C(25.9) | F(95.8)/ C(20.4) | E(59.5)/ B(18.3) | D(52.3)/ C(34.9) |
| PR-7733 with new road | N/E | D(35.1)/ C(32.1) | B(15.5)/ C(32.4) | D(36.2)/ C(28.8) | C(28.1)/ C(31.7) | C(31.5)/ D(47.0) |
| PR-734 with PR-7733 | F(449.7)/ E(65.8) | D(42.5)/ D(50.1) | F(139.5)/ D(49.8) | D(39.3)/ E(52.6) | D(50.2)/ F(102.9) | D(48.2)/ E(70.7) |
| PR-172 with PR-7733 | C(24.2)/ C(20.0) | C(32.7)/ C(30.6) | C(19.0)/ D(30.7) | C(333.4)/ C(27.2) | B(15.9)/ C(21.7) | B(18.8)/ C(29.2) |
| PR-172 with PR-787 | B(16.1)/ B(23.7) | B(10.3)/ B(11.5) | C(12.3)/ C(11.6) | B(10.8)/ A(9.7) | B(10.9)/ B(10.0) | A(9.7)/ B(11.1) |
| PR-1 with PR-184/new road | F(80)/ F(103.3) | C(26.4)/ C(23.3) | C(23.9)/ C(21.7) | C(26.4)/ C(23.0) | N/E | N/E |
| PR-184 with PR-52 SB Ramp | F(637.6)/ F(84.8) | C(22.2)/ D(50.6) | C(21.1)/ D(47.8) | C(23.3)/ D(43.9) | N/S | NA |
| PR-184 with PR-52 NB Ramp | F(4012.2)/ F(2625.9) | D(37.5)/ B(16.6) | D(36.2)/ C(16.5) | D(38.0)/ C(23) | N/S | N/S |
| PR-1 with new road | N/E | N/E | N/E | N/E | D(42.2)/ B(16.0) | D(44.2)/ C(23.5) |
| PR-743 with new road | N/E | N/E | N/E | N/E | NA | B(14.7)/ B(12.5) |
| PR-52 SB Ramps | N/E | N/E | N/E | N/E | A(7.0)/ A(7.0) | C(32.9)/ C(28.5) |
| PR-52 NB Ramps | N/E | N/E | N/E | N/E | A(7.2)/ A(7.3) | B(13.4)/ B(13.1) |

a/ LOS (Average Delay) AM/ LOS (Average Delay) PM; b/ Includes intersections improvements ; N/E – Not Exist, means that intersection would not exist under this alternative.; N/S – Not Significant, means that intersection was not evaluated because is not significant to alternative traffic performance.

### 4.2.5. Road Safety

Puerto Rico Safety Transit Commission (PRSTC) classified PR-172 as one of the most dangerous roads in Puerto Rico. Table 4.2-9 summarizes fatal accidents along PR-172, PR-171, PR-787 and PR-734.

Table 4.2-9 Fatal accidents in PR-172, PR-171, PR-787 and PR-734 (2000-2008)

| Year | Roads | | | |
|---|---|---|---|---|
| | PR-172 | PR-171 | PR-787 | PR-734 |
| 2000 | 3 | 2 | 0 | 0 |
| 2001 | 0 | 0 | 1 | 0 |
| 2002 | 3 | 1 | 0 | 2 |
| 2003 | 4 | 0 | 0 | 1 |
| 2004 | 3 | 1 | 0 | 0 |
| 2005 | 4 | 0 | 0 | 0 |
| 2006 | 8 | 0 | 1 | 1 |
| 2007 | 4 | 1 | 0 | 0 |
| 2008 | 3 | 0 | 0 | 1 |
| Total | 32 | 5 | 2 | 5 |

Source: Puerto Rico Safety Transit Commission

# 5. AFFECTED ENVIRONMENT

This chapter describes environmental, social, cultural and economic conditions in the project area, and also describes the methodology used to define resources. The general conditions in the two municipalities in the project area are first described, and then a more detailed description is given of conditions within the analyzed corridors (400 m wide).

## 5.1. General Description of Cidra and Cayey

The project area is located in the municipalities of Cidra and Cayey, both located in the central-east region of Puerto Rico (refer to Figure 2). This section provides a general description of Cidra and Cayey municipalities. A major component of this Draft Environmental Impact Statement is the evaluation of the alternatives to improve the mobility between the municipality of Cidra and the PRHSN. Most of the total length of the Build Alternatives corridors are located in Cidra, making it the most-affected municipality and for that reason the municipality given the greatest emphasis in this analysis.

### 5.1.1. Location, Topography and Water Bodies

Cidra is bounded on the north by the municipality of Aguas Buenas, on the south by Cayey, on the west by Comerio, Aibonito and Barranquitas, and on the east by Caguas (Figure 2). The municipality has a land area of approximately 36.51 square miles and has the following wards (barrios): Arenas, Bayamón, Beatriz, Ceiba, Monte Llano, Pueblo, Honduras, Rabanal, Rincón, Río Abajo, Salto, Sud and Toita, in addition to pueblo, the Central Business District (CBD).

Elevations in Cidra range from 200 to 700 meters, with the highest elevations in Rabanal and Honduras wards. The most level terrain is in the vicinity of Cidra reservoir, located northeast of the CBD. Principal watercourses include Río de La Plata, Río Arrayota, and Río Bayamón which was dammed to create Cidra reservoir, a source of drinking supply with a surface area of 0.42 square miles. Figure 20 shows the topographic map of Cidra.

Cayey's northern boundary is the municipality of Cidra. The southern boundaries are Guayama and Salinas. Caguas is the eastern boundary and Aibonito the western boundary. Cayey has a land area of approximately 51.91 square miles and consists of 22 wards named Beatriz, Cedro, Cercadillo, Culebras Alta, Culebras Bajo, Farallón, Guavate, Jájome Alto, Jájome Bajo, Lapa, Matón Abajo, Matón Arriba, Monte Llano, Pasto Viejo, Pedro Ávila, Piedras, Pueblo, Quebrada Arriba, Rincón, Sumido, Toita y Vegas.

Cayey ground elevation varies from 370 to 870 meters. Maximum elevation occurs in Cedro de la Tabla (890 m). The CBD is located in a valley surrounded by La Sierra de Cayey. Principal water bodies are Río de La Plata and Río Guavate. Figure 21 shows the topographic map of Cayey.

### 5.1.2. Climate

According to the Meteorological Station # 662634 (Cidra1E) of the National Oceanographic and Atmospheric Administration South East Regions, the average maximum temperature is 81.2 F, while the average minimum is of 62.4 F. The average rainfall for the area is approximately 63.38 inches per year, as stated by the Cidra 1E Meteorological Station.

### 5.1.3. Environmentally Sensitive Areas

Cidra has hilly topography and sensitive natural resources. The area is known as a habitat for the endangered Puerto Rican Plain Pigeon. The habitat area is illustrated in Figure 22. Another particularly sensitive area is Cidra reservoir, which provides water supply to Cidra via a filtration plant located adjacent to the reservoir. Water quality is a particular concern, especially since the reservoir receives runoff from the urban area.

The EPA National Priority List identified polluted ground water areas in Cidra. The Cidra Ground Water Contamination site consists of a ground water plume with no identified sources of contamination. The Puerto Rico Department of Health (PRDOH) ordered four public supply wells in Cidra to be closed due to contamination by tetrachloroethylene (PCE): Cidra Well #4 (Calle Padilla Final) in March 1996; Cidra Well #8 (Frente Cementerio) in October 1996; Cidra Well #3 (Planta Alcantarillado) in February 1999; and Cidra Well #6 (Calle Baldorioty) in August 2000. Other chlorinated volatile organic compounds (VOCs), including 1,1-dichloroethylene (1,1-DCE) and trichloroethylene (TCE), were also detected in these wells prior to closure. All wells are located near the Cidra CBD.

Cayey has also very sensitive natural resources. Carite Forest is the sole habitat of the endangered “Coqui Dorado” *Eleutherodactylus jasper*. This forest is located to the east of PR-52, and is a significant distance from any on the proposed alignments. Figure 23 presents the priority conservation areas identified by Puerto Rico Department of Environmental and Natural Resources. Cayey also have some sites of habitat for the Puerto Rican plain pigeon.

### 5.1.4. Major Infrastructure

Transportation

The Puerto Rico 2030 Long Range Transportation Plan (PRLRTP) places Cidra and Cayey in the Metro-South Region which includes Aguas Buenas, Aibonito, Barranquitas, Caguas, Comerío, Gurabo Juncos y San Lorenzo. The principal transportation mode in Cidra and Cayey is private cars due to the lack of sufficient or convenient public transportation. Main access to Cidra from PRSHN is along secondary road PR-172 which connects PR-52 (in Caguas area) to Cidra CBD. Other access to Cidra is along secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD, tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD, and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. PR-173 and PR-172 connects Cidra with Aguas Buenas and Comerío, respectively.

PR-52 and PR-1 extend northeast-southwest of the Cayey urban area and constitute the major highways in the area. Access ramps to PR-52 allow access from PR-1 and PR-184. Highways

PR-14 and PR-15 link Cayey with Aibonito and Guayama, respectively. Cayey is linked to Cidra via PR-171 and PR-734, and Cayey is linked to Salinas and Caguas by PR-52 and PR-1. Figure 24 shows the alignments of principal roads in Cidra and Cayey.

Potable and Wastewater System

The principal source of potable water is Cidra Filtration Plant with a capacity of 7 MGD; its service area includes Cidra and a part of Aguas Buenas. Water wells complement the water supply. Cayey receives potable water from five filtration plants located in the municipality. The largest plant withdraws water from Carite reservoir and serves the Cayey urban area.

Cidra and Cayey wastewater is treated at the Regional Wastewater Plant located in Rincón Ward at Cayey. This is a secondary plant with a treatment capacity of 4.28 MGD. Recently the Puerto Rico Aqueduct and Sewer Authority started improvements to Wastewater Treatment Plant to increase treatment capacity from 4.28 MGD to 9.0 MGD.

Power and Electricity

Cidra and Cayey are part of the Caguas Region of the Puerto Rico Energy and Power Authority. Electricity comes from Aguirre Power Plant and the distribution system has two sub-stations of 38/8.32 kV in each municipality.

### 5.1.5. Socioeconomics Characteristics

A Socioeconomic Report for Cidra and Cayey was prepared and is included in Appendix E.

Demographics, Population Density and Age Distribution

The population in Cidra and Cayey are compared to all of Puerto Rico in Table 5.1-1. By 2012, the Puerto Rico Planning Board (PRPB) projects a growth rate in Cidra of 1.2 % which is higher than Puerto Rico. The municipalities' information is shown in Table 5.1-1.

Table 5.1-1 Cidra and Cayey Population Characteristics, Year 2000.

| Geographic Area | Population 2000 | Density (persons/mi$^2$) | Population 2012 | Density (persons/mi$^2$) | Growth Rate (%) |
|---|---|---|---|---|---|
| Cidra | 42,753 | 1,179 | 49,220 | 1,363 | 1.2 |
| Cayey | 47,370 | 913 | 48,711 | 939 | 0.2 |
| Puerto Rico | 3,808,610 | 1,111 | 4,051,566 | 1,182 | 0.5 |

Source: Puerto Rico Planning Board and 2000 Census.

According to the 2000 Census the median age of residents in Cidra was 30.4 years and in Cayey was 32.5 years old. Similar to Puerto Rico as a whole, groups under 25 years old are projected to experience negative growth rate by 2012. However, this group will still account for 36% of the municipalities' population by 2012. Growth rate is expected in the 25-59 age groups, which is the most highly productive age cohort in the labor force. The older segment of the population, over 60

years, is the fastest growing group and will account for almost 20 % of the total population by 2012.

Per Capita and Family Income, and Education

Cayey has per capita and family income levels lower than Cidra's and both municipalities have lower levels than the island-wide average. Income characteristics are shown in Table 5.1-2.

Table 5.1-2 Cidra and Cayey Income Characteristics.

| Geographic Area | Per Capita Income | | Median Family Income | |
|---|---|---|---|---|
| | 2000 | 2012 | 2000 | 2012 |
| Cidra | $7,027 | $20,084 | $17,262 | $33,136 |
| Cayey | $7,877 | $16,467 | $15,939 | $29,692 |
| Puerto Rico | $8,185 | $18,349 | $16,543 | $30,309 |

Over time, Cidra and Cayey have made significant progress towards reducing the number of persons below poverty levels. However, as of 2000, Cayey still had 50% of its population below poverty level and Cidra had nearly 47%.

Both municipalities have lower levels of education than the average for the rest of the island and the number of dropouts has consistently grown over the past five years. According to the 2000 Census of Population, about 15.5 % of the Cayey population between 16 and 19 years of age were not enrolled in school and had not graduated from high school. This percentage was higher in Cidra with 17.2 %. The average for PR was 14.1 %. Between the 2001 to 2006 the percentage of dropouts from public schools grew by 7.2% and 5.3% in Cidra and Cayey, respectively.

Housing and Construction Projects

According to the 2000 Census of Population, housing conditions of existing units in Cidra and Cayey are relatively satisfactory. There are fewer renter occupied units in Cidra (24%) than in Cayey (30%). Historically, housing activity in the region has remained moderate, but there is still demand for new housing units in the region.

The Puerto Rico Planning Board (PRPB) provided a list of construction projects from 2003 to 2008 for Cayey and Cidra that highlighted the need for new housing units. Current project permits for Cayey include a medical office building, a furniture store, an office stationary store, 2 medium-scale residential projects (405 and 301 units), several smaller residential projects, and an auto dealership. The proposed industrial project "Parque Tecnológico" in Cayey is still in the permitting process. Permits in Cidra include a few small residential projects (34 and 61 units), but there are three additional residential permit requests not yet processed by the PRPB: Spring Hill Development (1,200 residential units and commercial area) and Bosque de Cidra (525 residential units).

Both municipalities have developed Strategic Plans identifying the initiatives that need to be programmed and executed immediately, in the short-term, medium-term and long-term.

Labor Market and Retail Trade

Data from the Puerto Rico Department of Labor (PRDL) for the 2nd quarter of 2007 indicate that service sector is the largest employer in Cayey with 38% of all jobs followed by manufacturing with 27%. Trade and government employed 17% and 13%, respectively. Construction accounted for 4% and transport for 1%. In contrast, manufacturing is the largest employer in Cidra with 37% of all jobs followed with services with 30%. Trade and government employed 14%, construction accounted for 3% and agriculture and transport with 1% each one. PRDL data from year 1997 and 2006 indicated that unemployment rate in the Cidra-Cayey region had remained less than 9%, lower than all Puerto Rico, except for 2007 when it reached 12.5 %.

Occupations can be categorized in two professions groups. Group 1 professions are those related with professional and management, service, and sales and office. Group 2 professions are those related with production and transportation, construction and maintenance, and agriculture. Table 5.1-3 summarizes the distribution of workers.

Table 5.1-3 Cidra and Cayey Percent of Group1 and Group 2 Workers.

| Geographic Area | Group 1 Workers | Group 2 Workers |
|---|---|---|
| Cidra | 64.2 | 35.8 |
| Cayey | 66.7 | 33.3 |
| Puerto Rico | 71.6 | 28.4 |

According to the Retail Census of Economic Activity, Cayey has more establishments with more sales than Cidra. Both municipalities have seen a decline in the number of establishments while retails sales have grown annually at 9.1 % in Cayey and 8.8 % in Cidra, reflecting the consolidation process that is taking place in the retail sector. Shopping centers located in large municipalities such as Caguas attract residents from smaller stores.

## 5.2. Study Area Location and Topography

The study area is located southeast of the urban area of Cidra, between the PR-7733 and PR-52, as shown in Figure 12. Figure 13 shows the study area in an aerial photo. The corridor is located in the Sud, Arenas and Beatriz Wards of Cidra and Vegas Ward in Cayey as shown in Figure 25 and is composed of mostly hilly topography. There are residential areas, pasture zones, forest and various rivers and streams. The study area includes the PR-734, PR-1 and PR-7787 roadways. Maximum elevation difference in this region is 170 m.

## 5.3. Land Use and Land Cover

As defined by 1991 Law for Autonomous Municipality, Cidra and Cayey are autonomous and phase III municipalities respectively. Cidra has its approved "Plan de Ordenamiento Territorial" (POT) and Cayey has its phase IV approved in November 2007 and is waiting for the Governor's Signature. Figure 26 shows land use for the area under study as defined on POT developed by Cidra and Cayey municipalities. Principals land uses are:

Developed Areas (AD) – Areas developed outside of the planned urban expansion zones.

Public Uses (P) – Area to be used for communal and public services.

Mixed Commercial and Residential Uses (CR-1, CR-3) – Area to be used for residential and commercial development.

Residential (R-0, R-1, R-3) – Residential areas.

Light Industrial (IL-1) – Areas to be used on light industrial uses.

Interior Forest (B-1) – Conservation zone with characteristics suitable for forestry activities and where the protection of soil and water resources is important.

Land Cover of the area as defined by the POTs of both municipalities is presented in Figure 27. Land cover classifications in the study area are:

Common Rustic Land (CRL) – Is the territory in rural areas were the urbanization process wasn't as strong as urban lands.

Especially Protected Rustic Land (EPRL) – Is the land that has special characteristics of high ecological or agricultural value and is identified for protection.

Urban Land (UL) – Developed land.

Planned Urban Land (PUL) – Land that will be urbanized the next four to eight years from the preparation of the land use map.

Most of the study area is classified as CRL.

There are several developments proposed along the proposed build alternatives corridors which are shown in Figure 28. These developments are in the process to obtain government permits. Major proposed developments are summarized on Table 5.3-1 and shown in Figure 28.

Table 5.3-1. Proposed Developments along the Build Alternatives Corridors.

| Name | Description |
|---|---|
| Spring Hills Development (2002-44-0985-JPU) | Propose the construction of 1,200 residential units with commercial, industrial and institutional areas in a parcel of 225 cdas. Located in Build Alternatives C-1, C-2 and C-3 corridors. |
| Parque Tecnológico (2004-70-0433-JPU) | Industrial project of six lots in a parcel of 199.5 cdas. Located at the end of Build Alternative C-5 corridor. |

## 5.4. Communities

There are various communities and sectors in the study area which are shown in Figure 29. Main communities are summarized on Table 5.4-1.

Table 5.4-1. Principal Comunities in the Study Area \a.

| Community | Description |
|---|---|
| Los Pinos and Martínez | 43 residences |
| Quintas Gloria | 25 residences |
| Montealban | 11 residences |
| Arenas | 55 residences |
| Sapera | 130 residences |
| Villa Carmen | 73 residences \b |

\a Description based on aerial photo and field visits.
\b Includes the residences near the project.

## 5.5. Existing Infrastructure

Transportation

The transportation system in study area is comprised of state and municipal roads. Municipal roads are widely used by residents to connect with state roads allowing the connection between Cidra and Cayey CBD, and with PRSHN. State roads in the study area are: PR-7733, PR-734, PR-7787, PR-1, PR-184 and PR-743. Figure 29 shows the road network in the study area, which is discussed in Section 5.1.4 .

Potable and Wastewater System

Figure 30 shows the potable and wastewater infrastructure in the study area. Build Alternative C-1 has a PRASA owned well named Sapera 1, which is currently out of service. The other build alternatives do not have PRASA wells or any other type of well identified in the USGS database. The nearest wells are Villa del Carmen and Río de la Plata intra-basing flow well at PR-7733, Sapera 1 well east of PR-7787, and Río Guavate 52 Hwy well south east of PR-52. Two PRASA water tanks (La Sapera and Arenas) are located at the fringe of the study area. Potable water pipelines in the area do not exceed 6" in diameter. Villa Carmen and part of the industrial zone near PR-7733 are the only communities with a PRASA sewerage system.

The principal source of potable water for Cidra municipality is Cidra Filtration Plant which has a capacity of 7 MGD.

Power and Electricity

PREPA has two power transmission rights-of-way that run through the study area. One runs south to north and has two power transmission lines: (1) line 50900 (230 kV) from Aguirre to Bayamon and (2) line 51000 (230 kV) from Aguirre to Sabana Llana. These lines are installed on

the same tower. The other line 37800 (115 kW) runs south west to north east from Cayey to Caguas. The right-of-way width for both the 230 kV and 115 kV power transmission lines are 100 feet (30.48 m). Smaller distribution lines (13 kV) which supply residences and commerce are also located in the study area. Figure 31 shows the major PREPA infrastructure located within the study area.

## 5.6. Soils

### 5.6.1. Agriculture and Farmlands

Evaluation of aerial historical photos (1937, 1962, 2007) show that the predominate land use in the study area was agricultural until 1960. In 1936 the area was deforested and was primarily planted with tobacco fields. From 1960 agricultural land use changed to rural residential area and pasture, associated with the decline of the local tobacco industry. Also, forest areas began to develop on abandoned fields.

Current land uses along the new road alternative corridors is predominately rural residential, secondary forest, and pasture zones. The largest farm in the study area is the Tres Monjitas Dairy. Figure 29 shows the location of Tres Monjitas Dairy. There are also small isolated areas with cultivation of bananas, plantains, oranges and ornamentals plants, as well as several hog farms.

### 5.6.2. Soils Classification

This section identifies soil characteristics in the area, as published by the Natural Resources Conservation Service. Figure 32 shows a soil classification map of the study area.

Aceitunas clay, 5 to 12 percent slopes (AaC) - This is a sloping, well drained soil on terraces and alluvial fans. Permeability and the available water capacity are moderate. Runoff is medium. It is difficult to work because of the stickiness and plasticity of the clay. Controlling erosion is the major concern of management. The soil is medium in natural fertility and has a deep root zone. This soil has been used for crops such as sugarcane, plantains, and taniers. It is suited to pangolagrass, stargrass, and Merker grass.

Caguabo clay loam, 40 to 60 percent slopes (CaF) - This is a very steep, well drained soil on side slopes and mountaintops of strongly dissected uplands. Permeability is moderate, and the available water capacity is low. Runoff is rapid, and erosion is a hazard. This soil is difficult to work because it is very steep and shallow. Hillside ditches and diversions are difficult to layout, establish and maintain. This soil is limited for most urban uses because is very steep, shallow and subject to landslides. If the soil is used a construction sites, development should by on the contour. The soil is fertile but has a shallow root zone. This soil has been used for tobacco and food crops such as sweet potatoes, bananas and coffee. It is best suited, however, to pangolagrass and stargrass. Also this soil is suited to Honduras pine and eucalyptus trees.

Caguabo-Rock outcrop complex, 40 to 60 percent slopes (CbF) – This complex consist of very steep, well drained soils and Rock outcrop on side slopes and narrow ridges. Permeability is moderate in the Caguabo soil, and the available water capacity is low. Surface runoff is very

rapid. This complex is poorly suited to most urban uses, mainly because of the very steep slopes and shallow depth to the volcanic rock. Most of the areas are subject to slides. Erosion is a severe hazard in areas not protected by vegetative cover. The vegetation is shrubs, brush, and grass. This complex is not suited to cultivated crops. The potential for pasture is low. In unlimed areas the soil is slightly acid.

Consumo clay, 40 to 60 percent slopes (CuE) – This is a very steep, well drained soil on side slopes at maturely dissected humid upland. Permeability and the available water capacity are moderate. Runoff is very rapid, and erosion is a hazard. Slippage is common in road banks ditches, and drainage ways. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for crops such as coffee. It is suited to pangolagrass and to molasses grass.

Daguey clay, 12 to 20 percent slopes (DaD) – This is a moderately steep, well drained soil on stable side slopes, ridge tops, and foot slopes of humid volcanic uplands. Permeability and the available water capacity are moderate. Runoff is rapid, and erosion is a hazard. This soil is difficult to work because of the stickiness and plasticity of the clay. This soil is limited for most urban uses because is very steep and subject to landslides. The root zone is deep. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for plantains, yams, taniers, and coffee. It is suited to pangolagrass and Merker grass.

Humatas clay, 20 to 40 percent slopes (HtE) – This is a steep, well drained soil on side slopes and ridge tops of strongly dissected humid uplands. Permeability and available water are moderate. Runoff is rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. It is limited for most urban uses because is very steep and subject to landslides. The root zone is deep. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for crops such as tainers, plantains, yams, tobacco, and coffee. It is suited to pangolagras and Merker grass.

Humatas clay, 40 to 60 percent slopes (HtF) - This is a very steep, well drained soil on side slopes and ridge tops of strongly dissected humid uplands. Permeability and the available water capacity are moderate. Runoff is rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainages ways. This soil is difficult to work because it is very steep and because of the stickiness and plasticity of the clay. This soil is limited for most urban uses because is very steep and subject to landslides. If the soil is used a construction sites, development should by on the contour. The root zone is deep. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for crops such as tainers, plantains, yams, tobacco, and coffee. It is suited to pangolagras and Merker grass.

Mabi clay, 2 to 5 percent slopes (MaB) – This is a gently sloping, somewhat poorly drained soil on alluvial fans and terraces above the river flood plains. Permeability is slow, and the available water capacity is high. Runoff is slow. This soil is difficult to work because of the stickiness and plasticity of the clay. This soil is limited for most urban uses because of the high shrink-swell potential and the flood hazard. The root zone is deep. Natural fertility is high. Crops respond well

to heavy applications of fertilizers. This soil has been used for sugarcane. It is suited to pangolagrass, improved bermudagrass, and Merker grass.

Mabi clay, 5 to 12 percent slopes (MaC) – This is a sloping, somewhat poorly drained soil on alluvial fans and terraces above the river flood plains. Permeability is slow, and the available water capacity is high. Runoff is slow. This soil is difficult to work because of the stickiness and plasticity of the clay. This soil is limited for most urban uses because of the high shrink-swell potential and the flood hazard. The root zone is deep. Natural fertility is high. Crops respond well to heavy applications of fertilizers. This soil has been used for sugarcane. It is suited to pangolagrass, improved bermudagrass, and Merker grass.

Mucara clay, 12 to 20 percent slopes (MxD) – This is a moderately steep, well drained soil on foot slopes, side slopes, and rounded hilltops of strongly dissected uplands. Permeability and the available water capacity are moderate. Runoff is rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. This soil is limited for most urban uses because it is moderately steep. The root zone is moderately deep. This soil is fertile. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for crops as coffee, tainers, plantains, and pigeon peas. It is suited to pangolagrass and Merker grass.

Mucara clay, 20 to 40 percent slopes (MxE) – This is a steep, well drained soil on side slopes and rounded hilltops of strongly dissected uplands. Permeability is moderate, and the available water capacity is low. Runoff is very rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. This soil is limited for most urban uses because it is steep and is shallow rock. The root zone is moderately deep. This soil is fertile. This soil has been in brush and brushy pasture. It is suited to pangolagrass.

Mucara clay, 40 to 60 percent slopes (MxF) – This is a very steep, well drained soil on side slopes and rounded hilltops of strongly dissected uplands. Permeability is moderate, and the available water capacity is low. Runoff is very rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. This soil is limited for most urban uses because it is steep and is shallow rock. Hillside ditches and diversions are difficult to layout, establish and maintain. The root zone is moderately deep. This soil is fertile. This soil has been in brush and brushy pasture. It is suited to pangolagrass.

Naranjito silty clay loam, 20 to 40 percent slopes, eroded. (NaE2) – This is a steep, well drained soil on strongly dissected uplands. Permeability is moderate, and the available water capacity is low. Runoff is rapid and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. It is limited for most urban uses because it is steep and is subject to landslides. The root zone is moderately deep. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been in brush and brushy pasture. It is suited to pangolagrass.

Naranjito silty clay loam, 40 to 60 percent slopes, erode (NaF2) – This is a very steep, well drained soil on strongly dissected uplands. Permeability is moderate, and the available water capacity is low. Runoff is rapid and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. It is limited for most urban uses because it is steep and is subject to

landslides. The root zone is moderately deep. Natural fertility is medium. This soil has been in brush and brushy pasture. It is suited to pangolagrass.

Rio Arriba clay, 2 to 5 percent slopes (RoB) – This is a gently sloping, moderately well drained soil on alluvial fans and terraces above the river flood plains. Permeability is moderately slow, and the available water capacity is high. Runoff is medium, and erosion is a hazard. It is limited for most urban uses because of its clayey nature, slow permeability, high shrink-swell potential and flood hazard. The root zone is deep. Natural fertility is medium. Crops respond well to heavy applications of lime and fertilizers. This soil has been used for sugarcane. It is suited to pangolagrass, improved bermudagrass, Para grass, and bermudagrass.

Rio Arriba clay, 5 to 12 percent slopes, eroded (RoC2) – This is a sloping, moderately well drained soil on alluvial fans and terraces above the river flood plains. This soil has lost much of the surface layer through erosion. Permeability is moderately slow, and the available water capacity is high. Runoff is rapid and erosion is a hazard. It is limited for most urban uses because of its clayey nature, slow permeability, high shrink-swell potential and flood hazard. The root zone is deep. Natural fertility is medium. Crops respond well to lime and fertilizers. This soil has been used for sugarcane. It is suited to pangolagrass, improved bermudagrass, paragrass, and bermudagrass.

Sabana silty clay loam, 40 to 60 percent slopes (SaF) – This is a very steep, well drained soil on side slopes and tops of humid volcanic uplands. Permeability is moderate, and the available water capacity is low. Runoff is rapid, and erosion is a hazard. Slippage is common in road banks, ditches, and drainage ways. It is limited for most urban uses because it is steep and is subject to landslides. The root zone is shallow. Natural fertility is medium. This soil has been in brush and brushy pasture most of the time. It is suited to pangolagrass.

Toa silty clay loam (To) – This is a nearly level, moderately well drained soil on flood plains. Permeability and the available water capacity are moderate. This soil is easy to work. This soil is limited for most urban uses because of the flood hazard, its clayey nature, and low strength. The root zone is deep. Natural fertility is high. Crops respond well to applications of lime and fertilizers. This soil has been used for sugarcane. It is suited to pangolagrass and Merker grass.

## 5.7. Geology and Geotechnical Characteristics

This section describes in general the geology and geotechnical characteristics of the soil and rocks along the proposed build alternatives. A General Geology and Geotechnical Study was prepared and is included in Appendix F. Evaluation was performed based on maps prepared by the USGS, aerial photos and field visits. Figure 33 shows the general geology at the study area.

Most of the rocks that underlie the build alternatives corridors are Formation J of Cretaceous age (Kj) Near Cidra CBD, sections of the corridors crosses formation TKhv that is identified as rocks that were hydrothermally altered between late Cretaceous and early Tertiary time. Corridors cross Quaternary terrace deposits (Qt) along Quebrada Beatriz and Río Guavate. General geology description of formations is summarized in Table 5.7-1.

Table 5.7-1 General Geologic Characteristics.

| Formation | Characteristics |
|---|---|
| Kj | Consist of mostly massive beds of volcanic breccia and lava flows with subordinate volcanic tuff and conglomerate and minor fine-grained volcaniclastic rock. |
| TKhv | Rock types are like Kj with the exception that hot magmatic fluids once baked the rock altering its mineralogical constituents and physical character. Compare with Kj is more soil-like than rock-like. |
| Qt | Unconsolidated sand, gravel and silt including large cobbles and boulders of volcanic rocks. |

Source: Geologic map of Caguas and Comerío quadrangles, USGS, San Juan.

Formation TKhv is located at the beginning of each build alternative corridor where they have a common alignment near Cidra CBD, and also along approximately 1 km of build alternative C-1 corridor. Kj underlies most of the study area and is present in all five build alternatives corridors. It is possible that the contact between the Kj and TKhv units is more irregular than shown by the USGS map. Qt is located at the end of all build alternatives corridors.

The USGS geologic map shows several geologic faults in the northwest portion of the study area; all are identified as showing strike-slip relative displacement. The largest fault is the east-northeast trending Río Arroyata Fault which crosses the northwest tip of build alternative C-1. Four smaller, northwest to north-northeast trending faults are shown crossing all alternative corridors where they have a common alignment near Cidra CBD. All the faults are old features (about 23 million years ago, prior to the Oligocene epoch of the Paleogene geological period) and are considered to be inactive.

Five places, where the surface topography suggests small landslides, were observed on the 1937 and 1962 aerial photographs. These areas are shown in Figure 20. Almost the entire build alternatives corridors are classified by the Puerto Rico Planning Board as an area with moderate susceptibility to land sliding.

## 5.8. Noise

Noise is defined as a sound which causes annoyance to the persons who perceive it. Sound is the sensation produced in the hearing organs when waves are created in the surrounding air by a vibrational disturbance created by a compressional wave which radiates spherically outward from the source. Sound level decreases as it gets further and further away from its source. If an obstacle or barrier is placed in the path of a vibrational wave, a portion will be reflected, another portion may be absorbed by it, and another may be transmitted through it. The most commonly used measure of noise levels is a weighted sound level on the decibel scale (dBA), which is a scale reflecting the frequency response of the human ear.

Environmental noises vary over time, with both quiet moments and peak levels resulting from noise sources. In assessing noise levels three main factors are considered: the magnitude of the loudest noise, the repetitiveness of the loudest noise, and the continuous nature of the noise. An equivalent sound level descriptor ($L_{eq}$), which is based on the average sound intensity over time,

combines these three factors. The $L_{eq}$ is equal to the equivalent steady noise level which, in a stated time period, would contain the same energy as the time varying noise during the same time period.

### 5.8.1. Existing Environment Noise Levels

Existing noise levels along the proposed build alternatives were measured during October 8-9, 2008 to document the existing ambient noise conditions (refers to Appendix G). Eight representative noise monitoring stations were selected for characterizing existing noise levels. The following criteria were selected to identify these measurement sites:

Land Use – The analysis were performed at locations representative of the different land uses within the study area. Land uses along the corridors are mostly homogenous. According to the FHWA Noise Abatement Criteria (NAC), developed by the FHWA, the build alternatives corridors are located in Land Use B with a maximum $L_{eq}$ of 67 dBA during one hour. Land Use B includes activities such: picnic areas, recreation areas, playground, active sports areas, parks, residences, motels, hotels, school, churches, libraries, and hospitals.

All surveyed sites are located within a 152 m (500 ft) fringe measured from the edge of the proposed road. Conceptual design drawings were used to define the location of the road edge in each alternative.

Figure 34 shows the location of the noise monitoring stations. Noise surveys were conducted during one (1) hour at each site. Table 5.8-1 shows noise survey results. Surveyed receptors experience noise levels below the NAC levels for Land Use B Category.

Table 5.8-1 Measured Noise Levels ($L_{eq}$ hr).

| Monitoring Station | Decibel Level (dBA) | Receptor |
|---|---|---|
| 1 | 43.8 | Villas de Monteverde (residential development, local access) |
| 2 | 41.1 | Hacienda Las Mercedes (residential development, local access road) |
| 3 | 45.7 | Brisas de Monticello (residential lots, local access road) |
| 4 | 47.0 | Sapera Community (agriculture uses) |
| 5 | 54.5 | Hacienda Las Cecilias |
| 6 | 54.6 | Colinas de Monticello (near Monticello Activity Center) |
| 7 | 51.6 | Los Pinos Sector, Quebrada Arenas Ward (residential area) |
| 8 | 51.2 | Estancias de Monte Rio (residential development) |

## 5.9. Air Quality

National Ambient Air Quality Standards (NAAQS) are promulgated by the US Environmental Protection Agency (EPA) as required by the Clean Air Act (CAA) as amended in 1990. Two types of standards were established: Primary Standards set limits to maintain public health and protect the most sensitive groups; and Secondary Standards set limits to protect public well-being with regards to matters such human comfort and damage to animals, crops and buildings. The Clean Air Act requires each state to develop a State Implementation Plan (SIP) to determine how the state will enforce the Act. The PREQB incorporated the NAAQS in the Regulation for the Control of Atmospheric Pollution. The government of Puerto Rico's State Implementation Plan defines the three classes of air quality shown in Table 5.9-1, and designates the Island as Class II.

Table 5.9-1 Puerto Rico SIP Classification of Air Quality.

| Class | Description |
|---|---|
| I | Increments permits allowing only minor air quality deterioration. Applies to areas where any change in air quality would be considered a significant impact. |
| II | Increments permit moderate air quality deterioration. Applies to areas where deterioration in air quality that normally accompanies moderate and orderly growth would not be considered significant. |
| III | Increments permits with the most deterioration, as long as the applicable NAAQS is not violated. Applicable in areas in which deterioration up to the standard would not be considered a significant impact. |

The PREQB operates air monitoring stations in Puerto Rico. The nearest station to project area is located in Caguas, about 13 km from the study area, and only monitors particlate matter. Maximum carbon monoxide measured in the island was 2.07 ppm during 1 hour. This value was measured at EQB Station No. 30 located in the San Juan Metropolitan area.

The study area is rural with mostly of hilly topography. A cement industry located at PR-734 (km. 2.7) is the only possible point source emission near the study area. This industry has EQB permits to operate and its potential emissions consist principally of particulate matter. Based on the available information it is determined that the study area does not exceed the NAAQS, and that air quality in the area is acceptable. The area is in attainment/maintenance for all pollutants indicated in the NAAQS.

## 5.10. Historic and Archaeological Resources

The National Historic Preservation Act (NHPA), as amended, established the National Register of Historic Places (NRHP) and created the Advisory Council on Historic Preservation (ACHP). Under Section 106 of the NHPA, federal agencies are responsible for identifying listed or eligible properties or sites and for assessing the effects of the agencies actions on them. The procedures

implementing Section 106 are set forth in regulation issued by the ACHP; Section 36 CFR, Part 800.

### 5.10.1. Historic Resources

Historic resources are those structures, objects and sites that are included, or eligible for inclusion, on the NRHP. The municipality of Cidra does not have properties registered in the NRHP. Cayey has 4 registered properties, but none are located within any of the alternative road corridors. No properties are listed in the Planning Board's "Listado de Sitios y Zonas Históricas". The State Historic Preservation Office (SHPO) and Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico files were consulted and no historic resources are identified within the build alternatives corridors.

### 5.10.2. Archaeological Resources

Archaeological Resources are those sites consisting of deposits of cultural materials and features resulting from human manufacture, occupation, or habitation that are listed or are eligible for inclusion in the NRHP. Archaeological Phase 1A and 1B studies were performed along the build alternatives corridors and are included in Appendix H. The Phase 1A study consisted of three basic tasks: a literature search, environment evaluation, and a walk-over survey to assess the potential for archeological sites to be present within the study area. The Phase 1B study included an archaeological survey and data collection by the excavation of test holes to a depth ranging from 0.1 m to 1.65 m that allows the examination of natural soil stratigraphy. The excavated soil is screened to recover any cultural material.

The research parameters for Phase 1A and 1B studies are based on the guidelines established by the State Historic Preservation Office (1993) and the Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico (1992). The studies comply with federal and state laws (Section 106 of the NHPA, as amended; Section 36 CFR, Part 800 of the Federal Register; and Law 112 of July 20, 1988), which require and regulate the protection of cultural resources.

Phase 1A Study

The SHPO and Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico files were investigated to determine if there are existing reported archeological sites along the build alternatives corridors. According to the regional quadrangles and the registered site forms, no archaeological cultural resources were identified within any build alternatives corridors. However, archaeological investigations executed in the build alternatives corridors did identify cultural resources.

The build alternatives corridors were classified as "high sensitivity" areas relative to the presence of cultural resources based on good soil fertility, an abundance of water in streams, rainfall appropriate for agriculture activities, archaeological documentation, physical rural integrity and information provided by residents. Field investigations were carried from the latter part of 2007 into early 2008. Field investigation evaluated previously identified and newly identified cultural

resources. Fifteen cultural resources were identified during field inspection, as located in Figure 35. The cultural resources can be grouped by sites:

Cerro del Bohique – Grouping of sections that possibly formed part of a single settlement associated with the pre-Columbian agro-ceramic aboriginal past, particularly the post-Saladoid cultural sequence (600-1492 A.D.) This site is located in Build Alternatives corridors C-1 and C-2. Four resources were find:

Piedra Hueca – This site is defined by the presence of large rocks grouped in a specific sector. There is the possibility of human burial (or dislocated human bones) in this area. Remnants of a residuary with ceramics fragments.

Stone Circle – Group of large rocks arranged (plan view) approximately in a circle.

Destroyed Batey - Remnants of an impacted batey.

Midden Section – Residuary with ceramic fragments discernible at an existing cut in the terrain.

Impacted Batey – A previously impacted batey is located in Build Alternative C-1 corridor, and an engraved rock (petroglyph) was identified during the inspection. As a preliminary estimate, this resource could potentially correspond to the cultural subseries Ostionan-Ostionoid (Ostiones), Elenan-Ostionoid (Santa Elena), and Chican-Ostionoid (Taíno), corresponding to Periods III-a (600-900 A.D.) and IV-a (1200-1492 A.D.).

Ceremonial Plaza and La Piedra Hueca – The Ceremonial Plaza consists of a stone circle with the presence of some in situ monoliths, one of them having a single petroglyph. Located at the edge of Build Alternative C- 1 corridor. Preliminary indications associate this with the Taíno culture (1200-1500 AD). La Piedra Hueca consists of large overlapping boulders which create a cavity.

Stone Grouping – Three groupings of individual boulders on the top of a hill (Stone Grouping 1, 2 and 3), located in Alternatives C-1 and C-2 corridors. Two lithic artifacts were recovered near Stone Groping 1. Small non-diagnostic ceramic sherds were identified amongst Groping 2 and 3. Characteristics of the ceramics sherds associate these areas with the Esperanza style of the Chican Ostionoid subseries (Taíno culture, 1200-1500 AD).

Heterogeneous finds – These constitutes diverse cultural resources associated with pre-Columbian past.

Impacted midden (H-1) - Disturbed artifacts were founded. Located at Build Alternatives C- 4 and C – 5 corridors.

Boulder Configurations (H-2) – Located at the build alternatives corridors, north of Star Mix Cement factory.

Possible midden (H-3) – Located at Build Alternatives corridors C- 3, C-4 and C-5. Shallow test pit uncovered charcoal and undecorated ceramics of aboriginal appearance.

Isolated find (H-4) - Located at Build Alternatives corridors C-3, C-4 and C-5. A single undecorated fragment of aboriginal appearance was found.

Lithic artifacts (H-5) - Located at Build Alternatives corridors C-3, C-4 and C-5. Found rocks that show artificial carving work, very similar to that of primitive archaic groups.

Lithic artifacts (H-6) - Located at Build Alternatives corridors C-3, C-4 and C-5. Lithic artifacts were found.

Lithic artifacts (H-7) –. Lithic artifacts were also found outside of the build alternatives corridors.

Phase 1A findings were used to determine the actions executed at each resource, as summarized in Table 5.10-1. The floodplain of Río Guavate associated with Build Alternative C-5 was also identified as a sector with potential for the existence of cultural resources; therefore a Phase 1B study was performed in the area.

Table 5.10-1 Cultural Resource Actions Executed based in Phase 1-A Study findings.

| Cultural Resource | Action a/ |
|---|---|
| Cerro del Bohique | |
| Piedra Hueca | Avoid Impact. |
| Stone Circle | Phase 1B Study. |
| Destroyed Batey | Documentation Finalized |
| Midden Section | Phase 1B Study. |
| Previously Impacted Batey | Phase 1B Study. |
| Ceremonial Plaza and La Piedra Hueca | Avoid Impact. |
| Stone Groupings (1, 2, 3) | Phase 1B Study. |
| Heterogeneous finds | |
| H-1 | Documentation Finalized |
| H-2 | Phase 1B Study. |
| H-3 | Phase 1B Study. |
| H-4 | Phase 1B Study. |
| H-5 | Documentation Finalized |
| H-6 | Documentation Finalized |
| H-7 | Phase 1B Study. |

a/ Refers to the activities performed as part of the environmental evaluation process.

Phase 1B Study

A Phase 1B study was executed at the cultural resource sites identified in Phase 1A. During execution of the Phase 1B study new cultural resources were identified on the Río Guavate floodplain. A pre-Columbian residuary and colonial residuary were identified in the area (refer to Figure 35). Cultural findings are summarized below:

Pre-Columbian – Located at Alternative C-5. Small non-diagnostic ceramics sherds were identified at the residuary. Characteristics of the ceramics findings associate the area with the Esperanza and Capá style of the Chican Ostionoid subseries (Taíno Culture, 1200-1500 AD).

Colonial – Located at Build Alternative C-5 corridor. Raw material (carbon stones), construction materials (bricks), metals (nails and screws) and glass bottles were identified at the residuary. These findings associate the area with the fist half of XIX century (Spanish Colonial Period, 1800-1850 AD).

Phase 1B findings were used to determine the actions to be executed at each archaeological resource, as summarized in Table 5.10-2.

Table 5.10-2 Cultural Resource Actions Identified in Phase 1-B Study.

| Cultural Resource | Action a/ |
|---|---|
| Cerro del Bohique | |
| a. Piedra Hueca | Avoid Impact. |
| b. Stone Circle | Avoid Impact |
| c. Destroyed Batey | Documentation Finalized |
| d. Midden Section | Phase II Study. b/ |
| Impacted Batey | Phase II Study. b/ |
| Ceremonial Plaza and La Piedra Hueca | Avoid Impact. |
| Stone Groupings (1, 2, 3) | Phase II Study for stone grouping 2 and 3. b/ |
| Heterogeneous finds | |
| a. H-1 | Documentation Finalized |
| b. H-2 | Documentation Finalized |
| c. H-3 | Phase II Study. b/ |
| d. H-4 | Documentation Finalized |
| e. H-5 | Documentation Finalized |
| f. H-6 | Documentation Finalized |
| g. H-7 | Phase II Study. b/ |
| Río Guavate Floodplain Residuary | |
| a. Pre-Columbian | Phase II Study. b/ |
| b. Colonial | Phase II Study. b/ |

a/ Refers to the activities performed as part of the environmental evaluation process or recommendations based on Phase 1B findings.
b/ Phase II studies will be conducted if an archaeological site will be affected by the preferred alternative.

## 5.11. Parkland

There is one public recreational park, the Sapara Recreational facility, which falls within the study area, located at the fringe of Build Alternative C-1 and east of PR-7787, and consisting of a baseball field and a basketball court located in Sapera community. Figure 29 shows the location of recreational facilities. A private area, Cerro del Bohíque, contains cultural resources and is used by a group called "neo-taínos" to perform cultural rituals. It is located within and along the fringes of Build Alternatives C-1 and C-2, as also shown in Figure 29.

## 5.12. Water Resources

The Clean Water Act (CWA), as amended, is the primary federal law governing water pollution. The act establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The law established the responsibility of the federal government agencies, specifically the EPA, for managing the Water Pollution Control Program. In Puerto Rico the Environmental Quality Board is the agency authorized by law to preserve and protect water quality.

### 5.12.1. Surface Waters

Rivers and streams in the study area are shown in Figure 36. The principal streams are: Río Guavate, Río Bayamón, Río Sabana, Río Clavijo and Quebrada Beatriz. None of these have a potable water intake in the study area. However, all of these drain into water bodies used as sources of potable waters: Quebrada Beatriz and Río Guavate drain toward Río La Plata, which has several potable water intakes including the La Plata Reservoir; Río Clavijo and Río Bayamón drain into Cidra Reservoir which supplies water to Cidra and Aguas Buena municipalities. Potential existing sources of water pollutants in the alternative corridors consist of non-point sources including agricultural activities including dairy farming, possible drainage from unsewered houses and commercial buildings, and runoff from roads and other impervious areas.

### 5.12.2. Ground Waters

The study area has two types of aquifers as shown in Figure 38. General characteristics of these aquifers are summarized below.

Alluvial Valley Aquifers – Alluvial aquifers are generally located in the floodplains of streams and consist of the unconsolidated river alluvium that fills bedrock valleys. Aquifers materials are predominantly sand and gravel interlayered silt and clay. These aquifers are unconfined, are hydraulically connected to their adjacent streams. In the study area this type of aquifers is found along Río Guavate and Quebrada Beatriz pathway.

Volcaniclastic-, igneous-, and sedimentary-rock aquifers – The volcanoclastic rocks in the island's are intensely faulted and folded. The volcanic rocks have been intruded in places by plutonic rocks, such as granodiorite, quartz diorite, and serpentinized peridotite. The volcaniclastic rocks generally poorly permeable, but where rainfall is significant, these rocks store and transmit water in fractures and other secondary openings. These rocks generally yield less than 10 gallons per

minute to wells, especially in the areas intruded by plutonic rocks. However, where wells penetrate weathered intrusive rocks, they may yield moderate to large quantities of water to wells. (Perry G. 1999).

Both PRASA records and the USGS well inventory were reviewed to determine how many wells are located within 400 m of the new road corridors. The identified wells are described in Table 5.12-1 and are located in Figure 38. The three PRASA wells previously provided potable water to the community, but were closed when PRASA began to supply the zone with water from Carite reservoir.

Table 5.12-1. Water Wells near the Study Area.

| Name | Flow (gpm) | Depth (ft) | Geologic Formation | Owner |
|---|---|---|---|---|
| Sector Sapera 1 | 150 | 168 | Rock | PRASA |
| Sector Sapera 2 | 80 | 380 | Weathered Rock | PRASA |
| Sector Sapera 3 | 50 | 200 | - | PRASA |
| La Central | - | - | - | Private |

Note: All wells are now closed.
Source: PRASA and USGS well inventory

### 5.12.3. Floodplains

Río Guavate is the only water body in which the floodplain and floodway were delimited by the Federal Emergency Management Agency (FEMA) and the Puerto Rico Planning Board (PRPB).

A floodplain is defined as a land area susceptible to being inundated by flood waters from any source. The PRPB is the government agencies authorized by law to manage and enforce regulations covering floodplain management in Puerto Rico. Their regulations are based in Federal Emergency and Management (FEMA) guidelines. The study area has three types of flood classifications per FEMA:

Zone AE – Located at the end of Build Alternative C-5. Zone AE is a flood insurance rate zone that will be inundated by the 1-percent annual chance (100-yrar) event, as determined in the Flood Insurance Study by a detailed analysis method.

0.2 PCT Annual Chance Flood Hazard - Located at the end of Build Alternatives C-5 plain of the study area. This zone has the 0.2 % of annual chance flood hazard.

Zone X – Located in the remaining portion of study area, Zone X corresponds to a flood insurance zones that lies outside of any identified flood zone. However, this does not guarantee that this land will not flood because FEMA does not examine all flooding sources.

Figure 37 shows a portion of the FEMA FIRM map panels 1195H, and 1215H dated April 19, 2005, where the build alternatives corridors are located.

## 5.13. Wetlands

Under the Section 404 of the Clean Water Act (CWA), the United State Army Corps of Engineers (USACE) regulates the discharge of dredge or fill material into waters of the United State. Waters of the United States includes, but is not limited to, all coastal and inland waters, lakes, tributaries to navigable waters, wetlands and water bodies. A wetland is defined in Section 404 of CWA as:

"Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

The study area is not included on the United States Fish and Wildlife Service National Wetland Inventory (NWI) maps. However a preliminary evaluation of the aerial photos and topographic maps indicate that the study area fringe is mainly composed of riverine or riparian systems (refer to Figure 36). A Wetland Jurisdictional Determination (JD) was prepared and is included in Appendix I. The JD includes:

A jurisdictional delineation of the wetlands along the five road alternatives corridors.

A qualitative and quantitative description of the wetlands plant composition, soils and hydrology.

An evaluation of the wetlands functional values.

A complete Level 1 and 2 Routine Evaluation was conducted at the study fringe of the five build alternatives to determine the precise delimitation of all wetland located within project boundaries, as required by the 1987 Army Corps of Engineers Wetland Delimitation Manual. Based on the Corps of Engineers Wetland Delineation Manual (1987), for an area to be considered a wetland a positive identification of three environmental parameters must be observed:

Wetland hydrology - An area with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soil due to anaerobic and reducing conditions, respectively. Such characteristics are usually present in areas that are inundated or have soils that are saturated to the surface for sufficient duration to develop hydric soils and support vegetation typically adapted for life in periodically anaerobic soil condition.

Hydric soils - Is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Only hydric when hydric soil support hydrophytic vegetation and the area has indicator of wetland hydrology may the soil be refferend to as a "Wetland" soil.

Hydrophytic vegetation - Hydrophytic vegetation is defined as the total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present.

Delineation along the studied area was performed using the following procedure:

Sixty-two (62) transects with a length of 50 meters were established in the study area. Each transect has four sampling sites with a diameter of 5 m. Soil and hydrologic data were collected from an 18 in. deep by 6 in. wide soil-bore hole at each sampling site. Vegetation was identified at each sampling site. Sampling sites and delineation were located using sub-meter GPS.

Computerized (ERDAS Imagine) analysis of high resolution aerial photograph classification system developed by Cowardin et. al. (1979) and remote sensing techniques were used to complete the delineation, which was complemented with field survey using sub-meter GPS.

All geographical data were processed using ArcGIS 9.2 and the imagery was analyzed using ERDAS Imagine 8.7.

The study fringe contains natural hydrographical features including rivers, channels, creeks, lagoons, ponds and riparian gallery forests. The US Soil Conservation Service classifies the soils in the study fringe as non-hydric soils. Vegetation along the study fringe is diverse in composition and structure. Plant species along the study fringe includes Spathodea, Tabebuia, Andira, Bambusa, Eugenia, Cassi, Albizzia, Casearia, Erythrina, Zanthoxylum and Syzigium among trees. Other herbaceous species includes, Mimosa, Collocasia, Pennisetum, Paspalum, Panicum, Andropogon, Brachiaria, Ipomea, Merremia, Allocasia, Ludwigia, Solanum and Cissus among others.

Table 5.13-1 shows the total area of wetlands per build alternative study fringe. Figure 39 shows the delineation of all wetlands in the study area. The fraction of these wetlands which could be impacted under each alternative is presented in section 6.10.

Table 5.13-1. Total Wetland Area Identified Within Each Alternative Corridor.

| | C-1 | C-2 | C-3 | C-4 | C-5 |
|---|---|---|---|---|---|
| Area (acres) | 41.07 | 38.21 | 38.50 | 31.58 | 61.89 |

Note: Wetland impacts, which are less than the total wetland area, are given in Table 6.10-1.

## 5.14. Biological Assessment

A Biological Assessment was prepared to assess the effects of the construction of a new roadway on federally and locally protected biotic resources along the alternative road corridors (refers to Appendix J). The Biological Assessment followed the guidelines established by the US Fish and Wildlife Service (USFWS) and included: (1) coordination with regulatory agencies like Puerto Rico Department of Environmental and Natural Resources (PRDNER) and USFWS; (2) evaluation of existing literature and publications of government agencies; (3) field surveys; and (4) evaluation of potential effects of the construction of a new road on wildlife.

Before initiating the field surveys, communication was established with the PRENRD and the USFWS. They indicated that their primary concern is with the Puerto Rican plain pigeon, *Patagioenas inornata wetmorei* (“Paloma Sabaneara”). Two letters from the USFWS to the PRHTA (08/15/07) and to the FHWA (04/14/07) were evaluated (refer to Appendix R).

Government publications were also analyzed to obtain preliminary information on topography, land use, protected areas, critical wildlife elements, plant communities, rivers and creeks. High resolution orthorectified aerial photos (2005 and 2007) were used during the assessment. Vegetation and animal surveys were performed from November 1, 2007 to March 5, 2008. The five build alternatives were divided into segments approximately 1.2 km in length, and observation points were established in each segment. Figure 40 shows the 29 observations points.

### 5.14.1. Land Cover

Field observations and aerial photo interpretation indicate that the build alternative corridors can be divided into at least eleven primary land cover categories, as described below.

Gallery Forest - Gallery Forests are a type of secondary forest found adjacent to rivers and creeks. It may also be classified as riverine forest. The mean tree height is 10 m and species diversity is moderate. This land is along of all build alternatives.

Secondary Forest - This is the most common habitat on the study site. Most of the Secondary Forests are found on the steeper portions of the hills and adjacent to the Gallery Forests, on soils less appropriate for urban development, crops or pastures. The western and southern portions of the study area have more Secondary Forests. This land is along of all build alternatives.

Albizia Woodland – Albizia woodlands are scarce throughout the study site, and the only uniform stands were found on the grassy plains west of PR-52 on Build Alternatives C- 4 and C- 5. Build Alternatives C-4 has the highest area of Albizia Woodland (1.9 acres). Build Alternatives C-1, C-2 and C-3 do not have Albizia Woodlands, although there are scattered *Albizia procera* trees, especially in grasslands and scrublands.

Caribbean Pine Forest - There are various Caribbean Pine Forests stands, especially on the western portion of the study site. The largest one is east of PR-7733 on the first segment were all alternatives start. There are other smaller stands along build alternative Corridors C-1 and C-2. Individual tress of *Pinus caribaea* are also scattered along all build alternatives.

Scrubland – Along with grasslands, scrublands are one of the most abundant habitat type found in the study area. There are different kinds of scrublands with different dominant species, the two principal types being the guava- and the Miconia- dominated scrublands.

Grassland - Grasslands constitute the second-most abundant habitat type found in the study area, and is found in different size patches in all five build alternatives corridors. Some are used as pastures but are not actively managed like the pasturelands, and they contain a variety of native and exotic grass species. Grasslands are the first community in a succession stage that developes into secondary and gallery forests. This land is along of all build alternatives

Cropland - There is no large-scale row crop production in the study area. Most crops consist of small, isolated plantings of banana, plantain, oranges or ornamentals cultivars. Many

residents have small plots (< 2 acres) planted with crops for their consumption or to sell in a small scale. This land is along of all build alternatives

Pastureland - Pasturelands are grasslands managed to provide feed to cattle. The principal pastureland is found in the western portion of Build Alternative Corridor C-1.

Wetlands - Due to the topography, herbaceous wetlands are not a common habitat at the study site. The vegetation of rivers floodplains consists primarily of gallery forest. Build Alternative Corridor C-3 has the most wetland area (3.2 acres), and Build Alternative Corridor C-1 has the least (1.6 acres), excluding the area of rivers which are covered on Section 5.12.1.

Urban Development – This area includes all construction, and in residential areas includes both the house and the patio area. Build Alternative Corridor C-4 has the most area covered with Urban Development (96 acres) and Build Alternatives Corridors C-1 and C-2 have the least (both have approximately 62 acres).

Bamboo Stands - Bamboo stands are common along the river banks, especially in the lower portions of the study site west of PR-52 and PR-1. Along all build alternatives, except Build Alternative C-3.

Figure 40 maps the vegetation in each of the 5 build alternatives corridors. Table 5.14-1 summarizes the acreage of each land cover type.

Table 5.14-1 Land Cover in each Corridor

| Cover | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Gallery Forest | 83.2 | 12.7 | 92.2 | 13.1 | 91.7 | 13.4 | 53.3 | 8.6 | 53.2 | 8.2 |
| Secondary Forest | 209.9 | 32.1 | 239.7 | 34.2 | 257.4 | 37.6 | 201.7 | 32.5 | 197.9 | 30.4 |
| Albizia Woodland | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.3 | 1.9 | 0.3 |
| Pine Forest | 16.6 | 2.5 | 16.6 | 2.4 | 15.5 | 2.3 | 13.5 | 2.2 | 13.5 | 2.0 |
| Scrubland | 50.0 | 7.7 | 71.9 | 10.3 | 77.9 | 11.4 | 96.4 | 15.5 | 110.7 | 17.0 |
| Grassland | 149.6 | 22.9 | 132.4 | 18.9 | 153.8 | 22.4 | 115.0 | 18.6 | 161.7 | 24.8 |
| Cropland | 4.3 | 0.7 | 8.3 | 1.2 | 8.6 | 1.3 | 4.3 | 0.7 | 4.3 | 0.7 |
| Pastureland | 72.4 | 11.1 | 72.4 | 10.3 | 3.9 | 0.6 | 26.9 | 4.3 | 5.6 | 0.9 |
| Wetland a/ | 1.6 | 0.2 | 2.1 | 0.3 | 3.2 | 0.5 | 1.9 | 0.3 | 1.9 | 0.3 |
| Urban | 62.4 | 9.5 | 62.3 | 8.9 | 73.0 | 10.7 | 95.9 | 15.5 | 79.0 | 12.1 |
| Bamboo | 3.7 | 0.6 | 3.7 | 0.5 | 0.0 | 0.0 | 9.3 | 1.5 | 21.2 | 3.3 |

a/ Excluding rivers.

### 5.14.2. Fauna and Flora

All the species found at the study area are common native or introduced species. No critical or endangered animal species was observed. Of the four main groups surveyed there are more birds species with 38; the others include reptiles, 9; mammals, 5 and amphibians, 6.

### 5.14.3. Protected Species

Plants - The plant species survey detected no critical or endangered plant species in the study area (the 400m wide strip along each build alternative corridor). This is attributed to the high degree of alteration to the natural vegetation in the area by urban development and agricultural activities. The prevailing habitats are secondary forests, scrubland and grasslands, with some pockets of gallery forests along rivers and creeks.

Animals - The only protected animal species reported by both the Puerto Rico Department of Natural Resources and the U.S. Fish and Wildlife service in the study area is the Puerto Rican plain pigeon, *Patagioenas inornata wetmorei*, previously known as *Columba inornata*. This species was not observed during this field survey but it has been reported from the area (PRENRD, 2007). It is likely that the plain pigeon uses some of the gallery and secondary forest along the rivers and creeks for foraging or nesting sites, specially those closer to Cidra reservoir at the western portion of the study site were it has been reported.

The Puerto Rican Plain Pigeon is a large pigeon about the size and shape of a domestic pigeon. At a distance the species appears pale blue-gray. The head, hind neck, breast, and the top central part of the folded wing are washed with a wine color. The wing coverts are margined with white. Legs and feet are dark red. A variety of fruits and seeds, and livestock feed provide nourishment for this species. Approximately 70% of the foods come from tree branches, and 30% from the ground. Principal foods at Cidra are royal palm (*Roystonea borinquena*); mountain immortelle (*Erythrina poeppigiana*); West Indies trema (*Trema lamarckiana*); and white prickle (*Zanthoxylum martinicense*). Water is usually taken from the axils of bromeliads or from water-retaining blossoms of the African tulip-tree. (USFWS, 2008)

### 5.14.4. Critical Habitats

Within the build alternatives impact area there are no critical habitats as defined by the federal Endangered Species Act.

The PRDNER has designated several isolated areas as “critical habitat” for the Puerto Rico Plain Pigeon, several of which would be potentially impacted by build alternatives. Figure 41 shows the PRDNER map indicating the critical habitat of the PR plain pigeon within and around the study area.

The endangered Puerto Rican plain pigeon was not observed during biological surveys undertaken for this study, but it has been reported from the area (PRDNER, 2007). It is likely that the PR plain pigeon uses the gallery forest along the rivers and creeks as and the secondary forests as foraging or nesting sites. Therefore, we have identified in Figure 42 the forest areas found along the five build alternatives that might represent Potential Habitat areas for the PR

plain pigeon. The Potential Habitat so indicated is not an official designation, but rather indicates areas which are more favorable to this species as compared to surrounding areas. Table 5.14-2 shows Puerto Rican Plain Pigeon Designated Critical and Potential Habitat.

Table 5.14-2. Puerto Rican Plain Pigeon Designated Critical and Potential Habitat.

| Alternative | Critical Habitat (acres) a/ | Potential Habitat (acres) b/ |
|---|---|---|
| C-1 | 44.70 | 293.16 |
| C-2 | 44.70 | 331.88 |
| C-3 | 8.87 | 349.30 |
| C-4 | 8.87 | 254.95 |
| C-5 | 8.87 | 251.16 |

a/ Critical habitat designated by PRDNER.
b/ Non-designated areas more favorable to this species as compared to surrounding areas.

## 5.15. Tree Inventory (PRDNER)

A Tree Inventory was performed along the build alternatives corridors. The inventory was performed according to PRDNER Regulation 25. A copy of the inventory is included in Appendix K.

The study was performed by random samplings of 20 x 20 m zones of continuous forest cover along the corridors. Fifty nine (59) zones were sampled to determine the composition and density of the woody areas. Every tree over six feet tall was identified, counted and measured. Sampling was used to determine the mean tree density in the 59 sampled areas. Mean tree density per acre of area is 1468 trees/acre. Density was used to estimate the numbers of trees at forested areas along the build alternatives corridors.

Forest areas in the corridors are shown in Figure 43. The Table 5.15-1 summarizes the results of the Tree Inventory within the footprint of each corridor.

Table 5.15-1. Summary Results of Tree Inventory in Compliance with PRDNER Regulation 25.

| Alternative | Forested Areas (acres) | Trees |
|---|---|---|
| C-1 | 249.5 | 366,266 |
| C-2 | 280.6 | 411,921 |
| C-3 | 344.6 | 505,873 |
| C-4 | 288.8 | 423,958 |
| C-5 | 299.9 | 440,253 |

## 5.16. Socioeconomics Characteristics

A survey of 300 residents in the municipalities of Cidra and Cayey was conducted to determine its socioeconomic characteristics (refers to Appendix E). Survey included 100 interviews in the communities along the build alternatives corridors. Data obtained indicate that residents potentially impacted by a build alternative has similar characteristics of the Cayey and Cidra Municipalities.

## 5.17. Hazardous and Non-Hazardous Waste

The Puerto Rico Waste Authority and Puerto Rico Environmental Quality Board did not identify Hazardous and Non-Hazardous Waste sites in the area under study.

## 5.18. Visual and Aesthetic Resources

The proposed construction area is located in the central east region of Puerto Rico, in a transition zone between the Cordillera Central and Sierra de Cayey. The zone has hilly conditions and is a rural area with a few planned developments. The area is good for leisure activities due to its vegetation and climate.

# 6. ENVIRONMENTAL CONSEQUENCES and MITIGATION MEASURES

This chapter describes the potential environmental, social, and economic impacts of each of the proposed alternatives, including both construction and cumulative impacts of each. This chapter also describes the measures proposed to mitigate adverse impacts. Impacts of build alternatives were determined using corridor widths defined in the Conceptual Design Drawings. The minimum width of these corridors is 120 m but could be increased to approximately 200 meters considering stability requirements on steep slopes. Figure 12 and Figure 13 show the location of build alternatives corridors.

## 6.1. Land Use and Land Cover

### 6.1.1. Land Use and Land Cover Impacts Assessment

The No Action alternative is not anticipated to have impacts on current land uses along the project corridor. However, the No Action alternative is considered not to be viable because it does not address the project purpose and need, and is incompatible with government planning studies described in Chapter 2 that identify the need for development of a new road connecting PR-7733 and PR-52.

Alternatives that propose the construction of a new road (build alternatives) are consistent with government planning studies as discussed on Chapter 2.

Build Alternatives corridors primarily impact land uses classified as Residential (R-0) and Common Rustic Land (CRL), as shown in Figure 44 and Figure 45. Residential (R-0) land use is characterized by single family houses located in parcels larger than 8,000 $m^2$. Common Rustic Land consists of rural areas with a much lower density of housing. Table 6.1-1 and Table 6.1-2 summarized impacts of each build alternatives in terms of land uses and land cover. Build alternatives will mainly impact residential land uses. Relocations and displacements required for each build alternative are discussed in Section 6.16.

Build Alternatives C-1, C-2 and C-3 run across the area of the proposed “Spring Hill” development is planned, while build alternatives C-4 and C-5 impact the area where Parque Tecnológico is proposed in Cayey. Both projects are in planning phases and initial coordination has been performed between the developers and PRHTA.

Table 6.1-1 Existing Zoning Areas Impacted by each Build Alternative Corridor.

| Zoning Category | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| AD a/ | 5.5 | 2.5 | 5.46 | 2.4 | 5.46 | 2.6 | NA | NA | NA | NA |
| P b/ | 28.1 | 13.0 | 28.1 | 12.2 | 27.9 | 12.9 | 29.4 | 14.4 | 32.9 | 14.6 |
| CR-1, CR-2 c/ | NA | NA | NA | NA | NA | NA | NA | NA | 2.8 | 1.2 |
| R-0,R-1, R-3 d/ | 176.7 | 82.0 | 191.05 | 82.7 | 176.8 | 81.9 | 174.2 | 84.9 | 174.7 | 76.9 |
| IL-1 e/ | 1.4 | 0.6 | 1.39 | 0.6 | 1.4 | 0.7 | 1.4 | 0.7 | 17.3 | 7.3 |
| B-1 f/ | 4.2 | 1.9 | 4.82 | 2.1 | 4.2 | 1.9 | NA | NA | NA | NA |

a/ Developed Areas.
b/ Public Uses.
c/ Mixed Commercial and Residential Uses
d/ Residential Areas.
e/ Light Industrial.
f/ Interior Forest.

Table 6.1-2 Land Use Plan Categories Impacted by each Build Alternative Corridor.

| Category | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| CRL a/ | 175.2 | 81.2 | 189.50 | 82.4 | 175.3 | 81.3 | 130.0 | 63.4 | 136.7 | 60.0 |
| EPRL b/ | 4.2 | 2.0 | 4.22 | 1.8 | 4.22 | 1.9 | NA | NA | NA | NA |
| UL c/ | 8.6 | 3.9 | 8.60 | 3.7 | 8.6 | 3.9 | 47.5 | 23.2 | 63.2 | 27.7 |
| PUL d/ | 27.8 | 12.9 | 27.8 | 12.1 | 27.8 | 12.9 | 27.52 | 13.4 | 27.9 | 12.3 |

a/ Common Rustic Land.
b/ Especially Protected Rustic Land.
c/ Urban Land.
d/ Planned Urban Land.

### 6.1.2. Mitigation Measures

Construction of a new road is not incompatible with the land uses and land covers in the build alternatives corridors. POT and PRHTA island wide studies will reflect the construction of a new road between the PR-7733 and PR-52.

## 6.2. Social Impacts

Community impacts resulting from the No Action Alternative are expected to be primarily an increase in traffic congestion as described in Chapter 4, and existing highway safety issues remain unresolved. The build alternatives alignments were selected based on previous studies and the public workshop held for this project, and alignments were selected to minimize community disruption and minimize impacts to environmental resources in the area. This section discusses impacts to community cohesion and specific social group.

### 6.2.1. Communities Cohesion Impacts Assessment

Community disruption exists whenever a new road alignment runs across an established urban area. Neighborhoods can be impacted because the road creates a physical barrier that affects resident's access to institutions, commerce's and leisure activities. New road Impacts to existing municipal roads alter travel patterns and the accessibility of vehicles and pedestrians. Impacts to communities created by Build Alternatives and mitigation measures are shown in Figure 46 and described below.

All build alternatives share the same initial alignment for approximately 1.5 km. This segment begins at Cidra Industrial Street and ends approximately 100 m after crossing PR-734. This segment affects the Los Pinos, Quintas Gloria, and Los Martínez communities. Approximately four municipal roads would be impacted in this area. Of these, three would be obstructed. The other route-specific impacts are listed below:

Build Alternative C-1 would impact PR-7787 at Km. 1.9 at the Sapera community.

Build Alternative C-2 would impact two municipal roads located at Sapera community and Sector Luisa Rolón, respectively.

Build Alternative C-3 would impact three municipal roads located at Sapera, Monticello and Sector Luisa Rolón communities, respectively.

Build Alternative C-4 would impact two municipal roads located at Monticello and Brisas de Beatriz communities.

Build Alternative C-5 would impact a municipal road located at Monticello community.

### 6.2.2. Social Groups Impacts Assessment – Environmental Justice

Executive Order 12898 (February 11, 1994), Federal Actions to Address Environmental Justice in Minority and Low –Income Population, requires that "each Federal Agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations".

Three environmental justice fundamentals principles and how they are addressed are summarized below.

Principle #1 - Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economics effects, on minority populations and low-income populations.

Socioeconomics studies (refer to Chapter 5 and Appendix E) performed as part of this DEIS indicate that no significant socioeconomics differences exist between Cidra, Cayey and the communities impacted by build alternatives. Therefore, the build alternatives will not impact disproportionately any social group.

Principle #2 - Promotes the participation of potentially affected communities in the transportation decision-making process.

During the last thirteen years an improvement to transportation system between Cidra and the PRSHN has been discussed between government agencies and the public. The PRHTA has provided public participation in the process to define the action required to provide a better transportation system between Cidra and the PRSHN (refers to Chapter 2). The PRHTA has held several informative workshops in which the public has had opportunities to discuss studies and provided comments.

A coordination plan as required by Section 6002 of Public Law 109-59, "Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users", (SAFETEA-LU) was prepared as part of the project development process. The Coordination Plan includes the public and government agencies in the environmental evaluation process. Two informative meetings were held in Cidra in which the public expressed their comments. There is a general agreement among Cidra residents that existing roads which connects the municipality to the PRSHN are unsafe and inadequate and that and adequate system is needed.

Principle #3 – Prevent the denial, reduction, or significant delay, in the recipient of benefits by minority and low income populations.

While the area is populated by a Hispanic population that would be considered a minority population on the mainland U.S., this is not a minority population in Puerto Rico. Furthermore, the area does not have income lower than the average throughout the municipality. Improvement to the transportation system will benefit the entire population.

### 6.2.3. Mitigation Measures

The section discusses the mitigation measures to minimize community disruption. These are conceptual measures, final mitigation measures would be determined during design stage.

Several impacts are common to all build alternatives. An overpass at new road across one of the municipal roads is proposed under all build alternatives common section (between Cidra Industrial Street and PR-734) to maintain the existing community transportation pattern. Another option to maintain the existing community transportation pattern could be to construct a local marginal road parallel to the new road, starting from PR-734 until reach the community. The final option would be determined during design stage.

The remaining mitigation measures are specific to each different new road alternative.

Build Alternative C-1. To maintain community cohesion and existing travel patterns, an overpass is proposed where the new alignment crosses PR-7787 (km 1.9). An access ramp will not be provided at this overpass.

Build Alternative C-2. To maintain community cohesion and existing travel patterns, an overpass is proposed over Sapera municipal road. An access ramp would not be provided at this overpass. Underpasses without access are proposed at local road located south of Sapera Community (Sector Luisa Rolón).

Build Alternative C-3. To maintain community cohesion and existing travel patterns, an underpass is proposed at Monticello and Sector Luisa Rolón municipal roads. An access ramp would not be provided at these underpasses. An overpass without access would be provided over the Sapera community local road.

Build Alternative C-4. To maintain community cohesion and existing travel patterns, an underpass is proposed below municipal road in the Monticello community. An access ramp would not be provided at this underpass. An underpass at Brisas de Beatriz local road is also proposed.

Build Alternative C-5. To maintain community cohesion and existing travel patterns, an underpass is proposed below Monticello municipal and road. An access ramp would not be provided at this overpass.

## 6.3. Existing Infrastructure

### 6.3.1. Existing Infrastructure Impact Assessment

Transportation

Impacts to the existing transportation system are described in Chapter 5. The No Action alternative will increase traffic congestion in the transportation system of the area, and the Level of Service (LOS) at existing intersections will decline. Build Alternatives that propose the construction of a new road will improve LOS at existing road intersections and reduce congestion and fatal accidents. Impacts during construction are discussed in Section 6.17.

Potable and Wastewater System

No impacts to PRASA potable water distribution system are expected under the No Action Alternative. Small segments of potable distribution lines equal or smaller than 6" in diameter would be impacted as part of build alternatives construction and would require replacement and re-alignment of a portion of these pipelines. This is not a significant impact. Major potable infrastructure system (water tanks and wells) will not be affected under any build alternative.

Power and Electricity

No impacts to PREPA distribution system are expected under the No Action Alternative. Small segments of smaller distribution lines (13 kV) would be impacted as part of build alternatives construction and would require reconstruction or relocation. This is not a significant impact. Towers of power transmission lines (230 kV and 115 kW) would not be affected under any build alternative. However, build alternatives corridors would cross existing power transmission line right of way. The 100 ft fringe required by PREPA at the east of the 230 kV right of way has been maintained under all build alternative alignments.

Communication

Build Alternatives C-1, C-2, and C-3 would impact a communication tower access road located west of Villas de Monte Verde.

### 6.3.2. Mitigation Measures

Impacted PRASA and PREPA utilities will be relocated along the PRDTPW right of way. A new access road from the proposed new road will be constructed to provide access to communication tower.

## 6.4. Soils

### 6.4.1. Agriculture and Farmland Impact Assessment

No impacts to agriculture and farmland are anticipated as a result of the No Action Alternative. Build Alternatives would impact Tres Monjitas Dairy which is the largest farm located in the study area. The farm is composed mainly of grasslands and secondary forest at the edge of the water bodies (rivers or creeks) and mountainous areas. The farm could be impacted because the road will create a physical barrier dividing the property and avoiding cattle access to grassland areas. Build Alternatives C-1 and C-2 pass through the middle of this dairy farm, while Build Alternatives C-3, C-4 and C-5 cross the southern portion of this farm, near the farm property edge in an area mainly composed of secondary forest. None of the alternatives impact the dairy milk parlor.

### 6.4.2. Mitigation Measures

An underpass structure would be required under Build Alternatives C-1 and C-2 to minimize property disruption and guarantee cattle access to grassland areas. Under Build Alternatives C-3, C-4 and C-5 an underpass structure and/or acquisition of isolated areas will be implemented. The final alternative would be determined during design stage.

## 6.5. Noise

No noise impacts are anticipated as a result of the No Action Alternative. Noise impacts due to build alternatives are described below.

### 6.5.1. Noise Impacts Assessment Methodology

A noise impact analysis was performed for each of the build alternatives following the criteria established in the “Development and Operation of Transportation Projects Policy”. This policy was developed by the Puerto Rico Department of Transportation and Public Works (PRDTPW) and the Puerto Rico Highway and Transportation Authority (PRHTA) and was approved by the Federal Highway Administration (FHWA). It was prepared to comply with the requirements set forth in Title 23, Part 772 of the U.S. Code of Federal Regulations and the noise related requirements of the National Environmental Policy Act (NEPA). The policy states:

“It is the policy of the PRDTPW to design and build highway projects taking into full consideration the potential noise impacts of each alternative, to conduct sufficient studies and analysis to determine these impacts and to provide for reasonable and feasible abatement measures.”

The policy defines that a traffic noise impact is one that occurs when the predicted noise levels approach or exceed the Noise Abatement Criteria (NAC), or when the predicted noise levels

substantially exceed the existing noise levels. Traffic Noise Analysis performed for the project is included in Appendix G. The following methodology was used in the noise assessment:

- Existing noise levels were measured at eight representative receptors along the build alternatives corridors, as described and reported in Section 5.8. Refer to Figure 34 and Table 5.8-1. Representative receptors were used to establish existing noise levels on representative receptors in the communities.
- Representative receptors in communities were identified for each build alternative. Predicted noise level to be generated by each build alternative was evaluated by Traffic Noise Model (TNM) software, version 2.5. TNM uses vehicle noise emission level, traffic characteristics (projected to year 2028), road geometric characteristics (based on CDD), road operational conditions, and the horizontal and vertical location of receptors in reference to the road geometry.
- The predicted noise levels and the project NAC ($L_{eq}$ of 67 dBA during one hour, refer to Section 5.8), were compared against the ambient noise level and against the NAC to determine if unacceptable noise impacts are associated with any build alternative. A receiver with significant increase in noise levels is one which has a loudest hour Leq that approaches (within 1.0 dBA) or exceeds the NAC, or which increase the existing noise levels by 10 dBA or more.
- Noise mitigation measures were proposed at those receptors that approach (within 1.0 dBA), or exceed the NAC.

### 6.5.2. Noise Impact Assessment

Receptors used in traffic noise analysis representing the communities are shown in Figure 48. Table 6.5-1 through Table 6.5-5 summarizes the noise impact assessment results. Results indicate that some residences in these communities may be substantially impacted by high noise levels from build alternatives construction. Efforts were made to minimize impacts to communities during preparation of Conceptual Design Drawings. However, structures located within approximately 25 m of the proposed new roads will experience a high increase in noise levels, particularly given that most of the area is rural with relatively low existing noise levels. The criteria for noise level would be exceeded by the Build Alternatives. Noise mitigation measures were proposed at receptors having significant noise impact. Receptors that would require mitigation measures are shown in Table 6.5-6.

Table 6.5-1 Noise Impacts for Build Alternative C-1.

| Receptor ID/ Number of Affected Units | Existing Noise Level (dBA) | Predicted Noise Level (dBA) | Increase in Noise Level (dBA) | Increase in Noise Level (dBA) |
|---|---|---|---|---|
| 1-1/1 | 51.6 | 73.3 | 21.7 | High |
| 1-2/1 | 51.6 | 66.4 | 14.8 | High |
| 1-3/1 | 51.6 | 62.2 | 10.6 | High |
| 1-4/1 | 47.0 | 54.5 | 7.5 | High |
| 1-5/2 | 47.0 | 60.3 | 13.3 | High |
| 1-6/4 | 47.0 | 62.5 | 15.5 | High |
| 1-7/1 | 47.0 | 61.6 | 14.6 | High |
| 1-8/19 | 43.8 | 54.8 | 11.0 | High |

Low – Increase in Noise Levels from 1.0 to 3.0 dBA; Moderate – Increase in Noise Levels from 3.1 to 5.0 dBA; High – Increase in Noise Levels equal or higher than 5.1

Table 6.5-2 Noise Impacts for Build Alternative C-2.

| Receptor ID/ Number of Affected Units | Existing Noise Level (dBA) | Predicted Noise Level (dBA) | Increase in Noise Level (dBA) | Increase in Noise Level (dBA) |
|---|---|---|---|---|
| 2-1/1 | 51.6 | 73.3 | 21.6 | High |
| 2-2/1 | 51.6 | 66.4 | 14.8 | High |
| 2-3/1 | 51.6 | 62.2 | 10.6 | High |
| 2-4/1 | 47.0 | 49.3 | 2.3 | Low |
| 2-5/1 | 47.0 | 49.6 | 2.6 | Low |
| 2-6/3 | 47.0 | 61.0 | 14.0 | High |
| 2-7/1 | 47.0 | 64.0 | 17.0 | High |
| 2-8/2 | 43.8 | 57.0 | 13.2 | High |
| 2-9/19 | 43.8 | 54.5 | 10.7 | High |

Table 6.5-3 Noise Impacts for Build Alternative C-3.

| Receptor ID/ Number of Affected Units | Existing Noise Level (dBA) | Predicted Noise Level (dBA) | Increase in Noise Level (dBA) | Increase in Noise Level (dBA) |
|---|---|---|---|---|
| 3-1/3 | 51.6 | 56.6 | 5.0 | Moderate |
| 3-2/1 | 51.6 | 66.3 | 14.7 | High |
| 3-3/1 | 51.6 | 56.7 | 5.1 | High |
| 3-4/4 | 45.7 | 59.5 | 13.8 | High |
| 3-5/2 | 45.7 | 64.3 | 18.6 | High |
| 3-6/2 | 45.7 | 55.6 | 9.9 | High |
| 3-7/1 | 54.5 | 56.0 | 1.5 | Low |
| 3-8/1 | 43.8 | 53.9 | 10.1 | High |
| 3-9/2 | 43.8 | 52.7 | 8.9 | High |

Low – Increase in Noise Levels from 1.0 to 3.0 dBA; Moderate – Increase in Noise Levels from 3.1 to 5.0 dBA; High – Increase in Noise Levels equal or higher than 5.1

Table 6.5-4 Noise Impacts for Build Alternative C-4.

| Receptor ID/ Number of Affected Units | Existing Noise Level (dBA) | Predicted Noise Level (dBA) | Increase in Noise Level (dBA) | Increase in Noise Level (dBA) |
|---|---|---|---|---|
| 4-1/3 | 51.6 | 56.6 | 5.0 | Moderate |
| 4-2/1 | 51.6 | 66.3 | 14.7 | High |
| 4-3/1 | 51.6 | 56.7 | 5.1 | High |
| 4-4/4 | 45.7 | 59.5 | 13.8 | High |
| 4-5/2 | 45.7 | 64.3 | 18.6 | High |
| 4-6/2 | 45.7 | 55.6 | 9.9 | High |
| 4-7/1 | 47.0 | 56.9 | 15.9 | High |
| 4-8/29 | 47.0 | 48.9 | 1.9 | Low |
| 4-9/7 | 45.7 | 59.1 | 13.4 | High |
| 4-10/7 | 45.7 | 63.8 | 18.1 | High |
| 4-11/1 | 45.7 | 64.6 | 18.9 | High |
| 4-12/1 | 45.7 | 61.0 | 15.3 | High |

Table 6.5-5 Noise Impacts for Build Alternative C-5.

| Receptor ID/ Number of Affected Units | Existing Noise Level (dBA) | Predicted Noise Level (dBA) | Increase in Noise Level (dBA) | Increase in Noise Level (dBA) |
|---|---|---|---|---|
| 5-1/3 | 51.6 | 56.6 | 5.0 | Moderate |
| 5-2/1 | 51.6 | 66.3 | 14.7 | High |
| 5-3/1 | 51.6 | 56.7 | 5.1 | High |
| 5-4/4 | 45.7 | 59.5 | 13.8 | High |
| 5-5/2 | 45.7 | 64.3 | 18.6 | High |
| 5-6/2 | 45.7 | 55.6 | 9.9 | High |
| 5-7/1 | 54.5 | 57.6 | 3.1 | Low |
| 5-8/29 | 41.1 | 50.9 | 9.8 | High |
| 5-9/7 | 41.1 | 60.3 | 19.2 | High |
| 5-10/4 | 41.1 | 67.0 | 25.9 | High |
| 5-11/1 | 41.1 | 66.0 | 24.9 | High |
| 5-12/1 | 41.1 | 58.8 | 17.7 | High |
| 5-13/10 | 51.2 | 58.9 | 7.7 | High |

Low – Increase in Noise Levels from 1.0 to 3.0 dBA; Moderate – Increase in Noise Levels from 3.1 to 5.0 dBA; High – Increase in Noise Levels equal or higher than 5.1

Table 6.5-6 Receptors that would require Noise Mitigation Measures.

| Alternative | Receptors |
|---|---|
| C-1 | 1-1, 1-2 (2 residences) |
| C-2 | 2-1, 2-2 (2 residences) |
| C-3 | 3-2, 3-5 (3 residences) |
| C-4 | 4-2, 4-5, 4-11 (4 residences) |
| C-5 | 5-2, 5-5, 5-10, 5-11 (8 residences) |

a/ Mitigation will be only provided for those receptors that approaches (within 1 dBA) or exceed NAC.

### 6.5.3. Mitigation Measures

Several measures were evaluated to mitigate impacts resulting from build alternatives construction, as described below:

- Administrative measures such lowering the speeds at certain segments of the new road and prohibit the transit of heavy vehicles. These alternatives were not considered feasible because it is inconsistent with the project purpose and need.
- Construction of barriers between the highway and receptors can reduce noise levels by up to approximately 10 dBA. However, this alternative is costly to implement considering

that only a few properties will be substantially impacted by increased noise level. Therefore, this alternative was considered not reasonable at the planning stage but will be re-considered during design stage.

- Acquiring the affected housing units. This measure was considered feasible due to the fact that they are scattered residences. A maximum of 8 residences acquisitions would be required under Build Alternative C-5.
- Establishment of a buffer zone of at least 30 m between the highway and the receptors, which could mitigate traffic noise impacts below the NAC. Fringe could be planted with trees. This measure will be evaluated during final design stage.

## 6.6. Air Quality

### 6.6.1. Air Quality Impact Assessment

An air quality assessment was performed to evaluate potential impacts to local air quality (refer to Appendix M). Local air quality was assessed on a micro-scale, evaluating potential Carbon Monoxide (CO) concentrations to be generated by build alternatives. CO emissions are associated with the incomplete combustion of fossil fuels in motor vehicles and are an indicator of vehicle-induced air pollution. High concentrations of CO tend to occur in areas of high traffic volume.

The CO analysis methodology prepared by the California Department of Transportation was used to evaluate potential CO impacts resulting from new road construction. This methodology is described in the "Transportation Project-Level Carbon Monoxide Protocol" (TPLCMP) and applies to FHWA transportation projects.

Based on the TPLCMP the five build alternatives did not required a regional CO emission analysis because it was included in a regional transportation plan. As discussed in Chapter 2, the construction of a new road between PR-7733 and PR-52 is included in the San Juan Metro South Region Transportation Plan. Therefore, only the potential of project-level CO air quality impacts were evaluated.

The need to perform a micro-scale CO analysis to evaluate possible local CO air quality impacts was determined by the methodology presented in the TPLCMP. This methodology determines if the projected CO level is satisfactory, or if the project needs more analysis. The following information was used to determine the necessity of a micro-scale analysis:

- The project is located in a CO attainment area.
- Proposed build alternatives will not include a signalized intersection with Level of Service (LOS) E or F, as evaluated for the project 2028 condition.
- Proposed build alternatives will not worsen the traffic conditions at existing signalized intersection with LOS E or F for the projected 2028 condition.
- There is no reason to believe that build alternatives may have adverse air quality impacts according to NAAQS and study area characteristics.

After applying TPLCMP methodology it was determined that CO emissions will not impact local air quality. Therefore, a CO micro-scale analysis is not required for the project.

### 6.6.2. Mitigation Measures

The increase in CO concentrations is not anticipated to exceed either the one one-hour or eight hour NAAQS for CO. Therefore, significant local air quality impacts are not anticipated as a result of the construction of a new road. Consequently, no mitigation measures are required.

## 6.7. Historic and Archaeological Resources

### 6.7.1. Historic and Archaeological Impact Assessment

No historic or archaeological resource would be affected by the No Action alternative. On a preliminary basis, no historic resource eligible to be included in the National Register of Historic Places (NRHP) was identified in any build alternative corridors. However, archaeological sites were identified during Phase 1A and Phase 1B archaeological studies (refer to Chapter 5 and Figure 35). The Conceptual Design avoids, whenever possible, impact to archaeological resources identified within the 400 m study belt. Table 6.7-1 summarizes the archaeological sites affected by the build alternatives corridors.

The consultation process pursuant to Section 36 CFR, Part 800 will be completed prior to completion of the National Environmental Policy Act process.

### 6.7.2. Mitigation Measures

Recommended actions to be executed at each archaeological resource potentially impacted by build alternatives corridors are summarized in Table 6.7-1

Table 6.7-1 Recommendations for Cultural Resource Mitigation Actions.

| Cultural Resource | Mitigation Action |
|---|---|
| Previously Impacted Batey | Phase II Study. |
| Stone Grouping 1 | Documentation Finalized |
| Heterogeneous finds | |
| a. H-4 | Documentation Finalized |
| b. H-5 | Documentation Finalized |
| Río Guavate Floodplain Residuary | |
| a. Pre-Columbian | Phase II Study. |
| b. Colonial | Phase II Study. |

An archaeological monitoring plan will be developed and implemented during construction activity in the Cerro del Bohique area (Build Alternatives C-1 and C-2), Stone Grouping 1 area (Build Alternatives C-1 and C-2), and heterogeneous H-2 area (Build Alternatives C-1 and C-2). These

sites are located near the new road impact corridors and there is a possibility of archaeological findings within the construction area. Archaeological sites located less than 50 m apart from the Build Alternatives Impact Fringe should be protected with a metallic fence during construction activities.

## 6.8. Parkland

None of the alternatives impact recreational parks or other recreational facilities. Build Alternatives corridors are conceptually designed to avoid impacts to recreational facilities. Therefore, no mitigation measures are required.

## 6.9. Water Resources

### 6.9.1. Surface Waters Impact Assessment

No impacts to surface water resources are expected from the No Action alternative. Under build alternatives, rivers and streams in the study area will be crossed by bridges or culverts. Figure 49 shows the locations of proposed bridges and culverts under each build alternative. Table 6.9-1 indicates the crossing structures per road alternative based on Conceptual Design Drawings and preliminary hydrologic and hydraulic analysis performed as part of the Environmental Hydrology (Appendix N) prepared for the project.

Table 6.9-1 River and Stream Crossing Structures.

| Alternative | Culverts | Bridges |
|---|---|---|
| C-1 | 23 | 2 (Río Sabana / Río Clavijo) |
| C-2 | 30 | 1 (Río Sabana) |
| C-3 | 27 | 0 |
| C-4 | 16 | 2 (Unnamed Creek / Quebrada Beatriz) |
| C-5 | 15 | 3 (Unnamed Creek / Quebrada Beatriz / Río Guavate) |

Río Clavijo, Río Sabana and Unnamed Creek could be crossed by a single span bridge, but Río Guavate and Quebrada Beatriz bridges will require intermediate piers. Location of piers will be defined during design stage, and to the extent possible intermediate piers will be located outside of the existing stream channel. Existing stream habitat and migration pattern may be permanently affected by culvert placement required as part of new road construction. Streams in the area are already impacted by in-stream structures such low head dams and culverts, as observed during field visits. Also, the study area is upstream of major dams (La Plata and Cidra) which blocks the migration of native aquatic species, and as a result the study area is not anticipated to have native aquatic species of fish or shrimp.

Rivers and streams in the study area did not have potable water intakes. However, all of the study area drains toward water bodies used as sources of potable water supply, like Cidra

reservoir. Approximately 5.25 km of the Build Alternative C-1 corridor runs through the watershed tributary to this reservoir. Build Alternative C-2 corridor runs approximately 4.5 km. Meanwhile, Build Alternatives C-3, C-4 and C-5 run 2.75 km along Cidra Reservoir watershed.

Build Alternatives construction would temporarily increase erosion and stream sedimentation, and would permanently increase the potential for contamination from vehicular traffic and associated hydrocarbons.

### 6.9.2. Ground Water Impact Assessment

No impacts to ground water resources are expected from the No Action alternative. Build Alternatives may reduce soil infiltration and recharge into rock aquifers. However, rock aquifers are currently not used as a significant source of water supply. A short portion of the roads may cross river floodplain and affect recharge into the alluvial aquifer by increasing impervious surface. No existing water wells will be impacted by Build Alternatives. However, Sapera 1 well is closer to Build Alternative C-1. Sapera 1 well was closed by PRASA, therefore there will no impact to ground water by Build Alternatives corridors.

### 6.9.3. Floodplain Impact Assessment

Río Guavate is the only water body in which the floodplain and floodway were delimited by the Federal Emergency Management Agency (FEMA) and the Puerto Rico Planning Board (PRPB). Build Alternative C-5 proposes the construction of a bridge to cross the river.

### 6.9.4. Mitigation Measures

Project bridges and culverts will need to be designed in accordance with FEMA and Planning Board flood control requirements. A preliminary Hydrologic and Hydraulic (H/H) analysis indicates that none of the proposed bridges or culvert structures will increase existing flood levels more than 0.15 m during a 100-yr flood event. During design stage the H/H analysis will be revised with more detailed information. However any change to proposed structures will comply with the 0.15 m maximum flood level increase during a 100 yr event in developed areas, and 0.30 m in areas which are undeveloped. Río Guavate bridge will not affect regulatory flood conditions defined in the FEMA and PR Planning Board flood regulatory maps. Flood hazard will not be increased as a result of constructing bridges or culverts.

Potential surface water pollution will be minimized to the extent possible. The following measures will be implemented as part of build alternative construction:

- Best Management Practices (BMPs) for avoiding and minimizing stream impacts will be implemented during design stage. Implementation of BMPs will help the new road to comply with the EPA Storm Water Phase Rule II under the National Pollutant Discharge Elimination System (NPDES) stormwater program.
- Design and construct all stormwater management structures to prevent or minimize erosion and sedimentation.
- Native plant species will be used to re-vegetate all disturbed areas to prevent erosion.

- Disturbed rivers banks will be stabilized.

## 6.10. Wetlands

### 6.10.1. Wetland Impact Assessment

A wetland delimitation was performed to evaluate potential impacts to wetlands (refer to Appendix I). No impacts to wetland are anticipated under the No Action alternative. The build alternatives corridors and wetland delimitations described in Chapter 5 were used to determine potential wetland impacts for each alternative, as required by Section 404 of the Clean Water Act. Table 6.10-1 shows the total area of wetlands impacted per new road alternative. Figure 50 locates the wetlands potentially impacted be new road alternatives. Impacts could be reduced during the design stage when alignments may be adjusted to further minimize impacts to wetlands.

Table 6.10-1 Potential Wetlands Impacted by Build Alternatives.

| | C-1 | C-2 | C-3 | C-4 | C-5 |
|---|---|---|---|---|---|
| Area (acres) | 5.77 | 5.13 | 12.23 | 11.93 | 13.02 |

Construction activities associated with the build alternatives would temporally or permanently impact wetlands. Impacts to wetland will be minimized to the extent possible.

Temporary wetland impacts occur in areas which are not affected by the permanent placement of fill material. These may include temporary impacts due to flow diversion, changes in water quality, and temporary impacts due to vehicular movement through or across wetland areas during construction activities. Permanent wetland impacts are those associated with permanent fill placement, including culverts and bridge piers.

Wetland functional values were evaluated following the Wetland Evaluation Technique (WET) methodology developed by FHWA. The WET methodology evaluates eleven (11) functions and values and assigned a qualitative probability rating (High (H), Moderate (M) or Low (L)) in terms of social significance, effectiveness, and opportunity. Social significance refers to the importance society may attach to the wetland due to the recognition of its natural features, potential economic value or strategic location. Effectiveness refers to the capability of a wetland to perform a function due to its physical, chemical and biological attributes. Opportunity refers to the chance a wetland has to perform a function. Table 6.10-2 to Table 6.10-6 shows the functional value evaluation for wetlands impacted by each build alternative corridor.

Table 6.10-2 Build Alternative C-1, Wetland Functional Value Evaluation.

| Functional Value | Social Significance | Effectiveness | Opportunity |
|---|---|---|---|
| Groundwater Recharge | H | H | H |
| Groundwater Discharge | H | H | H |
| Flood Flow Alteration | M | M | M |
| Sediment Stabilization | M | M | M |
| Sediment Toxicant Retention | L | L | L |
| Nutrient Removal Transformation | H | H | H |
| Production Export | H | H | H |
| Wildlife Diversity/Abundance | H | H | H |
| Aquatic Diversity/Abundance | M | M | M |
| Uniqueness Heritage | M | M | M |
| Recreation | M | M | M |

Table 6.10-3 Build Alternative C-2, Wetland Functional Value Evaluation.

| Functional Value | Social Significance | Effectiveness | Opportunity |
|---|---|---|---|
| Groundwater Recharge | H | H | H |
| Groundwater Discharge | M | H | H |
| Flood Flow Alteration | L | M | M |
| Sediment Stabilization | M | M | M |
| Sediment Toxicant Retention | M | L | L |
| Nutrient Removal Transformation | M | H | H |
| Production Export | M | H | H |
| Wildlife Diversity/Abundance | M | H | H |
| Aquatic Diversity/Abundance | M | M | M |
| Uniqueness Heritage | L | M | M |
| Recreation | M | M | M |

Table 6.10-4 Build Alternative C-3, Wetland Functional Value Evaluation.

| Functional Value | Social Significance | Effectiveness | Opportunity |
|---|---|---|---|
| Groundwater Recharge | H | H | H |
| Groundwater Discharge | M | M | M |
| Flood Flow Alteration | L | L | L |
| Sediment Stabilization | M | M | M |
| Sediment Toxicant Retention | L | L | L |
| Nutrient Removal Transformation | M | M | M |
| Production Export | M | M | M |
| Wildlife Diversity/Abundance | M | M | M |
| Aquatic Diversity/Abundance | M | M | M |
| Uniqueness Heritage | L | L | L |
| Recreation | M | M | M |

Table 6.10-5 Build Alternative C-4, Wetland Functional Value Evaluation.

| Functional Value | Social Significance | Effectiveness | Opportunity |
|---|---|---|---|
| Groundwater Recharge | H | H | H |
| Groundwater Discharge | H | H | H |
| Flood Flow Alteration | M | M | M |
| Sediment Stabilization | H | H | H |
| Sediment Toxicant Retention | L | L | L |
| Nutrient Removal Transformation | M | M | M |
| Production Export | M | M | M |
| Wildlife Diversity/Abundance | M | M | M |
| Aquatic Diversity/Abundance | M | M | M |
| Uniqueness Heritage | M | M | M |
| Recreation | M | M | M |

Table 6.10-6 Build Alternative C-5, Wetland Functional Value Evaluation.

| Functional Value | Social Significance | Effectiveness | Opportunity |
|---|---|---|---|
| Groundwater Recharge | H | H | H |
| Groundwater Discharge | H | H | H |
| Flood Flow Alteration | H | H | H |
| Sediment Stabilization | H | H | H |
| Sediment Toxicant Retention | M | M | M |
| Nutrient Removal Transformation | H | H | H |
| Production Export | M | M | M |
| Wildlife Diversity/Abundance | M | M | M |
| Aquatic Diversity/Abundance | M | M | M |
| Uniqueness Heritage | L | L | L |
| Recreation | M | M | M |

### 6.10.2. Mitigation Measures

A Section 404 (Clean Water Act) wetland permit will be required for the construction of any build alternative. The United State Army Corps of Engineers (USACE) determines the acceptability of an activity for a permit on the basis of the activity's compliance with the Clean Water Act Section 404(b)(1) guidelines. USACE regulations authorize mitigation to be added as a special condition of a wetland permit. The type and level of mitigation required is subject to compliance with Section 404(b)(1) guidelines in terms of restoring and maintaining the chemical, physical and biological integrity of the wetlands. The process for determining an appropriate means of mitigating wetland impacts is based on attaining the goal of no net loss of wetlands.

Under Section 404(b)(1) wetland impacts are mitigated in a three-phases evaluation process consisting of the following steps: (1) avoidance of wetland impacts; (2) minimization of wetland impacts; and (3) mitigation of unavoidable wetland impacts. During development of the route alternatives, efforts were made to avoid and minimize wetland impacts. This effort will continue during design and construction phases.

Not all impacts can be avoided, and all unavoidable wetland impacts will be compensated by mitigation measures. Mitigation will be performed through the creation of a forested wetland in one single parcel with, on a preliminary basis, a 3:1 (Creation: Impacted Wetland) ratio (see Table 6.10-7). The wetland mitigation site will be evaluated and selected in accordance with criteria concerning land availability in the project vicinity, proximity to a reliable water source to establish the required wetland hydrology, site topography, and construction feasibility. Other mitigation alternatives, such as wetland banking, will be evaluated during subsequent project phases.

Table 6.10-7 Preliminary Wetland Compensation.

| | C-1 | C-2 | C-3 | C-4 | C-5 |
|---|---|---|---|---|---|
| Area (acres) | 17.31 | 15.39 | 36.69 | 35.79 | 39.06 |

## 6.11. Threatened or Endangered Species

The only endangered species reported by both the Puerto Rico Department of Natural Resources and the U.S. Fish and Wildlife service in the study area is the Puerto Rican plain pigeon (Paloma Sabanera), *Patagioenas inornata wetmorei*, previously known as *Columba inornata*. This species was not observed during the field survey but it has been reported from the area. It is likely that the plain pigeon uses some of the gallery and secondary forest along the rivers and creeks for foraging or nesting sites, particularly those areas closer to Cidra reservoir at the western portion of the study area, were sightings have been reported.

### 6.11.1. Puerto Rican Plain Pigeon Impact Assessment

Direct and Indirect potential impacts to Puerto Rican plain pigeon were evaluated in the Biological Assessment prepared for the project (Appendix J). That assessment focused on the impacts to potential pigeon habitat. Direct impact areas are those associated with the new road corridors, and indirect impact areas fall between the corridor and the limit of the 400 m study belt.

No impacts to pigeon habitat are anticipated by the No Action alternative.

Land cover categories along the 400 m build alternatives study belt were presented in Chapter 5. Of these, the Gallery Forest, Secondary Forest and Bamboo have the potential to be Puerto Rican plain pigeon habitat. Table 6.11-1 summarizes the impacts to potential PR Plain Pigeon habitat.

Table 6.11-1 Direct, Indirect and Total Impacts to PR Plain Pigeon Habitat (acres).

| Alternative | Direct Impact | Indirect Impact | Total Impact |
|---|---|---|---|
| C-1 | 100.79 | 196.05 | 296.84 |
| C-2 | 111.23 | 224.33 | 335.56 |
| C-3 | 119.39 | 229.91 | 349.30 |
| C-4 | 100.67 | 163.58 | 264.25 |
| C-5 | 101.08 | 170.60 | 272.40 |

a/ Does not included Rivers.
b/ PR Plain Pigeon Potentail Habitat Includes Gallery Forest, Secondary Forest and Bamboo.

### 6.11.2. Mitigation Measures

All build alternatives cross potential habitat for the Puerto Rico Plain Pigeon. Impacts can be mitigated by planting trees associated with the Plain Pigeon habitat in other locations. Planting

would be performed in wildlife corridors such as river banks. This tree planting may also demonstrate compliance with the planting requirements established by PRDNER Regulation 25.

During construction there is a possibility that a nesting site could be disturbed. To protect the species the following conservation measures will be implemented during construction:

- Surveys by competent ornithologist will be performed during the breeding season before any cutting of a forested area. The aim of this survey is to detect any nesting activity by the pigeons.
- If breeding behavior or a nest is observed in the area, this location will be notified to the PRDNER and USFWS.
- Subsequent conservation measures will be implemented according to PRHTA protocols and regulations.

## 6.12. Tree Inventory

### 6.12.1. Tree Inventory Impact Assessment

No impacts to forest area are anticipated for the No Action alternative. The build alternative corridors and tree inventory described in Chapter 5 were used to determine potential forest areas impacts, as required by PR Department of Environmental and Natural Resources Regulation 25. Table 6.12-1 shows the total area of forest and trees impacted for each build alternative. Figure 52 locates the potential forest areas impacted by build alternatives.

Table 6.12-1 Potential Forest Impacted per Build Alternatives.

| Alternative | Forested Areas (acres) | Trees |
|---|---|---|
| C-1 | 117.01 | 171,771 |
| C-2 | 126.34 | 185,467 |
| C-3 | 105.94 | 155,520 |
| C-4 | 87.35 | 128,230 |
| C-5 | 99.91 | 146,668 |

### 6.12.2. Mitigation Measures

Forest areas impacted by build alternative construction will be compensated. As required by PRDNER Regulation 25, trees will be replaced using a 2:1 ratio (two trees planted for each tree removed). Due to the number of trees impacted, mitigation will be executed both within and outside of the road corridor. A preliminary assessment of tree mitigation requirements for each build alternative is summarized in Table 6.12-2. All mitigation will be executed using native species. Mitigation outside of the highway corridor may be executed according to the PRDNER Administrative Order # 2004-28. This administrative order establishes a monetary payment for each tree impacted.

Table 6.12-2 Preliminary Summary of Tree Mitigation Requirements.

| Alternative | Trees along the Corridor | Trees Outside the Corridor |
|---|---|---|
| C-1 | 1306 | 342,236 |
| C-2 | 1414 | 369,520 |
| C-3 | 1304 | 309,736 |
| C-4 | 1270 | 255,190 |
| C-5 | 1330 | 292,006 |

## 6.13. Economics

Economic analysis is discussed in Section 3.2. Implementation of No Action Alternative will not have any economic beneficial impact in Cidra municipality. The lack of an adequate mobility between PRSHN and Cidra constrains the economic development of Cidra.

As shown in Table 3.2-3, the build alternatives would have a positive impact in regional economics. During construction phase the Build Alternatives would generate jobs, promote the sales contributing to the fiscal revenues of Cidra and Cayey municipalities. The build alternatives also would increase the potential and attractiveness for the establishment of new business in Cidra.

## 6.14. Visual and Aesthetic Resources Impacts

### 6.14.1. Visual and Aesthetic Resources Impact Assessment

No impacts to visual and aesthetic characteristics are anticipated from the No Action Alternative. Visual and Aesthetic characteristics are estimated to be moderately impacted by new road construction. Cut and fills required for road construction would disrupt existing hilly conditions along corridors, and bridges would disrupt river and floodplain aesthetics.

### 6.14.2. Mitigation Measures

The principal aesthetic mitigation measure will be revegetation and reforestation of all cut and full slopes.

## 6.15. Energy

No impact to energy is anticipated as a result of the No Action Alternative. Energy impact due to build alternatives is described below.

### 6.15.1. Energy Impact Assessment Methodology

An energy impact assessment was performed to evaluate the potential direct energy savings of the Build Alternatives as compared with the No Action Alternative (refer to Appendix L). Direct

energy savings refers to the operational savings of facility after it is constructed, and mainly includes the energy consumed by vehicles using the facility.

Energy was primary evaluated in the form of vehicle fuel consumption. Fuel consumption is the amount of fuel that a vehicle needs to travel a given distance. Fuel consumption of traffic depends of vehicle type, vehicle speed, speed changes, vehicle mix (cars and trucks), driver behavior and geometrical configuration of the road. Average vehicle speed is widely used to estimate traffic fuel consumption. Recent studies (1997) performed by the FHWA indicated maximum fuel efficiency was achieved at speeds of 50 to 55 mph. Fuel efficiency decreases at higher speeds. At lower speeds fuel efficiency is reduced by engine and tires friction, and repeated acceleration and deceleration of vehicle. The principal energy source of the transportation system in the study area is gasoline.

Potential direct energy savings obtained by the construction of the Build Alternatives was determined comparing two scenarios:

- No Action Alternative – Existing transportation infrastructure in the study area between the municipality of Cidra and the Puerto Rico Strategic Highway Network which is defined by PR-172, PR-787, PR-171 and PR-734.
- Build Alternatives – This scenario is subdivided in five scenarios defined by the combination of the existing transportation infrastructure with one of the build alternatives.

Scenarios were analyzed for the Peak Hour Traffic (AM and PM) of the years 2018 and 2028. The initial data analysis and general assumptions are:

- Peak hour traffic, route length, travel speed were obtained from the traffic study performed for the project, aerial photos measurements and conceptual design drawings.
- Assumed that vehicle travel speed to be constant in the road segment.
- Assumed that all vehicles using the routes are passenger cars.
- Analysis only evaluated fuel consumption under conditions of free flow along the routes. Consumption at intersections was not included in the analysis.
- The analysis used the 1997 car fuel consumption values specified in the Transportation Energy Data Book Edition 28 prepared by the US Department of Energy as the Average Vehicle Fuel Consumption (AVFC). Values vary according to vehicle speed.
- Assumed that 2018 and 2028 gasoline cost (Fuel Cost) will be $3.20/gal which represents the average 2008 gasoline cost in PR. No attempt to estimate the 2018 and 2028 gasoline cost was executed since gasoline cost is unpredictable. This value is the same used in the Benefit/Cost Analysis.

The following methodology was used in the energy assessment:

- Annual Peak Hour Vehicles Miles Traveled (APHVMT) was determined by multiplying route length by peak hour traffic and 261, which is a conversion factor that converts peak hour traffic to annual peak hour traffic.
- Annual Peak Hour Vehicles Fuel Consumption (APHVFC) was calculated by dividing APHVMT by the AVFC.
- Annual Peak Hour Fuel Cost (APHFC) was estimated by multiplying APHFC by Fuel Cost (FC).

Table 6.15-1 and Table 6.15-2 evaluate and compare the energy usage and energy cost of the No Action Alternative and the Build Alternatives for the years 2018 and 2028.

Table 6.15-1. Peak Hours (AM and PM) Energy Usage and Energy Cost for the year 2018.

| Alternative | APHVFC (gal) | APHFC (dollars) |
|---|---|---|
| No Action | 499,046 | 1,596,946 |
| C-1 | 474,794 | 1,519,342 |
| C-2 | 481,488 | 1,540,763 |
| C-3 | 474,860 | 1,519,552 |
| C-4 | 463,354 | 1,482,732 |
| C-5 | 468,360 | 1,498,753 |

Table 6.15-2. Peak Hours (AM and PM) Energy Usage and Energy Cost for the year 2028.

| Alternative | APHVFC (gal) | APHFC (dollars) |
|---|---|---|
| No Action | 554,495 | 1,774,384 |
| C-1 | 530,968 | 1,699,099 |
| C-2 | 537,874 | 1,721,196 |
| C-3 | 530,969 | 1,696,101 |
| C-4 | 518,724 | 1,659,917 |
| C-5 | 524,834 | 1,679,470 |

The energy assessment indicates that build alternatives would decrease fuel consumption. Maximum decrease in fuel consumption, due to the construction of one of the build alternatives, is smaller than 7%, which is not significant.

### 6.15.2. Mitigation Measures

Construction of one of the Build Alternatives would not significantly change fuel consumption. Consequently, no mitigation measures are required.

## 6.16. Relocation

### 6.16.1. Relocation Impact Assessment

No property acquisition is required under the No Action alternative. However, relocations would occur under all build alternatives. A "Properties Inventory and Probable Acquisition Cost Study" (Appendix O) was prepared to estimate the number of properties that would be impacted and the estimated cost associated with construction of each build alternative.

A Property Inventory was prepared using information obtained from the Puerto Rico Municipal Tax Center (PRMTC) cadastral maps, aerial photos, build alternatives Conceptual Design Drawings, and field visits. During field visits property data were obtained such as current use and the estimated area of parcel that would be affected. All the information gathered during field visits was obtained without accessing any property. Evaluations were performed from properties boundaries.

Estimated acquisition cost of properties was made using information obtained from the property inventory, field visits, market research of real estate transactions, analyses and development of general market trends, and analyses and development of construction cost trends. The estimated acquisition cost was determined in accordance with applicable regulations and in compliance with the Uniform Standards for Professional Appraisal Practice for a consulting service. However, it did not represent an individual or detailed appraisal of the properties. Further evaluation will be conducted during subsequent project phases.

A descriptive sheet was prepared for potentially affected properties by any of the route alternatives. The property description includes; general location description; property description; current use; location coordinates, land registry number; and estimated acquisition cost. Table 6.16-1 summarizes number of properties that could be impacted and the estimated acquisition cost for each build alternative. Table 6.16-1 includes the number properties that would be totally and partially acquired and the estimate property acquisition cost. Among the properties are residences, commerce, agricultural, institutions and industrial. Residential and commercial structures that would be totally acquired and their acquisition costs are summarized in Table 6.16-2.

Table 6.16-1 Properties that would be Impacted and Estimated Acquisition Cost.

| Alternative | Properties | Estimated Acquisition Cost |
|---|---|---|
| C-1 | 133 | $19,361,000 |
| C-2 | 125 | $19,231,000 |
| C-3 | 133 | $18,811,000 |
| C-4 | 122 | $20,343,000 |
| C-5 | 116 | $19,571,000 |

Table 6.16-2 Residential and Commercial Structures that would be Totally Acquired and Estimated Acquisition Cost.

| Alternative | Properties | Estimated Acquisition Cost |
|---|---|---|
| C-1 | 69 (7) | $9,848,000 ($1,644,000) |
| C-2 | 56 (7) | $9,292,000 ($1,644,000) |
| C-3 | 54 (7) | $8,111,000 ($1,644,000) |
| C-4 | 56 (0) | $10,149,000 (0) |
| C-5 | 55 (1) | $9,882,000 ($175,000) |

a/ Residential (Commercial)

A Conceptual Relocation Plan was prepared for the project and is included in Appendix P. Data from the Puerto Rico and Planning Board indicate that Puerto Rico is experiencing a relative scarcity of mid- to low-cost housing, but that the inventory of mid- to high-priced properties is ample. Build alternatives require the acquisition of approximately 50 to 70 residential units, and this would increase the demand for replacement residential units in the Cayey-Cidra region.

Median Probable Acquisition Cost and available median housing unit costs are compared in Table 6.16-3 and Table 6.16-4. These tables indicate that housing needs created by build alternative construction would by mainly filled by the existing market of used properties. However, relocation, moving and last resort replacement housing expenses will be required for build alternative construction. Table 6.16-5 shows the estimated number of units to require replacement housing supplement and last resort.

Most of the impacted commercial properties are small local businesses. A displaced business may be eligible for a fixed payment in lieu of actual moving expenses, personal property losses, searching expense, and reestablishment expenses. It is estimated that a fixed amount of $20,000 will be required for each displaced business by a new road construction.

Table 6.16-3 Comparison of Median Acquisition Cost and available Used Residences Median Cost.

| Alternative | Median Acquisition Cost | Median Cost Used Units | Difference |
|---|---|---|---|
| C-1 | $128,000 | $158,000 | ($30,000) |
| C-2 | $157,000 | $158,000 | ($1,000) |
| C-3 | $153,000 | $158,000 | ($5,000) |
| C-4 | $168,000 | $158,000 | $10,000 |
| C-5 | $162,000 | $158,000 | $4,000 |

Table 6.16-4 Comparison of Median Acquisition Cost and available New Residences Median Cost.

| Alternative | Median Acquisition Cost | Median Cost New Units | Difference |
|---|---|---|---|
| C-1 | $128,000 | $254,000 | ($126,000) |
| C-2 | $157,000 | $254,000 | ($97,000) |
| C-3 | $153,000 | $254,000 | ($101,000) |
| C-4 | $168,000 | $254,000 | ($86,000) |
| C-5 | $162,000 | $254,000 | ($92,000) |

Table 6.16-5 Number of Residences to Require Relocation Assistance.

| Alternative | Properties | Relocation Cost |
|---|---|---|
| C-1 | 42 | $2,436,00 |
| C-2 | 28 | $1,344,00 |
| C-3 | 29 | $1,392,000 |
| C-4 | 26 | $1,248,000 |
| C-5 | 26 | $1,248,00 |

### 6.16.2. Mitigation Measure

An acquisition and relocation program will be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1070 as amended. Federal relocation resources are available to all residential and business relocates, without discrimination.

## 6.17. Impacts during Construction

### 6.17.1. Impacts during Construction Assessment

All alternatives that entail new road construction would generate construction impacts. These impacts will be temporary. All build alternatives are anticipated to have similar types of construction impacts. These impacts are classified by categories below.

Traffic and Circulation

Construction activity in the vicinity of existing roads would impact the existing traffic flow, plus the effect of additional traffic generated by construction workers and equipment. Although most construction impacts will remain within the project's impact fringe, there would be some traffic impacts to surrounding areas by re-routing of existing roads, construction worker vehicles, and equipment and cargo trucks. Principal roads to be affected by build alternative construction are PR-7733, PR-734, PR-7787, and PR-1. Build Alternatives C-1, C-2 and C-3 would also affect PR-184, and Build Alternatives C-4 and C-5 would also affect PR-52.

Neighborhoods

Construction impacts to the neighborhoods include the inconvenience of construction detours, temporary deterioration of air quality, and increased noise and vibration. Residential areas expected to experience the greatest levels of impacts are those located adjacent to the construction corridor.

Air Quality

Air quality impacts during construction would result from vehicle and machinery emissions and from dust raised by excavation and other construction activities.

Noise and Vibration

Construction would create temporary noise and vibration impacts to the surrounding neighborhoods. This impact is unavoidable due to the size and types of construction equipment required. Most noise and vibration impact will be generated during earth movement activities. Explosive will be used in some areas if rock excavation is required.

Construction would result in the temporally increase in the existing noise levels. The most sensitive receptors in the project area will be the surrounding communities that lie adjacent to the impact fringe. Vibrations will be caused by the nearby passage of heavy equipment or use of explosives.

Water Resources

Temporary impacts to water resources would occur during new road construction. Potentially affected water resources include streams and rivers, floodplains, and wetlands. Impacts are associated to earth movement activities and construction of stream and river crossings. Temporary effects would include increased sedimentation and turbidity in water bodies due to construction activities and temporary diversion of streams and rivers around instream construction sites for activities such as placement of culverts and bridge piers.

Non-Hazardous Waste

Non-Hazardous wastes to be generated during construction would consist of the following: vegetative and organic matter resulting from excavations and earth movement activities, surplus earth material from excavations, debris from removal of existing structures, construction debris from general construction activities (wood, concrete, steel, containers, etc.), domestic waste generated by construction workers, and wastewater from onsite portable toilets.

### 6.17.2. Mitigation Measures

Traffic and Circulation

To minimize the extent of traffic impacts the following measures will be implemented:

- A Management of Traffic (MOT) plan will be developed and implemented during construction. As a minimum the MOT will include: construction of temporary by-pass access; identification of alternate routes to maintain local traffic; and temporary lanes, sidewalks and bus stops. The MOT will be prepared following the PRDTOP's Manual for Traffic Signals in Public Roads of Puerto Rico, PRDTOP's Manual for Uniform Traffic Control Devices for Public Roads of Puerto Rico, and the Federal Highway Administration's Manual of Uniform Traffic Control Devices.
- Whenever possible, roads will remain open at all time to local traffic, and access will be provided to commercial and residential properties.
- A construction staging plan will be developed during the design stage which will include the scheduling lane closures, use of temporary traffic control devices, and specific provisions for building accessibility.
- Haul Route plans developed by the contractor will be reviewed and approved if acceptable to the PRHTA.

Neighborhoods

To minimize impacts, construction hours will be limited in conformance with current PREQB regulations, and temporary barriers will be erected as necessary to minimize noise impacts to sensitive receptors. Dust control measures will be implemented, and emission control devices on construction equipment will be maintained to minimize both noise and air quality impacts. The number of access points to construction areas will be limited to minimize conflict between construction traffic and local traffic.

Air Quality

Air quality degradation due to vehicle emissions will be minimized by specifying the use of construction machinery equipped with emission control devices. A fugitive control plan will be submitted to the Puerto Rico Environmental Quality Board as part of General Consolidated Permit, which will describe the control measures to be implemented throughout the project. Measures will include frequent watering of construction sites and washing vehicles tires before they leave the construction areas.

Noise and Vibration

To minimize impacts, construction hours will be limited in conformance with current PREQB regulations. As necessary, temporary barriers will be erected to minimize noise impacts to sensitive receptors. All heavy construction equipment will be maintained in optimal operating condition with silencers (mufflers) to minimize noise production. Staging areas will be located far from residential areas.

An Incidental Earth Movement Permit will be obtained from the PRDNER. Permit will be prepared according to the PRDNER Regulation #6916 ("Reglamento para Regir la Extracción, Remoción y Dragado de los Componentes de la Corteza Terrestre"). This regulation establishes the parameters and protocols required for the use of explosives during earth movement.

Water Resources

To minimize water resource impacts the following measures will be implemented:

- An Erosion and Sedimentation Plan will be submitted to the PREQB as part of General Consolidated Permit, which will specify the erosion and sedimentation control measures to be implemented during construction.
- Temporary stream diversions will be used to maintain water flow around instream areas affected by earth movement or other construction activities.
- Implement BMP's as established in the Erosion and Sedimentation Plan.
- A NPDES permit for construction sites will be obtained from the EPA.

Non-Hazardous Waste

As part of the mitigation measures for the Non-Hazardous Waste impacts, the following mitigation measures will be implemented:

- Re-use organic material (topsoil) whenever possible for landscaping and tree planting activities associated with the project.
- Balance cut and fill insofar as possible. If excess earth material is created by the project:
    - Send this material to other construction projects which require fill material.
    - Place the surplus material along the impact fringe areas not used to build the road.
    - Place the surplus materials in areas outside the study area. These areas shall comply with government regulations prior to receive the material.
- Removed structures and construction debris will be transported to local landfills for proper disposal in accordance with current regulations.
- Private garbage containers and collection services will be used for domestic wastes generated by the project.

- Contractor will be responsible for the transport of construction debris to an approved landfill.
- Contractor shall provide containers and sufficient area for the disposal of excess debris. Removal of debris shall be made on a periodic basis to avoid accumulation on site.Regular cleaning and emptying of portable septic tanks will be required.

## 6.18. Indirect and Cumulative Impacts

The Council on Environmental Quality (CEQ) regulations (40 CFR Sections 1500 -1508) defines the impacts that must be addressed and considered by Federal agencies in satisfying the requirements of the NEPA process. This includes direct, indirect and cumulative impacts.

CEQ guidelines broadly define indirect impacts as those that are *"caused by the action and are later in time or further removed, but are still reasonably foreseeable"*. Indirect impacts are those normally associated with development that may result from the construction of a transportation improvement project, but differ from those impacts directly associated with the construction and operation of transportation project. Indirect impacts may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

CEQ guideline define cumulative impact as those "which result from the incremental consequences of an action when added to other past, present, and reasonably foreseeable future action regardless of what agency or person undertakes such actions". Cumulative impacts are, past, present, and future impacts, which when considered as a whole, result in a combined effect on the environment which is greater than the expected from considering these impacts in isolation.

### 6.18.1. Indirect Impact Assessment

Construction of a build alternative would encourage land development in the area south of the Cidra central business district. However, this area is identified in Cidra planning studies as an area programmed for urban expansion, and thus the highway impacts are not different from those already planned. The value of terrain south of the Cidra central business district may also increase as result of build alternative construction.

### 6.18.2. Cumulative Impact Assessment

Population

Socioeconomics studies indicate that the Cidra population is currently growing. The Puerto Rico Planning Board identifies Cidra as one of the municipalities with the highest rates of population growth, with an annual growth rate of 1.2%. Several residential developments in Cidra are currently in the planning and/or permitting process.

It is expected that Cidra population will continuously growing under the No Action alternative, and that the growth rate may accelerate with the construction of a build alternative.

Land Uses and Development Trend

Until the mid-20th century the predominant land use in the study area was agricultural. The area was deforested and was primarily planted with tobacco fields. Thereafter, the tobacco industry declined and agricultural land use changed to pasture and rural residential. Secondary forests began to grow in abandoned fields not converted to pasture. Current land uses along the new road corridors are predominately rural residential, secondary forest, and pasture.

Build Alternatives corridors are mostly located in Residential (R-0) land use zone, or designated as Common Rustic Land (CRL) in the Land Use Plan. Residential land use R-0 is characterized by single units houses located in parcels larger than 8,000 m2. Common Rustic Land refers to land in rural areas which has residential occupation. These classifications allow development within the area.

New residential and industrial developments proposed in the project area are Spring Hills and Parque Tecnológico, respectively. Additional new development should be expected in the study area for the forecast year 2028.

Infrastructure

Wastewater from Cidra and Cayey is treated at the Regional Wastewater Plant located in Rincón Ward, Cayey. This is a secondary plant with a treatment capacity of 4.28 MGD. The Puerto Rico Aqueduct and Sewer Authority has initiated improvements to the Wastewater Treatment Plant to increase treatment capacity from 4.28 MGD to 9.0 MGD.

The Puerto Rico Electrical Power Authority has initiated improvements to transmission lines in the study area and their capital improvements program includes improvement of the Cidra distribution system. Improvements to infrastructure in combination with build alternative construction will promote development in the area.

Planning

The Municipality of Cidra has prepared a strategic plan establishing the municipal development pattern to year 2050. This plan defines the infrastructures improvements necessary to accommodate the estimated 2050 population. Leisure and entertainment infrastructure are also proposed.

### 6.18.3. Summary

No indirect impacts are expected as result of the No Action alternative. All Build Alternatives would support development that will impact natural systems. Several public and private development initiatives are proposed for the municipality of Cidra, and in conjunction with construction of a new road, these would promote the further development of Cidra and will exert pressure on existing resources.

### 6.18.4. Mitigation Measures

The adverse effects of additional population growth and development may be minimized through comprehensive planning, enforcement of environmental protection laws and regulations, and

incorporation of new “green” development technologies and strategies which can progressively minimize the potential adverse impacts of continued urban growth.

## 6.19. Irreversible and Irretrievable Commitment of Resources

Irreversible commitments are those that cannot be reversed or are lost forever. Irretrievable commitments, on the other hand, are those that are lost for a period of time, usually for twenty years or longer, but are exchanged for the benefit of the community.

An irreversible commitment of resources is defined as the loss of future options. It applies primarily to non-renewable resources, such as minerals or cultural resources, and to those factors that are renewable only over long time spans, such as soil productivity.

Irretrievable commitments represent the loss of production, harvest, or use of renewable resources. These opportunities are foregone for the period of the proposed action, during which other resource utilization cannot be realized. These decisions are reversible, but the utilization opportunities foregone are irretrievable

There are no irreversible or irretrievable resource commitments associated with the No Action Alternative.

All build alternatives require a commitment of natural, human, and fiscal resources for planning, designing, constructing, and operating the road. The use of land for highway construction is an irretrievable commitment of resources by the project. Land used for the right-of-way would not be available for other uses. However, the project is consistent with local planning documents.

Construction of the project could involve the irretrievable use of wetlands, floodplains, land and other natural resource areas. These types of losses will be minimized or mitigated, according to federal and local regulations, to lessen the overall impact to the environment.

### 6.19.1. Permits

Federal and local permits and endorsements must be obtained to construct a new highway. These include, but are not limited to, the permits and consultation shown in Table 6.19-1. All necessary permits will be acquired prior to construction.

Table 6.19-1 Permits and Endorsement required for New Road Construction.

| Government Agency | Permit Or Endorsement | Applicable Law or Regulation |
|---|---|---|
| FHWA | National Environmental Policy Act | 40 CFR Parts 1500-1508 |
| USACE | Section 404(b)(1) Permit | Section 404 of the Clean Water Act |
| USFWS | Endangered Species Act | Section 7 Endangered Species Act |
| SHPO | Section 106 Consultation – Historic and Archaeological Resources | Section 106 of the National Historic Preservation Act |
| EPA | National Pollutant Discharge Elimination System<br>Farmland Protection Policy Act | Clean Water Act |
| FEMA | Federal Emergency Management Act | Flood Plain Protection |
| PREQB | Puerto Rico Environmental Public Policy Law | Law Number 416, September 22, 2004 |
| PRDNER | Tree Removal Permit<br>Extraction of Earth Crust Permit<br>EIS Endorsement | Regulation #25<br>Regulation 6916 |
| PRCI | Endorsement | Law Number 112, July 20, 1988 |
| PRASA | Utilities Relocation Endorsement | Law Number 40, May 1, 1945<br>Section 10 (22 LPRA & 150) |
| PREPA | Utilities Relocation Endorsement | Law Number 83, May 2, 1941<br>Section 14 (22 LPRA & 204) |
| PRPB | Endorsement | Law Number 75, June 24, 1975 |
| PMO | Construction Permit | Law Number 170, August 12, 1988 |
| PRAD | Endorsement | Law Number 60, April 25, 1940 |
| PRLA | Endorsement | Law Number 26, April 12, 1941 |
| PRSWA | Endorsement | Law Number 70, June 23, 1978 |
| CM | Project Endorsement | Law Number 81, August 30, 1991 |

# 7. ALTERNATIVES EVALUATION

## 7.1. Alternatives Assessment

This chapter evaluates the alternatives in accordance with several criteria such as traffic, environmental, social, cultural, economics and engineering aspects. This evaluation identifies the Preferred Alternative to improve the mobility from the municipality of Cidra to PRSHN.

The No Action Alternative and Build Alternatives were evaluated in accordance with established and available criteria. Table 7.1-1 compares and rates the principal engineering characteristics, environmental impacts and economics characteristics of each alternative. Ratings could be qualitative or quantitative. The qualitative ratings scale is high (H), moderate (M) or low (L). The quantitative evaluation consisted of a numerical value of area, length, volume, cost, or number of resources impacted along the corridors fringes.

Alternatives were evaluated using the following criteria:

Transportation

Planning studies performed by government agencies identified the necessity of a new road to connect Cidra CBD with the PRSHN. Transportation Studies indicate that existing traffic infrastructure operates deficiently and this condition will worsen if no action is taken. There is a general agreement among Cidra residents that existing roads which connects the municipality to the PRSHN are unsafe and inadequate and that a new road is needed.

Transportation studies indicate that the No Action Alternative is not a feasible option to manage the expected traffic in the future. This alternative does not address the purpose and need of the proposed project. Transportation studies results showed that all the alternatives that proposed the construction of a new road (Build Alternatives) could improve and manage transportation until the forecast year 2028. The build alternatives' Level of Services (LOS) is adequate and in combination with small improvement at existing intersections will improve the LOS of existing intersections when compared with the No Action Alternative. Among the new road options, build alternatives C-5, C-4 and C-3 attract more traffic. Build Alternative C-4 is not a feasible alternative because the propose interchange at PR-52 does not meet the AASHTO minimum interchange spacing with existing PR-52/PR-184 interchange.

Capital Investment

Due to the actual economic situation, capital investment is one the principal criteria used to evaluate the alternatives. Capital investment is not required for No Action Alternative implementation. New road implementation will use federal and local funds. Build Alternative C-3 has the lower implementation cost, meanwhile Build Alternative C-5 has the higher implementation cost. The magnitude of the benefit/cost for the new road alternative is basically equal, with a slightly higher ratio for Build Alternative C-3.

Impacts to Communities

Impacts to communities as results of the No Action Alternative are expected to be primarily an increase in traffic congestion and higher potential for accidents. Based on the analysis performed for the project, the build alternative that required the lowest residential acquisition is Build Alternative C-3, followed by Build Alternative C-2. Build Alternative C-1 would have the highest number of properties acquisition.

Environmental Impacts

The No Action Alternative will have minimum impact to environment. There is not a significant difference in the magnitude, in total, of the environmental impacts of the build alternatives. Build Alternative C-5 would have the greatest impact to wetlands; meanwhile Build Alternative C-1 would have the lower. Build Alternative C-5 is the only alternative that would impact a regulatory flood zone. Build Alternative C-1 has the potential to impact a parkland. Build Alternative C-3 would have the greatest impact to Plain Pigeon Potential Habitat; meanwhile Build Alternatives C-4 and C-1 would have the lowest. Build Alternatives C-1 and C-5 will have the greatest impacts in archaeological resources; meanwhile Build Alternative C-3 and C-4 would have the lowest. Build Alternative C-1 would have the greatest impact in forest areas; meanwhile Build Alternative C-4 would have the lowest. Build Alternative C-5 would have the highest number of sensitive receptors with noise levels exceeding NAC; meanwhile Build Alternatives C-1, C2 and C-3 would have the lowest. Build Alternatives would provide a saving in fuel consumption.

Engineering Characteristics

Build Alternative C-5 is the longest alternative; meanwhile Build Alternative C-4 is the shortest. Build Alternatives C-5 and C-4 would require the greatest cut, which creates its high quantity of surplus material. Build Alternative C-5 would require the construction of three bridges over water bodies; meanwhile Build Alternative C-3 would not require bridges over water bodies. Right of Way of all build alternatives are comparable in magnitude. Build Alternative C-3 would require five overpasses or underpasses across existing roads; meanwhile Build Alternatives C-1 and C-5 would only require three.

Table 7.1-1 Alternatives Comparison Table.

| Parameter | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C-1 | C-2 | C-3 | C-4 | C-5 |
| Engineering Characteristics a/ | | | | | | |
| Length (km) | N/A | 7.06 | 7.59 | 7.04 | 6.9 | 7.31 |
| Cut Volume (m3) b/ | 0 | 2,728,973 | 2,480,897 | 2,602,693 | 3,268,629 | 3,281,010 |
| Fill Volume (m3) b/ | 0 | 1,411,369 | 1,606,745 | 936,874 | 617,060 | 648,477 |
| Surplus (m3) c/ | 0 | 1,317,604 | 874,152 | 1,665,819 | 2,651,568 | 2,632,533 |
| Bridges over Water Bodies | 0 | 2<br>Río Sabana/<br>Río Clavijo | 1<br>Río Sabana | 0 | 2<br>Unnamed Creek/<br>Quebrada Beatriz | 3<br>Unnamed Creek/<br>Quebrada Beatriz/<br>Río Guavate |
| Water Crossings (Culverts) | 0 | 23 | 30 | 27 | 16 | 15 |
| Bridges over Existing Roads | 0 | 2<br>Municipal Road (Sector Los Pinos)/<br>PR-7787 (Sapera Community) | 2<br>Municipal Road (Sector Los Pinos) /<br>PR-7787 (Sapera Community) | 2<br>Municipal Road (Sector Los Pinos)/<br>Municipal Road (Sapera Community) | 1<br>Municipal Road (Sector Los Pinos) | 1<br>Municipal Road (Sector Los Pinos) |
| Bridges at Existing Roads | 0 | 1<br>PR-734 | 2<br>PR-734 /<br>Municipal Road (Sector Luisa Rolón) | 3<br>PR-734 /<br>Municipal Road (Monticello Community) / Municipal Road (Sector Luisa Rolón) | 3<br>PR-734 / Municipal Road (Monticello Community) / Brisas de Beatriz | 2<br>PR-734 / Municipal Road (Monticello Community) |

| Parameter | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C-1 | C-2 | C-3 | C-4 | C-5 |
| Corridor (cdas) | 0 | 225 | 235 | 219 | 214 | 233 |
| CDD ROW (cdas) a/ | 0 | 124 | 129 | 119 | 112 | 118 |
| Implementation Cost | | | | | | |
| Construction | 0 | 93.7 | 88.6 | 74.8 | 90.9 | 98.9 |
| Mitigation d/ | 0 | 23.4 | 25.1 | 22.5 | 18.9 | 21.6 |
| Acquisition f/ | 0 | 22.1 | 20.8 | 20.4 | 21.7 | 20.9 |
| Total Cost | 0 | 139.2 | 134.5 | 117.7 | 131.5 | 141.4 |
| B/C | | 2.03 | 2.26 | 2.38 | 1.96 | 1.69 |
| Impacts to Existing Infrastructure | | | | | | |
| PRASA Utilities | 0 | Distribution lines (13.2 kV or lower) | Distribution lines (13.2 kV or lower) | Distribution lines (13.2 kV or lower) | Distribution lines (13.2 kV or lower) | Distribution lines (13.2 kV or lower) |
| PRASA Utilities | 0 | 5 pipelines (2”, 3-4”, 6” dia.) | 5 pipelines (4” dia.) | 5 pipelines (5-4” dia.) | 3 pipelines (3-4” dia.) | 3 pipelines (3-4” dia.) |
| Transportation Studies Impacts | | | | | | |
| Percent of Total Trips Attracted (AM) | N/D | 24.5 | 20.4 | 24.53 | 23.4 | 29.7 |
| Percent of Total Trips Attracted (PM) | N/D | 17.1 | 13.9 | 16.5 | 22.0 | 22.7 |
| Number of Intersection with LOS less than D (AM, 2018) | 8 | 4 | 4 | 4 | 2 | 2 |
| Number of Intersection with LOS less than D (PM, 2018) | 5 | 3 | 3 | 3 | 1 | 1 |

| Parameter | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C-1 | C-2 | C-3 | C-4 | C-5 |
| Number of Intersection with LOS less than D (AM, 2028) h/ | 8 | 1 | 1 | 1 | 1 | 0 |
| Number of Intersection with LOS less than D (PM, 2028) h/ | 10 | 0 | 0 | 0 | 1 | 1 |
| Impacts to Communities | | | | | | |
| Properties Affected (by use) | 0 | 85 residential, 12 agriculture, 7 commercial, 3 industrial, 2 residential/agriculture, 2 institutional, 22 unclassified | 81 residential, 7 agriculture, 7 commercial, 3 industrial, 2 residential/agriculture, 1institutional, 24 unclassified | 85 residential, 9 agriculture, 7 commercial, 4 industrial, 2 residential/agriculture, 1institutional, 25 unclassified | 82 residential, 6 agriculture, 3 industrial, 2 residential/agriculture, 1institutional, 28 unclassified | 76 residential, 9 agriculture, 3 industrial, 2 residential/agriculture, 1institutional, 25 unclassified |
| Residences to be Acquired | 0 | 69 | 56 | 54 | 56 | 55 |
| Commercial Structures to be Acquire | 0 | 7 | 7 | 7 | 0 | 1 |
| Economics | L | H | H | H | H | H |
| Communities Cohesion | N/I | H | M | M | M | M |
| Land Use Impacts | | | | | | |
| Land Uses/Land Cover | N/I | L | L | L | L | L |
| Farmland | N/I | Tres Monjitas | Tres Monjitas | Tres Monjitas | Tres Monjitas | Tres Monjitas |
| Visual | N/I | M | M | M | M | M |
| Environmental Impacts | | | | | | |
| Aquifers (acres) | N/I | L | L | L | L | L |

| Parameter | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C-1 | C-2 | C-3 | C-4 | C-5 |
| Regulatory Flood Zones | N/I | N/I | N/I | N/I | N/I | Río Guavate |
| Wetland (acres) | N/I | 5.77 | 5.13 | 12.33 | 11.93 | 13.02 |
| Parkland | N/I | 1 g/ | 0 | 0 | 0 | 0 |
| Plain Pigeon Potential Habitat Direct Impact (acres) | N/I | 100.79 | 111.23 | 119.39 | 100.67 | 101.08 |
| Plain Pigeon Potential Habitat Indirect Impact (acres) | N/I | 196.05 | 224.33 | 229.91 | 163.58 | 170.6 |
| Archaeological | N/I | (1)Near Cerro del Bohíque. Monitoring recommend during construction.<br>(2) Impacted Batey. Phase II recommended.<br>(3) Isolated find H-2. Monitoring recommend during construction. | (1)Near Cerro del Bohíque. Monitoring recommend during construction.<br>(2) Isolated find H-2. Monitoring recommend during construction. | No significant archaeologist resource founded. | No significant archaeologist resource founded. | (1) Pre-Columbian residuary. Phase II recommended.<br>(2) Colonial residuary. Phase II recommended. |
| Tree Inventory | N/I | 171,771 | 185,467 | 155,520 | 128,230 | 146,668 |

| Parameter | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | No Action | C-1 | C-2 | C-3 | C-4 | C-5 |
| Noise (Number of Representative Receptors with Noise Levels Approaching or Exceeding NAC / Number with substantial Increase in Noise) | N/I | 2 / 8 | 2 / 7 | 1 / 7 | 1 / 10 | 3 / 11 |
| Air Quality | N/I | N/I | N/I | N/I | N/I | N/I |
| Energy | N/I | FCINS | FCINS | FCINS | FCINS | FCINS |

a/ – Based on EIS Conceptual Design Drawings.
b/ – Without shrinkage or expansion factor.
c/ - Surplus material could be reduced during design stage when more detail information is available.
d/ - Works required to mitigate environmental impacts.
e/ - Summation of Construction and Mitigation.
f/ - Includes acquisition and relocation cost.
g/- Potential Impact to Cerro el Bohique.
h/ - Includes existing roads intersections improvements
N/I - No Impact
N/D – Not Determine
N/A – Not Apply
FCINS – Fuel Consumption Impact Not Significantly

## 7.2. Preferred Alternative

The information compiled and studies undertaken were used to compare the various alternatives. The No Action Alternative is not a prudent alternative to manage the expected traffic in the future. There is not a significant difference in the environmental impacts, in total, between the Build Alternatives. However, Build Alternative C-3 shows a slightly less environmental impact and has the lowest implementation cost and higher benefit/cost ratio. To summarize, Build Alternative C-3: the preferred alternative:

- Provides the second shortest route and has the lowest capital cost;
- Avoids the construction of any bridges over water bodies;
- Minimizes cultural resource impacts;
- Impacts 19% more plain pigeon habitat than the lowest-impact alternative; and
- Is equal to build alternative C-2 in having the lowest noise impacts.

# 8. COORDINATION

During the last 13 years an improvement to the transportation system between Cidra and the PRSHN has been discussed between government agencies and the public. The PRHTA has held several informative workshops and public hearings in which the public and communities had the opportunity to discuss studies and provide input regarding the alternative evaluation process. Government agencies have also been consulted regarding project development.

As part of the development of this DEIS, comments from the public and government agencies were requested regarding the purpose and need for the proposed project, project alternatives, alternatives evaluation process, and the level of analysis for the alternatives.

## 8.1. SAFETEA-LU

A coordination plan pursuant to Section 6002 of Public Law 109-59, "Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users" (SAFETEA-LU) was prepared as part of the environmental review process. The coordination plan guided the participation and comments from the public and government agencies. Appendix Q contains a copy of the coordination plan (Version 2.0).

As part of the environmental review process the FHWA and the PRHTA are designated as the Lead and Joint Lead Agency, respectively. Cooperating Agencies are the USACE, USFWS, SHPO and EPA. Participating agencies that accepted the invitation from FHWA are the Municipality of Cidra, PRDNER, PREQB, PRPB and the PRCI.

Two informative meetings and two interagency meeting were held as part of the coordination process. Informative meetings were held in Cidra where PRHTA representatives explained the project purpose and need, alternatives, and proposed schedule. The public expressed their comments during these meetings, and a total of seven written comments were received after the meetings. There is general agreement among Cidra residents that the existing roads that connect the municipality to the PRSHN are unsafe and inadequate and that a new road is needed. The community concerns largely revolve around the alternative to be selected.

Interagency meetings were held at PRHTA facilities. During these meetings agencies had the opportunity to become familiar with and comment on the project purpose and need, project alternatives, and implementation schedule. Methods to be used in evaluating alternatives were discussed with government agencies, who in turn offered comments and suggestions.

The FHWA and the PRHTA reviewed comments and suggestions made by the public and the government agencies, and modifications were made to the alternatives based on this review. The comments made during the first meetings were addressed in the current coordination plan (Version 2.0). This coordination plan may be further amended as the study develops.

## 8.2. Government Agencies Consulted

Table 8.2-1 summarizes the coordination performed between the FHWA, PRHTA and government agencies. Appendix R includes communication between agencies, and additional data obtained from agency web sites.

Table 8.2-1 Summary of coordination with Government Agencies.

| Agency | Coordination |
|---|---|
| USACE | Cooperating Agency. Indicated that project shall comply with Section 404 (b) (1) of Clean Water Act. |
| USFWS | Cooperating Agency. Indicated the need to evaluate possible impact to the Puerto Rico plain pigeon habitat. Provided ideas for water crossing configurations. |
| SHPO | Cooperating Agency. Phase 1A and Phase 1B reports were submitted for consultation. A Phase 1B addendum was prepared to attend SHPO comments. |
| EPA | Cooperating Agency. Provided information relevant to the project. |
| PRDTOP | Provided information relevant to the project. |
| PRDNER | Participating Agency. Issued comments and observations regarding the proposed build alternatives. Indicated the need to evaluate possible impact to the Puerto Rico plain pigeon habitat. |
| PRASA | Provides potable water and wastewater infrastructure within the study area. |
| PREPA | Provided information on 230KW and 115KW power transmission lines. Provided information relevant for future PREPA projects in the study area. |
| PRPB | Participating Agency. Provided information on proposed development in the study area. Indicated that Cidra POT should be amended to incorporate the Preferred Alternative. |
| PRPRA | Provided information of proposed development in the study area. |
| PREQB | Participating Agency. |
| PRSWA | Provides information relevant to the project. |
| PRCI | Participating Agency. Phase 1A and Phase 1B reports were submitted for consultation. Comments were issued by PRCI and answered. |
| Cidra Municipality | Participating Agency. Provides information relevant to the project. |
| Cayey Municipality | Provides information relevant to the project. |
| PRMTC | Provides information relevant to the project. |

## 8.3. DEIS Availability

A Notice of Availability for the DEIS will be published in the Federal Register. This notice establishes a period of at least 45 days for the receipt of comments on the DEIS.

### 8.3.1. DEIS Distribution

A copy of the DEIS was sent to government agencies as indicated in Chapter 11. The document will be available for review by the public at the following locations:

- FHWA, Virginia Division, 400 North 8th Street, Richmond, VA
- FHWA, Puerto Rico Division, 350 Ave Carlos Chardon Suite 210 San Juan, PR
- PRHTA Central Office, Centro de Gobierno Roberto Sánchez Vilella, Edificio Sur, Ave. De Diego, Santurce, Puerto Rico
- PREQB Central Office, Carretera 8838, km. 6.3, Sector El Cinco, Río Piedras, Puerto Rico
- Cidra Municipality City Hall
- PRDTPW web page: www.dtop.gov.pr

### 8.3.2. Public Hearings

A public hearing will be held to provide the public the opportunity to learn about the project, ask questions, and provide comments orally or in writing on the DEIS or other aspects of the project. The hearing will be held in the Municipality of Cidra. The date and location of public hearing will be published in a newspaper having island-wide circulation.

# 9. LIST OF PREPARES

This section lists the persons involved in the preparation of this document.

**John Simkins**
FHWA
Senior Environmental Specialist

Mr. Simkins is the FHWA Project Manager. He is responsible for review of the Draft EIS and provides overall supervision of the environmental review process. He ensures that the environmental review process complies with FHWA guidelines and NEPA requirements. Mr. Simkins holds a Bachelor of Science degree in Biology and a Master of Science degree in Environmental Sciences.

**Luis E. Rodríguez**
PRHTA
Director Programming and Special Studies Area

Mr. Rodriguez is the PRHTA Project Manager. He is responsible for evaluation of the Draft EIS and supervises the environmental evaluation process. He ensures the environmental process complies with PRHTA and FHWA guidelines, and with NEPA requirements. He has previous experience with infrastructure projects, including EIS prepared for the Hatillo Aguadilla Corridor (PR-22 Extension) and for PR-53. Mr. Rodríguez holds a Bachelor of Science degree in Civil Engineering.

**Carmen G. Alicea**
PRHTA
Chief Environmental Studies Office

Ms. Alicea provides suggestions and recommendations during Draft EIS preparation. She ensures the environmental process complies with PRHTA and FHWA guidelines, and with NEPA requirements. She has previous experience with infrastructure projects including EIS prepared for Hatillo Aguadilla Corridor (PR-22 Extension) and PR-53. Ms. Alicea holds a Bachelor of Science degree in Civil Engineering and a Master of Science degree in Environmental Engineering.

**Rafael Rosa**
Gregory L. Morris Engineering
Project Manager

Mr. Rosa is the consultant's Project Manager. He is responsible for conceptual engineering and evaluation of alternatives. He developed the Draft EIS document, supervises the professional team that participated in the environmental evaluation process and performed environmental analysis and evaluations. He has previous experience with design of infrastructure projects and participated in the preparation of EIS documents for offstream reservoirs and associated

infrastructure at Río Fajardo, Río Blanco, and Quebrada Beatriz, plus environmental documents for both urban and industrial development activities. Mr. Rosa holds a Bachelor of Science degree in Civil Engineering and a Master of Science degree in Water Resources Engineering.

**Gregory L. Morris**
Gregory L. Morris Engineering
QC/QA Manager

Dr. Morris performed the QC/QA for the Draft EIS document. He has over 35 years of experience evaluating and preparing environmental documents for local and international government agencies and the private sector. His experience includes preparation of EIS documents for offstream reservoirs and associated infrastructure at Río Fajardo, Río Blanco, Quebrada Beatriz, plus documents for both urban and industrial development activities. Dr. Morris holds a Bachelor of Science, Master's degree in Environmental Engineering, and a Doctorate in Environmental Engineering.

**Dianys Arocho**
Gregory L. Morris Engineering
Engineer in Training

Ms. Arocho coordinates the conceptual design of alternatives. Her duties include environmental analyses and production of graphic support to the Draft EIS. Ms. Arocho holds a Bachelor of Science degree in Civil Engineering.

**Hector E. Quintero**
Oikos Environmental Services
Biological Assessment

Mr. Quintero performed the Biological Assessment in the study area. His consulting firm has performed more than a 100 studies covering marine, aquatic and terrestrial ecosystems. He prepared the Cumulative Environmental Impact for PR # 66 and the Vegetation Study for PR-10 between Utuado and Adjuntas. Mr. Quintero has a Doctoral degree in Ecology.

**Pedro Rivera**
EcoAventuras Environmental Consultants
Jurisdictional Determination and Tree Inventory

Mr. Rivera performed the wetland Jurisdictional Determination and Tree Inventory within the study area. He has performed local and international evaluations and has performed Jurisdictional Determinations and Tree Inventories for other PRHTA projects. Mr. Rivera holds a Doctoral degree in Forestry.

**Heidi Calero**
H. Calero Consulting Group
Economist

Ms. Calero managed the SocioEconomics evaluations performed for the project and performed the Benefit/Cost Analysis of the evaluated alternatives. Her experience includes extensive economic analysis for both government agencies and the private sector. Ms. Calero holds Bachelor of Administration degree in Economics, a Master's degree in Economics, and a Juris Doctor degree.

**Evans González**
EFGB Consulting Engineers
Traffic Engineer

Mr. González managed the traffic field studies and performed the traffic analysis for the project. His experience includes traffics studies for Cayo Largo Hotel and several docks in San Juan Bay area. Mr. González holds a Bachelor of Science degree in Civil Engineering and a Master of Science degree in Traffic Engineering.

**Jaime Vélez**
Arqueoconsultoría
Arqueologist

Mr. Vélez performed cultural resource investigations and studies for the project. His consulting firm has performed more than a 100 archaeological studies for government agencies and the private sector. Mr. Vélez holds a Bachelor's degree in Archaeology form the National School of Anthropology and History, Mexico F.D.. He has a Master in Arts specialized in Puerto Rico and the Caribbean from the Centro de Estudios Avanzados de Puerto Rico y el Caribe.

**Luis Berríos**
Luis Berríos & Associates
Surveyor

Mr. Berríos managed and coordinated field survey data used in the project. He has 30 years of experience, including several prior PRHTA projects. Mr. Berríos holds a Bachelor's degree in Land Surveying.

**David Moreno**
Moreno Associates
Noise Evaluations

Mr. Moreno performed noise analyses and evaluations for the project. He has participated in several prior noise analyses studies including PR-60, Tren Urbano, and PR-199. Mr. Moreno holds a Bachelor of Science degree in Chemical Engineering.

**Ana M. Veitía**
MAG
Properties Appraiser

Ms. Veitía evaluated the probable acquisition cost of each alternative identified in the Draft EIS. Her prior experience includes the preparation of the probable acquisition cost estimates for the Hatillo Aguadilla Corridor (PR-22 Extension). She holds a Bachelor degree in Business Administration.

**Luis Benabe**
The Marketing Center
Community Poll

Mr. Benabe performed the socioeconomic poll in the study area. He has previously participated in the Tren Urbano transportation study. He holds a Bachelor degree in Mathematics, Master's degree in Business Administration and a Doctoral degree in Marketing.

**Alejandro E. Soto/Carlos García**
GeoCim
Geologist/Geotechnical Engineer

Mr. Soto and Mr. García prepared the geologic and geotechnical evaluation of the study area. They have extensive experience in highway geological and geotechnical studies and have performed several prior studies for the PRHTA. Mr. Soto has a Master of Science degree in Engineering Geology and Mr. García has a Master of Science degree in Civil Engineering.

## 10. List of Agencies, Organizations, and Persons to Whom Copies of the DEIS are Sent

A copy of the DEIS is being circulated to the following federal government agencies for their review and comment:

| Addressee | Agency | Location |
|---|---|---|
| Carl-Axel Soderberg | US Environmental Protection Agency | San Juan, PR |
| Sindulfo Castillo | US Army Corps of Engineers | San Juan, PR |
| Edwin Muñíz | U S Fish and Wildlife Service | Cabo Rojo, PR |
| Carlos A. Rubio | State Historic Preservation Office | San Juan, PR |
| Edwin Almodóvar | Natural Resources Conservation Service | San Juan, PR |

A copy of the DEIS is being circulated to the following state government agencies and entities for their review and comment:

| Addressee | Agency/Entity | Location |
|---|---|---|
| Rubén A. Hernández | Department of Transportation and Public Works | San Juan, PR |
| Rubén A. Hernández | Highway and Transportation Authority | San Juan, PR |
| Pedro J. Nieves | Environmental Quality Board | San Juan, PR |
| Daniel J. Galán | Department of Environmental and Natural Resources | San Juan, PR |
| Alexis J. Rivera | Institute of Culture | San Juan, PR |
| Leslie Hernández | Planning Board | San Juan, PR |
| Miguel A. Cordero | Electrical and Power Authority | San Juan, PR |
| José F. Ortiz | Aqueduct and Sewer Authority | San Juan, PR |
| Frederick Mulach | Land Authority | San Juan, PR |
| Javier A. Rivera | Department of Agriculture | San Juan, PR |

| Addressee | Agency/Entity | Location |
|---|---|---|
| Enrique Ortiz de Montelkeno | Telephone Company | San Juan, PR |
| Elí Díaz Atienza | Solid Waste Authority | San Juan, PR |
| Ivan Casiano | Land Administration | San Juan, PR |
| Lorenzo González | Department of Health | San Juan, PR |
| Yesef Y. Cordero | Department of Housing | San Juan, PR |
| José Pérez | Industrial Development Company | San Juan, PR |
| Pedro I. Cintrón | House of Representatives | San Juan, PR |

A copy of the DEIS is being circulated to the following municipal government entities for their review and comment:

| Addressee | Entity | Location |
|---|---|---|
| Angel Malavé | Municipality of Cidra | Cidra, PR |
| Rolando Ortíz | Municipality of Cayey | Cayey, PR |
| Eduardo Carrasquillo | Municipality of Cidra | Cidra, PR |

A copy of the DEIS is being circulated to the following members of the general public:

| Addressee | Entity | Location |
|---|---|---|
| Juanita García | Comite Despertar Cidreño | Apartado 11998 Suite 167, Cidra PR 00739 |
| Norma Rivera | Comunidad San José por el Ambiente | 61 Sector San José, Cidra PR 00739 |
| Victor Cabello | Consejo Directivo de la Asociación para el Rescate y Conservación de Monumentos Indígenas de Puerto Rico | Apartado 1231, Cidra PR 00739-1231 |
| Diana Valldejulli | Comité Pro Buen Juicio Comunidad Sapera | PO Box 1391, Cidra PR 00739 |
| Thomas J. Trebilcock | Cidra Inc. (Tres Monjitas Dairy) | Apartado 366266, San Juan PR 00936-6266 |

# INDEX

## W

# DRAFT-Environmental Impact Statement
# Cidra Corridor from Cidra Industrial Street to PR-52

## Figures

U.S. Department of Transportation
Federal Highway Administration

AUTORIDAD DE CARRETERAS Y TRANSPORTACION

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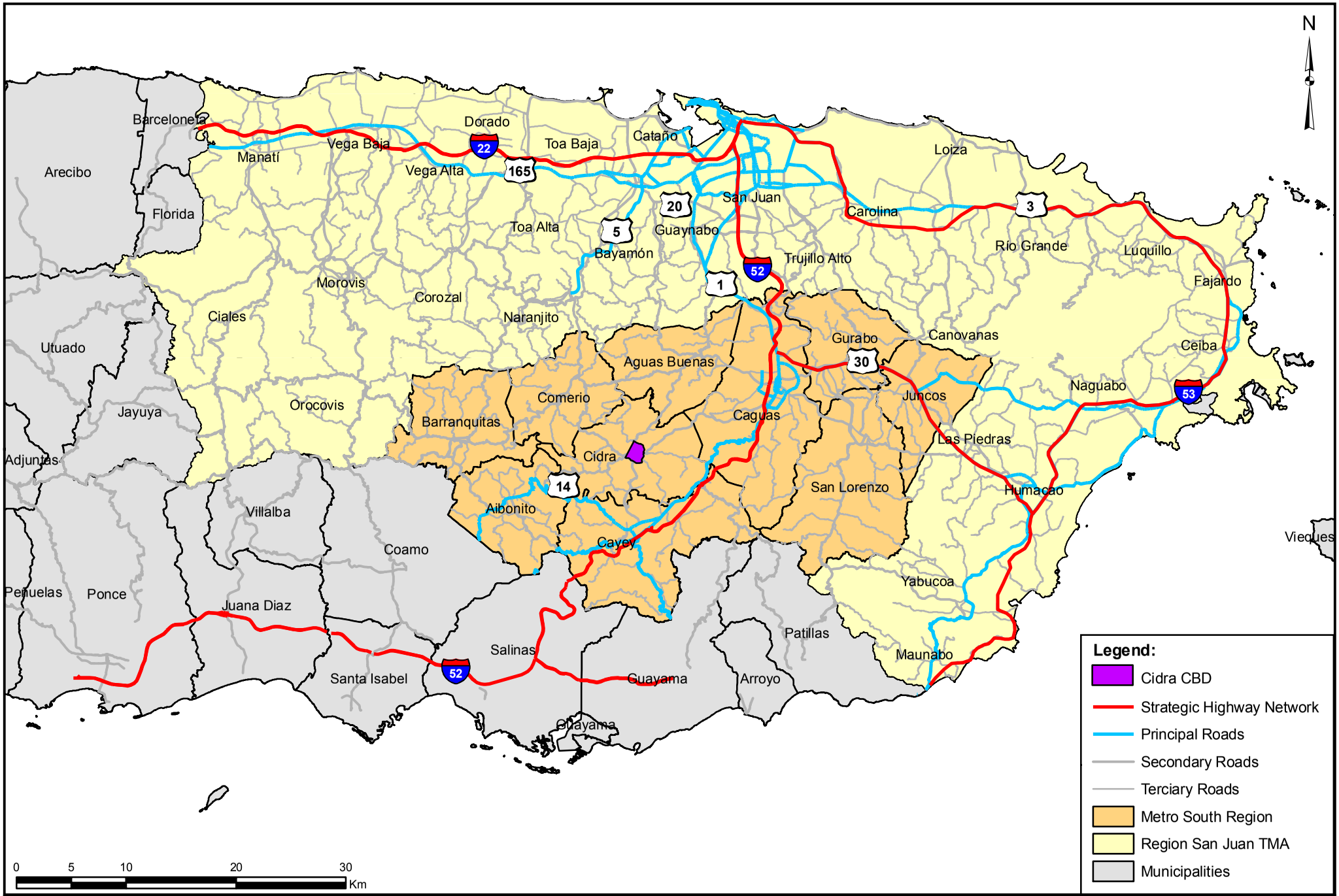
Figure 1. Geographic Location of Puerto Rico.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: ESRI Maps


Figure 2. Location of Cidra and Cayey in Puerto Rico Map.
(Not to scale)

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT




U.S. Department of Transportation
Federal Highway Administration

Figure 3. Location of Cidra CBD and Transportation Network in the Metro South Region.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREETTO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Puerto Rico 2030 Long Range Transportation Plan

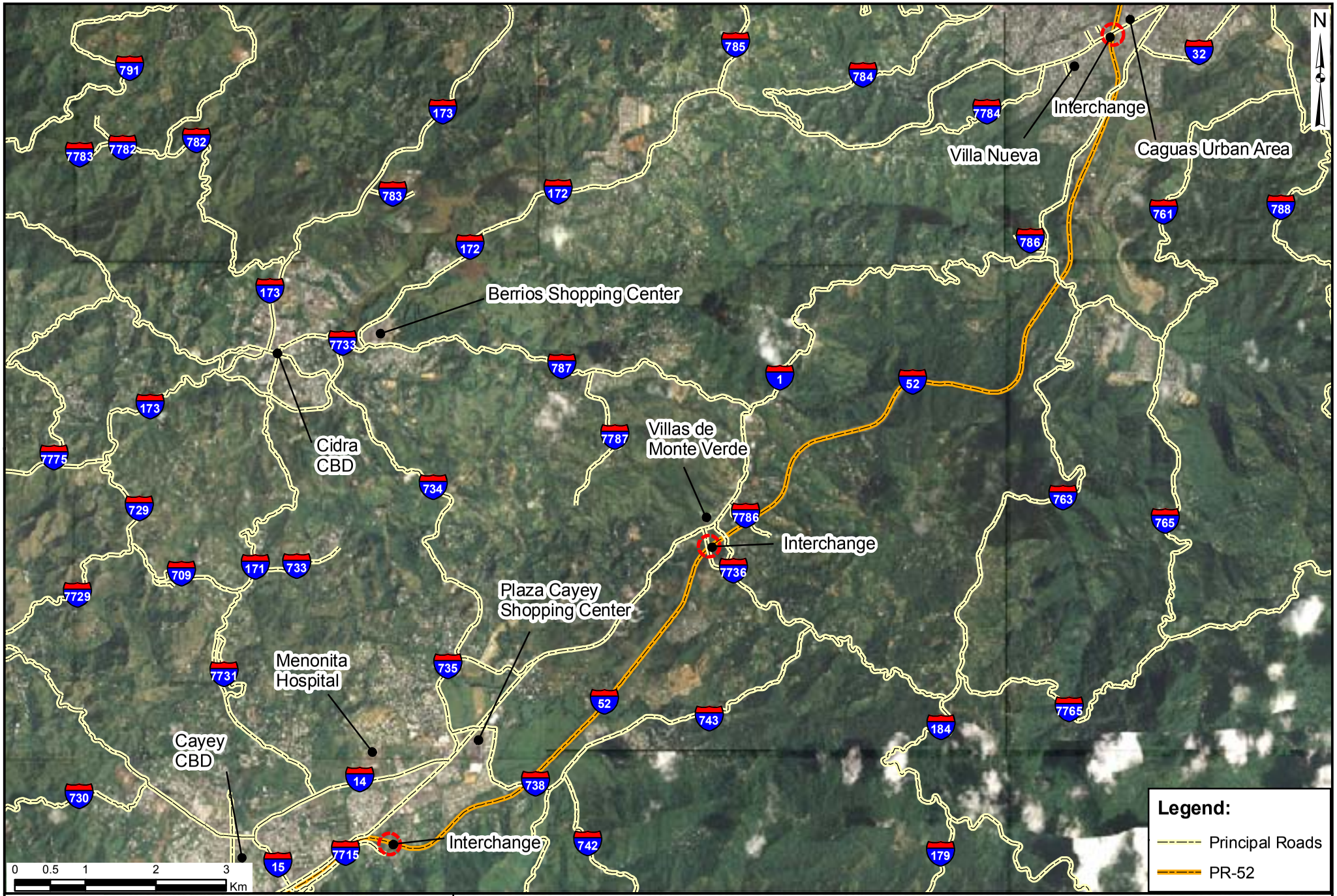



Figure 4. Existing Cidra CBD Access Roads from PR-52.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRHTA

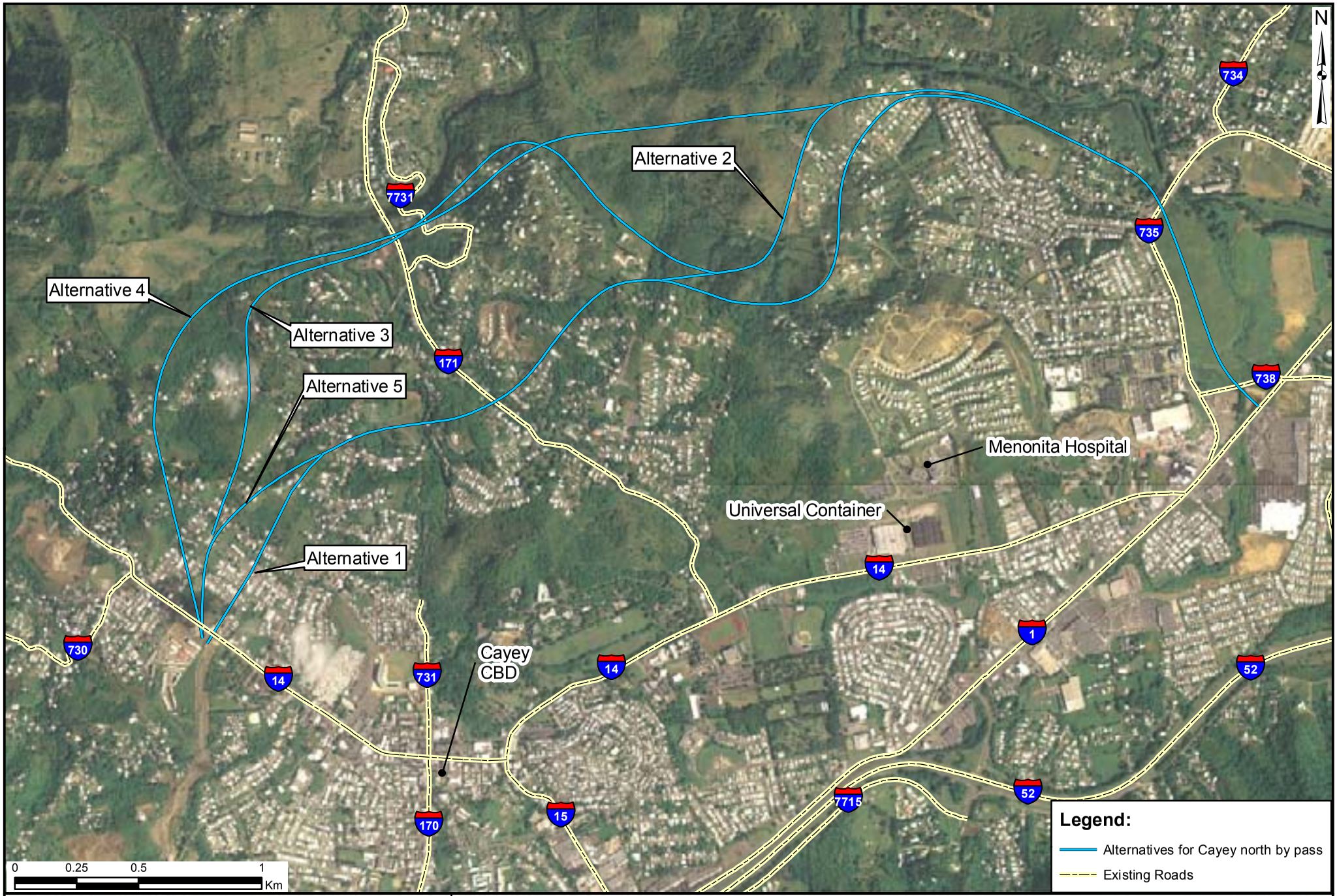



Figure 5. Cayey North By-Pass Preliminary Alternatives.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRHTA

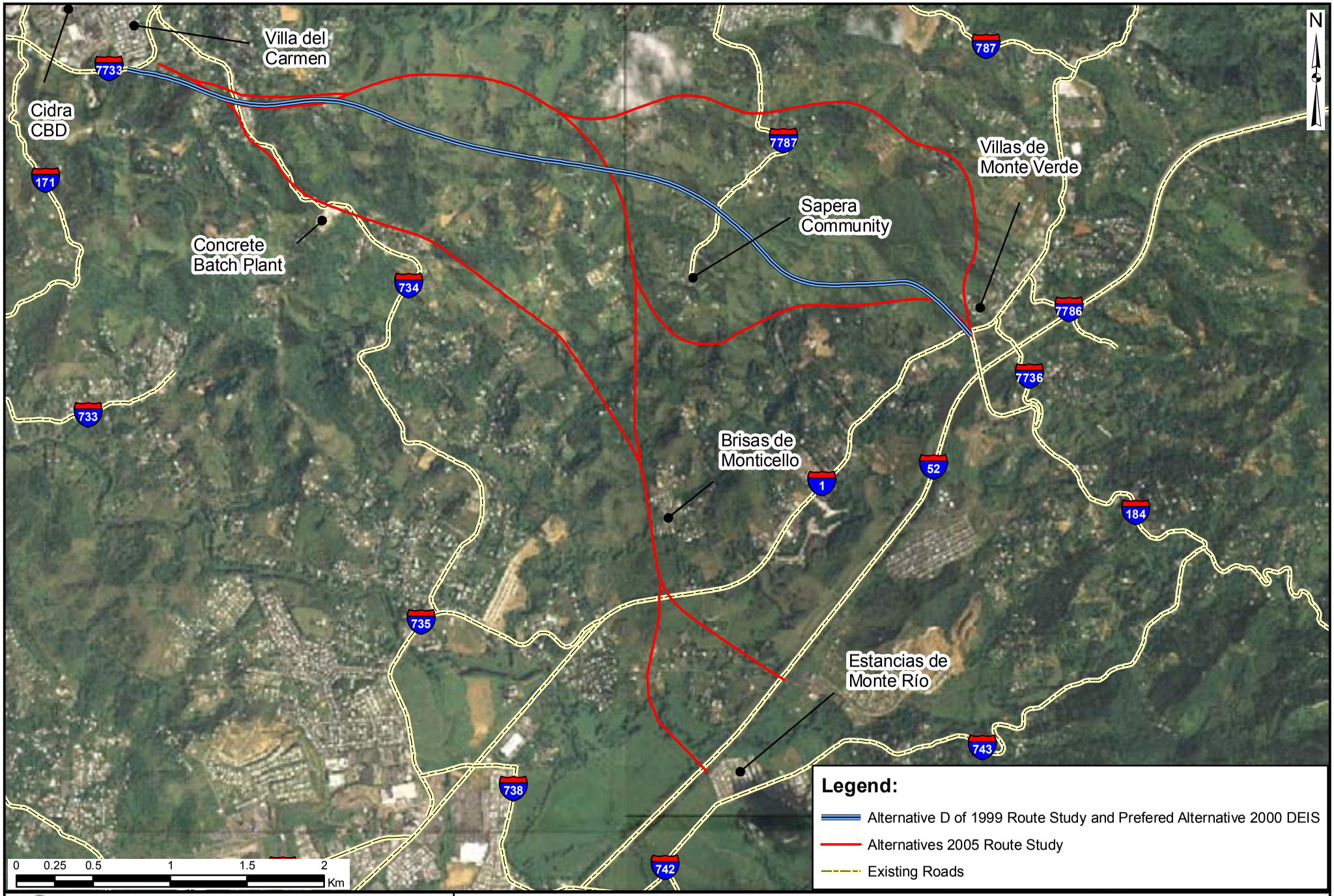



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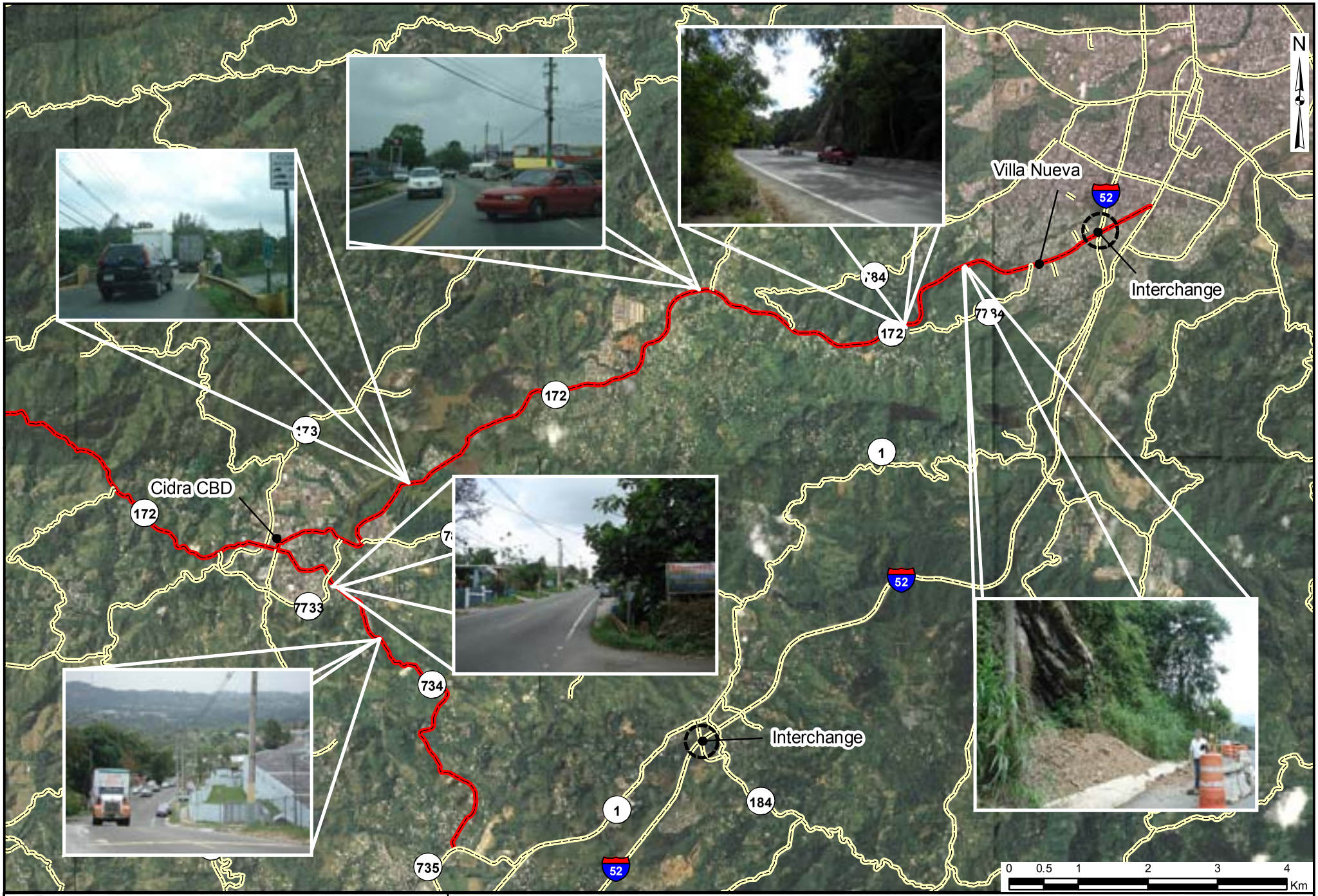
Figure 6. Previous Studies Road Alternatives.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRHTA

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ACT

GLM MORRIS ENGINEERING

Figure 7. PR-172 and PR-734 Photos.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

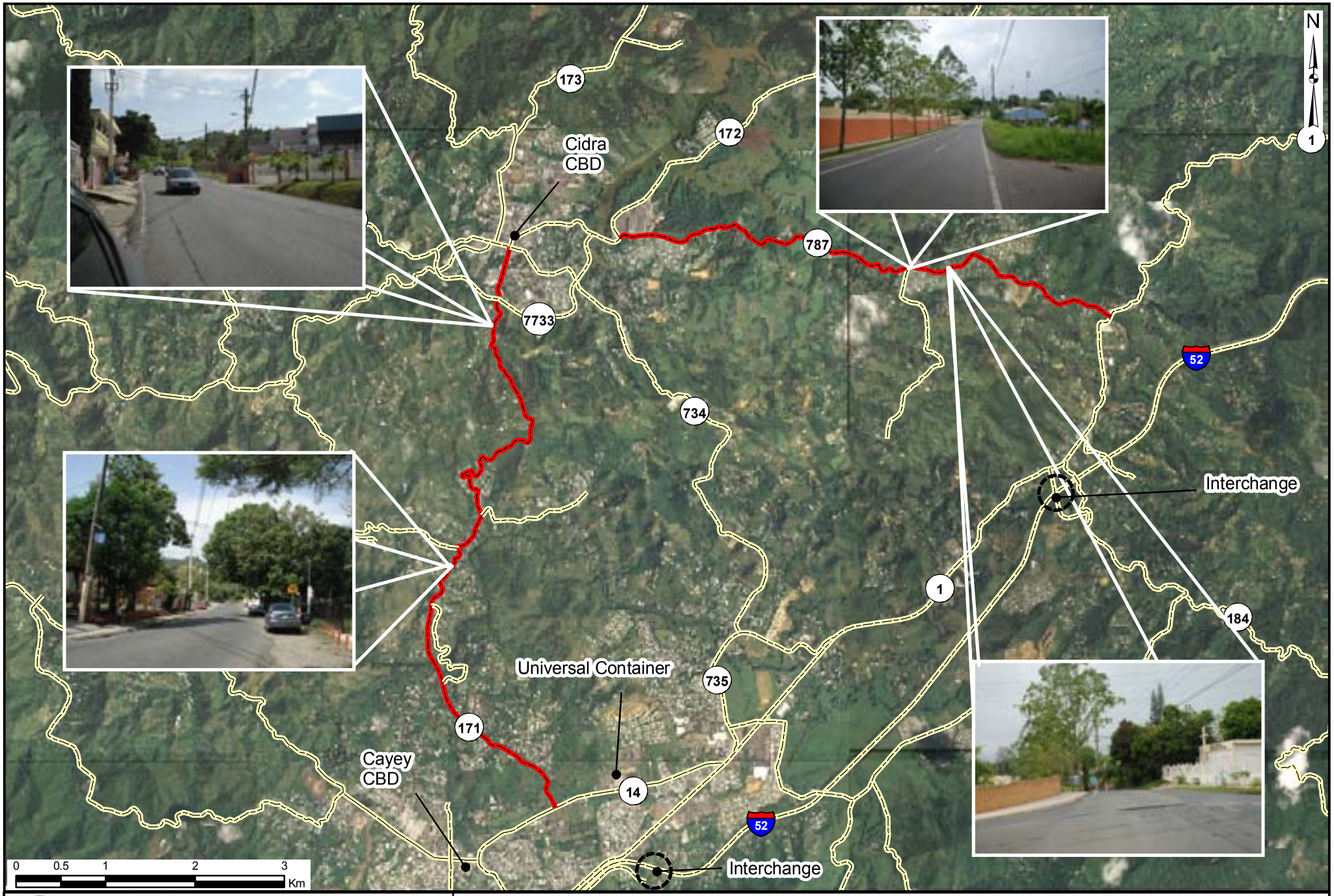


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Figure 8. PR-171 and PR-787 photos.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

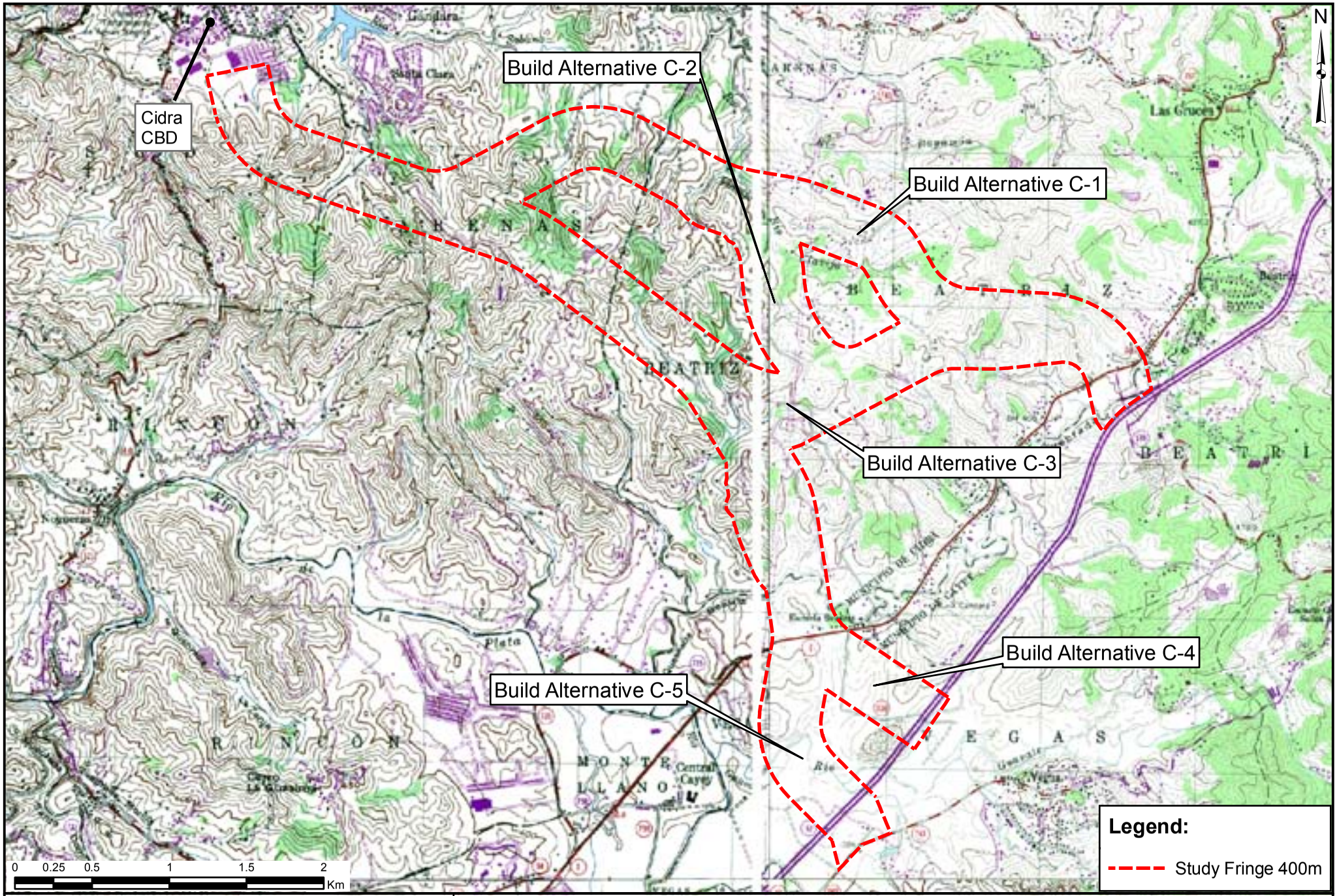


Figure 9. Location of the 400 m Study Fringe in USGS Topographic Map.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

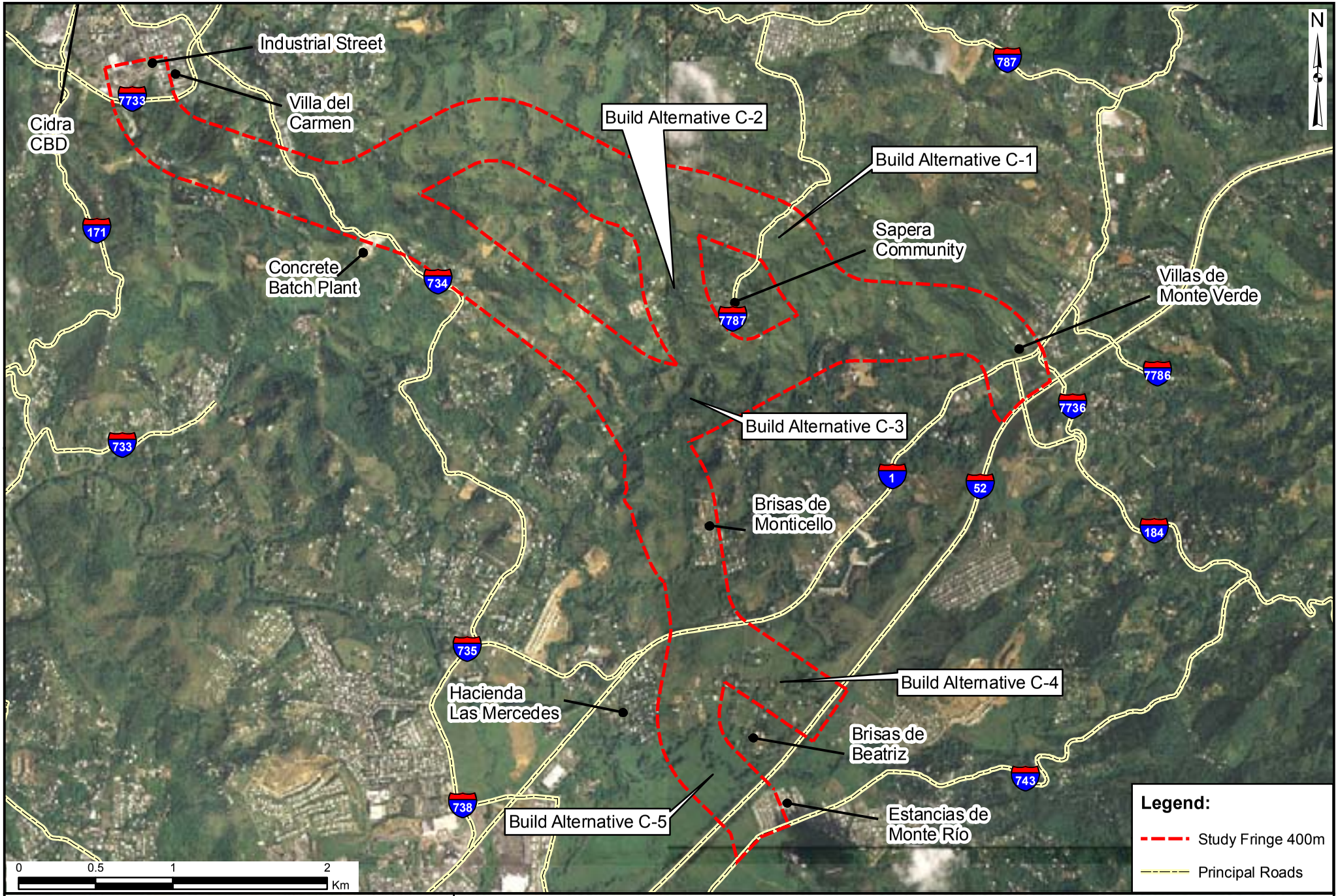


Figure 10. Location of the 400 m Study Fringe in 2007 Aerial Photo.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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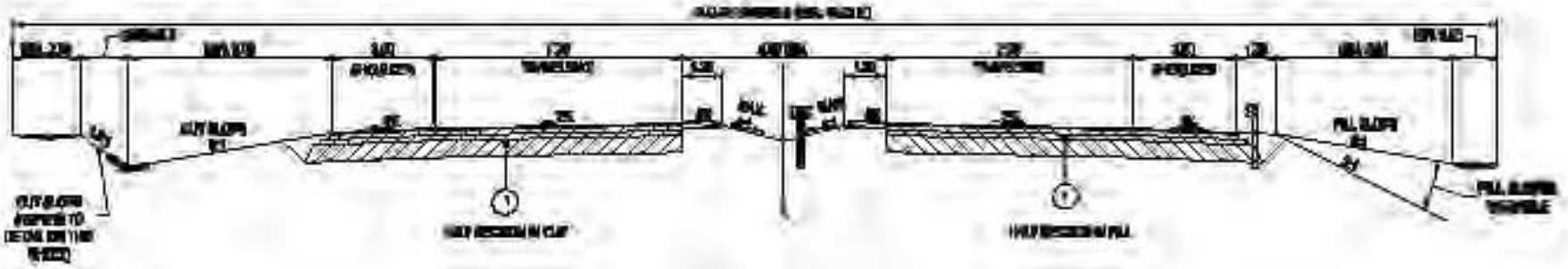

TYPICAL SECTION R-5
SCALE 1:200

TYPICAL CUT SLOPE DETAIL
SCALE=1:200

LEGEND:
EXISTING GROUND
ROAD CENTERLINE
PAVEMENT SECTION

DESIGN STANDARDS
DESIGN SPEED (V) = 50 MPH
MAXIMUM GRADE = 7%
MINIMUM CURVE RADIUS = 820 ft
MAXIMUM SUPERELEVATION = 4%

Source: PRHTA

Figure 11. Principal Design Standards for an R-5 Road.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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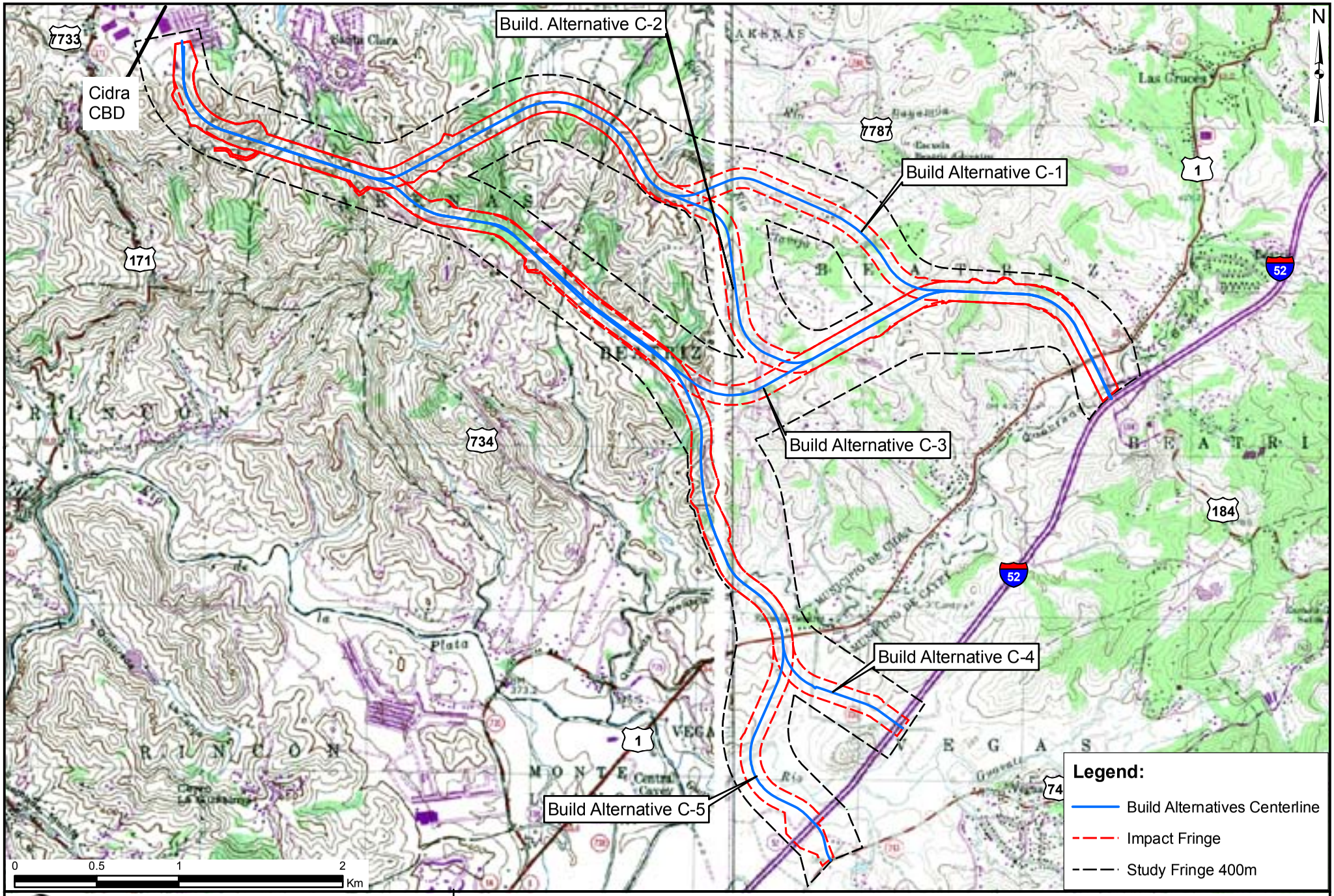


Figure 12. Location of Build Alternatives Corridors in USGS Topographic Map.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

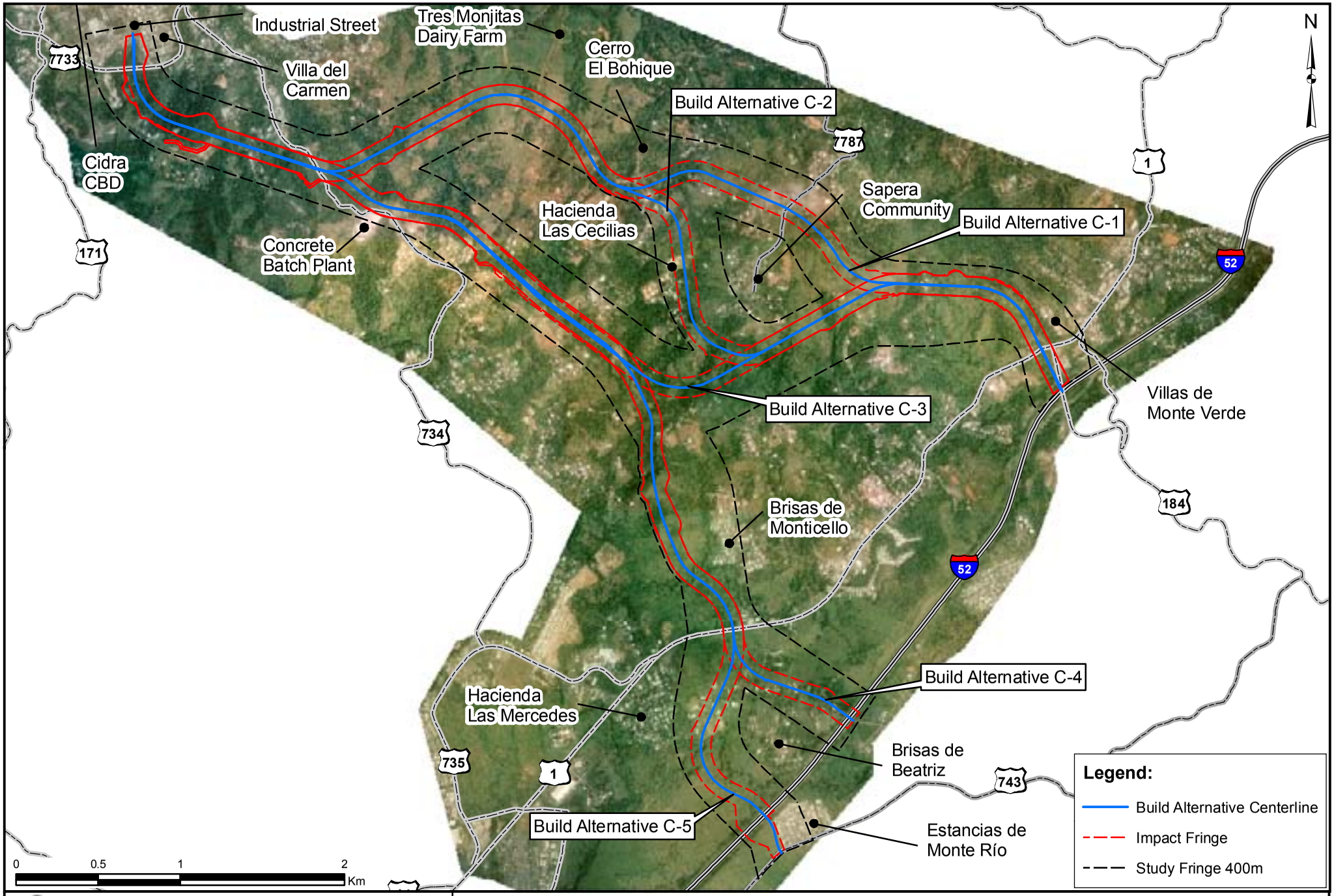


Figure 13. Location of Build Alternatives Corridors in 2008 Aerial Photo.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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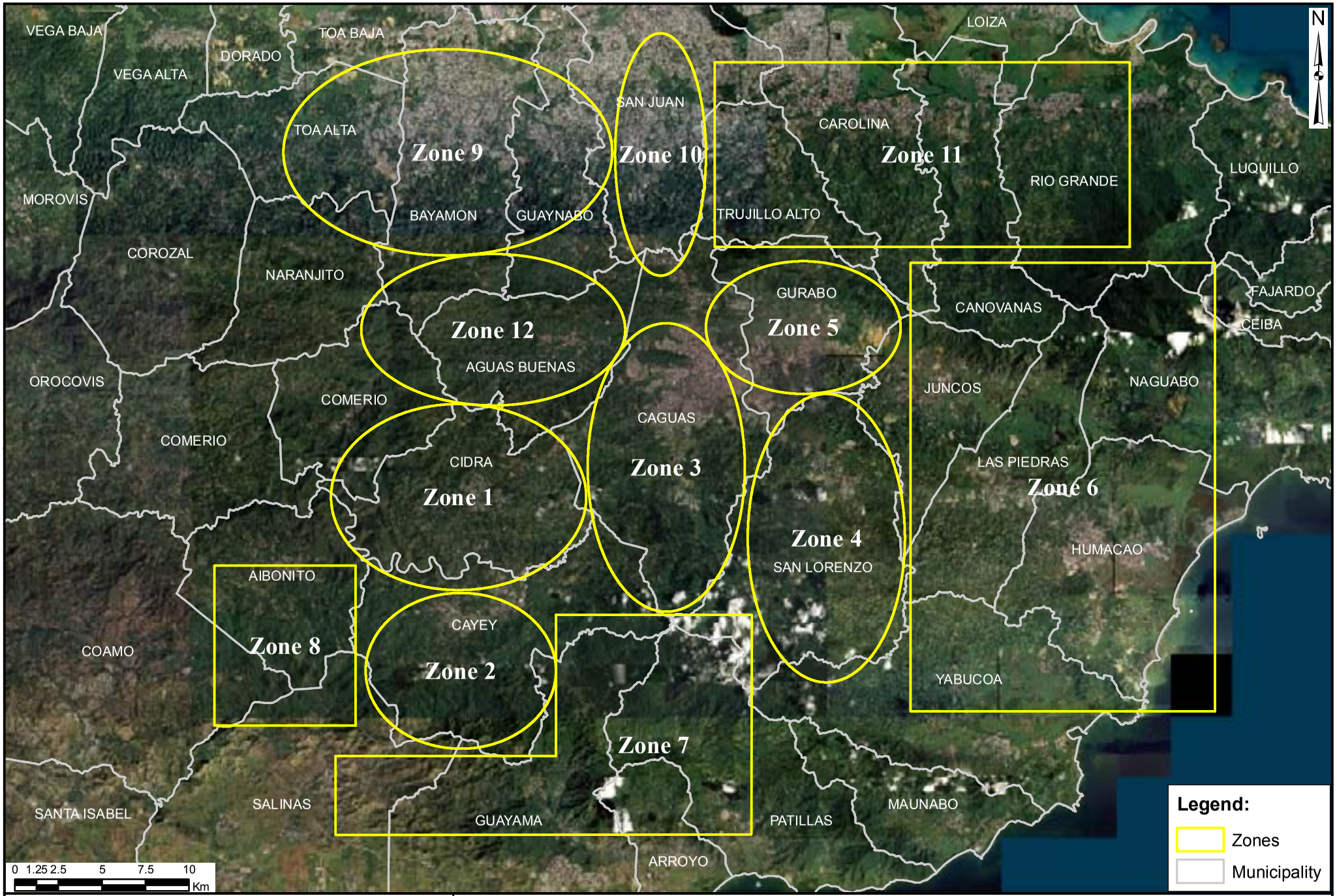


Figure 14. Origin and Destination Zones.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Origin and Destiny Study

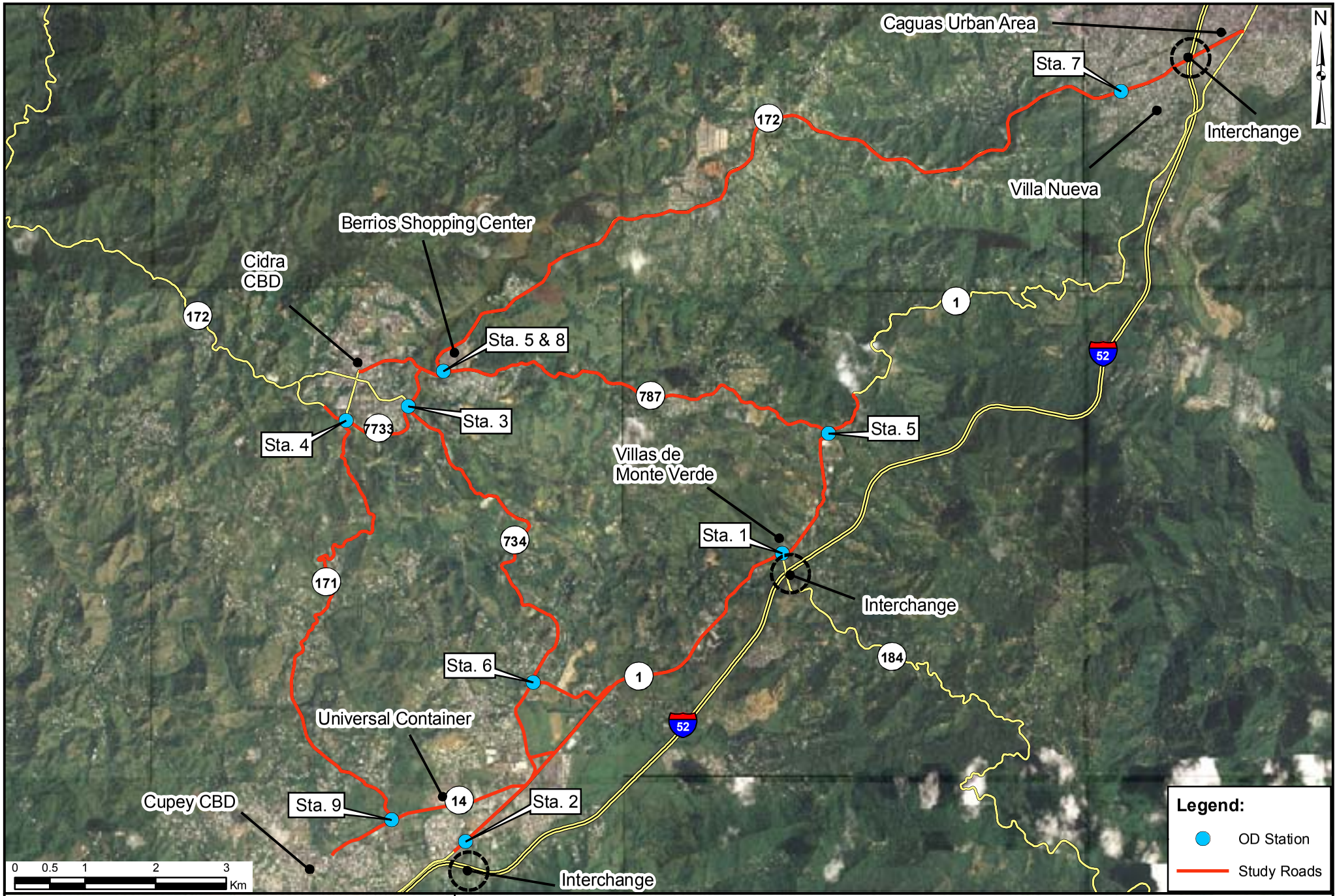


Figure 15. Origin and Destination Survey Stations.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Origin and Destiny Study

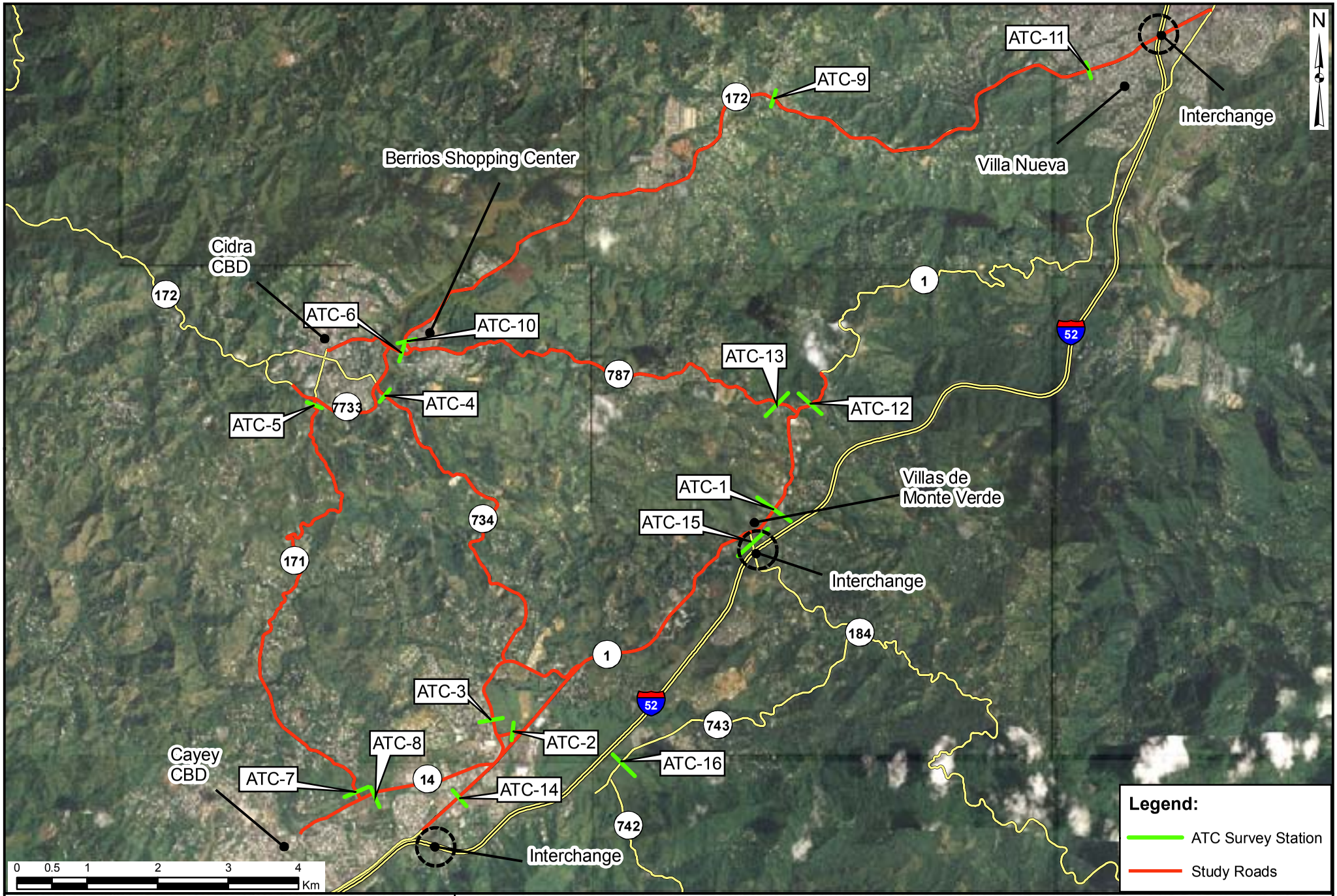


Figure 16. Traffic Study Survey Stations.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Traffic Study

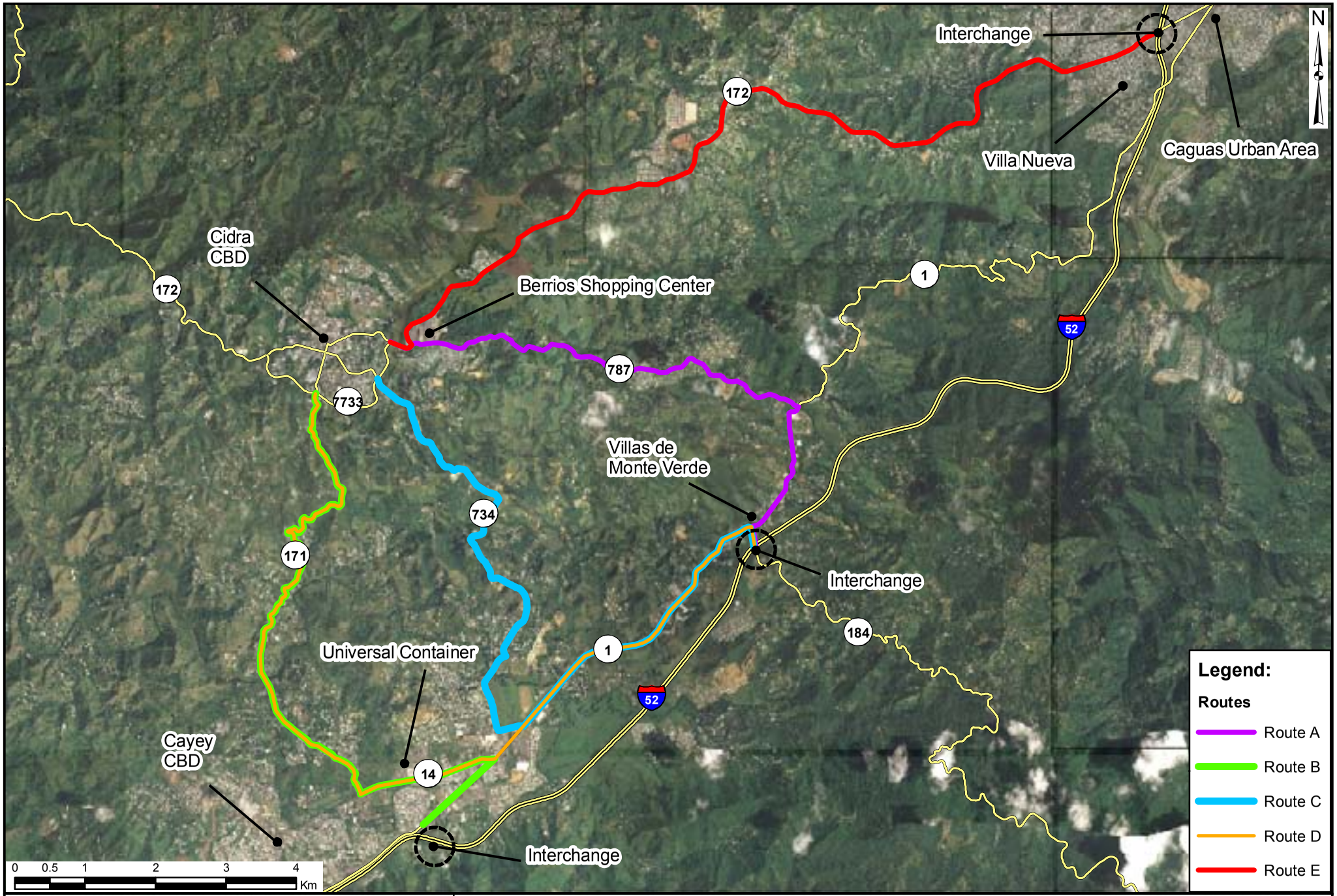


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Figure 17. Routes Studied for Travel Times.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Traffic Study

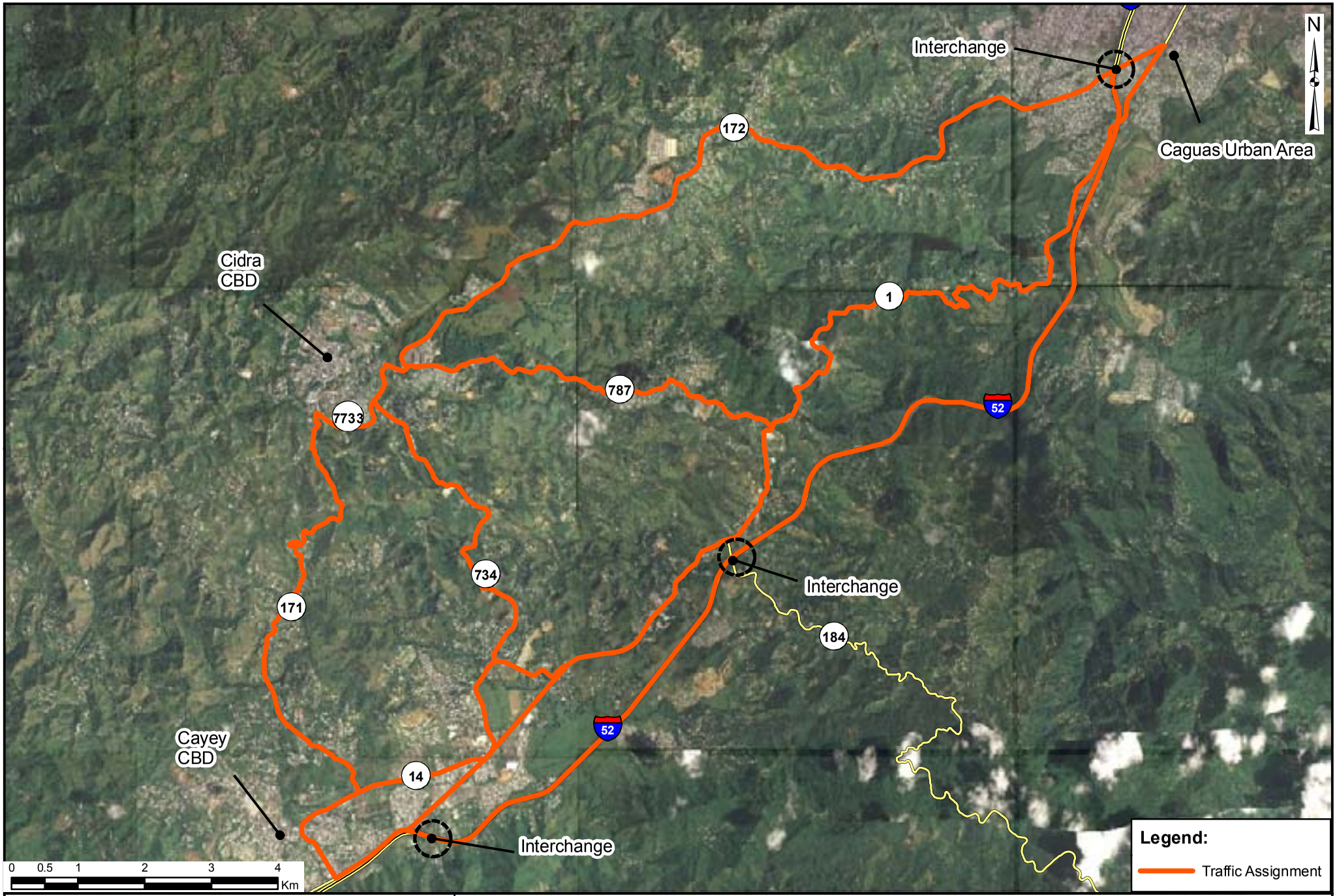


Figure 18. Traffic Assignment Modeling Network.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Traffic Study


Figure 19. Intersections Evaluated in Traffic Study.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Traffic Study

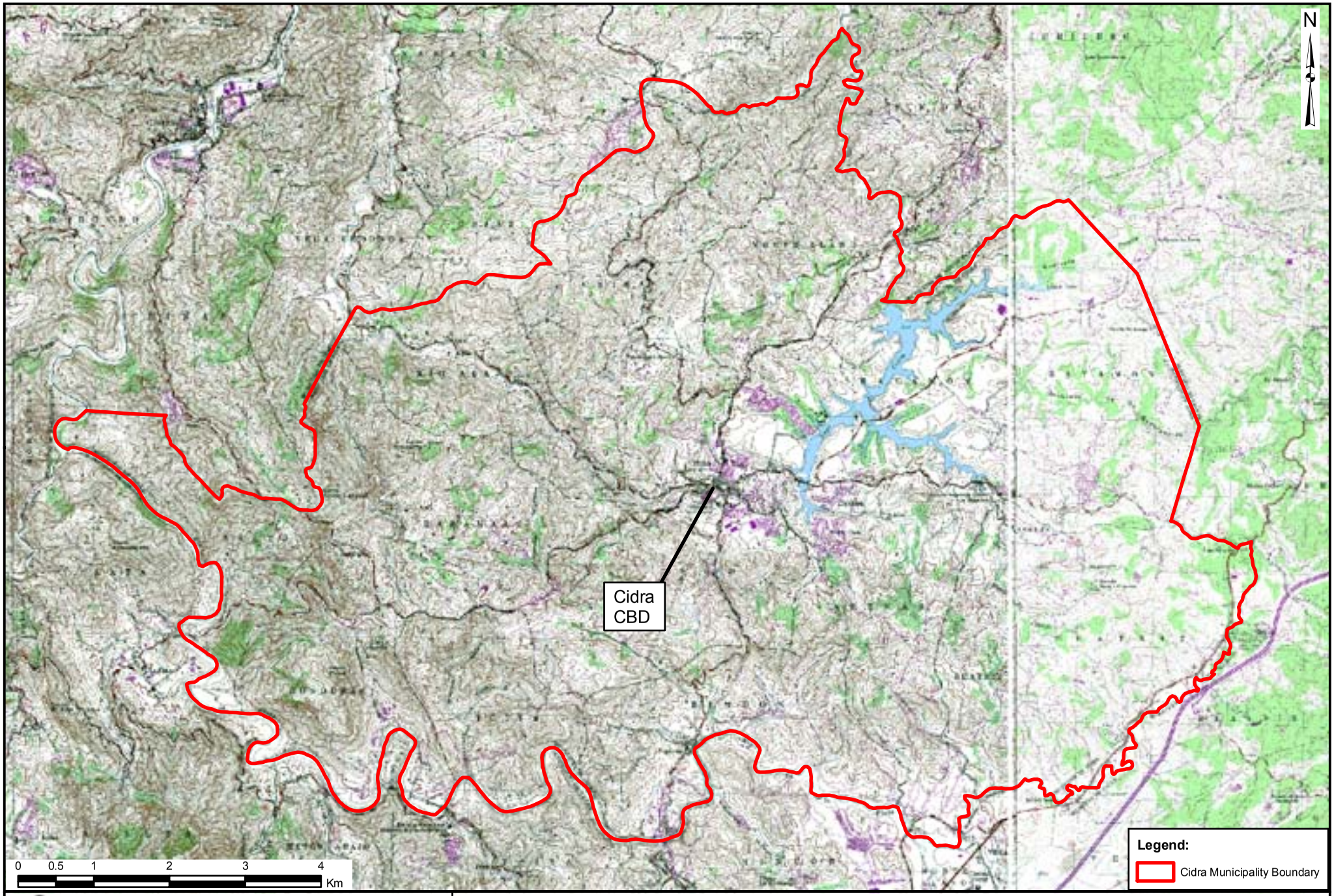


Figure 20. Cidra Municipality in USGS Topographic Map.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: USGS

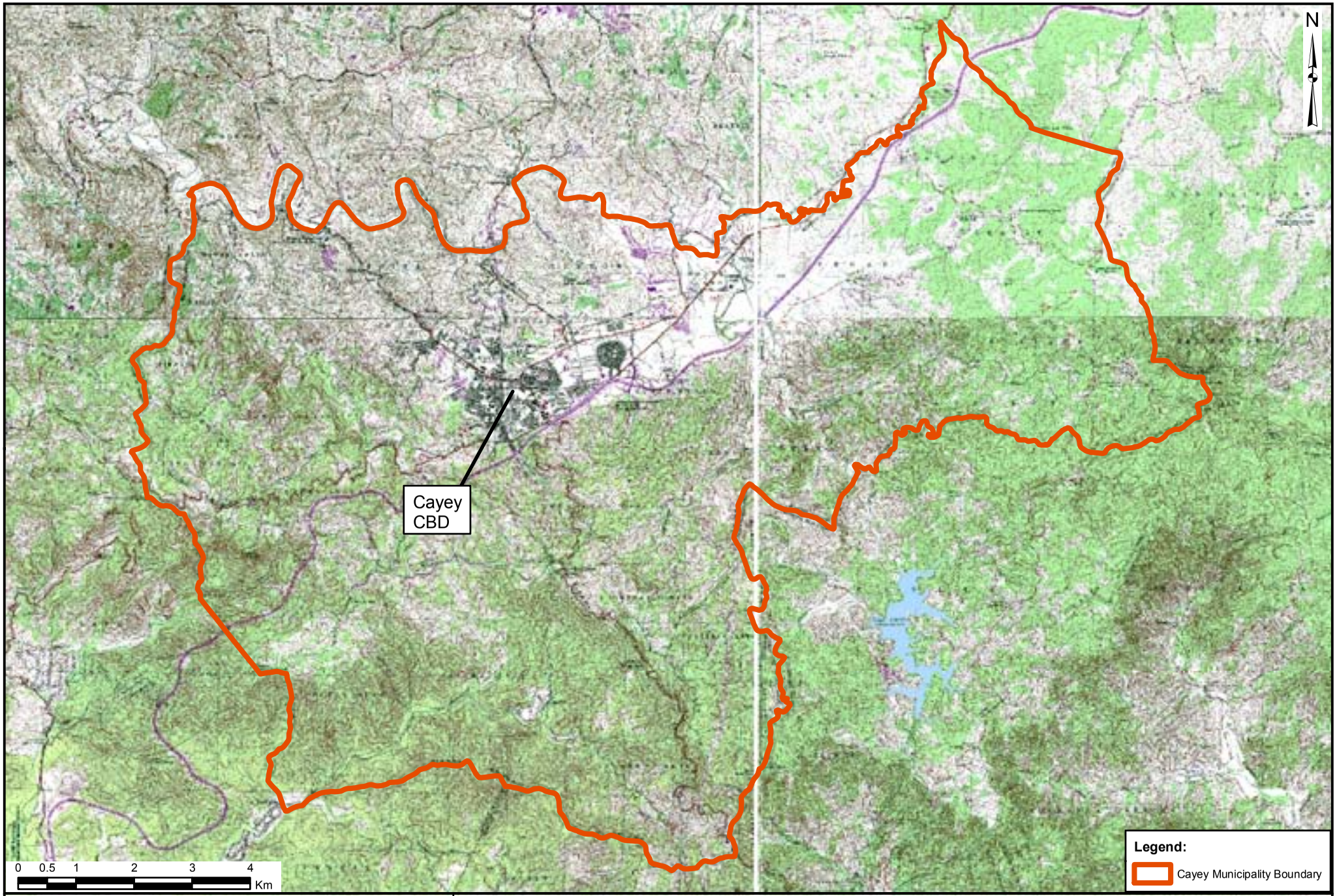


Figure 21. Cayey Municipality in USGS Topographic Map.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: USGS

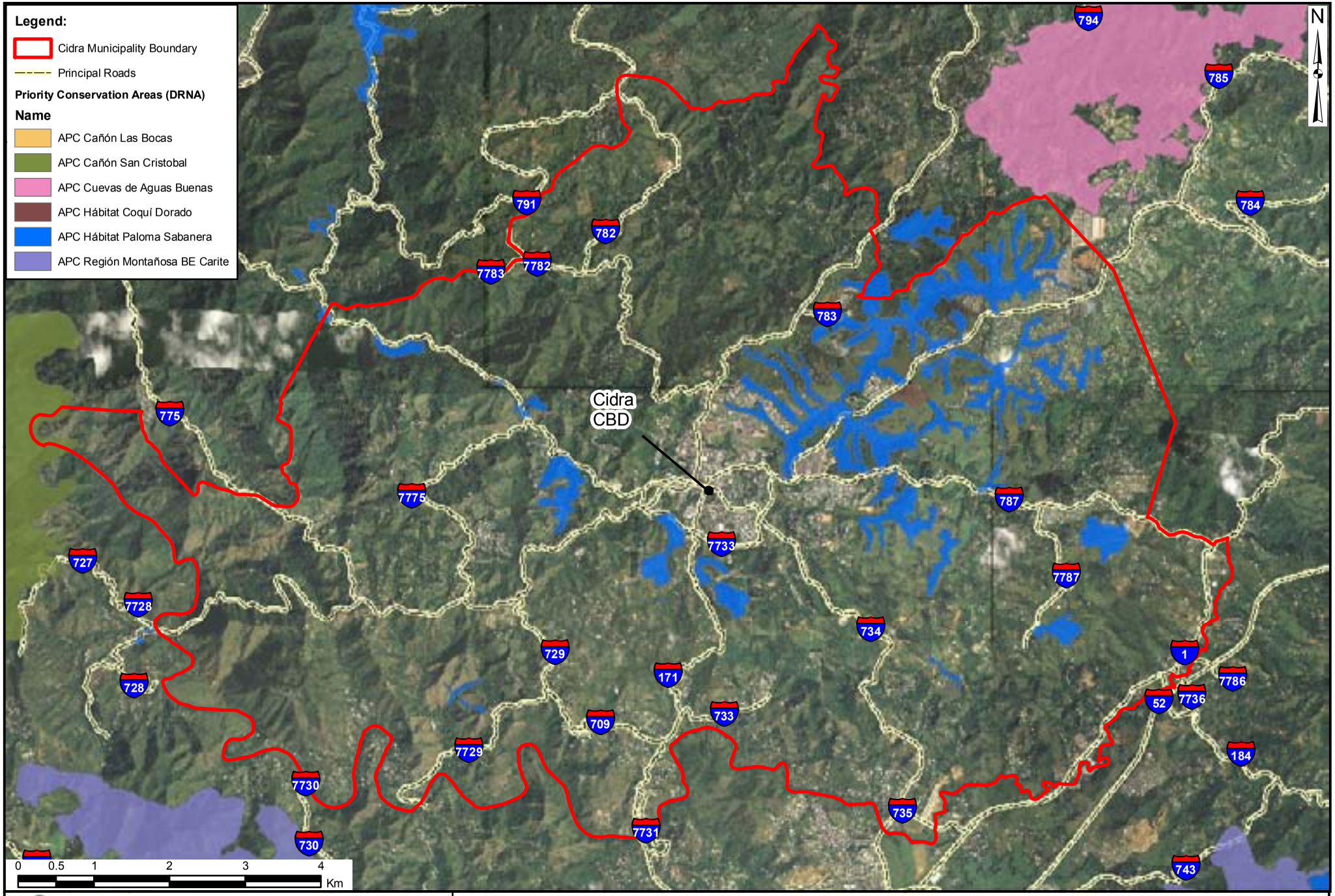


Figure 22. Environmental Sensitive Areas in Cidra.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source:PRDNER

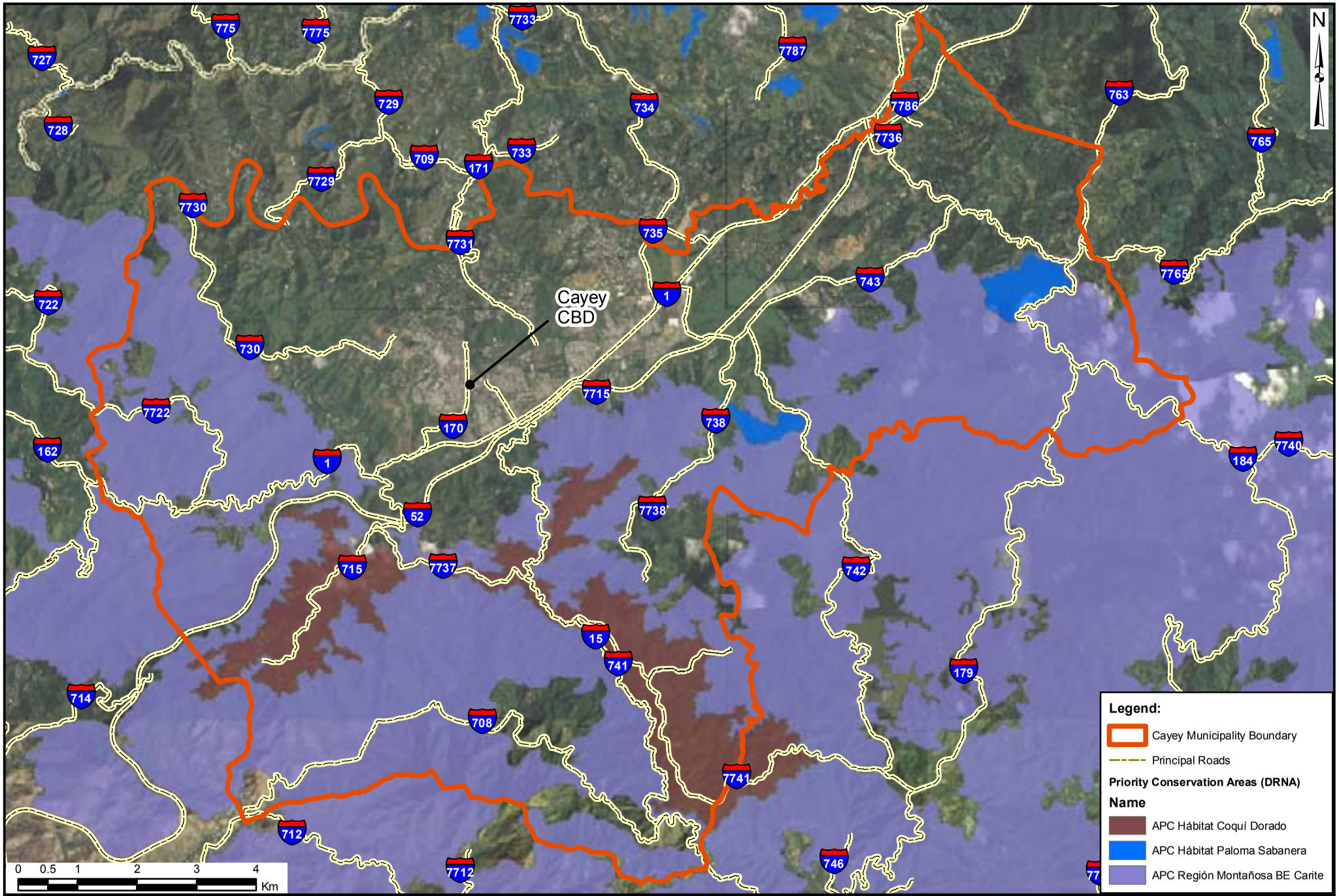


Figure 23. Environmental Sensitive Areas in Cayey.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRDNER

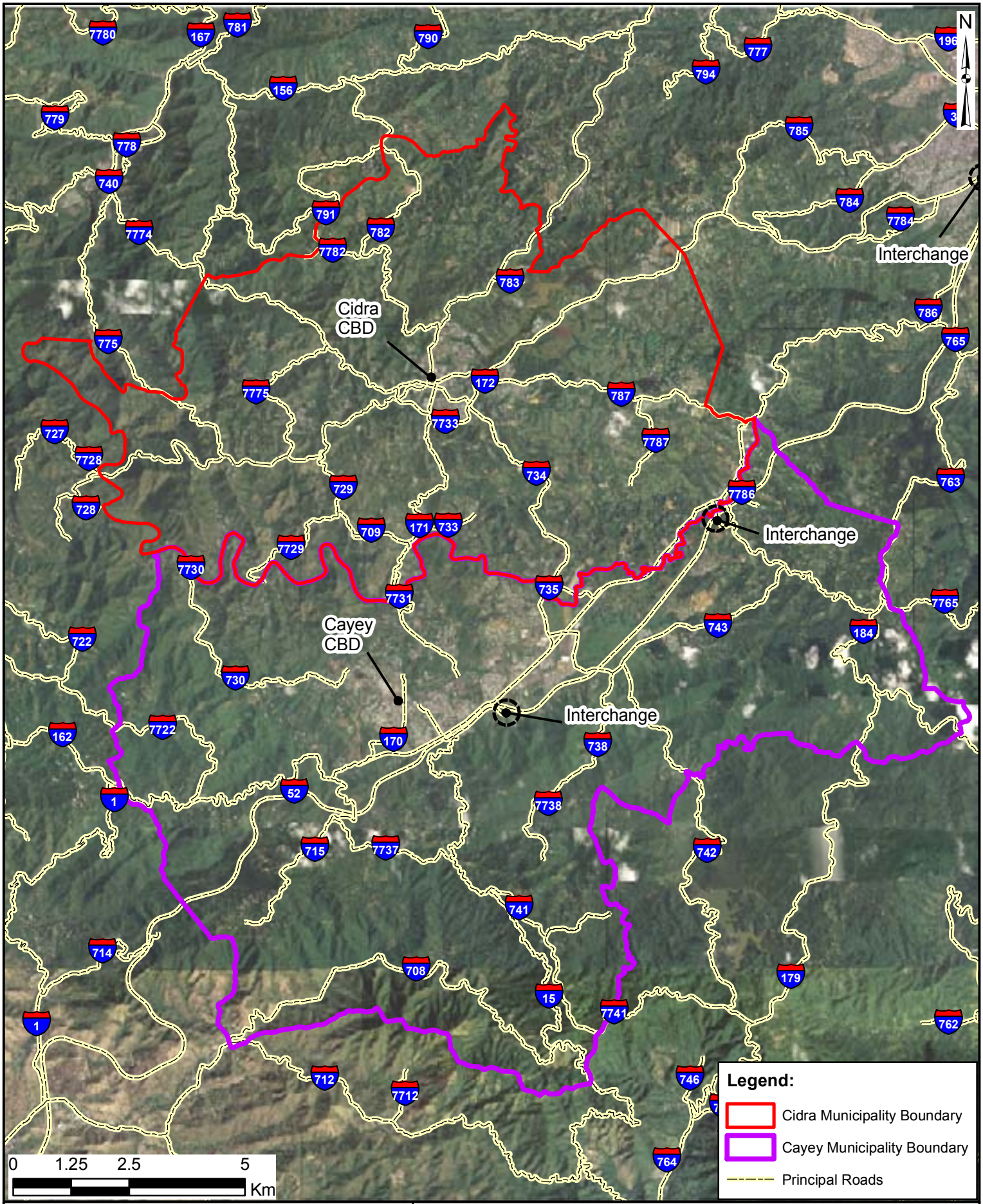


Figure 24. Principal Road Infrastructure in Cidra and Cayey.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRHTA

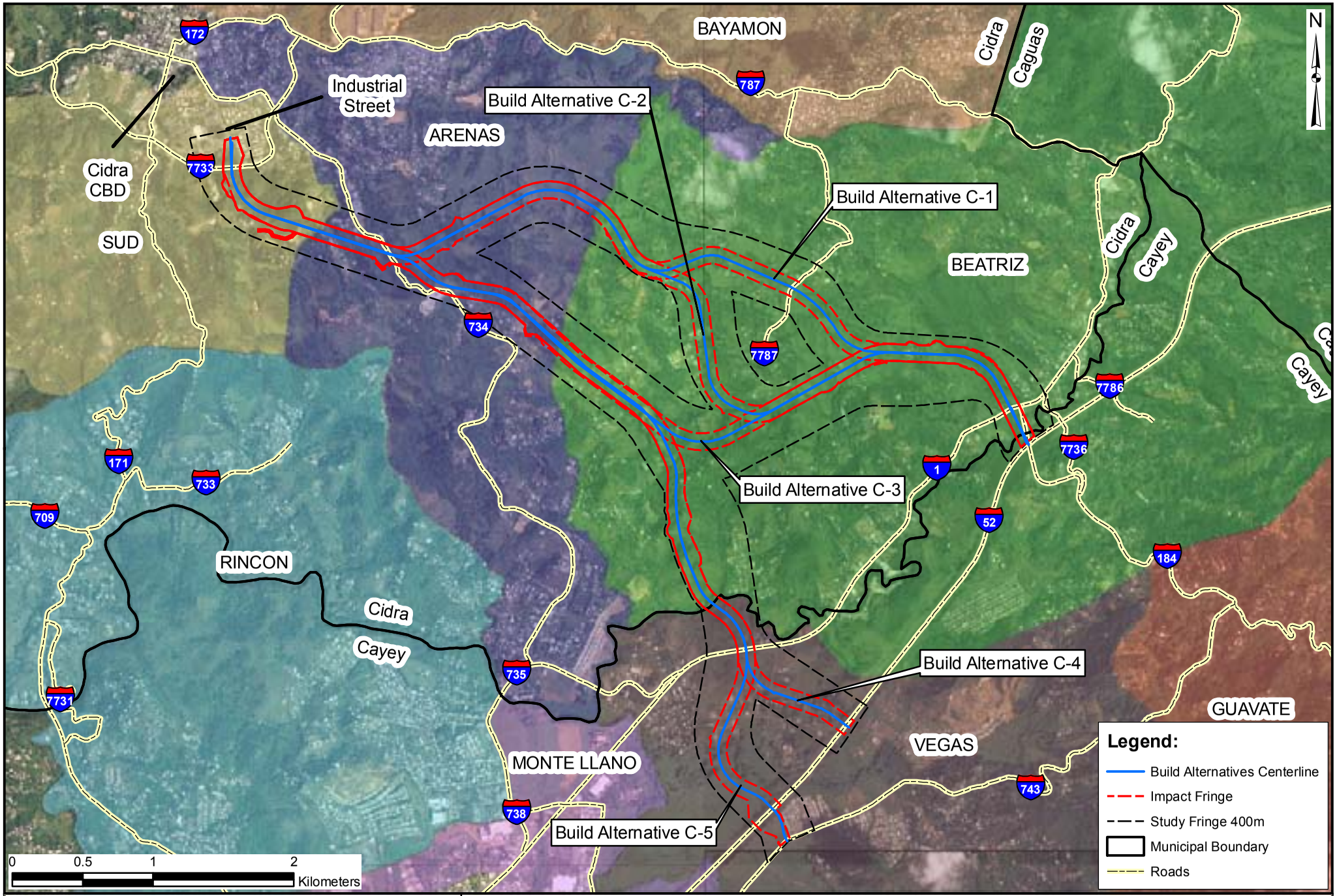


Figure 25. Cidra wards in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source:PRPB

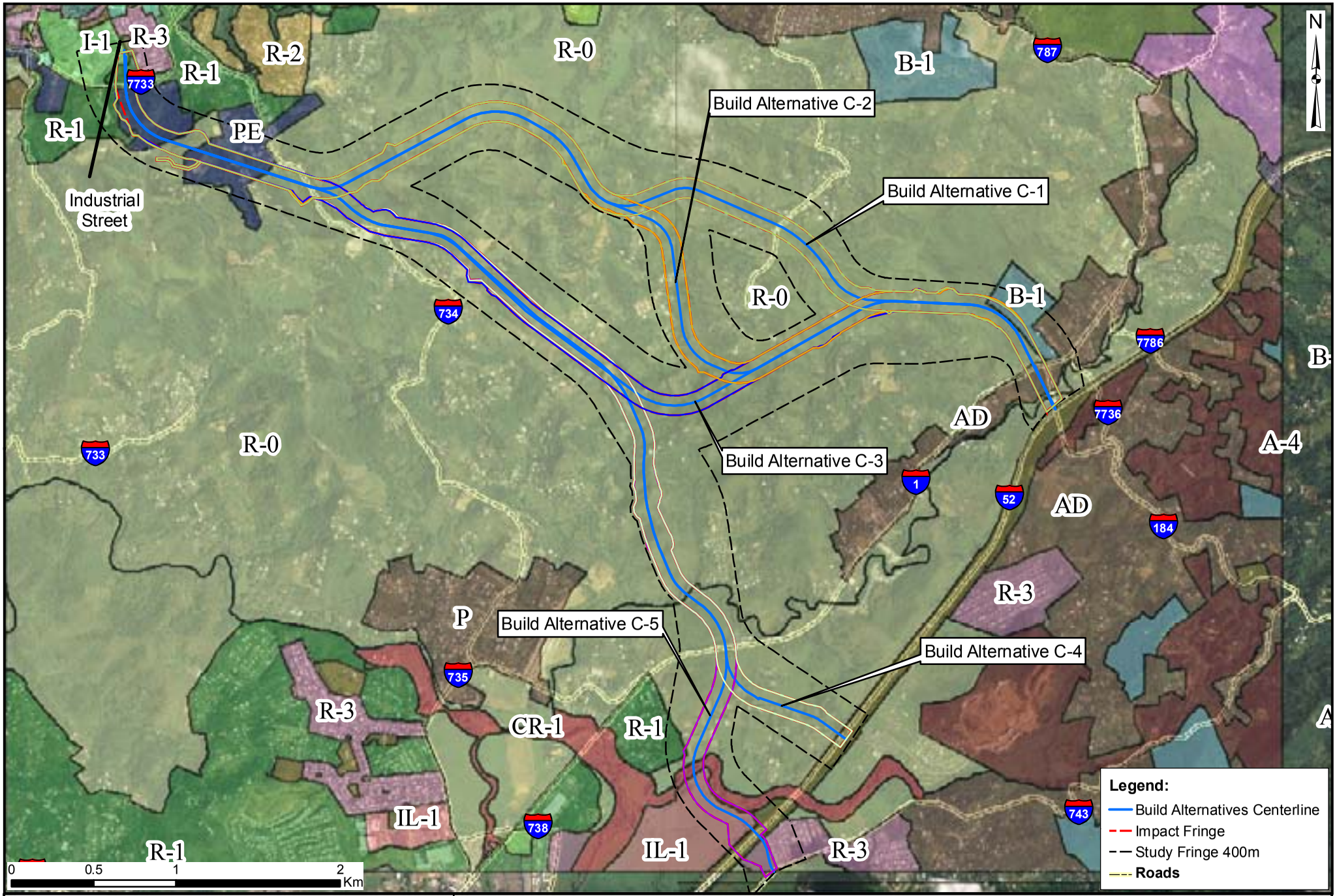


Figure 26. Land Use Plan in the Area under Study.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRPB

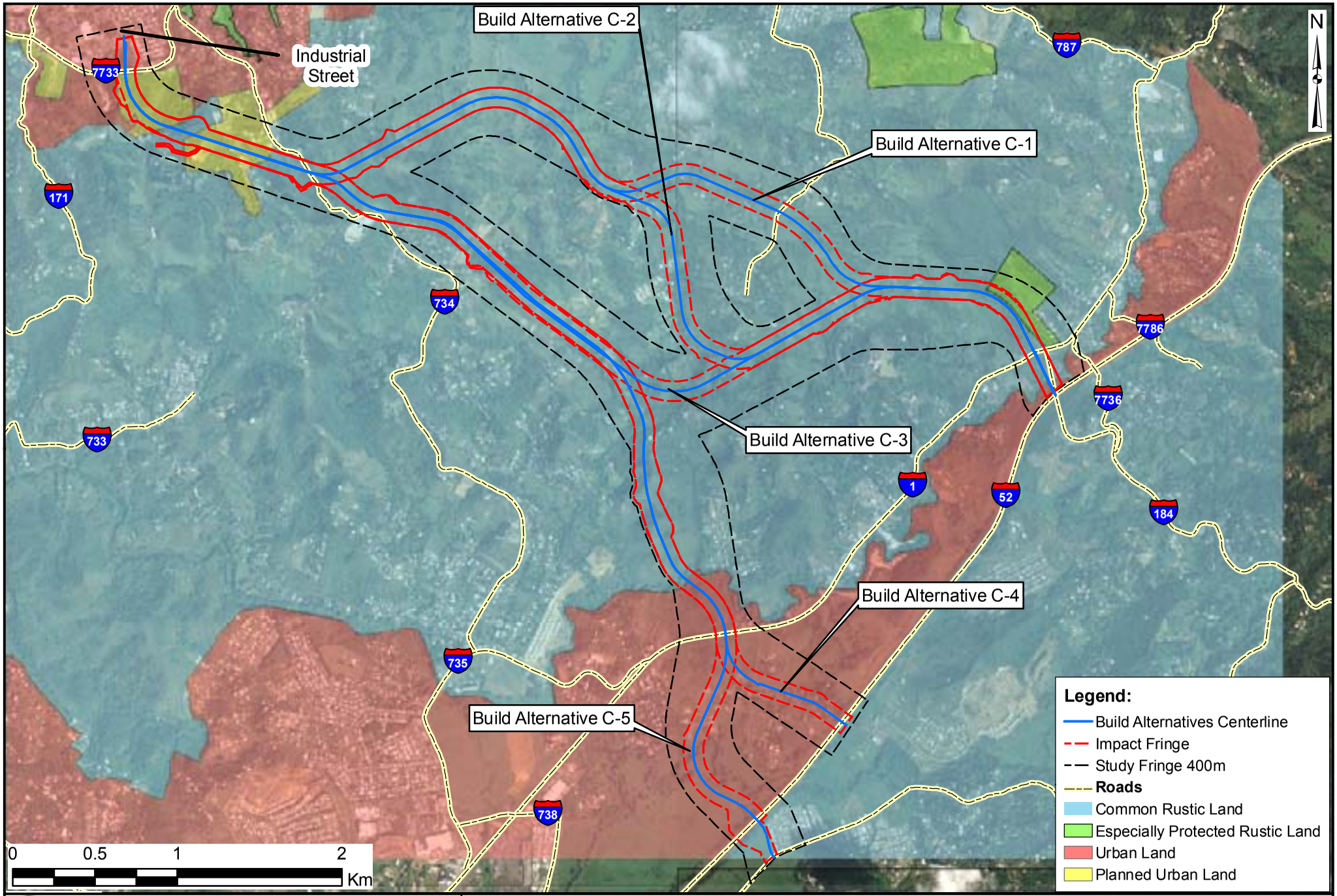


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Figure 27. Land Cover in the Area under Study.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source:PRPB

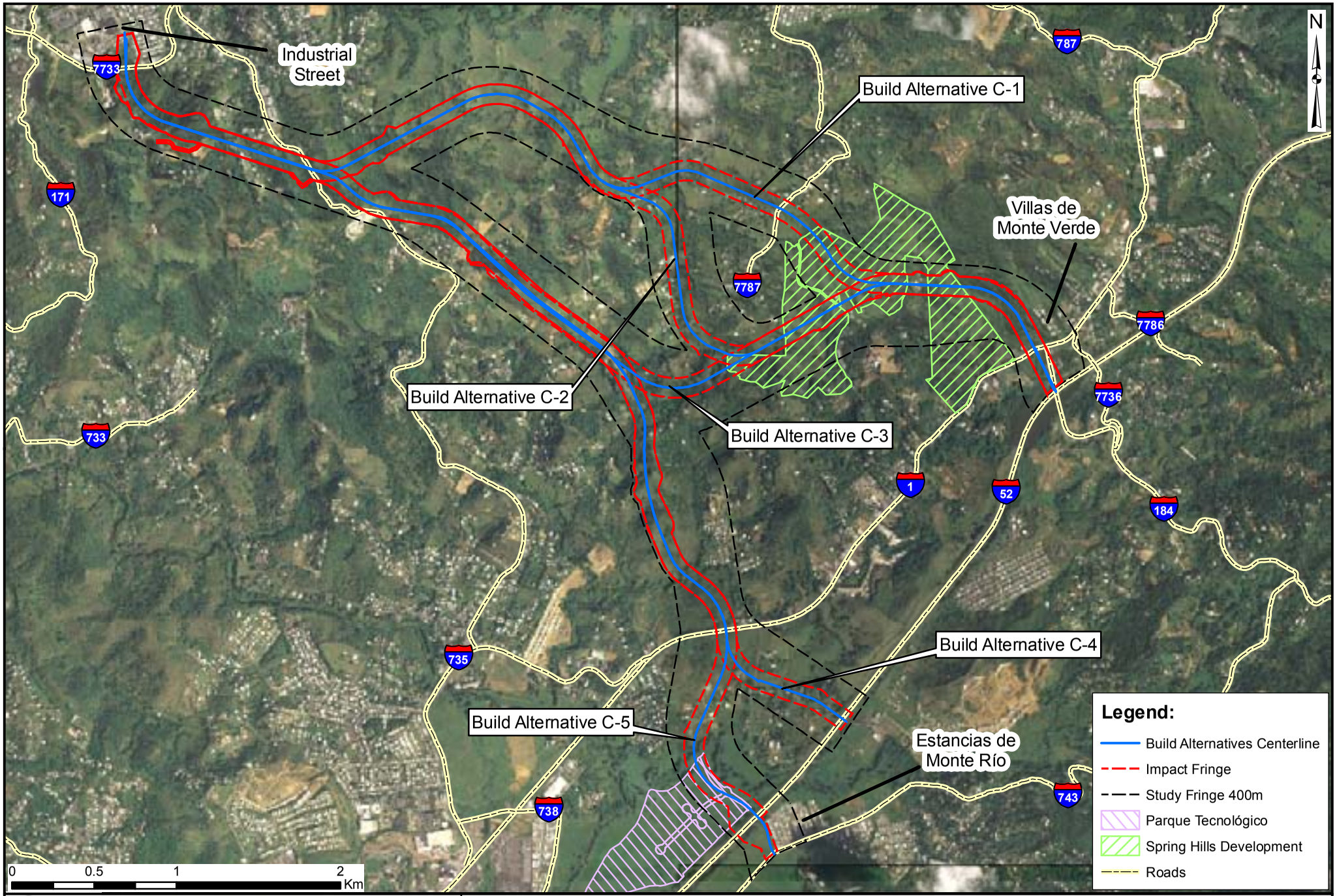


Figure 28. Proposed Developments in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source:PRPB

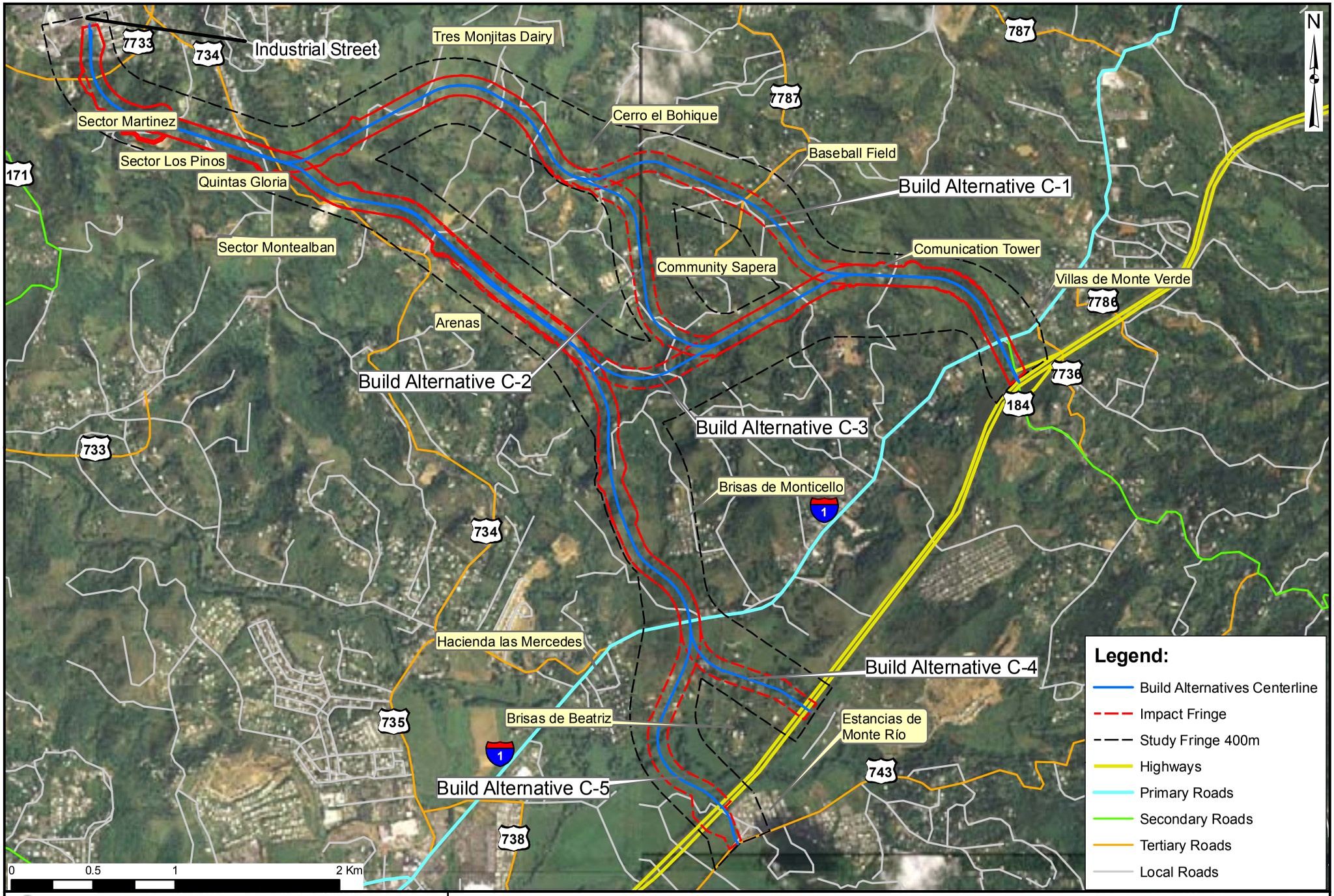


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Figure 29. Communities, Road System and Parkland in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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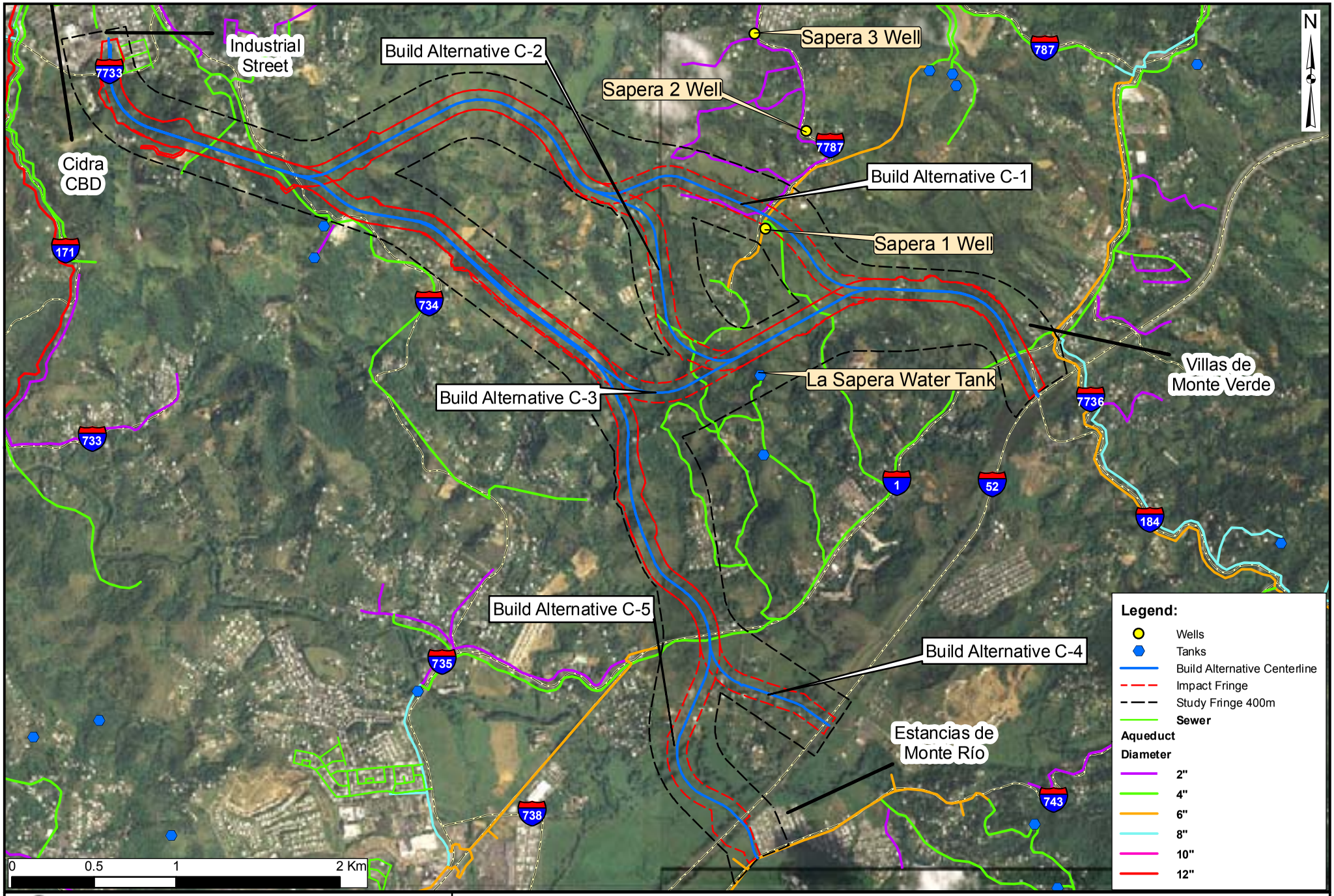


Figure 30. Potable and Wastewater System in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRASA

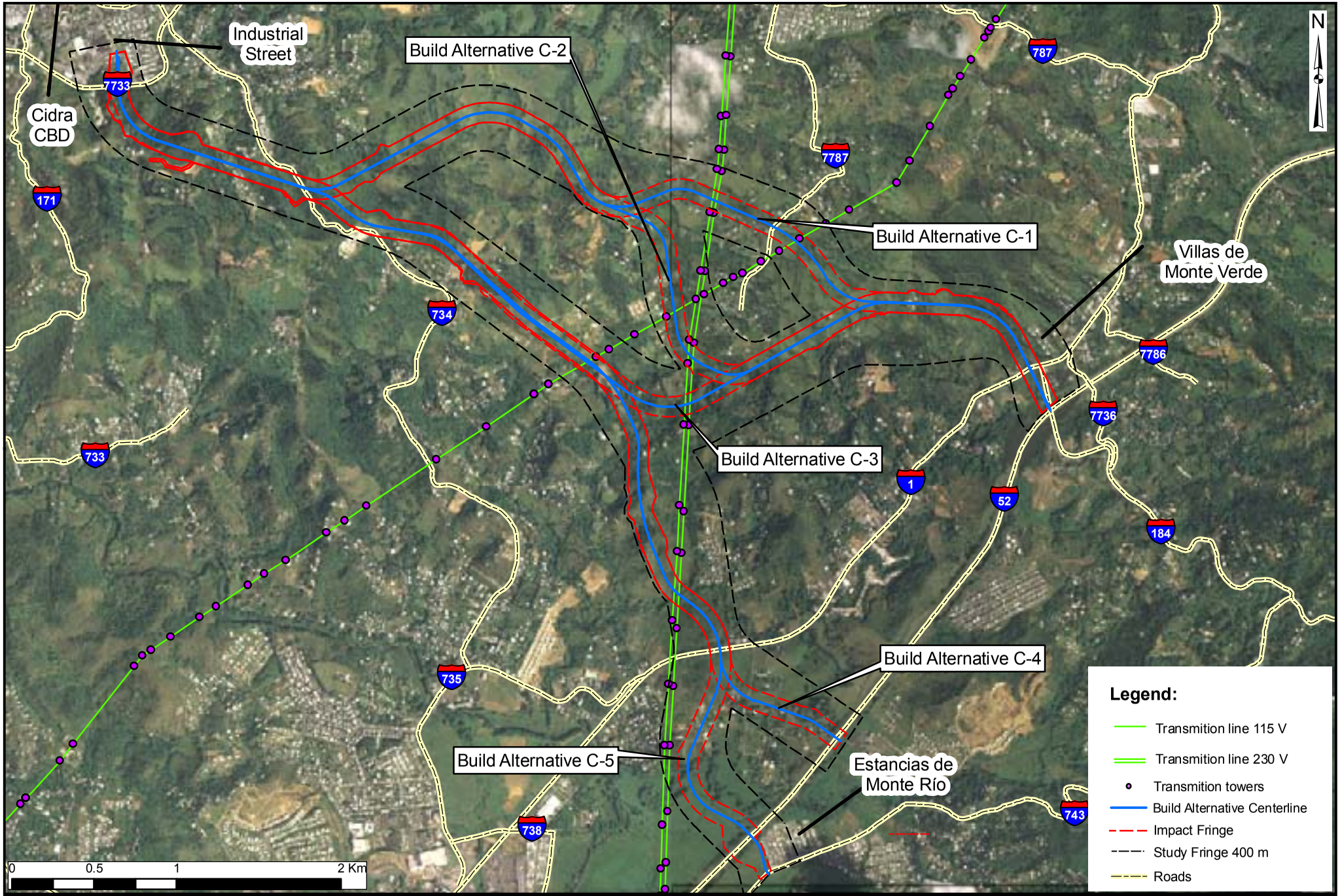


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Figure 31. Major PREPA Infrastructure in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PREPA

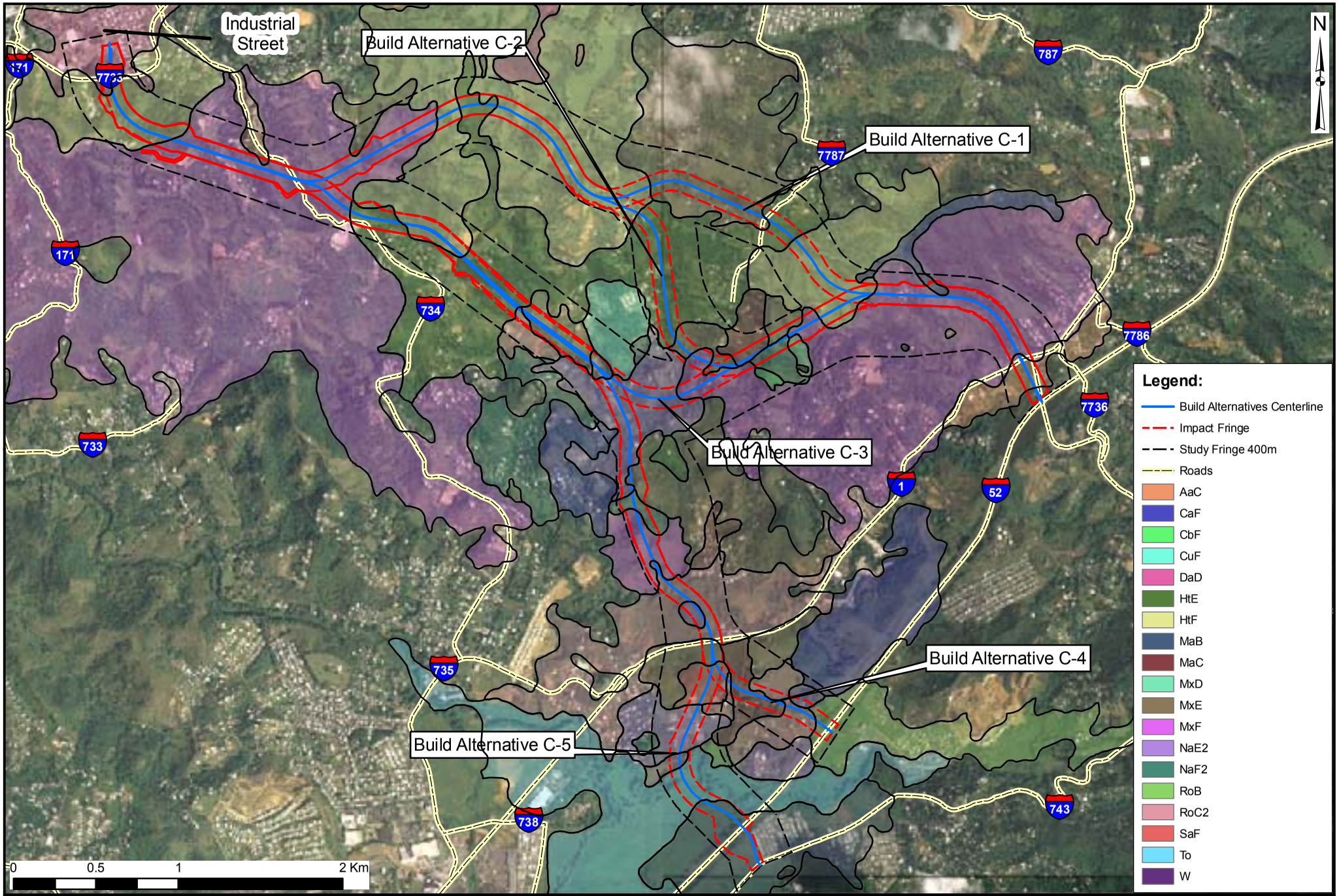


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Figure 32. Soils in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source:USGS

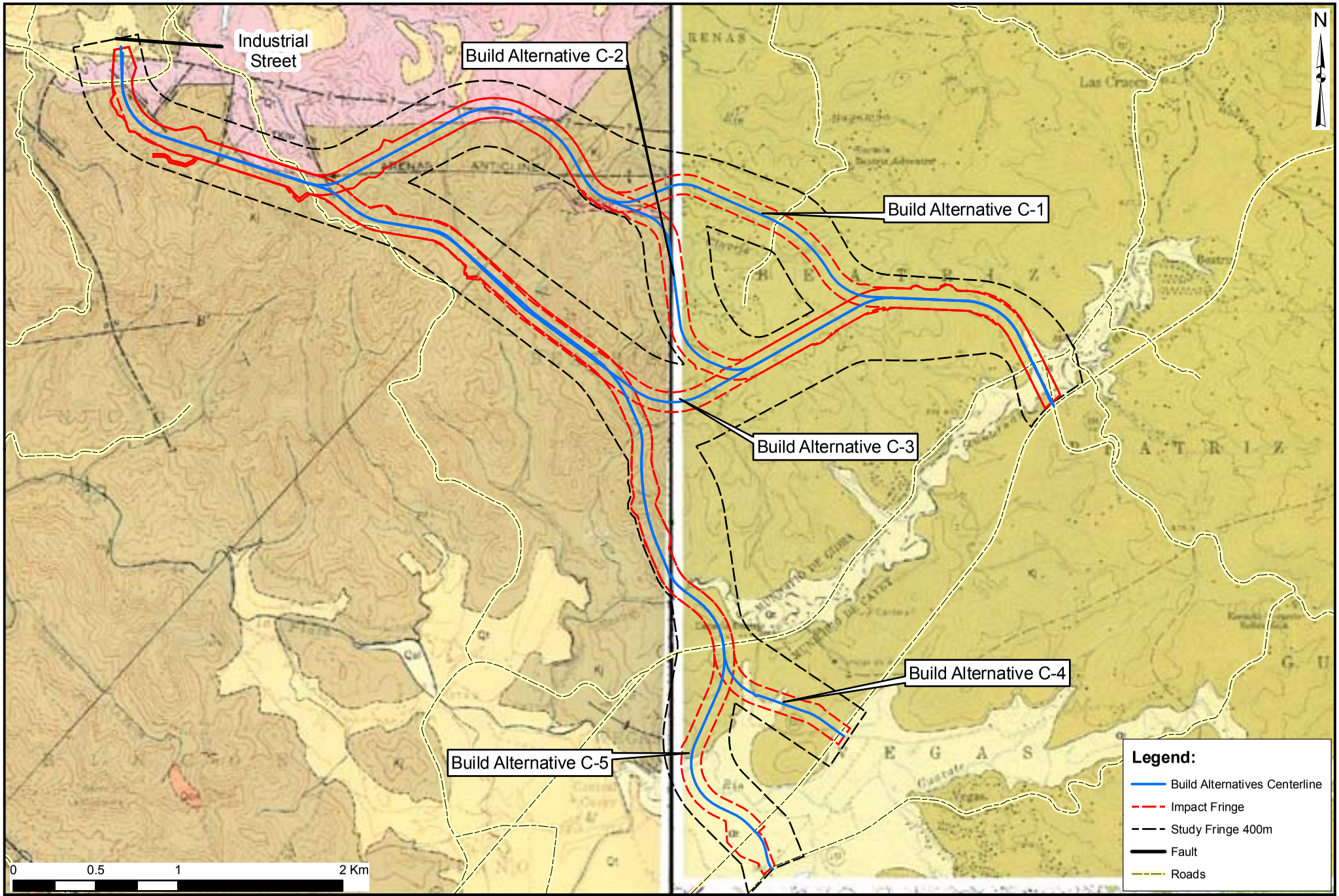


Figure 33. Geological Configuration in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source:USGS

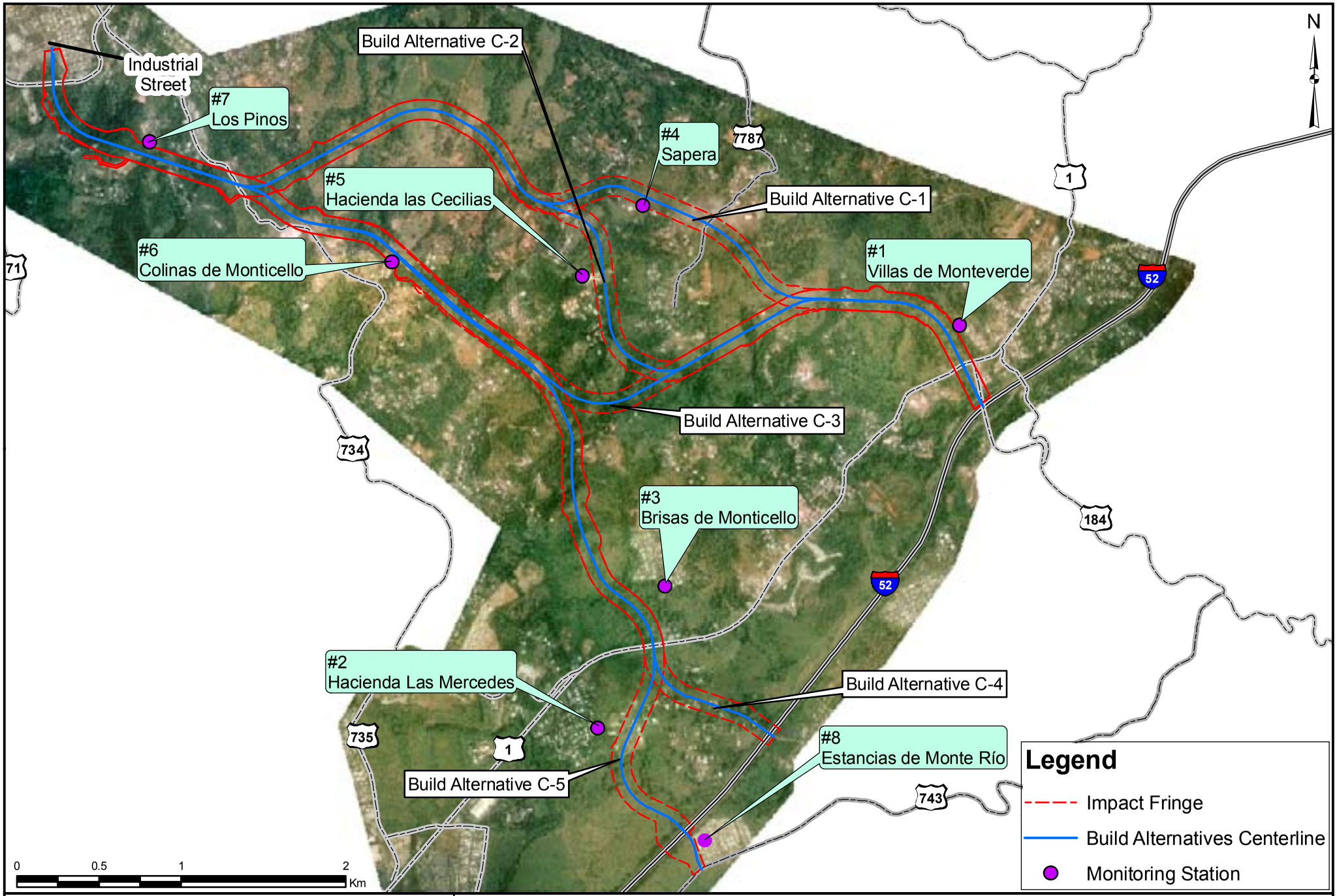


Figure 34. Location of Noise Monitoring Stations.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Traffic Noise Analysis

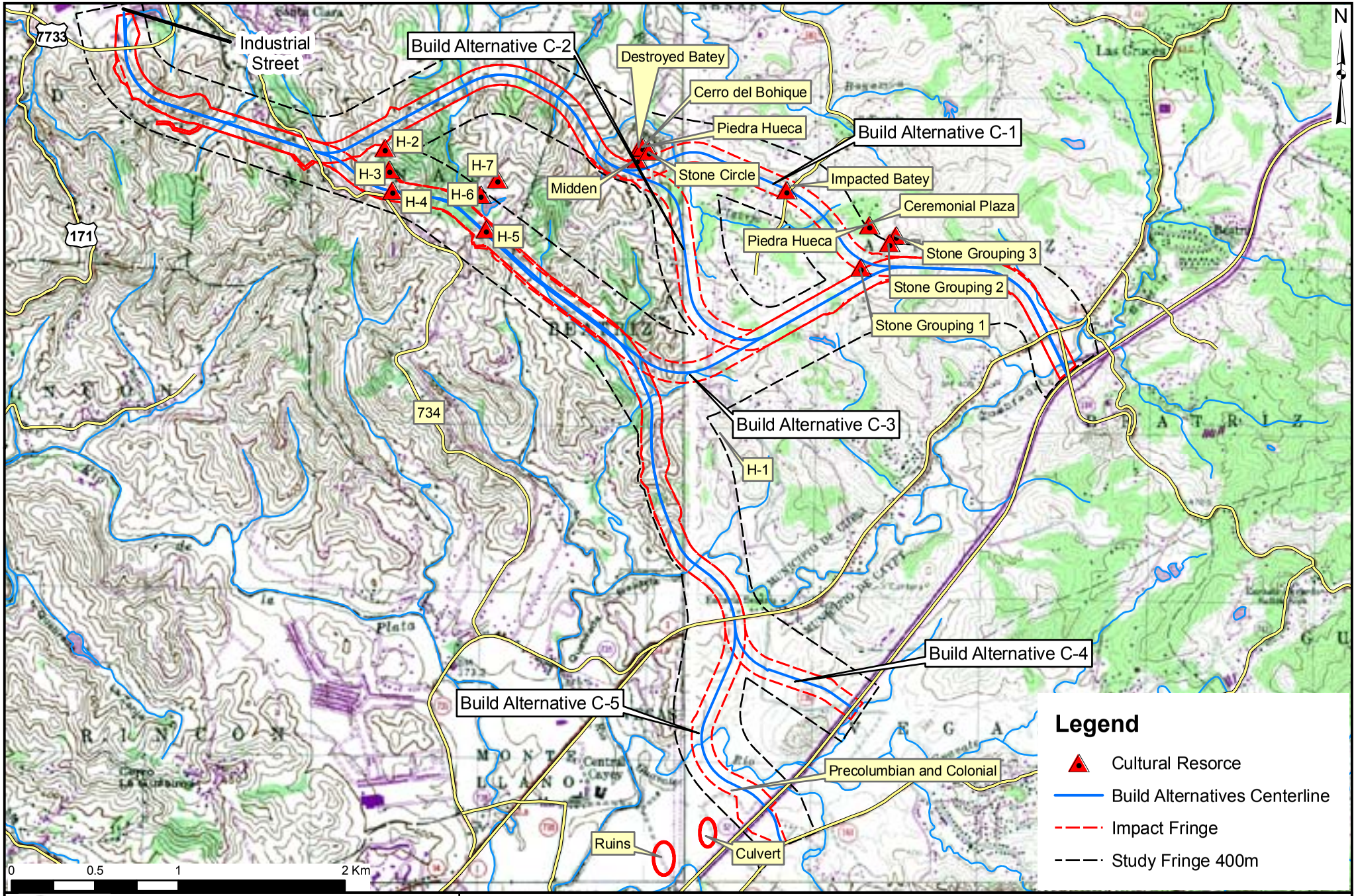


Figure 35. Location of Cultural Resources in Build Alternatives Corridors

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source:Archaeological Studies

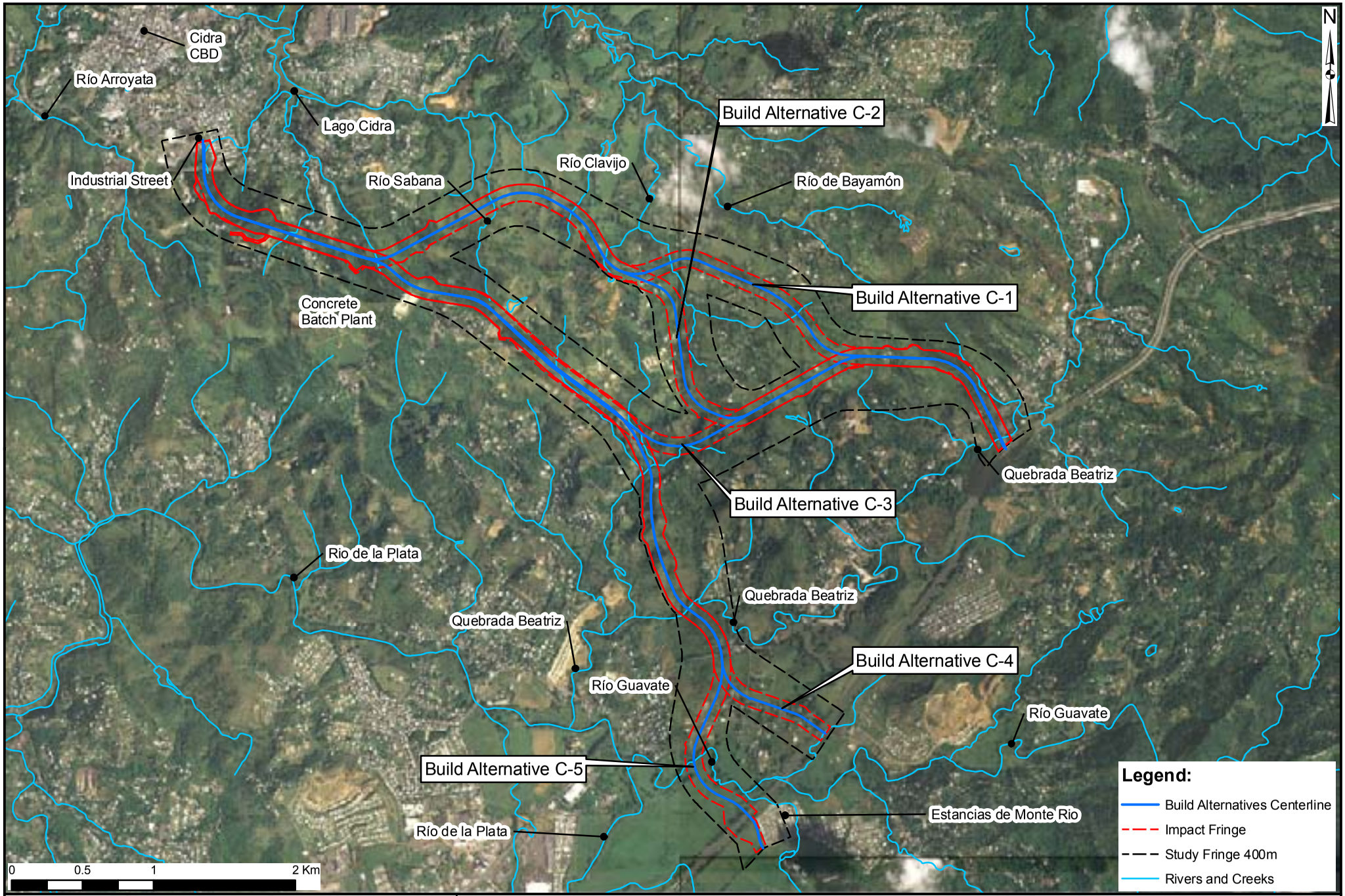


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Figure 36. Surface Water Bodies in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: PRPB

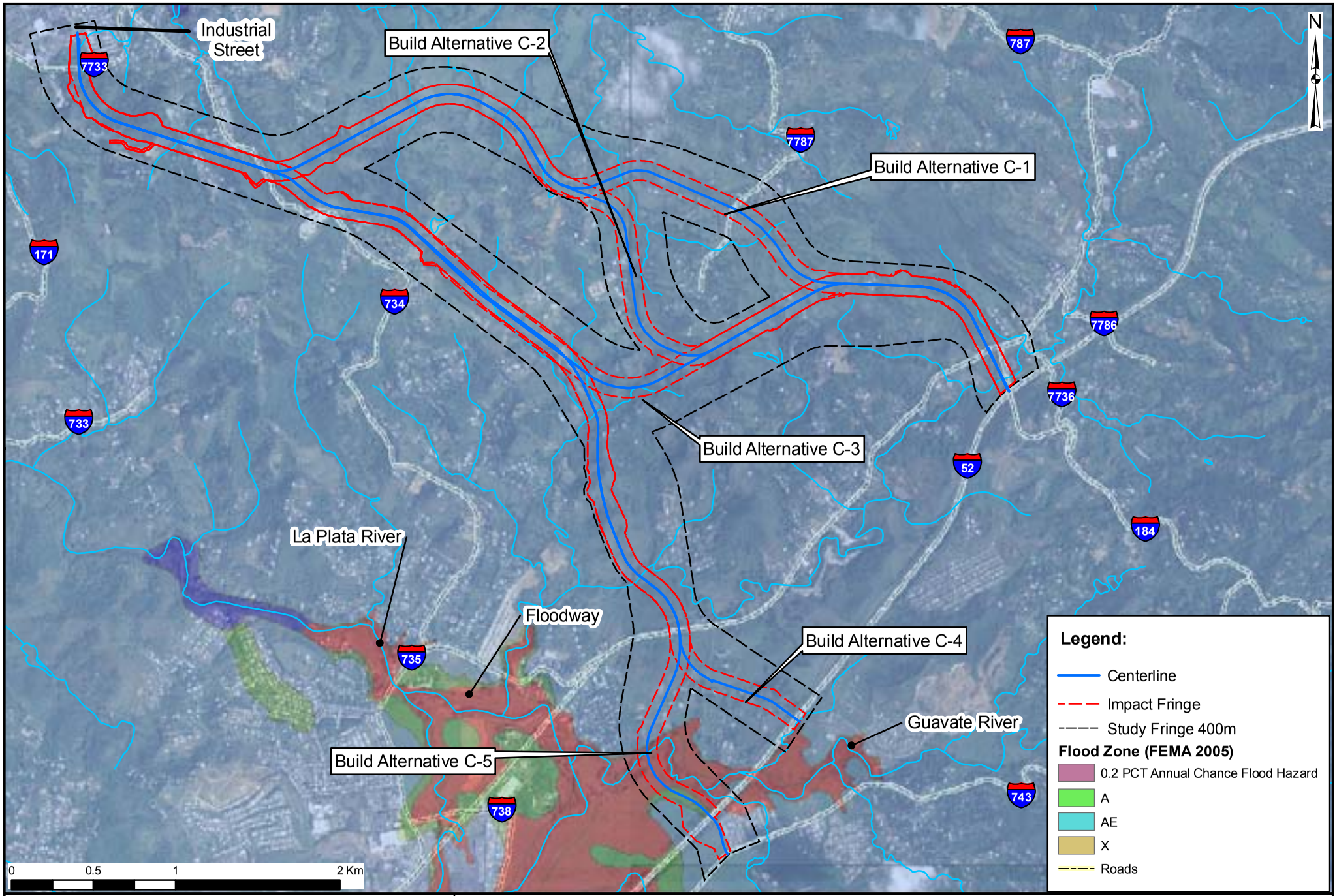


Figure 37. Flood Zones in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: FEMA Regulatory Maps (2009)

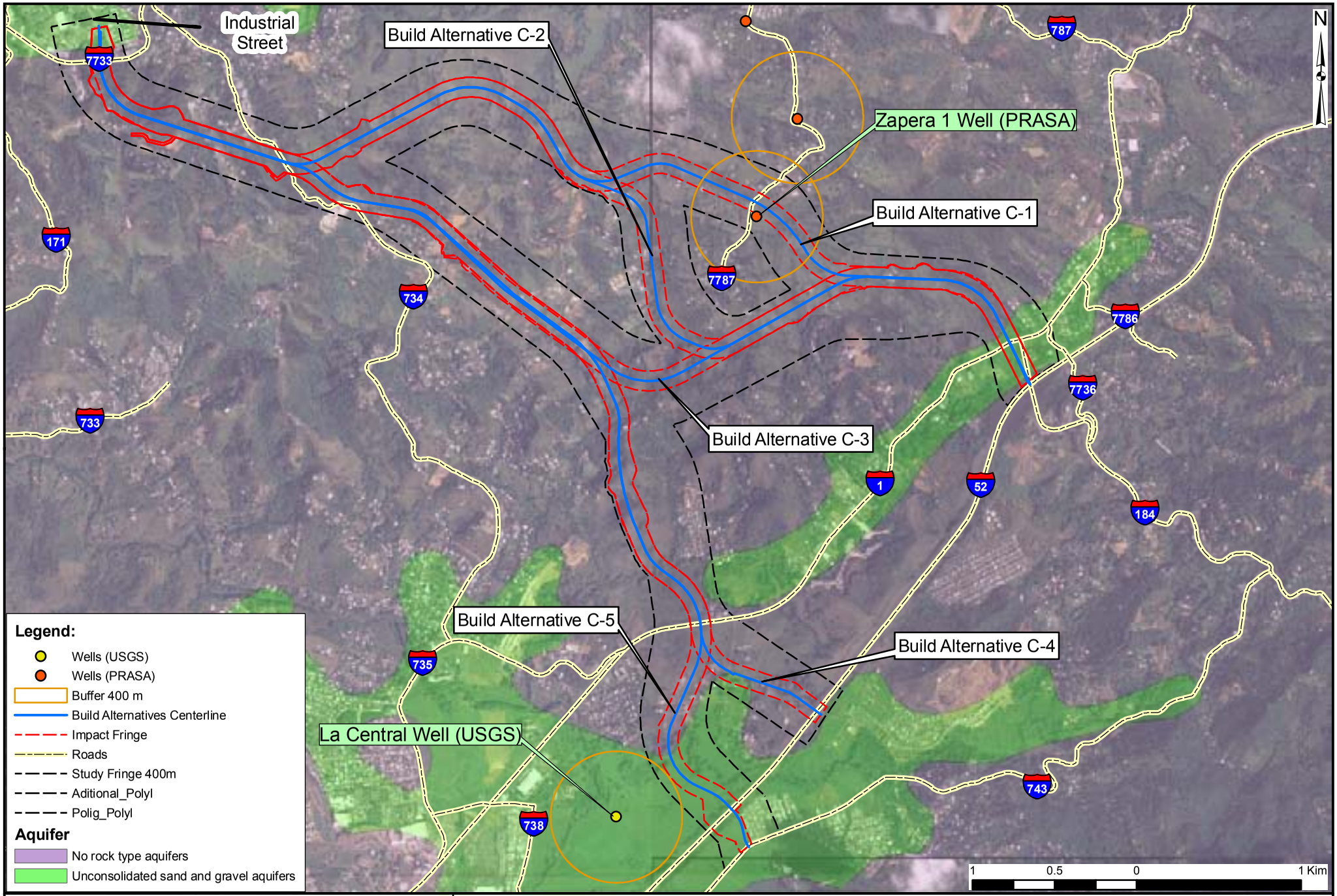


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Figure 38. Aquifers and Wells in the Study Area.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: PRDNER

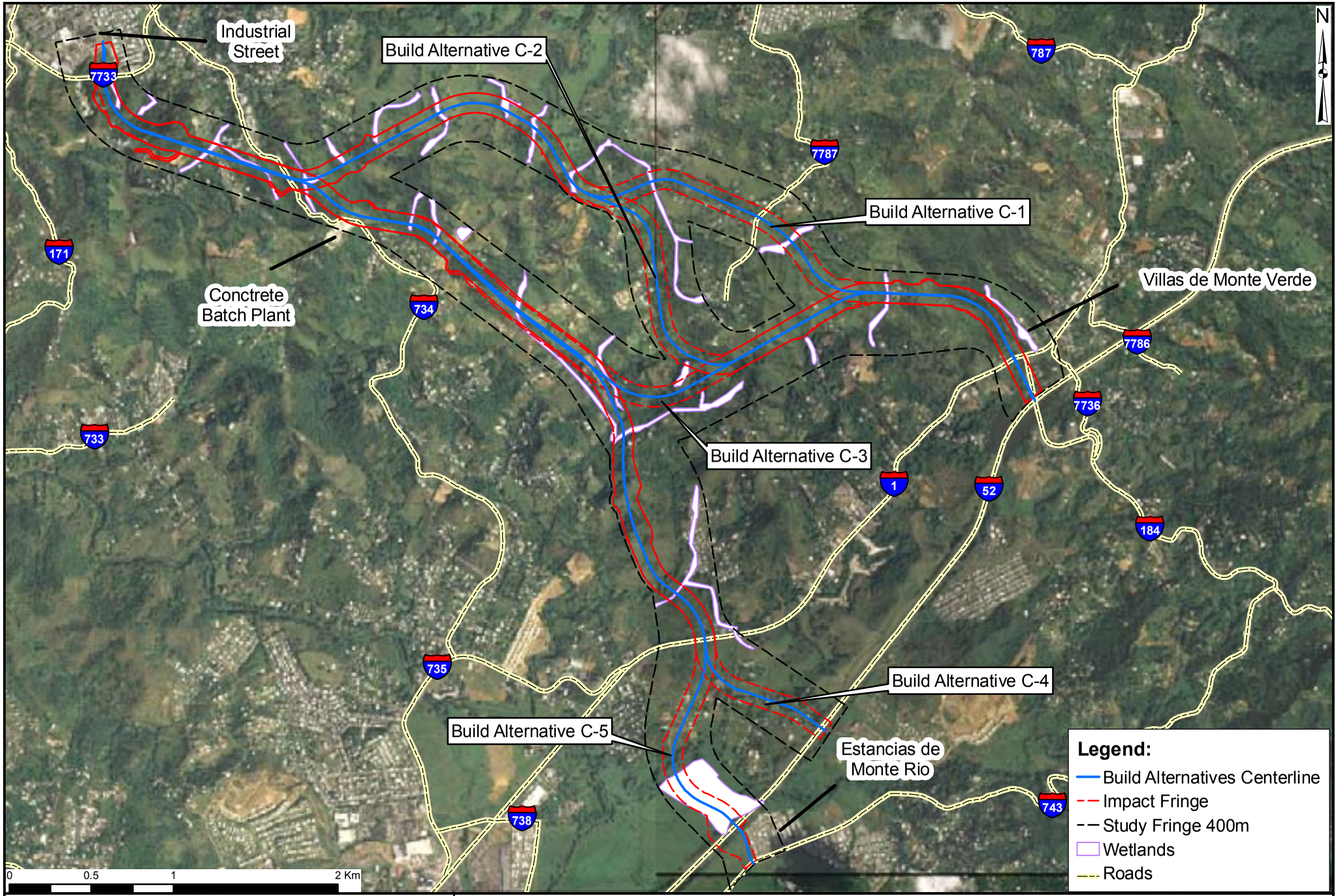


Figure 39. Wetland Delineation on Build Alternatives Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Wetland JD Study

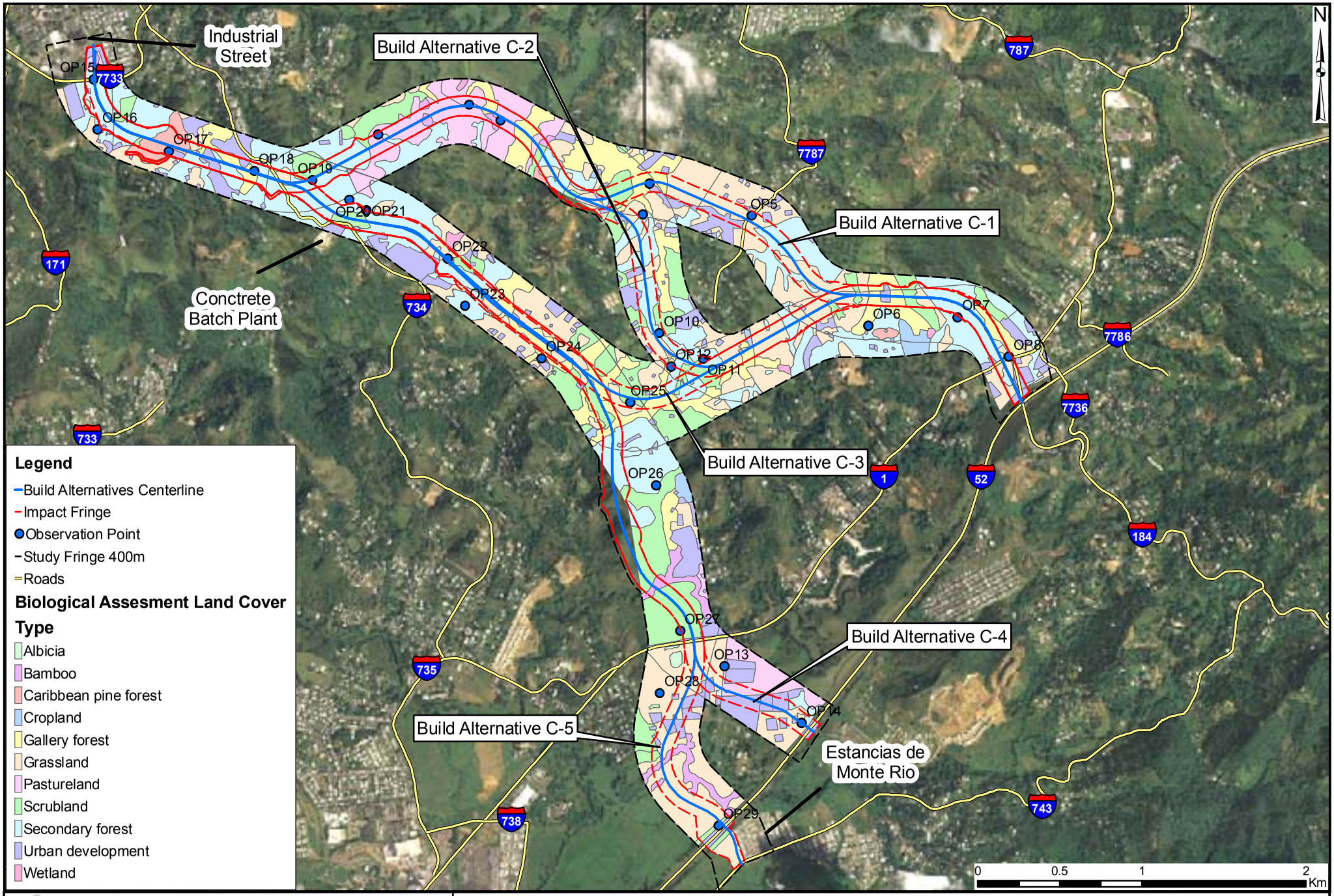


Figure 40. Biological Assessment Land Cover and Observation Points.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Biological Assessment Study

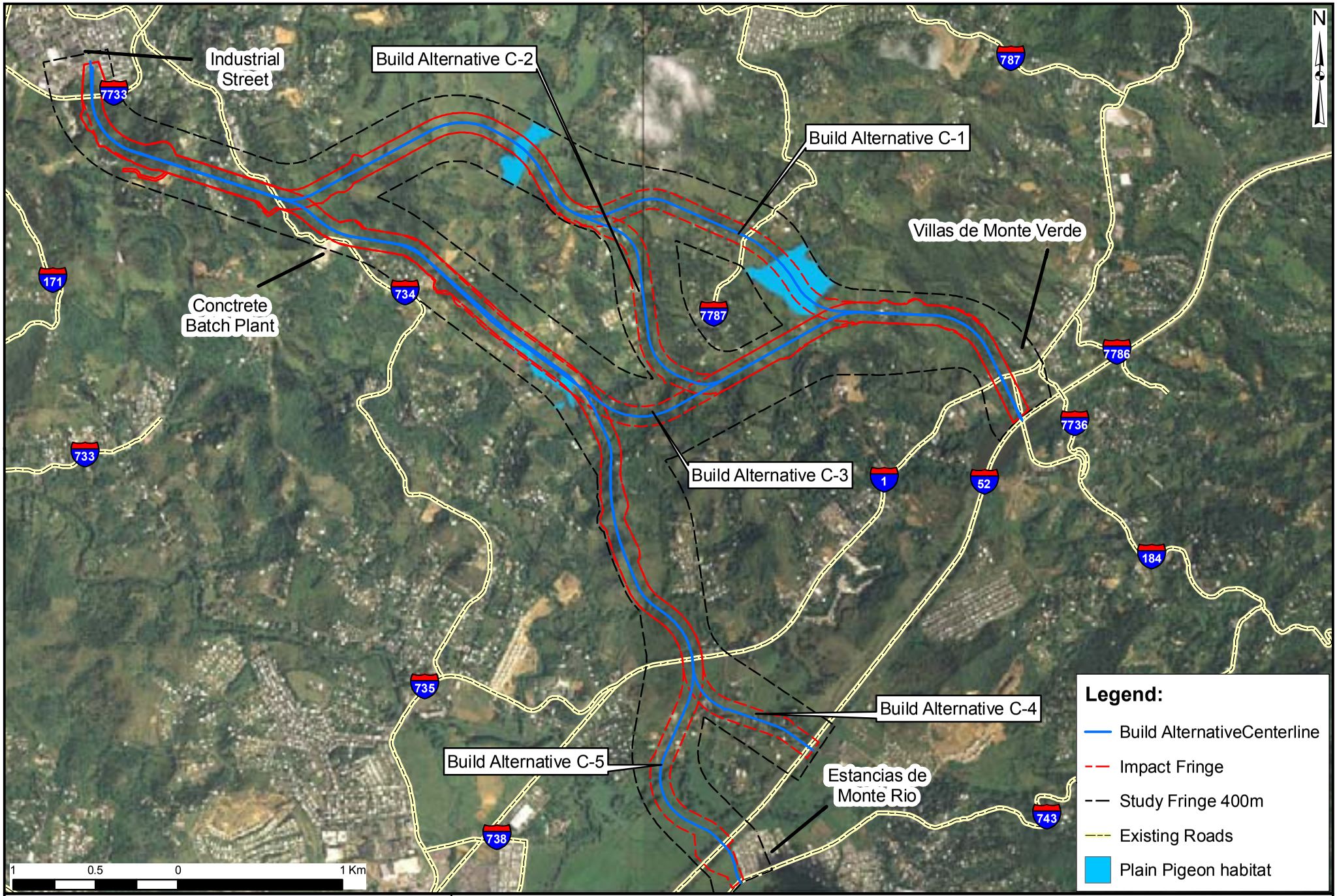


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Figure 41. Designated Critical Habitat of Puerto Rico Plain Pigeon.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRDNER

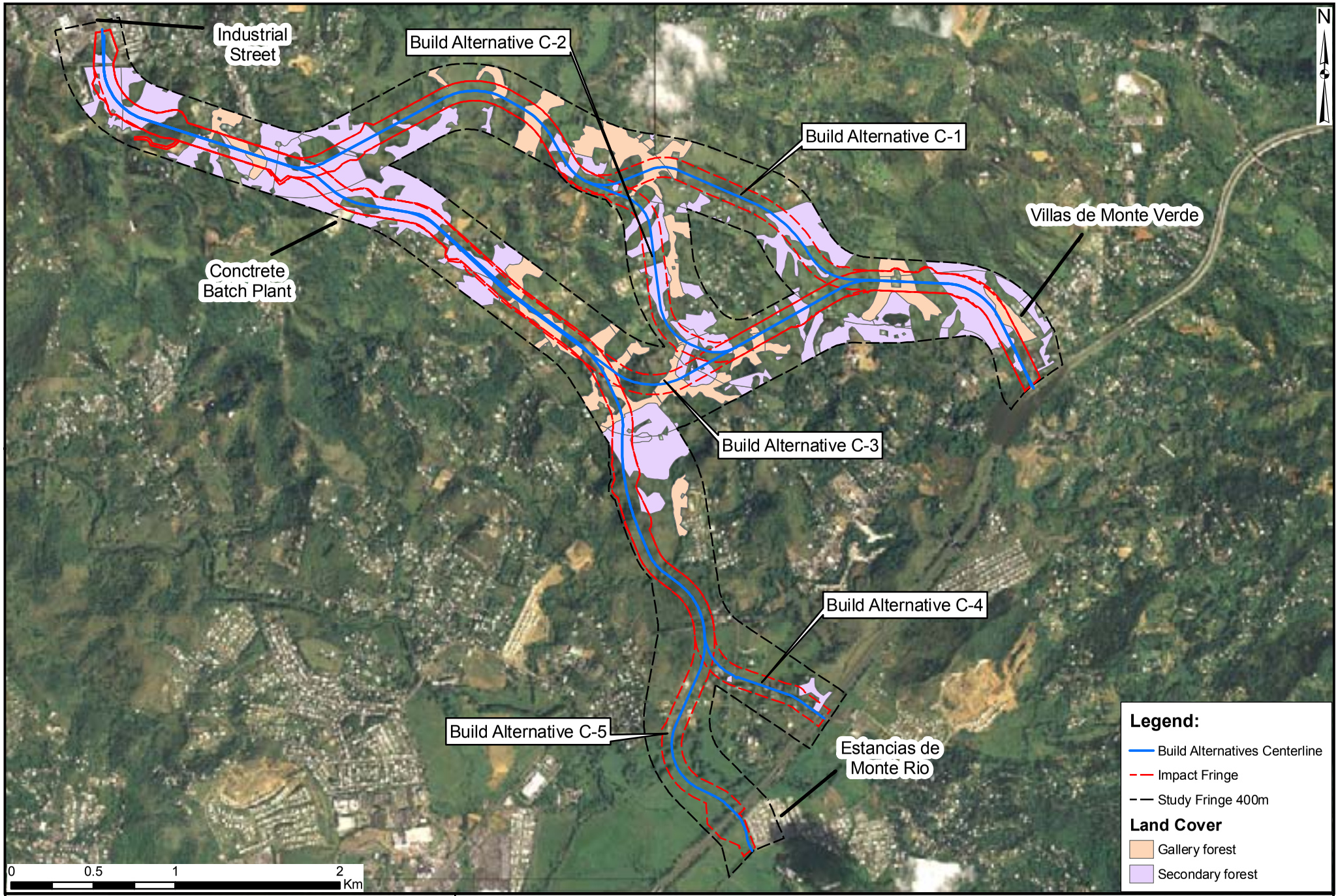


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Figure 42. Secondary and Gallery Forest, Potential Habitat of the Puerto Rican Plain Pigeon.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Biological Assessment Study

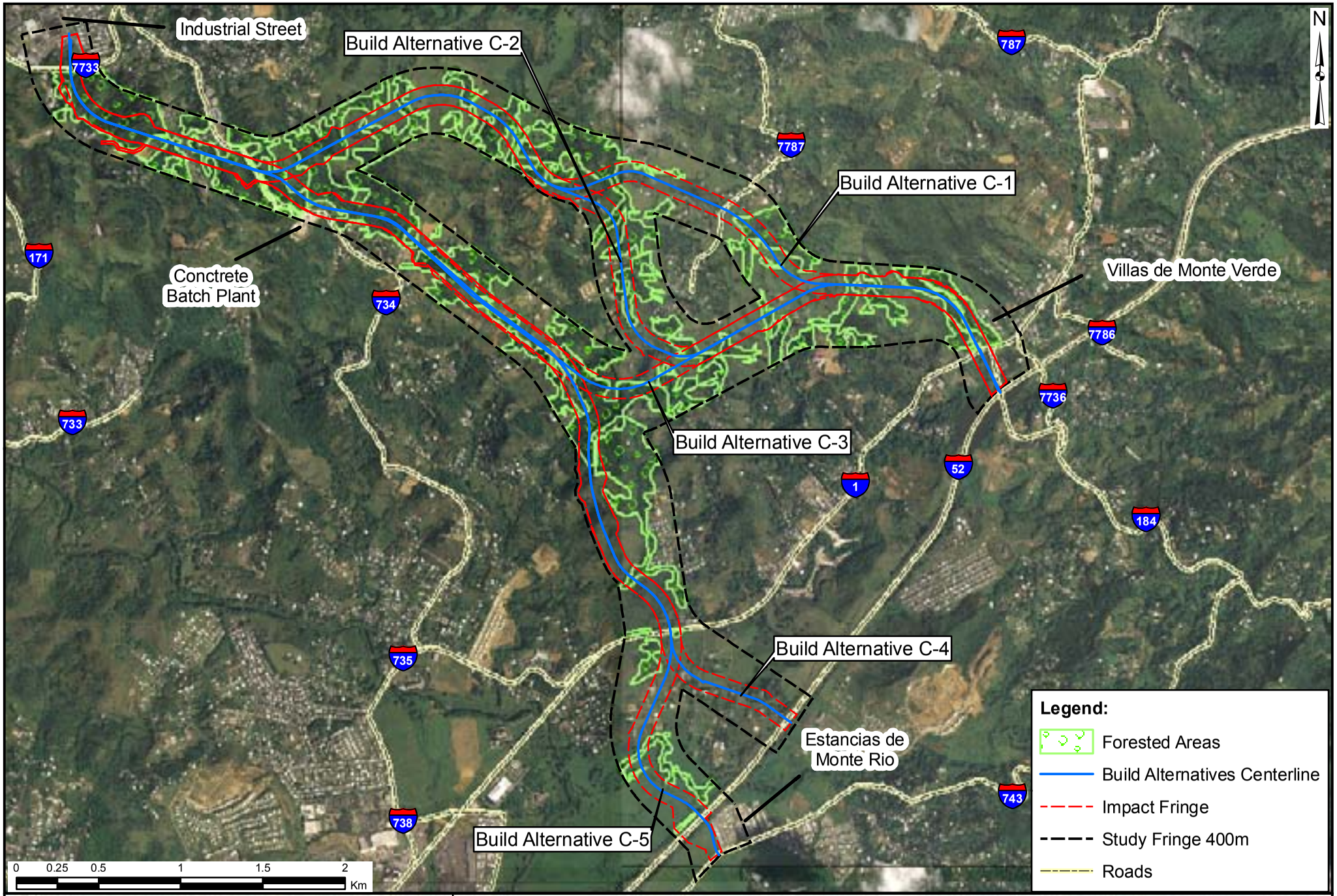


Figure 43. Forested Areas in Study Fringe.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
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Source: Trees Inventory Study

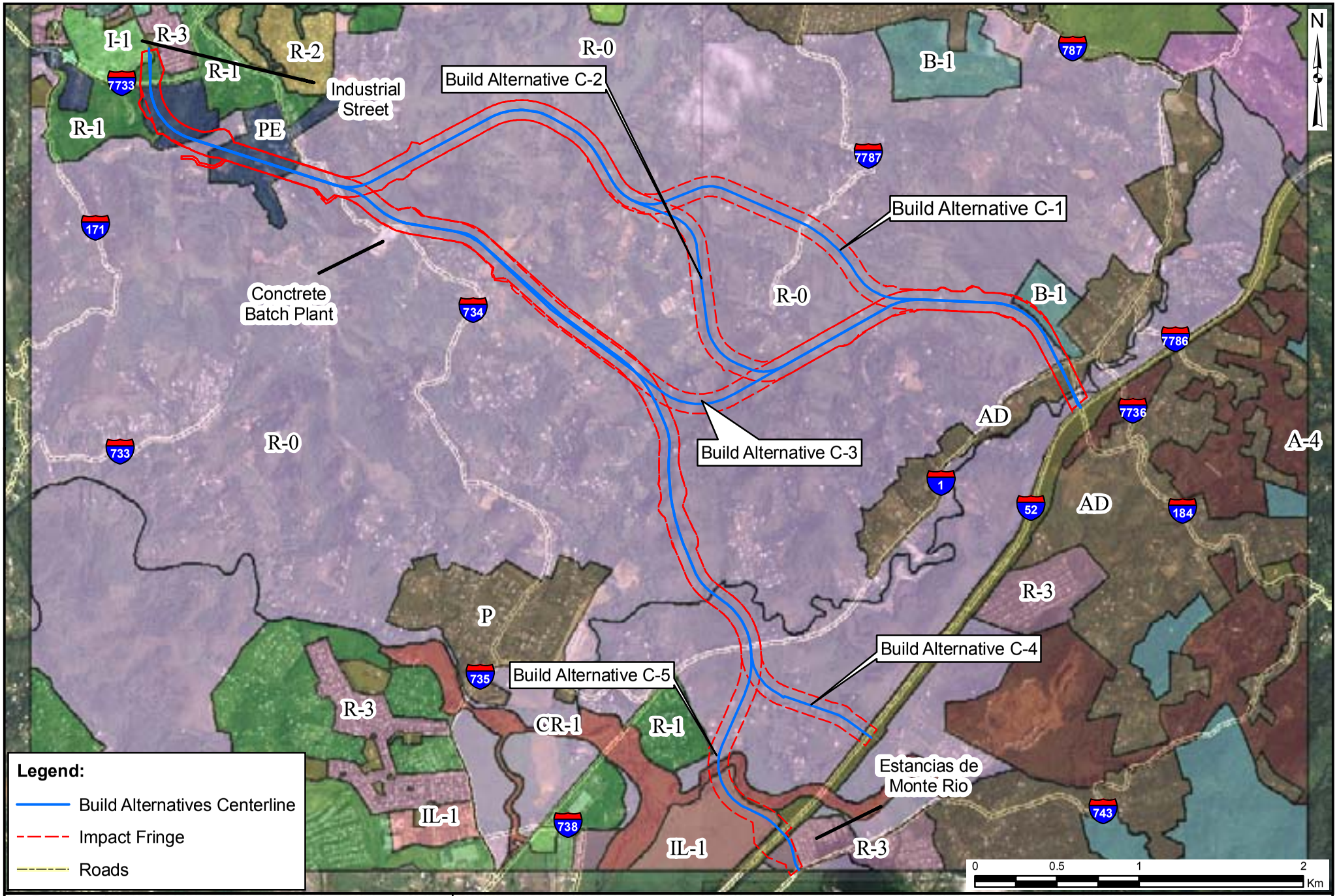


Figure 44. Land Use Plan in the Build Alternatives Impact Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRPB

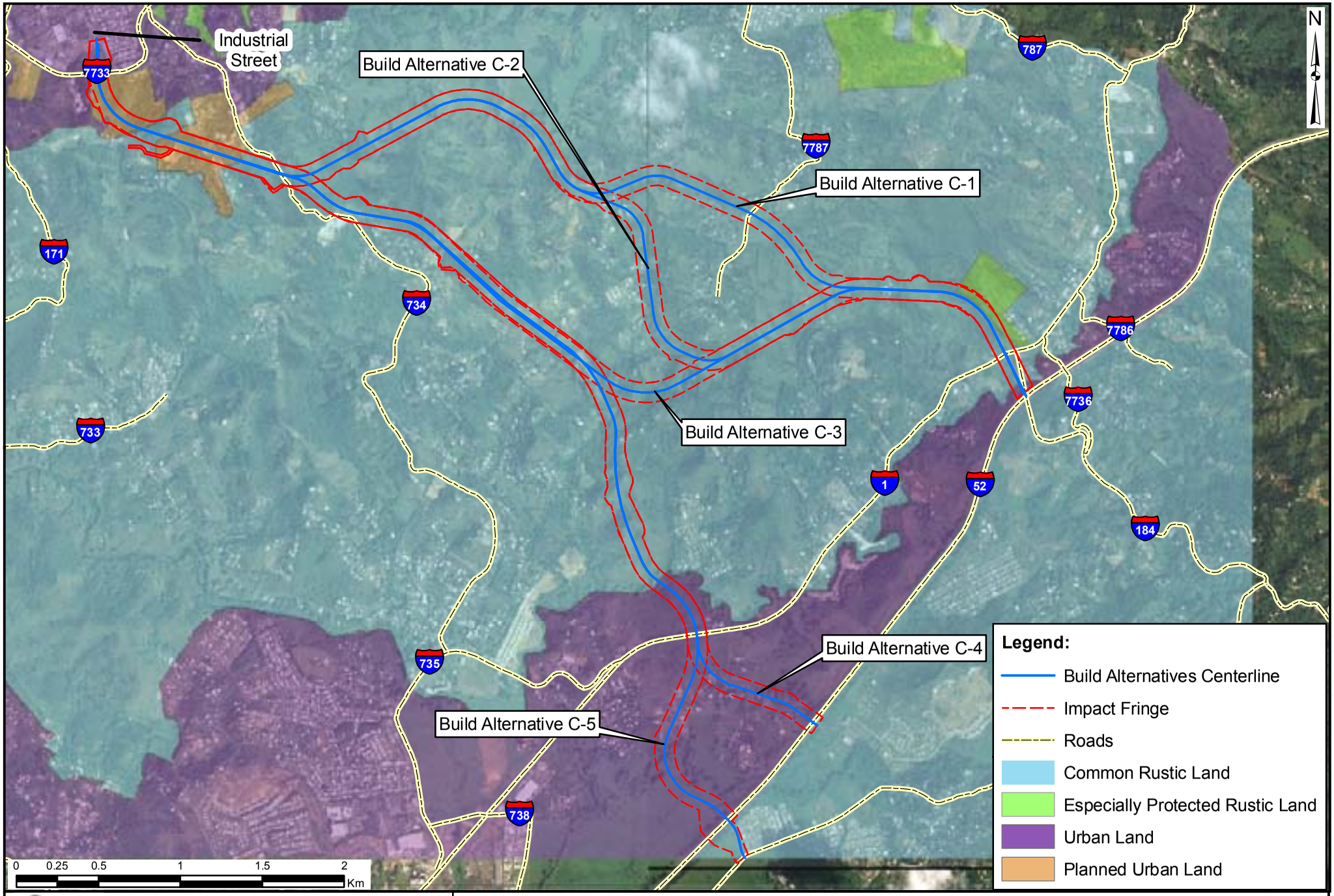


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Figure 45. Land Cover in the Build Alternatives Impact Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: PRBP

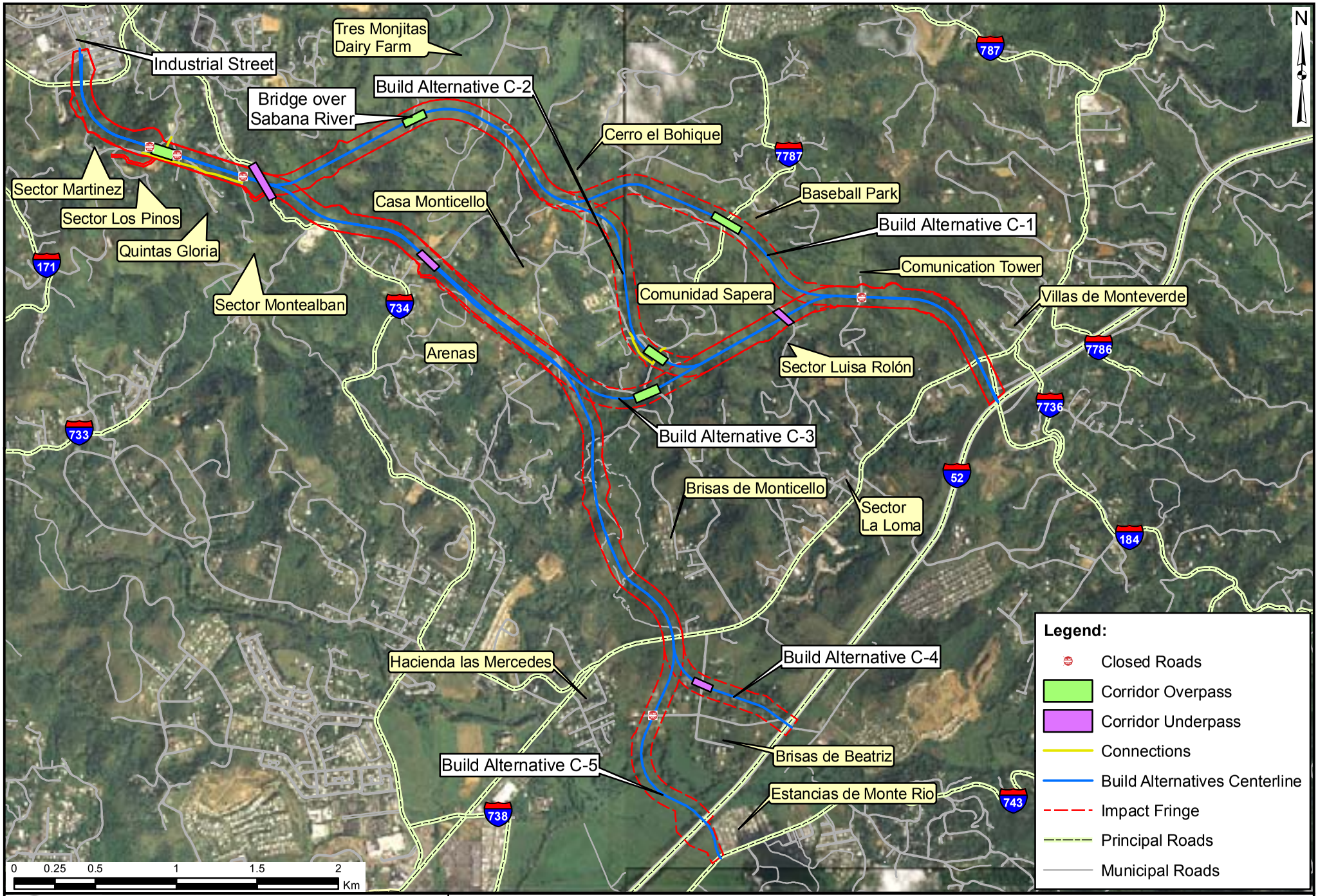


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Figure 46. Communities Cohesion Impact and Mitigation Measures.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

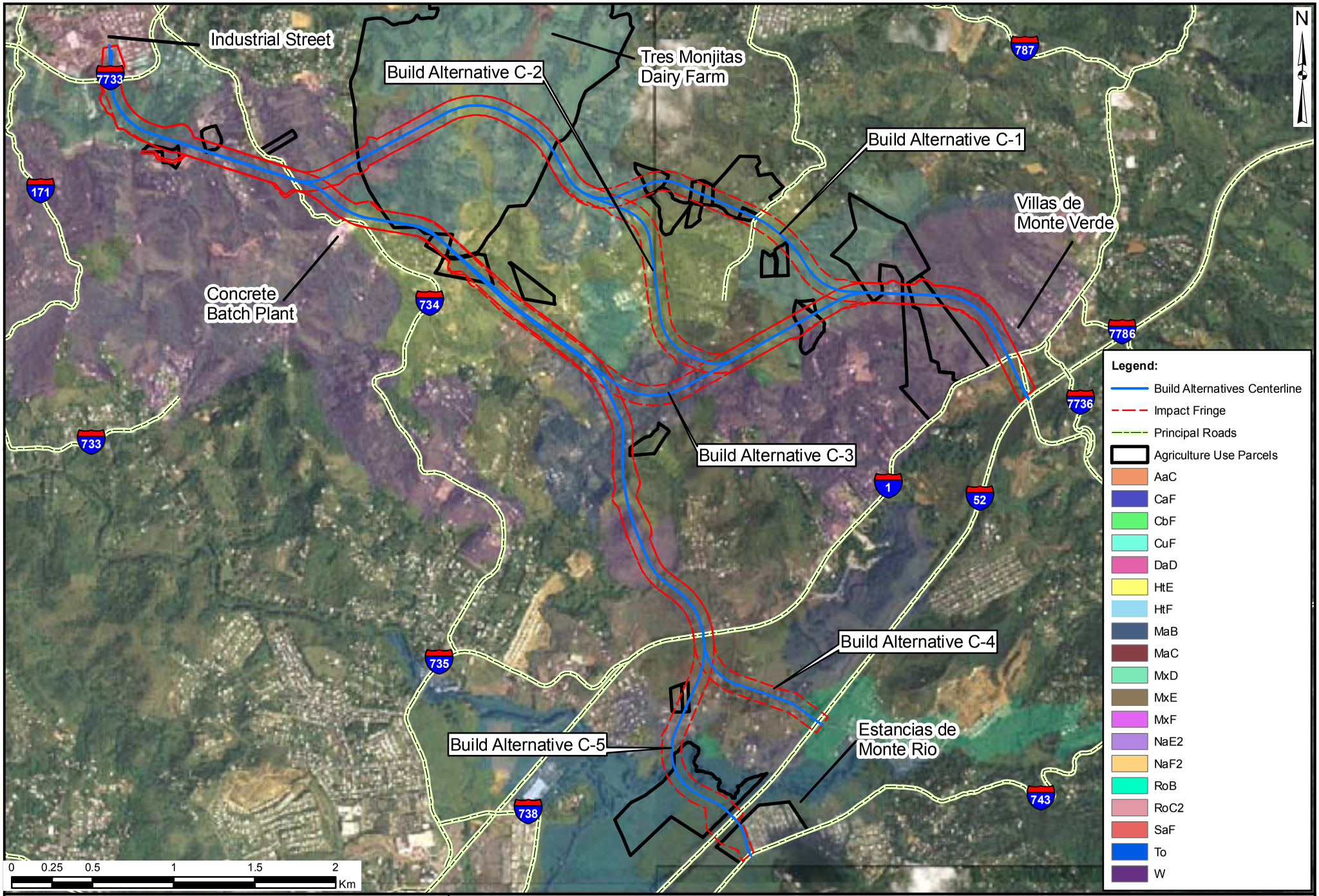


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Figure 47. Impacted Parcels with Agricultural Use.

CIDRA CORRIDOR FROM CIDRA iNDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

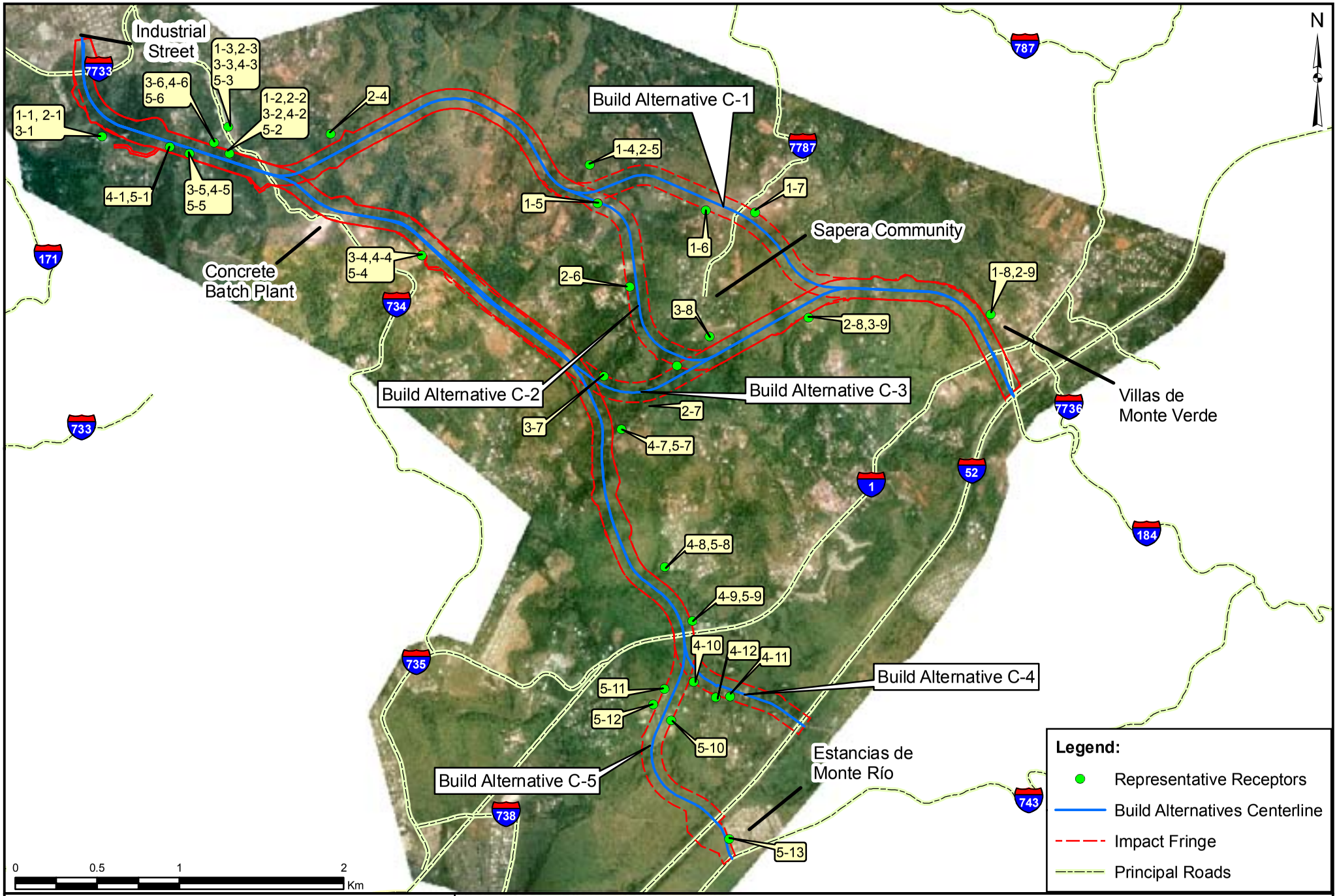


Figure 48. Noise Communities Representative Receptors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Traffic Noise Analysis

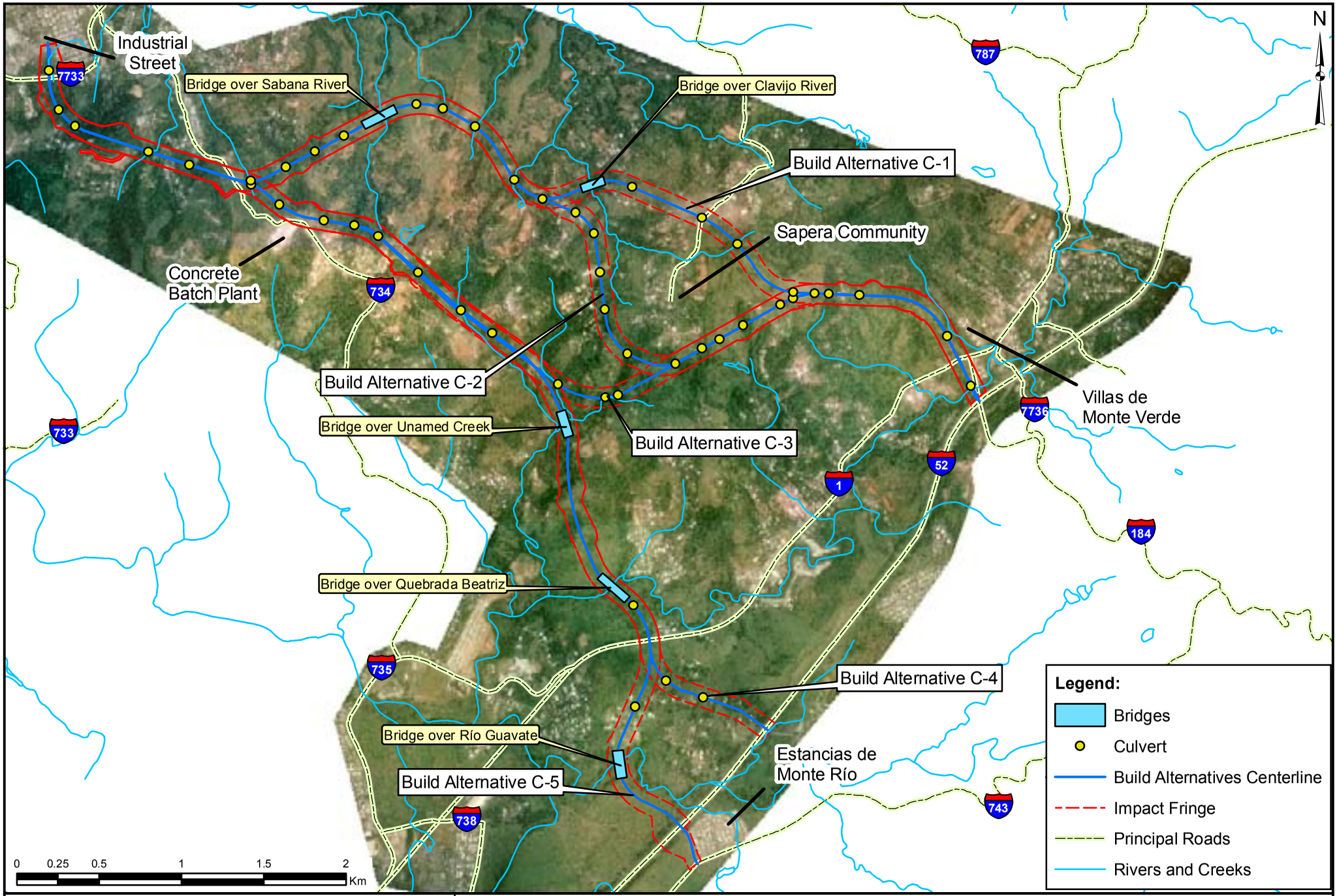


Figure 49. Location of Bridges and Culverts along New Roads Alternatives.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Environmental Hydrology Study

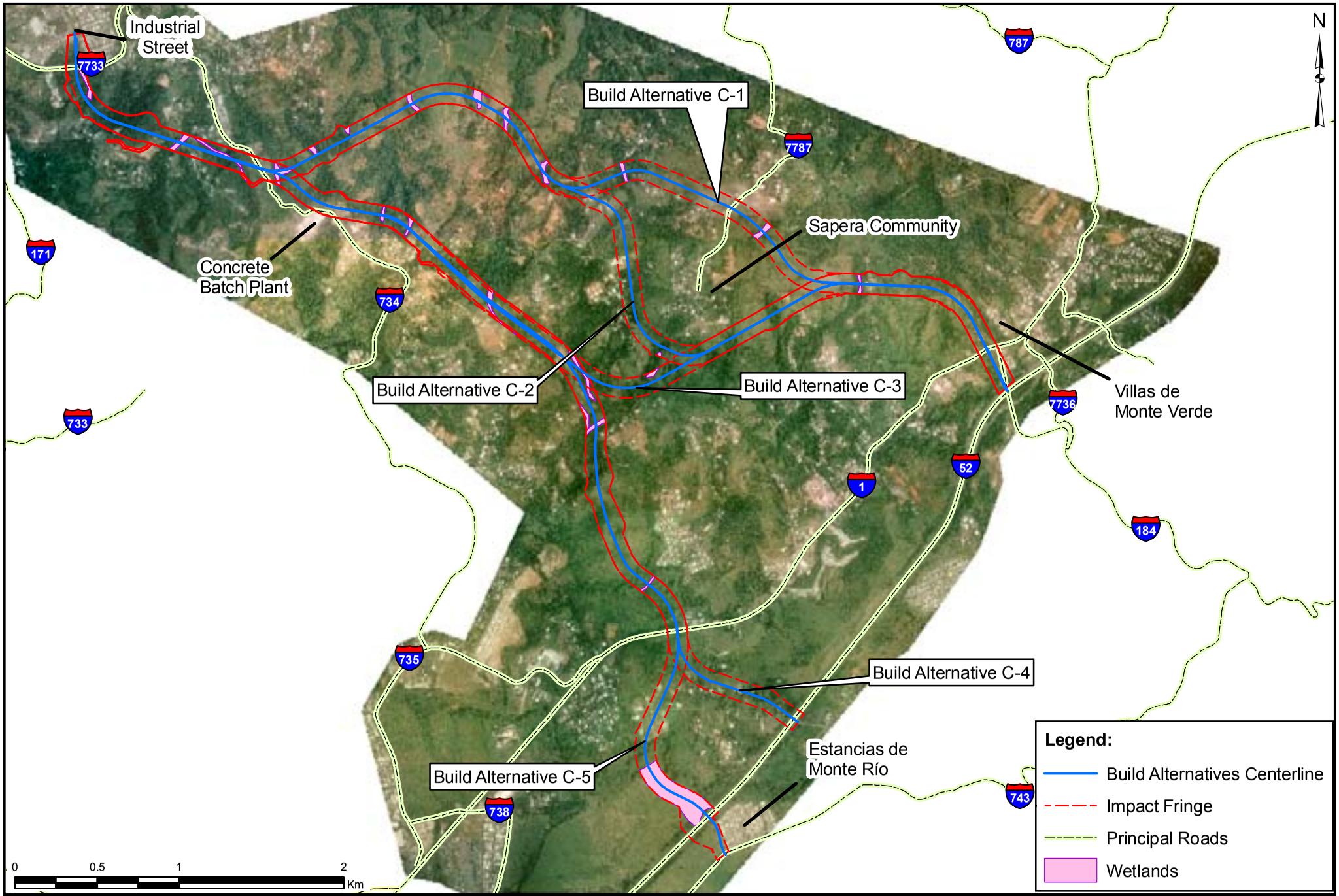


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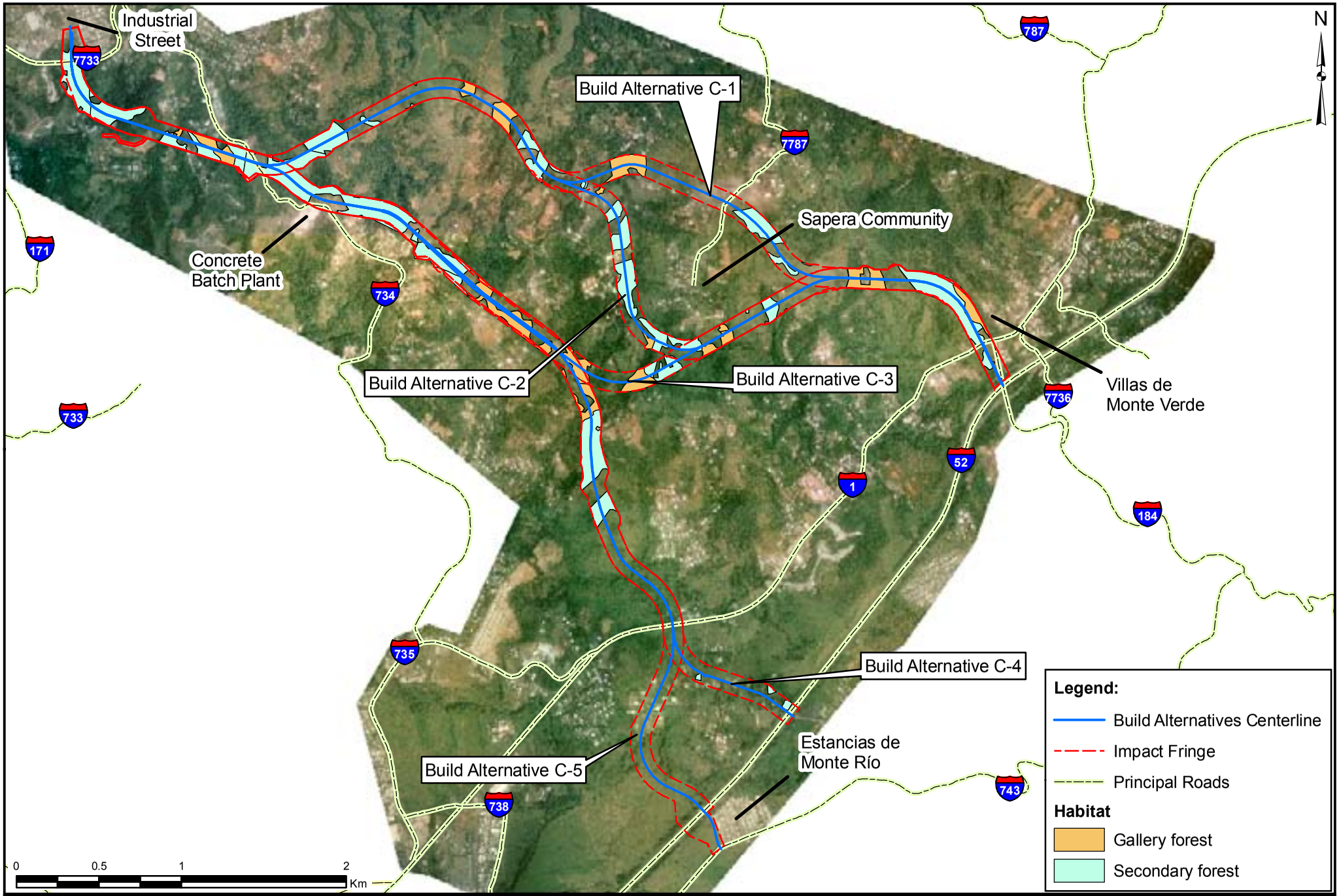
Figure 50. Potential Wetland Impacted by Build Alternatives Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Wetland JD Study

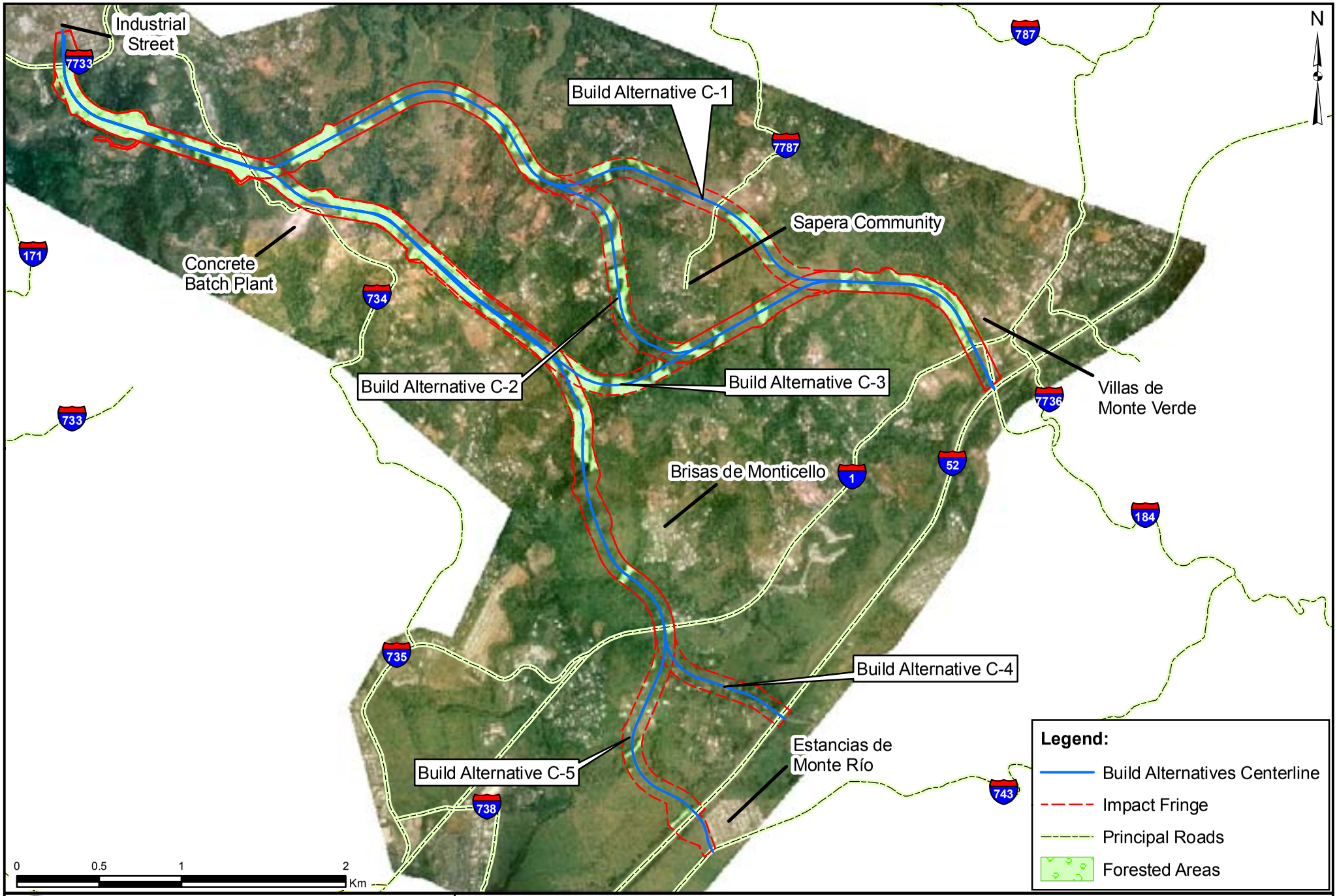



U.S. Department of Transportation
Federal Highway Administration

Figure 51. Direct Impacts to Potential Habitat of the Puerto Rican Plain Pigeon by Build Alternatives Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Biological Assessment Study




U.S. Department of Transportation
Federal Highway Administration

Figure 52. Potential Impact to Forest Areas by Build Alternatives Corridors.

CIDRA CORRIDOR FROM CIDRA INDUSTRIAL STREET TO PR-52
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Source: Tree Inventory Study

- Chapter 8 Coordination – Summarizes coordination performed with cooperating and participating government agencies and the community. Coordination was performed in accordance with Section 6002 of Public Law 109-59, "Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users", (SAFETEA-LU).
- Chapter 9 List of Prepares – Lists personnel responsible for preparing the DEIS and supporting studies.
- Chapter 10 Distribution List – Lists the entities receiving a copy of the DEIS.

An index is also provided, and six additional separate technical appendixes contain copies of supporting studies plus documentation of coordination with government agencies and the community.

**Environmental Setting**

Puerto Rico is a Caribbean Island measuring approximately 3,500 square miles, has a population of over 3.8 million people, and is located about 1,000 miles southeast of Miami, Florida. The two principal municipalities affected by the proposed action are Cidra and Cayey, both located in the central-east region of Puerto Rico and designated as part of the Metro South Region as defined in the Puerto Rico 2030 Long Range Transportation Plan prepared by the PRHTA.

The Municipality of Cidra has deficient vehicular transportation linkages with adjacent municipalities and the PR-52 expressway which provides rapid vehicular transport to both the south and north coastal areas, including the San Juan metropolitan area. Private vehicles are the principal mode of transportation in the Metro South Region including the municipality of Cidra. The lack of a mass transportation system in the Metro South Region requires residents and businesses to depend on private vehicles for their transportation needs. Figure ES-1 shows the principal access roads to the Cidra Central Business District (CBD).

The current main access to Cidra is along PR-172, a secondary road which connects to PR-52 in Caguas. This is an undivided roadway and has sections of both two and four lanes, without shoulders, having steep slopes, small radius horizontal curves, drainage problems, and some sections with poor pavement markings. Numerous residences and commercial and institutional buildings such schools and churches have direct access to the road. Landslides are common along PR-172 and in some instances road lanes are closed to repair landslides.

Other access to Cidra is along the secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD; and tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD; and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. These are two lane rural roads (one narrow lane in each direction without shoulders) with poor geometric characteristics and residences, commercial and institutional buildings close to both sides of the roads.

**Table 2: Summary Income Characteristics.**

| Geographic Area | Per Capita Income | | Median Family Income | |
|---|---|---|---|---|
| | 2000 | 2012 | 2000 | 2012 |
| Cidra | $7,027 | $20,084 | $17,262 | $33,136 |
| Cayey | $7,877 | $16,467 | $15,939 | $29,692 |
| Puerto Rico | $8,185 | $18,349 | $16,543 | $30,309 |

**Existing Environment**

The Municipality of Cidra occupies an area of hilly to mountainous topography underlain by volcanic rocks and crossed by numerous small streams. Cidra has a moist tropical environment, cooled by its higher elevations and the approximately 70 inches of rainfall per year. Cidra reservoir, is located adjacent to the Town of Cidra, to which it provides drinking water after filtration. This is the most sensitive and important water resource in the municipality, though other streams in the municipality drain to water supply intakes further downstream in other municipalities.

Until the mid-20$^{th}$ century the predominant land use in the study area was agricultural, with tobacco being the primary cash crop. As the tobacco industry declined following the 1940s, tobacco and other farms were converted into pasture, returned to secondary forest, or converted to rural residential and urban land uses. Current land uses along the new road corridors are predominately rural residential, secondary forest, and pasture.

Cidra has significant areas of forest recognized as habitat for the endangered Puerto Rican Plain Pigeon. Although this species was not observed during studies performed for this DEIS, the pigeon is presumed to inhabit forested areas within the study area. Agriculture is limited to cattle grazing, and the Tres Monjitas dairy farm is located in the area of the proposed new road alignments.

**Alternatives Considered**

A broad range of alternatives to improve the mobility from the Municipality of Cidra were considered including: (1) No Action, (2) Expansion or Improvement to Existing Roads, (3) Transportation System Management (TSM), (4) Mass Transit Alternative (MSA), and (5) Construction of a New Road (along one of five possible alignments). Six of these alternatives were subject to detailed study in the DEIS: “No Action” and “Construction of a New Road” along five possible alignments (identified through the document as Build Alternatives). A comprehensive assessment of the positive and negative environmental, social, and economic impacts associated with these six alternatives, as well as impact avoidance and minimization measures, is also included.

each of five build alternatives. Table 3 summarizes major engineering characteristics of the five proposed build alternatives, of which C-3 was identified as the preferred alternative.

**Table 3: Major Engineering Characteristics of New Road Alternatives.**

| Parameter | Alternatives | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Length (km) | 7.06 | 7.59 | 7.04 | 6.9 | 7.31 |
| Cut Volume (m3) a/ | 2,728,973 | 2,480,896 | 2,602,692 | 3,268,673 | 3,281,010 |
| Fill Volume (m3) a/ | 1,411,368 | 1,606,744 | 936,874 | 617,060 | 648,477 |
| Surplus (m3) b/ | 1,317,605 | 874,152 | 1,665,818 | 2,651,568 | 2,632,533 |
| Bridges over Water Bodies | 2 | 1 | 0 | 2 | 3 |
| Water Crossings (Culverts) | 23 | 30 | 27 | 16 | 15 |
| Bridges over Existing Roads | 2 | 2 | 2 | 1 | 1 |
| Bridges at Existing Roads | 1 | 2 | 3 | 3 | 2 |
| Corridor (cdas) | 225 | 235 | 219 | 214 | 233 |
| Conceptual Design Drawing ROW (cdas) | 124 | 129 | 119 | 112 | 118 |

a/ Without shrinkage or expansion factor.
b/ Surplus material could be reduced during final design when more detailed information is available.

Table 4 shows the Capital cost of each of the proposed Build Alternatives, estimated using Conceptual Design Drawings including others studies performed as part of environmental evaluation process.

**Table 4: Implementation Cost for New Road Alternatives.**

| Component | Cost of Each Alternative ($ Millions) | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| Construction | 93.7 | 88.6 | 74.8 | 90.9 | 98.9 |
| Mitigation a/ | 23.4 | 25.1 | 22.5 | 18.9 | 21.6 |
| Acquisition b/ | 22.1 | 20.8 | 20.4 | 21.7 | 20.9 |
| Total Cost | 139.2 | 134.5 | 117.7 | 131.5 | 141.4 |

a/ Activities required to mitigate environmental impacts.
b/ Includes Acquisition and Relocation Cost.

**Environmental impacts**

The total area of wetlands potentially impacted under each build alternative is summarized in Table 5. Impacts could be further reduced during the design stage when the selected alternative

may be adjusted to further minimize impacts to wetlands. Not all impacts can be avoided, and it is planned that unavoidable wetland impacts be mitigated through the creation of a forested wetland in a single parcel with, on a preliminary basis, a 3:1 (Creation: Impacted Wetland) ratio (Table 5). The wetland mitigation site will be evaluated and selected in accordance with criteria concerning land availability in the project vicinity, proximity to a reliable water source to establish the required wetland hydrology, site topography, and construction feasibility. Other mitigation alternatives, such as wetland banking, will be evaluated during subsequent project phases.

**Table 5: Potential Wetlands Impacted by New Road Alternatives (acres).**

| | C-1 | C-2 | C-3 | C-4 | C-5 |
|---|---|---|---|---|---|
| Impact Area | 5.77 | 5.13 | 12.23 | 11.93 | 13.02 |
| Mitigation Area | 17.31 | 15.39 | 36.69 | 35.79 | 39.06 |

**Threatened or Endangered Species**

The only endangered species reported in the study area by both the Puerto Rico Department of Natural Resources and the U.S. Fish and Wildlife Service is the Puerto Rican plain pigeon (Paloma Sabanera), *Patagioenas inornata wetmorei*, previously known as *Columba inornata*. This species was not observed during the field survey but has been reported from the area. It is likely that the plain pigeon uses some of the gallery and secondary forest along the rivers and creeks for foraging or nesting sites, particularly those areas closer to Cidra reservoir at the western portion of the study area, were sightings have been reported.

Direct and Indirect potential impacts to Puerto Rican plain pigeon were evaluated in the Biological Assessment prepared for the project, which focused on the impacts to potential pigeon habitat. Direct impact areas are those associated with the build alternatives corridors, and indirect impact areas fall between the corridor and the limit of the 400 m study belt.

Land cover categories along a study belt 400 m wide were presented in Chapter 5. Of these, the Gallery Forest, Secondary Forest and Bamboo have the potential to be Puerto Rican plain pigeon habitat. Table 6 summarizes the potential impacts to PR Plain Pigeon habitat.

**Table 6: Direct, Indirect and Total Impacts to PR Plain Pigeon Habitat (acres).**

| Alternative | Direct Impact | Indirect Impact | Total Impact |
|---|---|---|---|
| C-1 | 100.79 | 196.05 | 296.84 |
| C-2 | 111.23 | 224.33 | 335.56 |
| C-3 | 119.39 | 229.91 | 349.30 |
| C-4 | 100.67 | 163.58 | 264.25 |
| C-5 | 101.08 | 170.60 | 272.40 |

a/ Does not included Rivers;
b/ PR Plain Pigeon Potentail Habitat Includes Gallery Forest, Secondary Forest and Bamboo.

All build alternatives cross potential habitat for the Puerto Rico Plain Pigeon. Impacts can be mitigated by planting trees associated within the Plain Pigeon habitat along wildlife corridors such as river banks. This tree planting could also meet the mitigation requirements established by P.R. Dept. of Natural and Environmental Resources (PRDNER) Regulation 25.

**Forest Impacts Under Regulation #25**

Forest impacts, as defined under PRDNER Regulation 25, are summarized in Table 7.

**Table 7: Potential Forest Impacted per New Road Alternatives.**

| Alternative | Forested Areas (acres) | Trees |
|---|---|---|
| C-1 | 117.01 | 171,771 |
| C-2 | 126.34 | 185,467 |
| C-3 | 105.94 | 155,520 |
| C-4 | 87.35 | 128,230 |
| C-5 | 99.91 | 146,668 |

**Cultural Resources and Impacts**

Phase 1A and 1B Cultural Resource studies were undertaken within the corridors associated with each of the five build alternatives under consideration. Both pre-Columbian and colonial resources were identified.

Preliminarily, no historic resources eligible to be included in the National Register of Historic Places (NRHP) were identified in any build alternative corridors. However, both pre-Columbian and colonial archaeological resources were identified during Phase 1A and Phase 1B archaeological studies. Phase II studies will be conducted if an archaeological site will be affected by the preferred alternative, and the consultation process pursuant to Section 36 CFR, Part 800 will be completed prior to completion of the National Environmental Policy Act process.

**Affected Land Uses**

The land use affected by each of the build alternatives was determined by reference to aerial photography with ground truthing, and is summarized in Table 8.

**Table 8: Land Use Cover in each Corridor**

| Cover | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Gallery Forest | 25.3 | 11.7 | 23.1 | 10.0 | 33.5 | 15.5 | 20.4 | 9.9 | 20.4 | 8.9 |
| Secondary Forest | 72.6 | 33.6 | 85.2 | 37.0 | 85.3 | 39.4 | 78.1 | 38.1 | 76.7 | 33.7 |
| Pine Forest | 8.2 | 3.8 | 8.2 | 4.0 | 8.2 | 3.8 | 7.7 | 3.7 | 8.2 | 3.6 |
| Scrubland | 16.3 | 7.6 | 19.6 | 8.6 | 21.4 | 9.9 | 38.3 | 18.7 | 41.7 | 18.3 |

| Cover | Alt. C-1 | | Alt. C-2 | | Alt. C-3 | | Alt. C-4 | | Alt. C-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Grassland | 47.8 | 22.1 | 48.3 | 21.1 | 51.2 | 23.7 | 35.1 | 16.2 | 59.2 | 25.9 |
| Cropland | 0.0 | 0.0 | 0.4 | 0.2 | 0.4 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pastureland | 26.2 | 12.1 | 26.1 | 11.0 | 0.0 | 0.0 | 3.5 | 1.7 | 0.0 | 0.0 |
| Wetland a/ | 0.0 | 0.0 | 0.03 | 0.01 | 0.04 | 0.01 | 0.09 | 0.05 | 0.09 | 0.04 |
| Urban | 16.5 | 7.7 | 16.0 | 7.0 | 15.6 | 7.2 | 21.6 | 10.5 | 17.8 | 7.8 |
| Bamboo | 2.9 | 1.4 | 2.9 | 1.0 | 0.6 | 0.3 | 2.2 | 1.1 | 4.0 | 1.7 |

a/ Excluding rivers.

**Water Resource Impacts**

None of the build alternatives is anticipated to have an appreciable impact on either ground or surface water resources, assuming environmental controls are responsibly implemented, particularly during the construction stage. However, there is a significant difference in the number and magnitude of the stream crossings among the different alternatives, as summarized in Table 9. Build Alternative C-3 is the only one not requiring bridge construction, although the number of culverts is the second-highest among the routes.

**Table 9: Stream Crossings for each New Road Alternative.**

| Alternative | Culverts | Bridges |
|---|---|---|
| C-1 | 23 | 2 (Río Sabana / Río Clavijo) |
| C-2 | 30 | 1 (Río Sabana) |
| C-3 | 27 | 0 |
| C-4 | 16 | 2 (Unnamed Creek / Quebrada Beatriz) |
| C-5 | 14 | 3 (Unnamed Creek / Quebrada Beatriz / Río Guavate) |

**Noise Impacts**

A noise impact analysis was performed for each of the new roads alternatives following the criteria established in the “Development and Operation of Transportation Projects Policy”, which was prepared to comply with the requirements set forth in CFR Title 23, Part 772 and the noise related requirements of the National Environmental Policy Act.

Noise impacts were analyzed for each alternative. The receptors that would require mitigation measures were identified assuming that mitigation will be provided only for those receptors within 1 dBA or exceeding the established Noise Abatement Criteria (Table 10).

**Table 10: Receptors that would Require Noise Mitigation Measures.**

| Build Alternative | Receptors |
|---|---|
| C-1 | 1-1, 1-2 (2 residences) |
| C-2 | 2-1, 2-2 (2 residences) |
| C-3 | 3-2, 3-5 (3 residences) |
| C-4 | 4-2, 4-5, 4-11 (4 residences) |
| C-5 | 5-2, 5-5, 5-10, 5-11 (8 residences) |

**Relocation Impact Assessment**

A "Properties Inventory and Probable Acquisition Cost Study" was prepared to estimate the number of properties that would be impacted and the estimated cost associated with each build alternative, along with the impacted structures. These results are summarized in Table 11 and Table 12.

**Table 11: Properties that would be Impacted and Acquisition Cost.**

| Alternative | Properties | Acquisition Cost |
|---|---|---|
| C-1 | 133 | $19,361,000 |
| C-2 | 125 | $19,231,000 |
| C-3 | 133 | $18,811,000 |
| C-4 | 122 | $20,343,000 |
| C-5 | 116 | $19,571,000 |

**Table 12: Residential and Commercial Structures that would be Totally Acquired and Acquisition Cost.**

| Alternative | Properties | Acquisition Cost |
|---|---|---|
| C-1 | 69 (7) | $9,848,000 ($1,644,000) |
| C-2 | 56 (7) | $9,292,000 ($1,644,000) |
| C-3 | 54 (7) | $8,111,000 ($1,644,000) |
| C-4 | 56 (0) | $10,149,000 (0) |
| C-5 | 55 (1) | $9,882,000 ($175,000) |

a/ Residential (Commercial)

**Cumulative Impact Assessment**

No cumulative environmental impacts are assigned to the "No Action" alternative, although some additional development may nevertheless occur in the absence of transportation improvements. However, all build alternatives will support additional development that would impact natural systems. Several public and private development initiatives are proposed for the municipality of Cidra, and in conjunction with construction of a new road, these will promote the further development of Cidra and will exert pressure on existing resources.

**Selection of Preferred Alternative**

The information compiled and studies undertaken were used to compare the various alternatives, and to prepare a matrix of characteristics and impacts of each alternative as presented in Chapter 7 of the DEIS. Build Alternative C-3, the preferred alternative:

- provides the shortest route and has the lowest capital cost;
- avoids the construction of any bridges over water bodies;
- minimizes cultural resource impacts;
- impacts 19% more plain pigeon habitat than the lowest-impact alternative; and
- is equal to build alternative C-2 in having the lowest noise impacts.

With respect to other characteristics or impacts, this alternative is not markedly different from other build alternatives.

# 1. INTRODUCTION

The Puerto Rico Highway and Transportation Authority (PRHTA) is evaluating alternatives to improve mobility from the municipality of Cidra to the Puerto Rico Strategic Highway Network (PRSHN). The PRHTA, in cooperation with the Federal Highway Administration, prepared this Draft Environmental Impact Statement (DEIS) to evaluate the alternatives and their environmental, social, and economic impacts. This DEIS was prepared in accordance with the National Environmental Policy Act (NEPA), as amended and its implementing regulations, as well as the Puerto Rico Environmental Public Policy Act as amended.

Puerto Rico is a Caribbean Island measuring approximately 3,500 square miles, has a population of over 3.8 million people, and is located approximately 1,000 miles southeast of Miami, Florida. Figure 1 shows the location of Puerto Rico. Cidra municipality is located in the central-east region of Puerto Rico (see Figure 2) and is part of the Metro South Region as defined in the Puerto Rico 2030 Long Range Transportation Plan (PRLRTP) prepared by the PRHTA. Figure 3 shows the location of Cidra and the PRSHN in the Metro South Region.

A broad range of alternatives to improve the mobility from the municipality of Cidra were considered including: (1) No Action, (2) Expansion or Improvement to Existing Roads, (3) Transportation System Management (TSM), (4) Mass Transit Alternative (MSA), and (5) Construction of a New Road (along one of five possible alignments). From these alternatives six were carried forward for a detailed study in the DEIS. The alternatives evaluated in detail are the No Action and five Build Alternatives (Construction of a New Road along five possible alignments). A comprehensive assessment of the positive and negative environmental, social, and economic impacts associated with these six alternatives, as well as impact avoidance and minimization measures, is also included.

The DEIS summarizes the analysis and studies performed evaluating the possible alternatives to improve the mobility from the municipality of Cidra. The DEIS identifies the Preferred Alternative (PA) to improve the mobility from the municipality of Cidra to the PRSHN. This DEIS includes the transportation system, natural and social environment, cultural resources, economics, and engineering consideration for the study area.

The DEIS is organized into 10 chapters as summarized below:

Chapter 1: Introduction – This chapter provides an introductory description of the DEIS and its components.

Chapter 2: Purpose of and Need for Action – This chapter provides a general description of the transportation system and socioeconomic characteristics, identifies existing and future transportation problems, summarizes the planning studies performed by government agencies related to the project, and summarizes community participation.

### 2.2.2. Previous New Road Alternatives Studies

Alternatives to improve mobility from the municipality of Cidra to the PRSHN have been evaluated by the PRHTA and Cidra municipality prior to initiating the NEPA process. Evaluations began in 1997 and were focused on developing a new connector to link Cidra CBD with PR-52 at Cayey. Several studies and informative workshops were conducted to find a reasonable and prudent alternative for this connector. Documents and activities associated with the analysis and evaluations performed to identify a connector are summarized below.

Cidra Municipality Public Hearing (October 1997). In October 1997 the municipality of Cidra discussed with the community the municipality's intent to request funds to develop a new road between PR-7733 and PR-52. Most participants agreed with the development of a new road. Residents near the alignment of the proposed road requested access to the new road.

Route Study for Connector from Cidra Bypass (PR-7733) to the Intersection of PR-1 with PR-184 (January, 1999). In January 1999, the PRHTA presented the first Route Study of the Cidra New Corridor. This study evaluated four alternatives and identified as the Preferred Alternative an alignment which begins at road PR-7733, about 300 meters south the PR-734 intersection. The alternative then continues east bordering the south part of Santa Clara community and crossing several tributaries of the Sabana River. It then crosses the Tres Monjitas Farm and Clavijo River, and continues to the Sapera community where it turns southeast to protect a communication tower in the sector. After it passes the communication tower it turns northeast to end at PR-1 with a proposed new intersection. Figure 6 shows the alignment of the 1999 Route Study Preferred Alternative.

Route Study (1999) Informative Workshop. In December 6, 1999 the PRHTA held an informative workshop to discuss with the community the results and findings of the Route Study performed in January 1999. PRHTA discussed the project needs, benefits and impacts on the environment and the community. During this workshop groups from the Sapera community were strongly against the development of the connector through their community. The key concerns expressed by the community were: (1) it will affect the cohesion of the community; (2) it will promote the uncontrolled and undesired development around the new route; (3) it will destroy the Puerto Rican Plain Pigeon habitat; (4) it will threaten the quality of life of the resident of the area and (5) it will promote the destruction of agricultural and forest lands.

Declaración de Impacto Ambiental Preliminar Conector Cidra – Cayey desde la PR-7733 hasta la Intersección de las Carretera PR-1 y PR-184" (June, 2000). In 2000 the PRHTA prepared a Draft Environmental Impact Statement to analyze in detail the alternatives studied in the 1999 Route Study. The DEIS was prepared pursuant to the Puerto Rico Environmental Public Policy Law as amended and not the federal National Environmental Policy Act. Alternatives were modified to incorporate comments expressed by the Sapera community in the 1999 Informative Workshop. Figure 6 shows the alignment of the 2000 DEIS Preferred Alternative.

Commonwealth of Puerto Rico Legislature Resolution # 27 (2001). In 2001 the Commonwealth of Puerto Rico Legislature issued a resolution ordering the Highway and Transportation Department to stop the planning of the Cidra-Cayey Corridor.

Conector Cidra – Cayey Estudio de Ruta Suplementario Final (November, 2005). Due to opposition to the 2000 DEIS, the PRHTA performed a new Route Study that considered the issues and opposition associated with previous studies. The study considered nine alternatives, three of them already evaluated by previous studies. Four of the Alternatives evaluated are shown in Figure 6.

Route Study (2006) Informative Workshop. On November 15, 2006, the PRHTA held an informative workshop to discuss with the community the results and findings of the Route Study performed in November, 2005.

## 2.3. Community Participation

During the last 13 years an improvement to the transportation system between Cidra and the PRSHN has been discussed between government agencies and the public. The PRHTA has held several informative workshops and public hearing in which the public has had opportunities to discuss studies and provided comments regarding to the potential alternatives.

A coordination plan as required by Section 6002 of Public Law 109-59, “Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users”, (SAFETEA-LU) was prepared as part of the preparation of this DEIS. As specified in the coordination plan, the public and government agencies have been included in the development of this DEIS. Two informative meetings were held in Cidra in which the community expressed their comments and suggestions. There is a general agreement among Cidra residents that existing roads that connect the municipality to the PRSHN are unsafe and inadequate and that a new road is needed. The community concerns largely revolve around the alternative that should be selected.

# 3. ALTERNATIVES

This chapter discusses the broad range of alternatives considered, describes the reasonable alternatives evaluated in detail and those alternatives eliminated from detailed study, and summarizes the studies and analyses performed to evaluate the alternatives.

## 3.1. Evaluation and Selection of Reasonable Alternatives

Private cars are the principal mode of transportation in Metro South Region which includes Cidra. Roads are the only infrastructure used to move people and goods in Cidra and Cayey. Therefore the alternatives considered focused on improvement of the transportation system based on the context of the transportation system of the area.

Several alternatives were evaluated including: (1) No action, (2) Expansion or Improvement of Existing Roads, (3) Transportation System Management (TSM), (4) Mass Transit Alternative (MSA), and (5) Construction of a New Road (along one of five possible alignments).

### 3.1.1. No Action Alternative

No action means maintaining the existing transportation infrastructure with no significant changes or actions to expand or improve it. The principal access routes to Cidra are PR-172, PR-734, PR-141 and PR-787, with PR-172 and PR-734 being the ones with highest use. Figure 4 shows existing access roads to Cidra CBD from PR-52.

The main access to Cidra from PRSHN is along secondary road PR-172 which connects PR-52 (in the Caguas area) to the Cidra Central Business Districts (CBD). This road is used by residents, visitors and heavy freight traffic. From PR-52 to La Sierra Sector (Cañaboncito ward in Caguas) PR-172 is an undivided four lane road without shoulders, and characterized by steep slopes, small radius horizontal curves, drainage problems, and some segments with poor pavement markings. From La Sierra Sector (east of PR-172 and PR-785 intersection) to Cidra CBD PR-172 is a two lane road with small-radius horizontal curves. Along PR-172 there are residences, commercial and institutional buildings such schools and churches close to and with direct access to the road. Improvements to the PR-172 and PR-7733 intersection were recently performed by PRHTA. Improvements include the construction of a new bridge over Cidra Lake and geometric changes to the intersection.

Other access routes to Cidra are along secondary road PR-171 which connects PR-14 in Cayey with Cidra CBD, tertiary road PR-787 which connects PR-1 at Beatriz ward in Cidra to Cidra CBD, and PR-734 which connects Cidra CBD with PR-735 near PR-1 in the municipality of Cayey. These are rural 2-lane roads (one narrow lane in each direction, without shoulders) with poor geometric characteristics, and residences, commercial and institutional buildings close to the pavement on both sides of the road. Several municipal roads connect Cidra communities but

none of them has the capacity for large quantities of vehicles. PRHTA planning studies or strategic plans do not include improvements to the existing transportation system. Only regular maintenance like pavement repair, pavement marking and vegetation cutting are currently planned. The No Action Alternative is under consideration and is evaluated in the DEIS.

### 3.1.2. Expansion or Improvement of Existing Roads Alternative

Existing access roads to Cidra CBD are characterized by narrow surface pavement sections, poor geometry (steep slopes, small-radius horizontal curves), and high levels of development close to both sides of the road. Most structures along both sides of these roads have direct uncontrolled highway access. PR-172 and PR-734 are the roads with the highest percent of users, and run along sloping terrain which would require large amounts of earth movement to provide a safe and reliable road. PR-172 was constructed during the 1970's and PR-734 is an older rural road. Both roads do not comply with currently road safety standards. Figure 7 shows existing conditions of the PR-172 and PR-734.

PR-171 and PR-787 are rural roads characterized by narrow pavement section, poor geometry (steep slopes, small-radius horizontal curves), and structures close to the pavement on both sides of the road and which have direct access to the highway. Figure 8 shows existing condition of the PR-171 and PR-787.

The engineering and construction effort required to bring these existing roads into compliance with current road safety standard are comparable to the effort required to build a new road. Expansion, widening or improvement of existing road would require the acquisition of many residences, commercial and institutional structures. Structures not acquired would still maintain direct access to the roads. Community disruption would be extensive and traffic would be affected during construction. Due to the engineering difficulties, high cost of implementation (land acquisition, construction, etc ) and high social impact of implementation, and the fact that it would not meet the purpose and need, this alternative was not carried forward for detailed analysis in the DEIS.

### 3.1.3. Transportation System Management (TSM) Alternative

TSM focuses on improving the operational characteristics of the existing transportation system using low cost approaches that can be implemented addressing the transportation needs in the study area. Alternatives include use of High Occupancy Vehicle (HOV), ridesharing, exclusive lanes on existing roadways, and traffic signal timing optimization. These options are usually implemented in urbanized areas with a population over 200,000 people. PRLRTP and PRSJTP did not identify any TSM in the Metro South Region. Utilization of HOV is not a reasonable alternative because the existing roads are not prepared to handle this situation. Ride-sharing would require resident education and substantial change in travel habits, and its implementation is likely not feasible due to the rural configuration of the area. Traffic signal timing optimization would not improve the unsafe characteristics of existing roads and would not improve existing

traffic conditions. TSM would not adequately address the purpose and need. Therefore, the TSM Alternative was not carried forward for detailed analysis in the DEIS.

### 3.1.4. Mass Transit Alternative (MSA)

The Mass Transit Alternative was not considered in the PRSJTP for internal movements within the Metro South Region Area. Currently the region lacks of an effective mass transportation system such as buses. Only a few private public cars provide service, and they do not have a programmed schedule and their trip schedule is determined by passenger demand. This alternative is usually implemented in urbanized areas with a population over 200,000 people. MSA was not carried forward for detailed analysis in the DEIS because implementation would required a high economic investment and it would not meet the purpose and need.

### 3.1.5. Construction of a New Road (Build Alternatives)

Construction of a new road was evaluated in detail. The PRHTA initially defined each alignment with a 400 m wide corridor (see Figure 9 and Figure 10). Environmental, cultural, social and engineering studies were performed in the 400 m corridor. Study results and public comments were used to prepare Conceptual Design Drawings (CDD) for each alternative. The following general criteria were used to develop to the Conceptual Design Drawings:

- Roads shall comply strictly with PRHTA and American Association of State Highway and Transportation Officials (AASHTO) design standards without modifications.
- Provide as possible an earth-balanced project. However, the build alternatives run across a mountainous area and an earth-balanced project is difficult to obtain without modification of design standards.
- Avoid as possible impacts to areas or properties that could qualify under Section 4(f) or have archaeological resources.
- Reduce the number of structures to be acquired for road construction.
- Minimize environmental and social impacts.
- Comply with government agency requirements expressed in preliminary consultations. For example, the Puerto Rico Energy and Power Authority (PREPA) requested a 100 ft setback measured from the existing 230 KW east right-of-way.

Traffic study results indicated that a roadway section of one lane in each direction and the inclusion of climbing lanes would adequately handle some of the projected traffic for the horizon year of 2028 (refer to Chapter 4). Conceptual Design Drawings (CDD) were initially prepared using a R-6 road typical section (two lanes, one in each direction) with climbing lanes when needed. However, results indicate that at least 63% of the road length would need three or four lanes, and 90% of one of the build alternatives would need three or four lanes. In addition, engineering and construction effort to build an R-6 road with climbing lanes would be similar to

Table 3.2-2 Financial Analysis Results (millions).

| Build Alternative | Net Present Value | B/C |
|---|---|---|
| C-1 | $145.3 | 2.03 |
| C-2 | $172.2 | 2.26 |
| C-3 | $166.9 | 2.38 |
| C-4 | $128.2 | 1.96 |
| C-5 | $98.8 | 1.69 |

### 3.2.3. Build Alternatives Economic Impacts

An inter-industry model was developed to asses the economic impacts of Build Alternatives (refer to Appendix B). The model quantifies the direct and indirect impacts of the Build Alternatives investments, during the construction phase, in terms of production (sales), compensation (wages), and employment. Additionally, the fiscal revenues for Cidra and Cayey municipalities are estimated. Table 3.2-3 summarizes the economic impacts for the different Build Alternatives.

Table 3.2-3 Economic Impact of Build Alternatives (millions).

| | Build Alternative | | | | |
|---|---|---|---|---|---|
| | C-1 | C-2 | C-3 | C-4 | C-5 |
| Investment | $139.2 | $134.5 | $117.7 | $131.5 | $141.4 |
| Sales a/ | $228.9 | $221.2 | $193.6 | $216.2 | $232.4 |
| Compensation a/ | $34.5 | $33.3 | $29.2 | $32.6 | $35.0 |
| Employment a/ | 1,479 | 1,429 | 1,252 | 1,397 | 1,502 |
| Potential Fiscal Revenues b/ | $5.6 | $5.4 | $4.7 | $5.3 | $5.7 |

a/ Direct and Indirect
b/ Construction Excise Taxes and Municipal Patent

Traffic Assignment Modeling

SATURN, a traffic assignment model, was used to evaluate the capacity of each proposed build alternative to attract traffic from the existing network. The modeled network is described in Table 4.2-3. Figure 18 shows the road network configuration.

Table 4.2-3 Traffic Assignment Model Network.

| Road | Description |
|---|---|
| PR-1 | from the intersection with PR-172 to the intersection with PR-15 |
| PR-52 | from the ramps at the intersection with PR-172 to its cross over with PR-15 |
| PR-14 | between PR-1 and PR-15 |
| PR-171 | from PR-14 to PR-7733 |
| PR-734 | from PR-1 to PR-7733 |
| PR-787 | from PR-1 to PR-172 |
| PR-172 | from PR-1 to the entrance to Cidra |
| PR-15 | from PR-14 to the under pass with PR-52 |
| PR-7733 | between PR-171 and PR-172 |

New Road Geometric Configuration

The basic road section for the proposed build alternatives was determined using the Multi-lane module of HCS+ Version 5.3. Level of Service (LOS) was the criteria used to evaluate road sections, categorizing road operations into the following categories:

LOS A describes primarily free-flow operations. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream. Even at the maximum density, the average spacing between vehicles is about 528 ft which affords the motorist with a high level of comfort.

LOS B represents reasonably free flow, and speeds at the free-flow speed are generally maintained. The lowest average spacing between vehicles is about 330 ft. The ability to maneuver within the traffic stream is only slightly restricted, and the general level of comfort provided to drivers is still high.

LOS C provides for flow with speeds still at or near the free-flow speed of the freeway. Freedom to maneuver within the traffic stream is noticeably restricted at LOS C, and lane changes require more vigilance on the part of the driver. Minimum average spacing are in the range of 220 ft. Drivers experiences a noticeable increase in tension because of the additional vigilance required for safe operation.

LOS D is the level at which speeds begin to decline slightly with increasing flows. Density begins to deteriorate somewhat more quickly with increasing flow. Freedom to maneuver within the traffic stream is more noticeably limited, and the driver experiences reduced comfort levels. Vehicles are spaced at about 165 ft.

LOS E describes operations at capacity. Vehicles are spaced at approximately 100 ft, leaving little room to maneuver within the traffic stream at speeds that still exceed 50 mph. Maneuverability within the traffic stream is extremely limited, and the level of comfort is extremely poor.

LOS F describes breakdown in vehicular flow. Such conditions generally exist within queues forming behind breakdown points. Breakdown occurs when the ratio of arrival flow rate to actual capacity or the forecast flow rate to estimate capacity exceeds 1.00.

New intersection configurations were defined as part of Intersections Operational Analysis.

Intersections Operational Analysis

SYNCHRO V7.0, a traffic simulation model based on the 2000 Highway Capacity Manual (HCM), was used to determine average intersection delay and Level of Service (LOS) for each signaled and unsignaled intersection. LOS represents intersection operating conditions as shown below:

LOS A describes intersection operation with very short delays, not exceeding 5 seconds per vehicle. This level of service occurs when signal progression is extremely favorable and most vehicles arrive during the green phase, and most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes intersection operation with delay between 5 and 10 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LOS C describes intersection operation with average delays between 15 and 25 seconds per vehicle. These higher delays may result from fair progression, longer cycle length, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes intersection operation with average delay between 25 and 40 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume to capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes intersection operation with average delay between 40 and 60 seconds per vehicle. This is considered by many agencies to be the upper limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high volume-to-capacity ratios. Individual cycle failures are frequent occurrences.

LOS F describes intersections operating with an average delay exceeding 60 seconds per vehicle. This level, considered to be unacceptable by most drivers, often occurs with