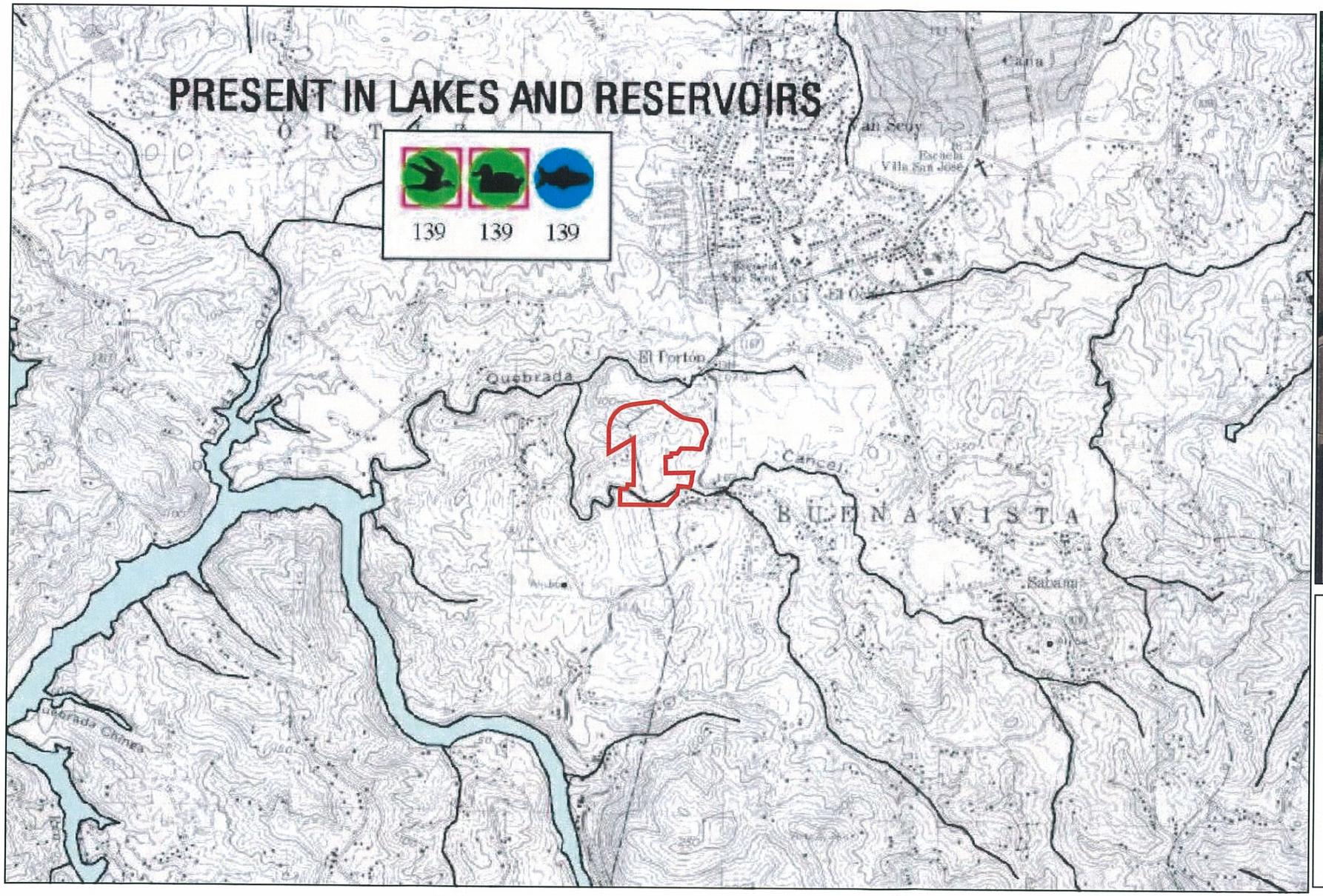
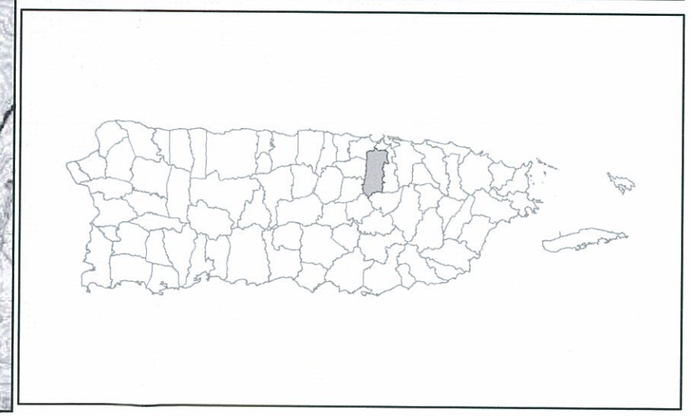
Anejo X, Enviromental Sensitivity Index Map





Bayamón Towne Center

Carretera PR-5
Barrios Ortiz y Buena Vista
Bayamón, Puerto Rico

Mapa de Sensitividad Ambiental

Fuente: NOAA (May 2000) Environmental Sensitivity Index Map, Map PR-23, PR.

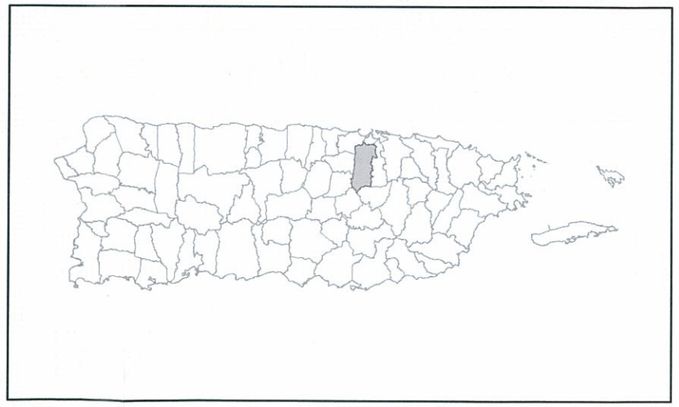
Fuente: Junta de Planificación de Puerto Rico.

LEYENDA

Area de Estudio

N

Anejo XI, Mapa Sistemas Naturales



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Bayamón Towne Center

Carretera PR-5
Barrios Ortiz y Buena Vista
Bayamón, Puerto Rico

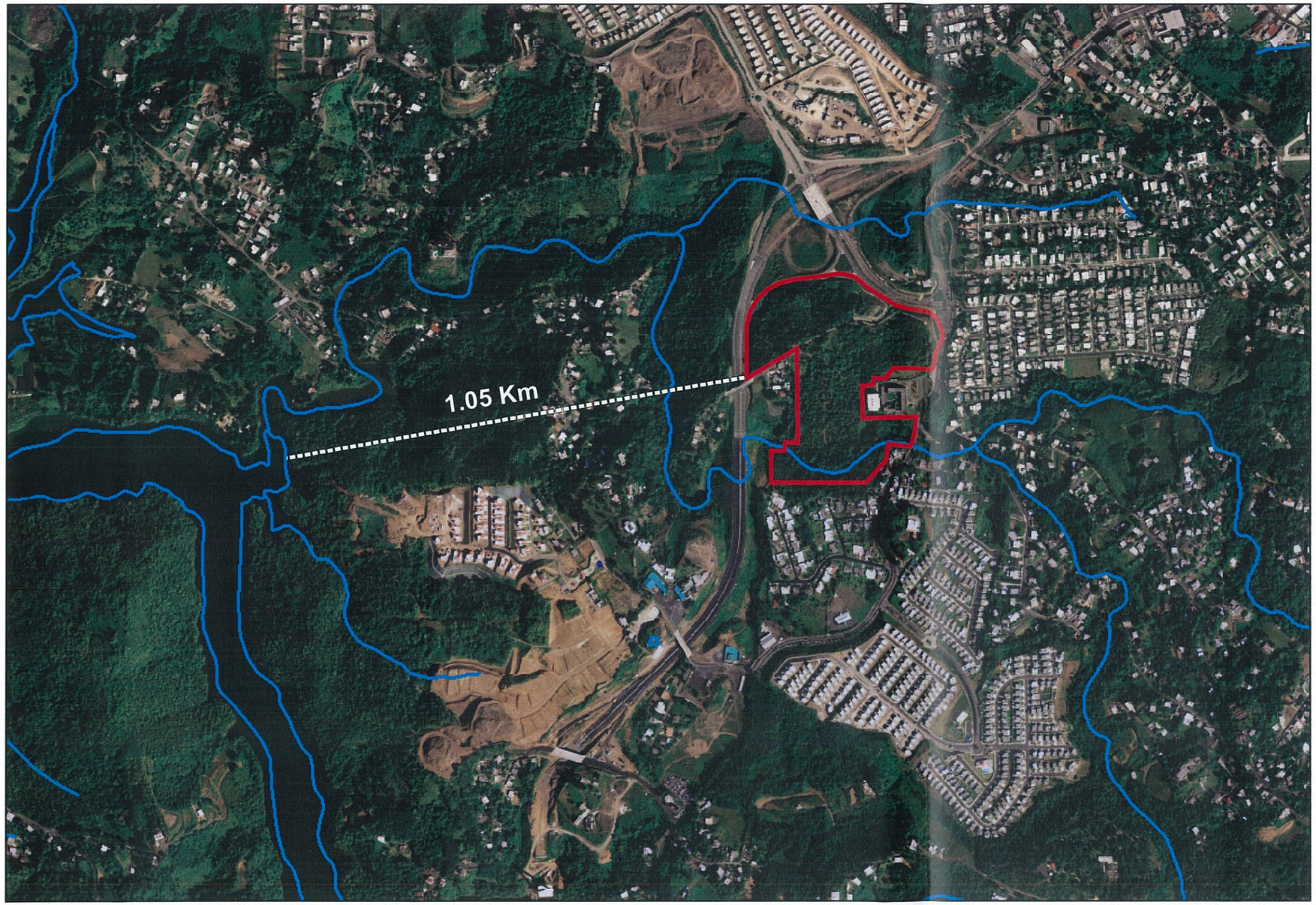
Sistemas Naturales

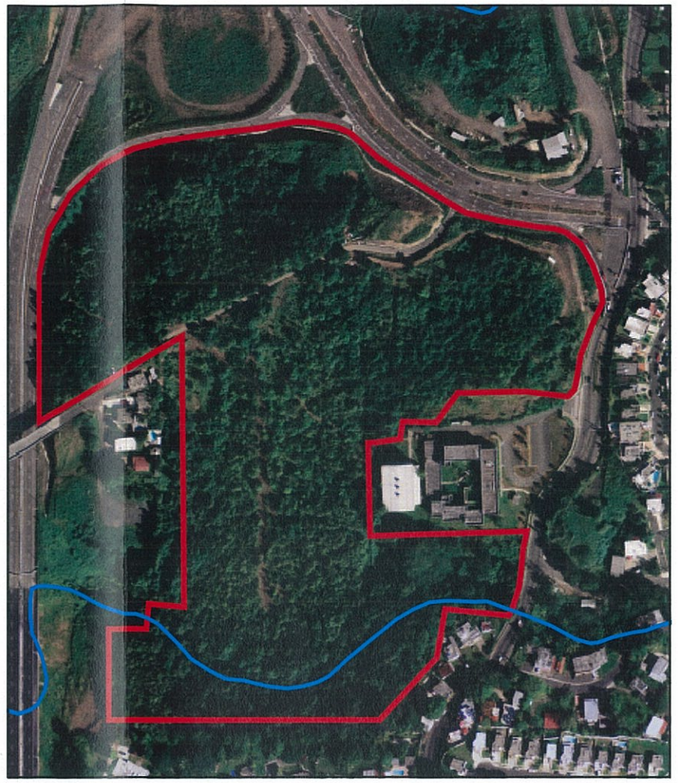
Fuente: Departamento de Recursos Naturales y Ambientales.

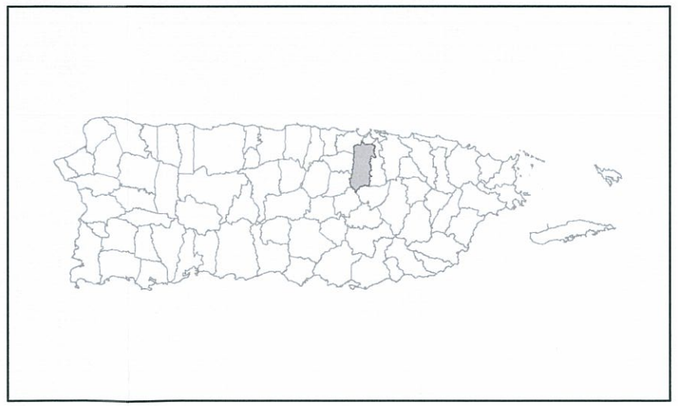
LEYENDA

- Cuerpos de Agua
- Reservas Naturales
- Areas con Prioridad de Conservación
- Lagos / Lagunas

N







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Bayamón Towne Center

Carretera PR-5
Barrios Ortiz y Buena Vista
Bayamón, Puerto Rico

Distancia al Río La Plata

Fuente: USGS (1982) Mapa Topográfico del Cuadrángulo de Naranjito, PR.

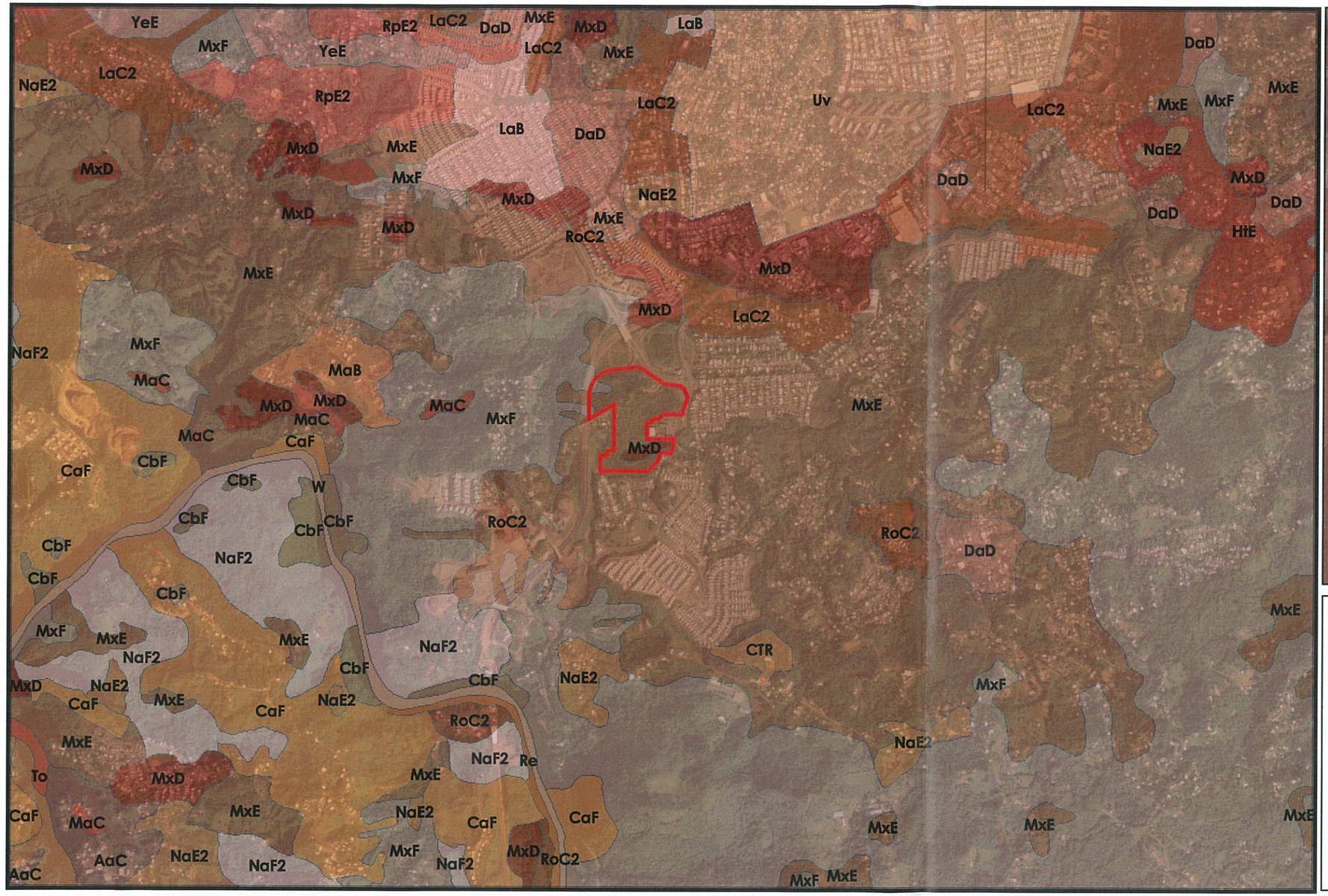
LEYENDA

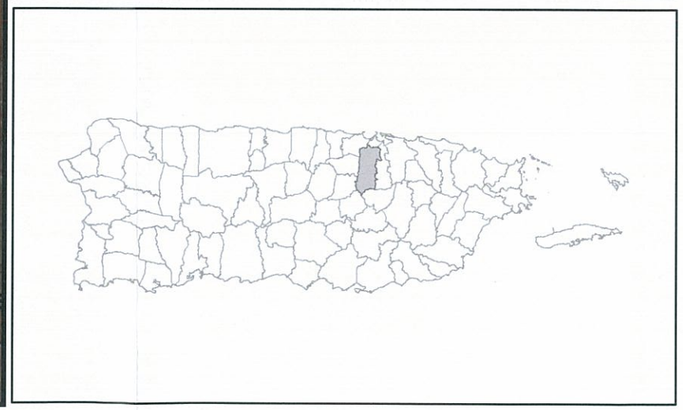
Area de Estudio

Cuerpos de Agua

N

Anejo XII, Figura Tipos de Suelo





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Bayamón Towne Center

Carretera PR-5
Barrios Ortiz y Buena Vista
Bayamón, Puerto Rico

Mapa de Suelos

Fuente: US Department of Agriculture, Soil Conservation Service. (Nov. 1978). Soil Survey of San Juan Area of Puerto Rico.

LEYENDA
Tipos de Suelo

- MxD Mucara clay, 12 to 20 % slope
- MxE Mucara clay, 20 to 40 % slope
- MxF Mucara clay, 40 to 60 % slope

N

Anejo XIII, Carta DRNA 4 de agosto de 2009

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES

AUG 0 4 2009

JAVIER MATOS VÁZQUEZ
COMPAÑÍA DE FOMENTO Y EXPORTACIÓN DE PUERTO RICO
PO BOX 195009
SAN JUAN PR 00919-5009

Estimado señor Matos:

Declaración de Impacto Ambiental Preliminar
Centro Comercial Bayamón Town Center
PR-167, Km. 13.6
Bo. Buena Vista
Bayamón

O-PA-DIA01-SJ-00102-28092007
O-CE-EJP01-SJ-00568-25062007
Caso Núm. 0A-08-AC-91
JCA-07-0024 (CCEPR)
2007-15-0272-JPU-M

Hemos evaluado la comunicación del 30 de marzo de 2009 relacionada al asunto descrito en epígrafe. Además incluyó el "Hydrologic Aspect" y el "Wetland Jurisdictional Determination".

En comunicación del 30 de septiembre de 2008, el Departamento de Recursos Naturales y Ambientales (DRNA) solicitó información al proyecto propuesto. En la misma se categorizó el predio bajo las disposiciones de la Ley Núm. 241 de 15 de agosto de 1999, según enmendada, conocida como "La Nueva Ley de Vida Silvestre de Puerto Rico" y el Reglamento Núm. 6765 (Reglamento para Regir la Conservación y el Manejo de la Vida Silvestre, las Especies Exóticas y la Caza en el Estado Libre Asociado de Puerto Rico). Además, de la cantidad de cuerpos de agua, zona de amortiguamiento y humedales, entre otros.

El DRNA evaluó el "Hydrologic Aspect" de marzo de 2009, relacionado a los aspectos hidrológicos del predio donde se propone la construcción del Centro Comercial. El estudio presenta un análisis para establecer si las recogidas pluviales se pueden definir como cuerpos de agua. Este concluyó que las áreas tributarias son pequeñas y que sólo producen agua cuando llueve, que la topografía no presenta marcas de inundación en la trayectoria y que debido a la pronunciada de la pendiente no hay conexión hidráulica o remanso sobre los niveles de inundación de la Quebrada Cancel. Por lo que, se establece que las recogidas pluviales del predio no pueden definirse como cuerpos de agua. En base a lo anterior el Departamento determina que el análisis presentado es aceptable.

P. O. Box 366147, San Juan, Puerto Rico 00936
Tel. (787) 999-2200

No obstante, en relación a la evaluación del predio sobre las disposiciones de la Ley Núm. 241, supra, se le informó que el predio categorizó como un Hábitat de valor ecológico (**Categoría 4**) y que se requiere que se mitigue en proporción no menor de 1:1 con terrenos de igual o mayor valor ecológico al hábitat impactado. Parte de esta mitigación es la zona de amortiguamiento de la Quebrada Cancel de veinte (20) metros a partir de los cinco (5) metros requeridos desde el borde del cauce. Además, de dos áreas en el predio y un corredor (Figura 1). Estas áreas deberán ser dedicadas a conservación y se deberá estimar su cantidad en cuerdas. La implementación de las mitigaciones podrá ser mediante la cesión de terrenos, dinero o ambas, lo cual incluirá como mínimo el costo de adquisición de terrenos, acciones de mitigación, mantenimiento y cualesquiera otras acciones necesarias para la protección a largo plazo y manejo del área de mitigación. No obstante, de la parte proponente tener otras alternativas de mitigación, podrá presentarlas como plan de mitigación y ser aprobadas por el DRNA

Una vez sometida la Declaración de Impacto Ambiental Enmendada que incluya el "Hydrologic Aspect", "Wetland Jurisdictional Determination" y la información antes mencionada estaremos en la mejor disposición de continuar con la evaluación del proyecto y emitir nuestros comentarios

Cordialmente,

Ana M. López Cruz
Secretaria Auxiliar
Secretaría de Permisos, Endosos
y Servicios Especializados

AML/GF/MAC/JB/jb

Anejo: Figura 1

cc. Sr. Roberto Ayala Prado
Gerente Interino
Agrupamiento Científico
Junta de Calidad Ambiental

Sra. Cynthia Báez Rivera
Secretaria
Junta de Planificación

Fernando Molinl Vizcarrondo
PMB 604, 80 De diego Avenue, Suite 10b
San Juan, PR 00927-6346

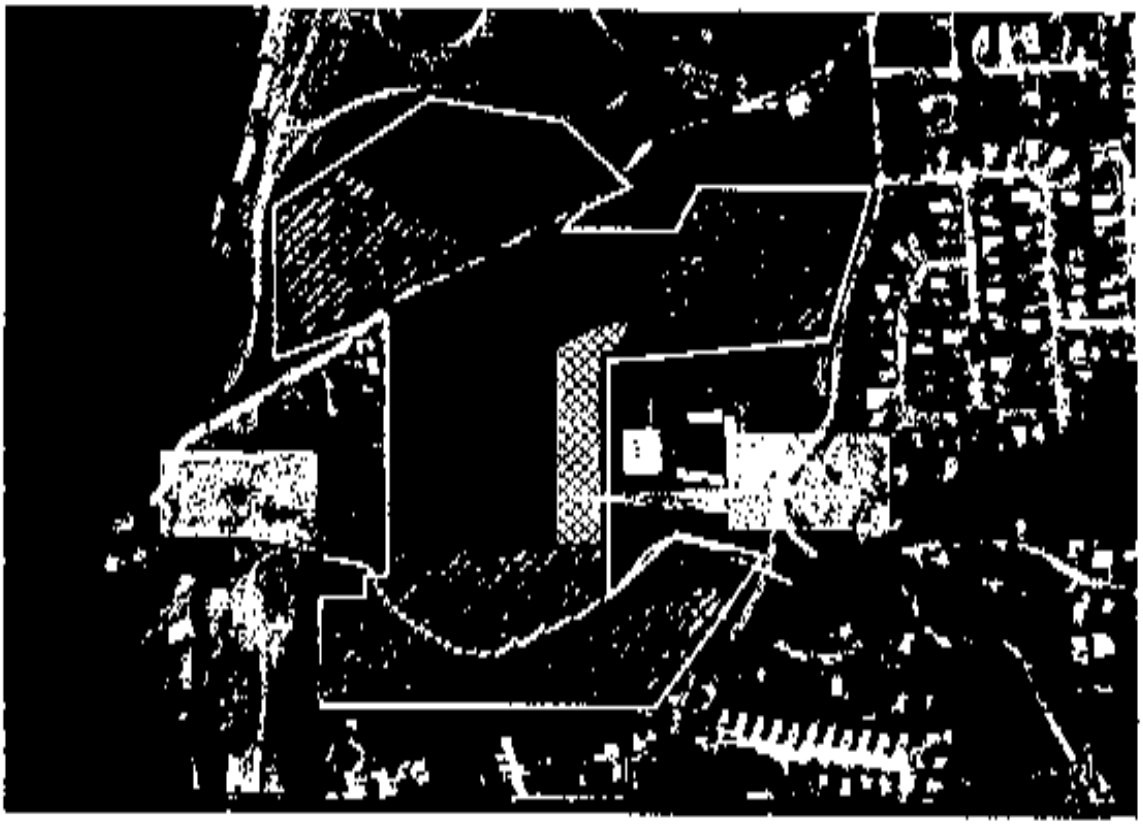
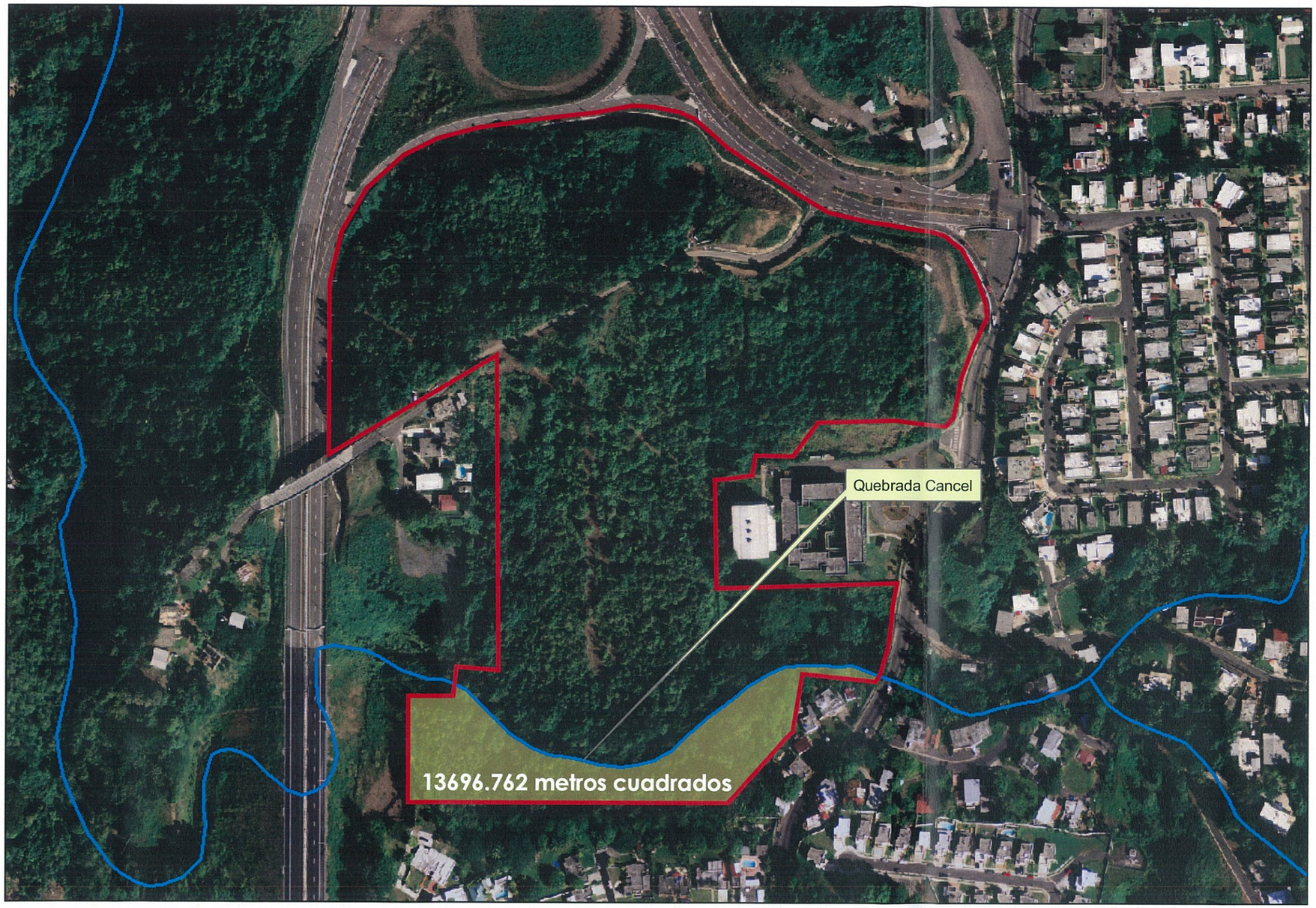
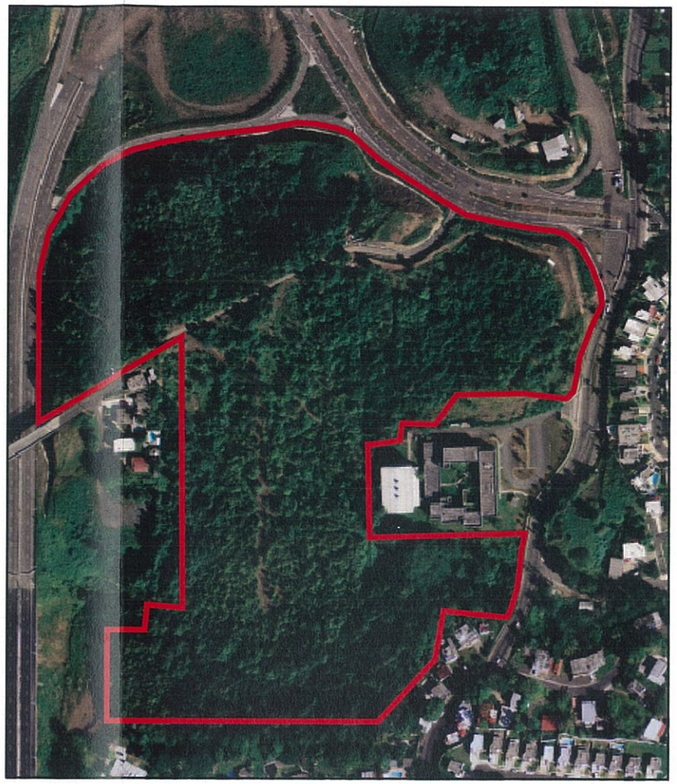
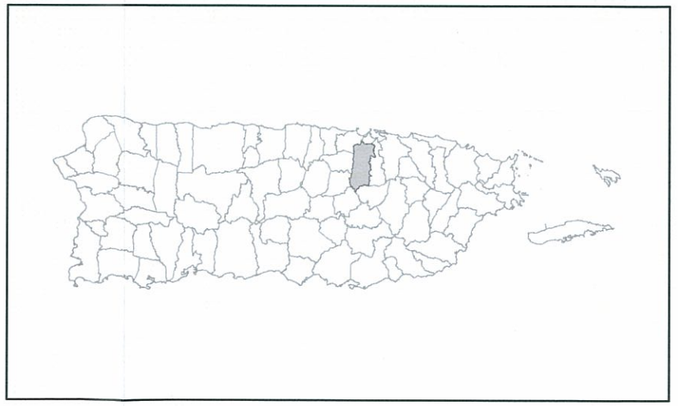


Figura 1. Imagen aérea del predio ubicando por donde discurre la Quebrada Cancel y áreas que deben ser conservadas (polígono de rayas horizontales) junto a una franja de vegetación que permita conectar cada parcho (polígono cuadriculado).

Anejo XIV, Figura Área Mitigación, Remanente







0 50 100 200 Meters

1:3,000

Bayamón Towne Center

Carretera PR-5
Barrios Ortiz y Buena Vista
Bayamón, Puerto Rico

Porción de Terreno Remanente

Fuente: Gobierno de Puerto Rico. (2007). Fotos Aéreas.

LEYENDA

Area de Estudio

Remanente

N

ANEJO 6:
PROTOCOLO DE LA BOA PUERTORRIQUEÑA

PROTOCOLO DE PROTECCIÓN DE LA BOA DE PUERTO RICO A SEGUIR DURANTE ACTIVIDADES DE IMPACTO

1) Toda persona a trabajar en el proyecto de construcción debe participar, con antelación al comienzo de las labores, de una charla educativa sobre la Boa Puertorriqueña, *Epicrates inornatus*, a ofrecerse por el personal del Departamento de Recursos Naturales y Ambientales. Esta deberá proveer la siguiente información:

   a) Datos generales sobre la especie, ilustrados con fotos y diapositivas (i.e. característica de su hábitat, ausencia de veneno, mito sobre el poder curativo de sus aceite, identificación, beneficio de la especie a la sociedad y al ecosistema, leyes y reglamentos que la protegen y las penalidades que conlleva intervenir con ellas, ya sea para hacerles daño o capturarlas para venderlas).

   b) Literatura con fotos de la serpiente.

   c) Procedimientos a seguir al encontrar un espécimen de serpiente, tanto de forma oral como escrita.

   d) Lista de personas u oficinas a llamar en caso de encontrar una serpiente (boas u otras especies) de manera que esta pueda ser identificada y si resultara ser una boa, relocalizarla a las áreas de mogotes adyacente. En un plazo no mayor de 24 horas a partir del momento del hallazgo.

   e) Identificar las personas encargadas de reportar el hallazgo de serpientes en el área.

f) Todo personal que sea contratado por el proponente, con posterioridad al ofrecimiento de esta charla, deberá contactar al DRNA para que se le provea una charla con el mismo contenido de información.

2) Los procedimientos a seguir en caso de encontrar una serpiente en el área del proyecto al estar durante las labores de extracción serán los siguientes:

a) Los trabajadores en un radio de no menos de 50 pies alrededor de la serpiente detendrán su labor y apagaran la maquinaria.

b) Una persona mantendrá la serpiente bajo observación en tanto otra se comunica con la persona encargada de reportar el hallazgo a las agencias o personas en lista (el período de observación solo se mantendrá durante las horas laborables de los empleados del proyecto).

c) El observador deberá mantener una distancia no menor de 25 pies, mayor de ser posible, con la serpiente de manera que esta se percate lo menos posible de su presencia y no se oculte. La serpiente deberá mantenerse bajo observación hasta que el personal técnico encargado de su relocalización arribe al área.

d) El encargado se comunicará o designara a alguien que se comunique por teléfono con alguna de las agencias o personas en la lista.

ANEJO 7:
WETLAND JURISDICTION DETERMINATION

Wetland Jurisdictional Determination

State Road PR-167, km 13.6 Buena Vista Ward,
Bayamón, Puerto Rico

Prepared for:

Michael J. Scarfia Jr.
Gibraltar Development Corp.
1079 Cephas Drive
Clear Water, FL 33765
Tel. 727-447-2155

Prepared by:

Yousev Garcia
130 Winston Churchil Ave. PMB 228
San Juan, PR 00926
Tel. 787-942-4242

March 2009

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1.0 Introduction

The purpose of this study was to identify the waters of the United States of America (USA) present within a mountainous interior site of approximately 24 acres, located at Buena Vista Ward in the Municipality of Bayamón. In order to identify the waters of the USA, Mr. Michael Scarfia Jr. of Gibraltar Development Corp., contracted Yousev Garcia Ramos to perform a Jurisdictional Determination (JD) for the site.

The term "waters of the United States of America" is defined in 33 CFR 3288.3 and includes a variety of water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, wetlands, prairies, potholes, wet meadows, beach lakes, natural and, in some cases, artificial ponds.

Wetlands are a subset of the waters of the United States of America. Section 404 of the Clean Water Act defines a wetland as an area that is inundated or saturated by surface or ground water 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.

The identification of wetlands regulated by the U.S. Army Corps of Engineers (Corps) under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act is physically performed through a process known as a JD. The JD process establishes a line (delineation) which separates and identifies the Corps regulated wetland areas from non-wetland (upland) areas, which are not regulated by the Corps.

This report includes basic information required by the Public Notice of the Antilles Regulatory Section, published in October 12, 2001. According to the Public Notice, all requests for verification of JDs performed by landowners and private consultants in Puerto Rico and the U.S. Virgin Islands must be made in writing and, as a minimum, must include the following information:

- **Name, address and phone numbers of current properties owner(s) and authorized agent (if applicable):** This information is included in the portrait of this report.
- **A description of the parcel:** This information is included in Section 2.0 of this report (Location and Topography).
- **Permission for the Corps personnel to enter the properties:** A permission letter is included as Appendix 5 of this report.
- **An accurate location map and concise directions on how to get to the property:** The physical address of the site is included in the portrait of the report. Also, Figure 1 (included in Appendix 1), illustrate the accurate location of the study area in the 1: 20,000 USGS Topographic Map.
- **Plan, aerial photo, map or sketch showing the jurisdictional boundary line:** Appendix 1 includes a 2007 Aerial Photo illustrating the jurisdictional boundary as well as the properties boundaries.
- **Area of review if different from properties boundary:** The area of review is within the properties boundaries. Additional observation points were performed outside of the property, to better understand the physiography of the area (See Figure 5, Appendix 1).
- **Name of waterways:** The property is located in the mountainous interior of the island, bordered by the Cancel Creek by the south.
- **Latitude and longitude (NAD 83 at the center of the property):** The Latitude and Longitude of the center of the properties are X: 224,397.41 and Y: 255,615.55
- **Aerial photographs (should be the latest available and must be as clear as possible):** This report includes a 2007 Aerial Photograph, which is used in figure2 presented in Appendix 1. The jurisdictional delineation is illustrated over this aerial photograph (Figure 8).
- **Reference Information:** Available official references were used for the study. The resources used for the figures (like topographic and soil maps) and analysis of this study, are listed in Section 6.0 of the report (Literature Cited).

- **Approximate total acreage of the site:** The study area has approximately 24 acres.
- **Data forms for uplands and wetlands of various points in the properties:** 4 data forms for the 4 sampling points established are included in Appendix 2 of the report.
- **General climatological condition at the time of the evaluation:** The fieldwork was conducted during four site visits on February 2009 and March 2009. It was moist (with relatively) fresh temperatures during the first three visits, and rainy during the last one. All site inspections were performed during the afternoons.

2.0 Location and Topography

The study area is located at State Road PR 167, km 13.6, Buena Vista Ward, Municipality of Bayamón, Puerto Rico. The site is limited to the north by a state road of recent construction, to the east by state road PR 167, to the south by the Cancel Creek and to the west by a small (3 houses) residential community. This JD covers all the property illustrated in figure 1 (Appendix 1), which has an approximate area of 24 acres.

The property is located in the humid mountainous interior zone of the island, bordered by the Cancel Creek by the south. Most of the topography is steep (more than 90%). The higher elevation at the site is about 130 meters above mean sea level, while the lowest is 100 meters above mean sea level.

Figure 1 illustrates the property boundaries in the Topographic Map of the Naranjito Quadrangle. Figure 2 presents the site location on a 2007 Aerial Photograph. Both figures are included in Appendix 1 of this report.

3.0 Methods

This JD was conducted following the guidelines and procedures recommended in the Corps of Engineers Wetlands Delineation Manual (Technical Report Y-87-1,

1987). The On-site Inspection of the Routine Determination Method was the selected approach to perform it. The December 2, 2009 EPA memorandum, Establishing Guidelines for Clean Water Act Jurisdiction Following the US Supreme Court's Decision in Rapanos v. United States & Carabell v. United States was used as a reference for this study. Our field experience in Puerto Rico's physiography, mix with USGS glossaries and mapping instructions, were useful to perform this study.

An interagency group is regionalizing the 1987 Manual in 10 supplements (currently in various stages). The supplement for Caribbean is scheduled for interim phase in mid 2009 (February 19, 2009 Corp of Engineers -Puerto Rico Regulatory Workshop-). Once officially adopted, it will be mandatory and the former 1987 Manual can't be used except under limited circumstances. Even were the 1987 manual is utilized across entire U.S. & Territories, and is very generic in approach, is still the norm to perform Jurisdictional Determinations at the moment of this study (it is also old; new information and jurisprudence has been generated during the past 21 years).

Before performing the site inspection, the study area was previously located at the Topographic Map of the Naranjito Quadrangle, the 2007 Aerial Photograph and sheet number 18 of the Soil Survey of San Juan Area of Puerto Rico. The fieldwork was conducted during four site visits on February 2009 and March 2009.

3.1 Transects and Sampling Points

Four sampling points were assessed for vegetation, hydrology and soils. Also 6 observation points (one inside and 5 outside the property) were established to better understand the area physiography. The selected sampling point's location was based on the characteristics of the site in such way that the information collected represents the different plants,

hydrologic and soils at the nearly level portions located inside topographic depressions at the lowest elevations of the site. Additional observations along the property were made to accurately define wetland/uplands and other possible jurisdictional waters (like intermittent creeks) boundaries.

Figure 5 illustrate the sampling and observation points locations. Appendixes 2 and 3, respectively, include the field data forms and a photographic record for each sampling point.

4.0 Results

4.1 Vegetation

Hydrophytic vegetation is defined as the sum of the total macrophyte plant life growing in water, soil or on substrate that is at least periodically deficient in oxygen as a result of excessive water content. Vegetation in wetlands consists of one or more plant associations Therefore, it is mandatory to consider plant species dominance among other things to determine if a particular area is dominated by hydrophytic vegetation.

The property presents various stratums within different plant communities. The selected sampling points were representations of three stratums at the nearly level areas in the topographic depressions at the lowest elevation of the site. The relative dominance was measured by the greatest percentage of aerial cover.

For this wetland determination, vegetation samples were inspected visually. The 1988 and 1996 National Lists of Plants Species that Occur in Wetlands for the Caribbean Region were used to identify the indicators of wetland vegetation. Obligate (OBL), Facultative (FAC) and upland (FACU) species were found at the site. Indicators for wetland vegetation in humid areas were represented by Dumb cane *(Dieffenbachia seguina)* and Facultative vegetation by Royal Palm *(Roystonia borinquena)*. The occurrence of this

two species is insignificant and sporadic. The site is widely dominated by FACU specie, African tulip tree *(Spathodea campanulata)*. Specific vegetation observed at sampling points is included at the field data forms (Appendix 2).

4.2 Hydrology

Wetland hydrology refers to the presence of water either above the soil or within the soil for a prolong period of time during the year. Plants development and soils formation are directly influenced by wetland hydrology.

Hydrology is favorable only at the southern (lowest) border of the site, where is bordered by Cancel Creek. The rest of the site has steep topography at higher elevations (> 100 meters (msl) and is basically part of the Cancel Creek watershed. The site is not affected by flood prone areas (See Figure 4).

Sampling points were negative for wetland hydrology indicators, even at a portion of a natural swale where ephemeral ponding occur (sampling point 4). Soil saturation wasn't found on the sampling points.

The NRCS Soil Survey of the San Juan Area (Plate 18) illustrates 3 intermittent water bodies flowing from the site (See Figure 3). These are not illustrated at the USGS topographic map ("the water recourses export agency") (See Figure 1). During the field inspection, we didn't observe intermittent flow or springs at any of the topographic depressions. We did observe significant humidity and water flow in these same topographic depressions, but at lower elevations outside of the study area (Observation Points 1 and 4). Therefore, we conclude that intermittent creeks are not present inside the study area. What is present inside the study area, are topographic depressions that act as ephemeral (short duration flow) swales

and gullies that drain storm water during significant rain events. These ephemeral natural drainage futures are located below the water table and therefore have no base flow (dry weather flow or flow without rain).

4.3 Soils

According to the Soil Survey of the San Juan Area of Puerto Rico, there is one soils type mapped in the study area: Mucara clay (12 to 20 % slopes, 20 to 40 % slopes and 40 to 60 slopes). The Hydric Soils List of the Caribbean Area doesn't identify this soil type as a hydric soil or with potential hydric inclusions.

Even when Mucara soils at the site are not listed as hydric or with hydric inclusions by the Hydric Soils List of the Caribbean Area, we decided to sample it, since it shows potential indicators of reduction conditions at a topographic depression on an intermittent creek nearby (personal observation; observation point 6). In order to determine locations for the soil samplings, a visual assessment of the area was performed with the guidance of the soils and topographic maps.

4.4 Atypical Situations or Problem Areas

An atypical situation or problem area was found on sampling point 4. This portion of a natural swale was intercepted by a dirt road without the appropriate drainage (culvert). As a result, ponding and overflow at this site is evident during heavy rain events. However, after performing this study, we concluded that the ponding occur only in an ephemeral way as a direct response to significant rains. After a rain event, the water drains easily through the permeable soils since it doesn't have a perennial or intermittent water body feeding it. At this sampling point, hydrology and soil saturation was absent during the field inspections.

The study area form part of a water shed that has been recently modified by the construction activities of the State Road PR-5 at the north (See aerial photograph Figure 2 in Appendix 1).

5.0 Conclusions

During February 2009 and March 2009 a Jurisdictional Determination was performed on a site of approximately 24 acres located in State road 167 km 13.6 Buena Vista Ward, Bayamon, Puerto Rico. Four Sampling points were assessed for vegetation, soils and hydrology. Also 6 observation points (5 of them outside of the property) were established to better understand the physiography of the area. Soil saturation wasn't found on any of the sampling points. The site is widely dominated by FACU specie, African tulip tree *(Spathodea campanulata)*. The soils in the site are not identified as hydric or with potential hydric inclusions. Hydrology is favorable only at the southern (lowest) border of the site, where is bordered by Cancel Creek. The rest of the site has steep topography at higher elevations (> 100 meters (msl) and is basically part of the Cancel Creek watershed. The site is not affected by flood prone areas.

The NRCS Soil Survey of the San Juan Area (Plate 18) illustrates 3 intermittent water bodies flowing from the site (See Figure 3). These are not illustrated at the USGS Topographic Map of the Naranjito Quadrangle (See Figure 1). During the field inspection, we didn't observe intermittent flow or springs (that give origin to intermittent creeks) at any of the topographic depressions. We did observe significant humidity and also water flow in these same topographic depressions at lower elevations outside of the study area (Observation Points 1 and 4). Therefore, we conclude that intermittent creeks are not present inside the study area. What is present inside the study area, are topographic depressions that act as ephemeral (short duration flow) swales and gullies that drain storm water runoff only during significant rain events. As state on the December 2, 2008 EPA Memorandum (Establishing Guidelines for Clean Water Act Jurisdiction Following the US Supreme Court's Decision in Rapanos v. United States & Carabell v.

United States), these ephemeral features present in the study area, should not be considered waters of the United States and agencies generally will not assert jurisdiction over them (See Appendix 4). Ephemeral streams could be jurisdictional waters of the United States, only in arid planes, but not in steep mountainous humid locations like the study area..

An atypical situation or problem area was found on sampling point 4. This portion of a natural swale was intercepted by a dirt road without the appropriate drainage (culvert). As a result, ponding and overflow at this site is evident during heavy rain events. However, after performing this study, we concluded that the ponding occur only in an ephemeral way, as a direct response to significant rains. This situation must be corrected by installing a culvert at this point.

As a result of this study, three intermittent creeks starting "downstream" (outside of the property) of sampling points 1, 2 and 3 were identified. These intermittent creeks were channelized at their very beginning outside of the property. The northern creeks were channelized as part of the construction of the new State Road Number 5 and the southern one was channelized during the construction of the Francisco Gastambide Vega School. No wetlands were found inside the study area. The ephemeral futures (topographic depressions) inside the property are not intermittent creeks since their flow is limited to the duration of rain events Intermittent creeks originates with intermittent springs (which are absent in the study area but present downstream) and their duration although not perennial, remains longer and is not limited to the duration of a rain event. The best evidence of lack of significant flow in this geographic area is the absence of reduced soils in these features. Waters of the United States identified near the study area are illustrated over the 2007 aerial photograph on figure 6 of this report.

6.0 Isolated Wetlands and Significant Nexus

None isolated wetlands were identified within the property boundaries. The intermittent creeks identified outside the property, have significant nexus with navigable waters since they drain to the Cancel Creek which is a perennial creek tributary of La Plata River (specifically La Plata Water Reservoir) (See Figure 1).

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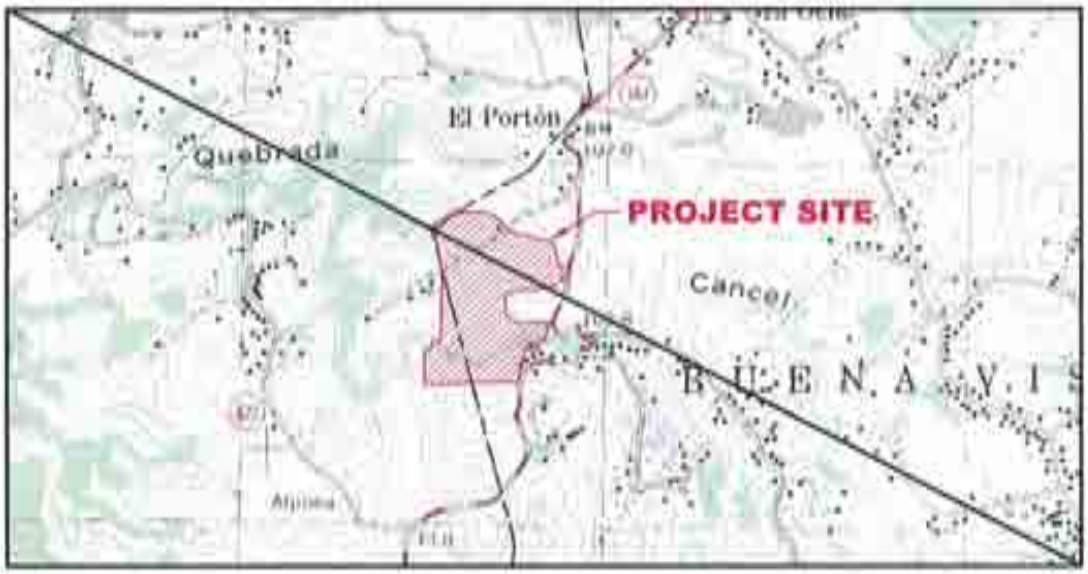
Appendixes

ANEJO 8:
HYDROLOGIC ASPECT OF BAYAMON SOUTH COMMERCIAL CENTER

Gibraltar Development Corp.
Clearwater, Florida

HYDROLOGIC-HYDRAULIC STUDY FOR BAYAMON SOUTH COMMERCIAL CENTER BAYAMON, PUERTO RICO



August 2006

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HYDROLOGIC-HYDRAULIC STUDY
BAYAMON SOUTH COMMERCIAL CENTER
BAYAMON, PUERTO RICO

Casiano Ancalle, P.E.
August, 2006

I. INTRODUCTION

A commercial development project named Bayamon South Commercial Center is planned to be constructed in a 27-acre property located west of state road PR-167, at Buena Vista Ward, in the Municipality of Bayamón.

Quebrada Cancel crosses the proposed development site from east to west. This storm watercourse will not be affected by the project. According to the regulatory flood maps, the project site is not considered floodable for the 100-year rainfall event.

The development of the site is going to increase runoff. This increase has to be mitigated according to the stipulations of the Puerto Rico Planning Board Regulation No. 3.

Purpose of Study

The purpose of the study is to determine the 100-year water surface elevation at the watercourse, and to mitigate the increment in runoff discharge due to the development in accordance to the Puerto Rico Planning Board Regulation No. 3.

Approach

The following steps have been undertaken throughout the study:

Hydrologic Analysis: The following parameters were determined for the hydrologic analysis: drainage areas, average soil curve number and runoff lag time. Based on these parameters, discharges for 100, 50, 25, 10 and 2-yr frequencies storm were determined for existing and proposed conditions. HEC-1 model was used.

Runoff Discharge Mitigation Analysis: A mitigation analysis was made in order to counteract the effect of the proposed development peak discharge onto the downstream areas. HEC-1 model was used for the mitigation analysis. Discharges for 2, 10, 25, 50 and 100-year frequencies were analyzed for runoff mitigation.

Hydraulic Analysis: Hydraulic computations were made to determine the 100-yrs. water surface elevations at Quebrada Cancel. COE's HECRAS model as used.

Conclusions and recommendations were elaborated.

Authorization

RAY Engineers P.S.C. on behalf of the owner authorized this study, under a contract signed with Eng. Cosiano Ancelle, principal of CA Engineering.

II. PROJECT BACKGROUND

Location

The project site is located at state road PR 167, Buena Vista Ward, in the Municipality of Bayamon. The project site is bordered by the PRITA Parcel 008-07-A on the north, Las Quintas Development on the south, Francisco Gastambide Vega School and state road PR-167 Road on the east, and Succession Ramos Vásquez on the west. Figure 1 shows the approximate location of the site in the USGS quadrangle. Figure 2 shows a layout of the proposed project.

Topography

Topography of the site shows slopes towards Quebrada Cancel. Ground elevation of the site varies between 125 and 105 m. referred to a local vertical control. Figure 3 shows the topography of the site.

Water Bodies

Quebrada Cancel is the only water body related to the site. This creek crosses the site from east to west. The project will not intend to affect neither the banks nor the bed of this watercourse. The project will be constructed outside of the 100-year flood footprint of the creek.

Flooding

From the regulatory point of view, the project site is not classified as floodable for a 100-year rainfall event. Figure 7 shows a portion of the FEMA flood insurance rate map Panel 705, revised on April 2005.

Field Work

Field data used in this study was taken by the drawings provided by RAY Engineers. This information was used for the hydraulic modeling. Results obtained in this study are strictly based on this information. Fieldwork is attached in a pocket at the end of this study, as Appendix G.

Former Studies

No previous studies were found for this site. This study is based on the information provided by the engineer and gathered through site inspection and interviews of neighboring residents.

Study Level

This study is intended as an aid to the design engineer in the preparation of the construction drawings for the recommended structures. Figures, schematics and drawings must not be used as construction drawings. The design engineer must elaborate the construction drawings in agreement with the recommendations of this study.

III. HYDROLOGIC ANALYSIS

Methodology

The computer program entitled Flood Hydrograph Package (HEC-1) developed by the U.S. Army Corps of Engineers [1990] was used for the hydrologic analysis. Using this program, the Unit Hydrograph method and the Runoff Curve Number (CN) method, both developed by the Soil Conservation Service (SCS), were applied to determine the design hydrograph. This was computed by a process of translating the rainfall excess into a runoff hydrograph known as convolution.

Peak discharges ranging in frequencies from 2, 10, 25, 50 and 100-year were estimated for existing and proposed condition.

Drainage Areas

From the topography, the project site drains to the watercourse. The project area shows to have four independent drainage areas at existing condition: Drainage area P1 with 4.50 acres, P2 with 13.83 acres, P3 with 5.34 acres and P4 with 6.21. Area P1 drain to two storm watercourses located to the northwest of the site. Areas P2, P3 and P4 drain to Quebrada Cancel.

The four drainage areas have been essentially kept at proposed condition but area P2 has been subdivided in two areas; Drainage area P1 has 3.90 acres, P2A has 5.98 acres, P2B 7.50 acres, P3 5.34 acres and P4 has 7.15 acres.

Seven offsite drainage areas contribute to Quebrada Cancel: E1 with 3.25 acres, E2 with 12.16 acres, E3 with 15.82 acres, E4 with 399.96 acre, E5 with 226.1 acres, E6 with 69.64 acres, and E7 with 241.99 acres. Offsite areas E4, E5, E6 and E7 were subdivided for the hydrologic computations. Figure 4 shows the drainage areas at existing condition and Figure 5 at proposed condition.

Curve Numbers

Curve numbers were computed using the NRCS methodology. Soil types and land uses were gotten from SCS (1978) soil maps. According to the Soil Survey of San Juan Area of Puerto Rico, most of the soil of the project site was classified as Mucara clay (MxE) 20 to 40% slopes, and Mucara clay (MxD) 12 to 20% slopes. Soils at the offsite areas are Mucara clay (MxE) 20 to 40% slopes, and Mucara clay (MxD) 12 to 20% slopes, Naranjito silty clay (NaE2), Daguey clay (DgD) and Rio Arriba clay (RoC2). Weighted curve numbers for these soils were estimated. Curve Number of 93 was adopted for the developed area in consideration of the type of proposed land use. Appendix A shows the weighted Curve Number (CN) estimations and other physiographic characteristics of the drainage areas. Figure 6 shows the portion of the soil map corresponding to the area of study.

Lag Time

The lag time was estimated as sixty percent of the time of concentration as estimated by the formula of Kirpitch.

$$Tc = 0.00781 L^{0.77} / S^{0.385}$$

where:

L	=	channel length (ft)
S		channel slope
Tc		Time of concentration in min

Detailed Lag Time calculations are shown in Appendix A.

Rainfall Data

The variation of rainfall volume with time was required as part of the storm input for the SCS Curve Number method. Therefore, the development of a design storm with a rainfall frequency

and duration was necessary to compute the design hydrograph for the watershed. Rainfall data used in this study was obtained from the Technical Paper No. 42 (TP-42) [National Weather Service, 1961]. The rainfall depths for 100, 50, 25, 10 and 2 years frequency for several durations was used and are shown in Table 1. Rainfall depths for 5 and 15 minutes duration were extrapolated by a regression analysis of the IDF curves.

Table 1

Rainfall for 2, 10, 25, 50 y 100 years

Duration Hrs.	Precipitation Inches				
	2-yr	10-yr	25-yr	50-yr	100-yr
0.083	0.34	0.53	0.60	0.61	0.64
0.25	0.84	1.30	1.48	1.53	1.63
1	2.15	3.15	3.50	3.90	4.40
2	2.70	3.95	4.45	4.95	5.50
3	2.95	4.30	5.00	5.60	6.25
6	3.50	5.30	6.15	6.95	7.75
12	4.30	6.45	7.50	8.50	9.30
24	4.95	7.50	8.75	9.95	11.00

Depth-Area Adjustment

Point rainfall estimates obtained from the TP-42 represent values for areas up to 10 mi^2; therefore, a depth-area adjustment should be applied to the rainfall data when the watershed area is greater. In this case, the largest watershed is approximate 0.07 mi^2. Hence, this adjustment was not applied.

Time Distribution of Rainfall

The triangular type methodology was used to distribute the rainfall depth in time. This method is considered acceptable for small areas.

Rainfall Extraction

Rainfall extraction such as the vegetative interception, the depressional storage, and the infiltration were estimated using the SCS's Runoff Curve Number method. Though this method is used to predict runoff volume directly, the rainfall extraction is incorporated in the model as function of the curve number of the watershed.

Hydrologic Results

Following HEC-1 methodology, hydrographs were determined for existing and proposed condition. Input and output data for the HEC-1 model are included in Appendix B for existing condition and Appendix C for proposed condition. Table 2 shows the results of the hydrologic analysis.

Table 2
Peak Discharges for 2- 10- 25- 50 and 100-yr Frequencies

CONDITION	BASIN	Peak Flow (cfs)				
		2-yr	10-yr	25-yr	50-yr	100-yr
EXISTING	D7	685	1116	1280	1357	1471
	D6	187	304	349	371	408
	D7+D6+D5	1538	2492	2856	3154	3463
	D4	1028	1708	2029	2162	2370
	D7+D6+D5+D4	2599	4181	4786	5242	5793
	D2	41	68	78	81	87
	D7+D6+D5+D4+D2	2620	4215	4836	5299	5858
	D4	18	30	34	36	39
	D1	20	33	38	39	42
	D2	46	76	88	91	97
	D1+D2	84	139	160	166	178
	D7+D6+D5+D4+D1+D2+D3+D2	2665	4284	4919	5415	5990
	D3	42	70	80	85	104
	D3	18	29	34	35	37
	D7+D6+D5+D4+D2+D1+D4+D2+D1+D3	2707	4367	5033	5518	6105
	D1	15	25	29	30	32
PROPOSED	D7	685	1116	1280	1357	1471
	D6	187	304	349	371	408
	D7+D6+D5	1538	2492	2856	3154	3463
	D4	1028	1708	2029	2162	2370
	D7+D6+D5+D4	2599	4181	4786	5242	5793
	D2	41	68	78	81	87
	D7+D6+D5+D4+D2	2620	4215	4836	5299	5858
	D4	19	31	36	37	40
	D2A	18	29	33	35	38
	D4+D2A	40	63	72	75	81
	D1	20	33	38	39	42
	D2B	21	36	41	43	47
	D1+D2B	42	68	78	82	88
	D7+D6+D5+D4+D2+D1+D4+D2	2660	4289	4944	5418	5992
	D3	42	70	80	85	104
	D3	18	29	34	35	37
	D7+D6+D5+D4+D2+D1+D4+D2+D3+D3	2711	4372	5038	5521	6106
	D1	15	25	29	30	30

From the inspection of Table 2, the peak discharge of the project site at proposed condition is higher than that of the existing condition at drainage areas P1, P2, P3 and P5; also the accumulated discharge at Quebrada Cancel. The increment in discharge has to be mitigated as required by Section 14.04 of the Puerto Rico Planning Board Regulation No. 3.

IV. RUNOFF MITIGATION ANALYSIS

The development of the site will increase the runoff discharge. The Puerto Rico Planning Board Regulation No. 3 requires a flow mitigation structure wherever an increase in discharge is produced. Therefore, a flow detention structures will be included in the project.

One (1) detention pond was used: The pond will be located at drainage area P3. Figure 8 shows the location of this pond. The design engineer must provide the means to assure that the entire runoff of these areas discharges into the corresponding detention structure.

The computer program HEC-1 provides the means for routing hydrographs through detention structures.

Depth-Volume Relations

The base area of the pond Pond will be 1,450 square meters and the side slopes 1V:2H. The Depth-Volume calculations for the pond were made under the assumption of a square base. Appendix D includes a spreadsheet with the depth-volume relation computations and the curve for the pond.

Flow – Depth Relations

The control structure for the pond will consist on one (1) 18" diameter orifice at the pond bottom, and a 20-feet wide rectangular weir located 2.3 meter above the bottom of the pond. Flow-Depth relations for these structures were estimated taking into consideration discharges through orifices. Flow through the orifices was computed using Torricelli's formula. Appendix D includes a spreadsheet with the depth-flow relation computations and its respective curve.

Results

Input and output data for the HEC-1 mitigation model are included in Appendix E. Table 3 shows the comparison of the discharges for existing, and proposed condition.

Table 3
Mitigation Analysis Results Comparison

CONDITION	BASIN	Peak Flow (cfs) 2-yr	10-yr	25-yr	50-yr	100-yr
EXISTING	E7	685	1116	1280	1357	1471
	E6	187	304	349	373	408
	E7+E6+E5	1538	2492	2856	3154	3463
	E4	1078	1768	2029	2161	2370
	E7+E6+E5+E4	2599	4183	4786	5242	5793
	E2	41	68	78	81	87
	E7+E6+E5+E4+E2	2620	4215	4836	5299	5858
	P4	18	30	34	36	39
	E1	20	33	38	39	42
	P2	46	76	88	91	97
	E1+P2	84	139	160	166	178
	E7+E6+E5+E4+E2+E1+P2	2665	4284	4939	5414	5990
	E3	47	78	89	95	104
	P3	18	29	34	35	37
	E7+E6+E5+E4+E2+E1+P4+P2+E3+P3	2707	4367	5033	5518	6105
	P1	15	25	29	30	32
PROPOSED	E7	685	1116	1280	1357	1471
	E6	187	304	349	373	408
	E7+E6+E5	1538	2492	2856	3154	3463
	E4	1078	1768	2029	2161	2370
	E7+E6+E5+E4	2599	4183	4786	5242	5793
	E2	41	68	78	81	87
	E7+E6+E5+E4+E2	2620	4215	4836	5299	5858
	P4	19	31	36	37	40
	P2A	18	29	33	35	38
	P4+P2A	40	63	72	75	81
	E1	20	33	38	39	42
	P2B	23	36	41	43	47
	E1+P2B	42	68	78	82	88
	E7+E6+E5+E4+E2+E1+P4+P2	2669	4289	4944	5418	5992
	E3	47	78	89	95	104
	P3	18	29	34	35	37
	E7+E6+E5+E4+E2+E1+P4+P2+E3+P3	2711	4372	5038	5521	6106
	P1	15	23	26	28	30
PROPOSED W/MITIGATION	E7	685	1116	1280	1357	1471
	E6	187	304	349	373	408

[illegible]	1538	2602	2856	3154	3463
[illegible]	1938	1768	2029	2161	2170
[illegible]	2599	4185	4286	5242	5793
[illegible]	41	68	78	81	87
[illegible]	2620	4215	4816	5299	5858
[illegible]	19	31	36	37	40
[illegible]	18	29	33	35	38
[illegible]	40	63	72	76	83
[illegible]	20	33	38	39	42
[illegible]	23	36	43	44	47
[illegible]	42	68	78	82	88
[illegible]	15	19	23	25	35
[illegible]	2658	4268	4902	5326	5941
[illegible]	47	78	89	95	104
[illegible]	18	29	34	35	37
[illegible]	2700	4379	5001	5479	6058
[illegible]	13	23	26	28	31

The results of the detention analysis show that the proposed detention pond provides appropriate runoff mitigation for the 100-year frequency discharge. Mitigation for 2-, 10-, 25- and 50-yr frequency peak discharges was also verified.

Runoff Mitigation Structure Dimensions and Accessories

The maximum water stage at the tank for the 100-yr peak will be 2.36 m (7.76 ft). Final dimensions for the pond will include a minimum free board of 0.60 meters. Then, the detention pond will have the characteristics shown in Table 4.

Table 4
Detention Tank Characteristics

	Description	Pond P3
Dimensions	Base Area, m2	1,450
	Side Slope 1:	2
Outlet Control	Orifices (@ bottom, inches	one-18"
	Weir Width (@ 2.3 m above bottom	6.09 m
	Discharge Pipe	One-36"ø

For the mitigation analysis, the bottom geometry of the pond has been considered square but another shape can be used as well if the magnitude of the area is maintained. The pond has been located discharging above the 10-years water surface elevation at Cancel Creek. Figure 9 shows the schematics of the detention pond and the outlet accessories.

V. HYDRAULIC ANALYSIS

A hydraulic analysis of Quebrada Cancel crossing the site has been made in order to find the water surface elevations and the extent of the 100-year footprint. This creek will not be affected by the project. The proposed pipe crossing will be made above the existing box culvert, therefore, way above the 100-year water surface elevation.

The analysis was made by using the mathematical model HEC-RAS developed by the US Corps of Engineers. The friction coefficient used in the modeling was obtained from visual inspection of the existing structures; and cross-checked with the typical values provided by Barnes (1967) and Chow (1959). Manning's coefficient used for modeling the drainage system was 0.040 for the natural watercourse and 0.013 for the concrete structures.

Contraction and Expansion Coefficients

Coefficients of contraction and expansion used are those recommended by the HEC-RAS user's manual. Thus, coefficients of 0.1 and 0.3 respectively were used for gradual transitions.

Hydraulic Run

The geometry for the existing condition includes the natural watercourse across the site. The hydraulic analysis was made mainly for a 100-year discharge; but discharges for more recurrent storm events were also analyzed. Location of the cross sections used shown in Figure 10. Appendix F includes the analysis computer output. Table No. 5 shows the summary of the results.

Table 5; Results of the Hydraulic Run

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
1	7	2-yrs	74.26	98.00	100.74	100.04	101.33	0.012392	3.33	22.33	16.30	0.91
1	7	10 yrs	119.47	98.00	101.45	101.17	102.06	0.012350	3.44	34.78	18.63	0.80
1	7	25 yrs	137.02	98.00	101.67	101.34	102.30	0.011714	3.52	38.93	19.11	0.79
1	7	50-yrs	150.70	98.00	101.82	101.46	102.48	0.011410	3.59	41.82	19.28	0.79
1	7	100-yrs	166.06	98.00	101.99	101.69	102.68	0.011148	3.67	45.28	20.38	0.78
1	6	2 yrs	74.26	97.50	100.64		100.89	0.003320	2.19	33.87	16.90	0.49
1	6	10 yrs	119.47	97.50	101.14		101.67	0.004089	2.57	46.45	19.26	0.53
1	6	25 yrs	137.02	97.50	101.55		101.97	0.004823	2.71	50.64	19.94	0.54
1	6	50-yrs	150.70	97.50	101.70		102.10	0.005040	2.80	53.59	20.42	0.55
1	6	100-yrs	166.04	97.50	101.86		102.30	0.005166	2.91	57.03	20.97	0.56
1	5	2 yrs	76.59	97.00	100.33		100.57	0.004364	2.18	35.06	17.40	0.49
1	5	10 yrs	123.30	97.00	100.97		101.31	0.005355	2.60	47.50	21.71	0.55
1	5	25-yrs	142.09	97.00	101.15		101.54	0.005770	2.76	51.50	22.02	0.58
1	5	50-yrs	155.71	97.00	101.28		101.70	0.005910	2.80	54.45	22.59	0.59
1	5	100-yrs	172.36	97.00	101.41		101.88	0.006169	2.98	57.81	23.23	0.60
1	4	2-yrs	76.59	97.00	99.96		100.04	0.010128	2.77	28.12	19.51	0.72
1	4	10 yrs	123.30	97.00	100.35		100.44	0.009345	2.78	44.36	28.52	0.71
1	4	25-yrs	142.09	97.00	100.58		100.97	0.008848	2.77	51.31	32.00	0.70
1	4	50-yrs	155.71	97.00	100.73		101.17	0.008452	2.75	56.56	34.42	0.69
1	4	100-yrs	172.36	97.00	100.91		101.29	0.008016	2.74	62.80	37.14	0.67
1	3	2-yrs	76.59	96.00	99.09		99.15	0.003124	2.24	34.12	18.80	0.53
1	3	10 yrs	123.30	96.00	99.67		100.01	0.006564	2.72	45.31	22.75	0.62
1	3	25-yrs	142.09	96.00	99.84		100.25	0.006752	2.83	50.21	24.40	0.63
1	3	50-yrs	155.73	96.00	99.98		100.41	0.006834	2.90	53.72	25.35	0.63
1	3	100-yrs	172.36	96.00	100.15		100.60	0.006906	2.97	58.09	26.40	0.64
1	2	2 yrs	76.59	96.00	98.53		98.91	0.011648	2.25	27.80	24.12	0.82
1	2	10 yrs	123.30	96.00	99.31		99.61	0.006906	2.48	49.65	30.11	0.62
1	2	25-yrs	142.09	96.00	99.56		99.88	0.005993	2.48	57.37	31.40	0.58
1	2	50 yrs	155.71	96.00	99.71		100.04	0.005552	2.48	62.72	32.26	0.57
1	2	100 yrs	172.36	96.00	99.92		100.24	0.005147	2.50	69.06	33.25	0.55
1	1	2-yrs	76.59	95.88	98.34	97.83	98.70	0.008001	2.68	28.60	16.83	0.66
1	1	10 yrs	123.30	95.88	99.00	98.41	99.47	0.008013	3.03	40.67	17.88	0.68
1	1	25 yrs	142.09	95.88	99.22	98.61	99.72	0.008086	3.15	45.14	20.85	0.68
1	1	50-yrs	155.73	95.88	99.36	98.75	99.89	0.008002	3.23	48.22	21.58	0.69
1	1	100-yrs	172.36	95.88	99.51	98.90	100.09	0.008001	3.32	51.87	21.99	0.69

Flood Footprint

With the results of the hydraulic analysis, a flood footprint has been drawn and is shown in Figure 11. The project will not affect the course of the creek. The toe of the fill, if any, will be located outside of the flood footprint.

VI. CONCLUSIONS AND RECOMMENDATIONS

The following are the conclusions of this study:

1. According to the regulatory flood maps, the project site is not considered floodable for the 100-year rainfall event.

2. Proposed condition discharge is higher than that of the existing condition at areas P2 and P4. Runoff discharge mitigation is needed for each and all these areas. Different from them, discharge from area P1 does not increase; it can be discharge without a mitigation structure.

3. The proposed runoff mitigation pond reduces the local peak discharge to levels below the ones of the existing condition, as well as the overall discharge of Quebrada Cancel onto the downstream.

The following are the recommendations of this study:

1. The project shall be constructed outside of the 100-year flood footprint.

2. Mitigation structure will have the dimensions and accessories indicated in Table 4 of this report.

3. The pipes must be installed to the elevations given in this study; any change found necessary must be subject to hydraulic verification.

4. It is very important to prepare a long-term maintenance plan, which should include the proposed pipes, the pond outlet structure and the receiving storm system inspection after each significant discharge events. Damages, if any, must be repaired promptly and properly.

Study Limits

All the recommendations specified in this study must be considered to assure the optimum performance of the proposed discharge mitigation tank and receiving stream. The design engineer will be responsible for elaborating the drawings in conformance with the recommendations of this study.

The results of this study are based on free flow conditions through the hydraulic structures. Proper maintenance must be developed to assure this condition. On the event of the occurrence of any severe obstruction to the flow, the results and recommendations may be impaired. Finally, results and recommendations included in this report must be used only and exclusively by the design engineer for the intended purposes as indicated in this study.

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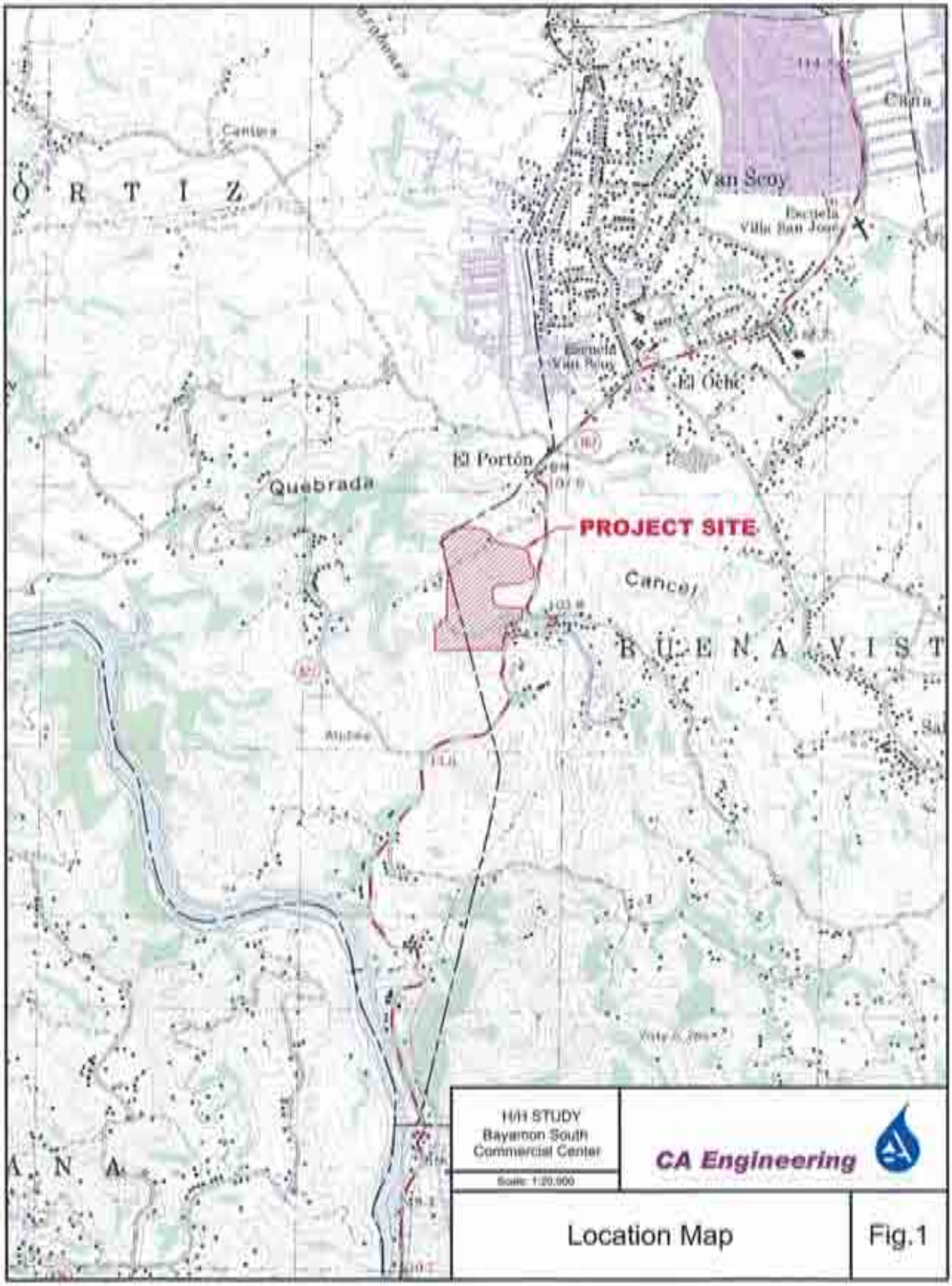


H/H STUDY
Bayamon South
Commercial Center

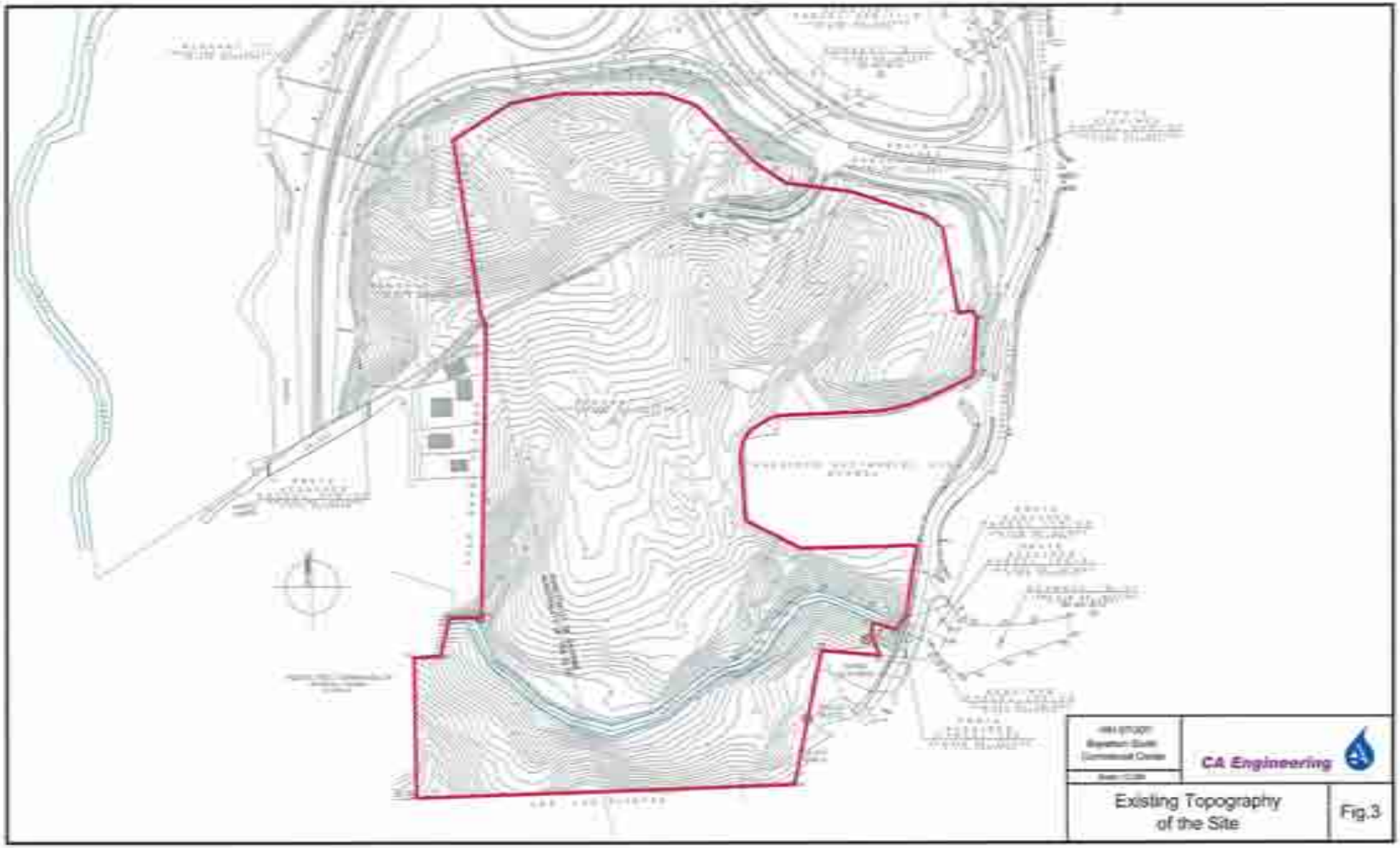
Scale: 1:20,000

CA Engineering

Location Map

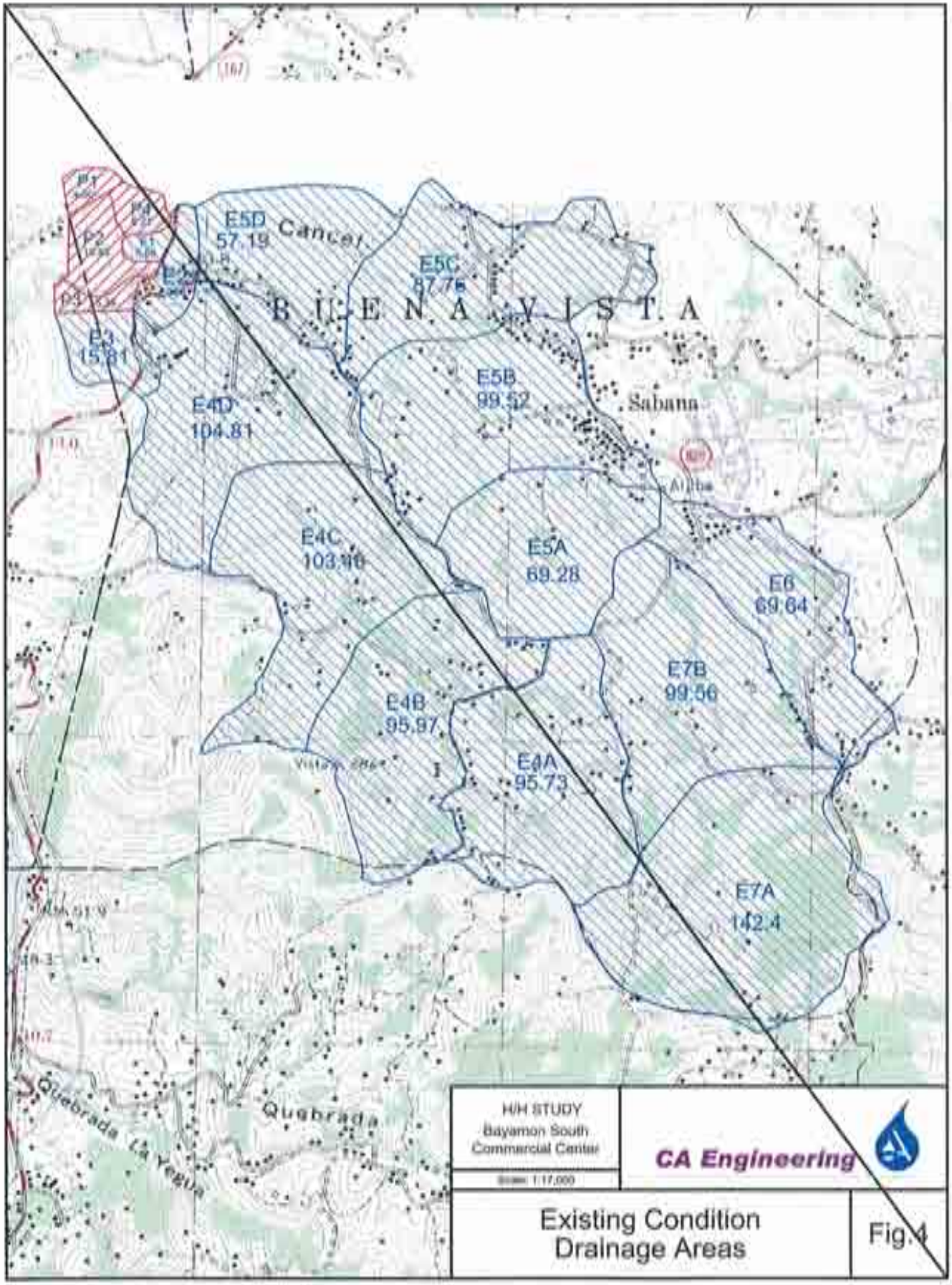
Fig.1

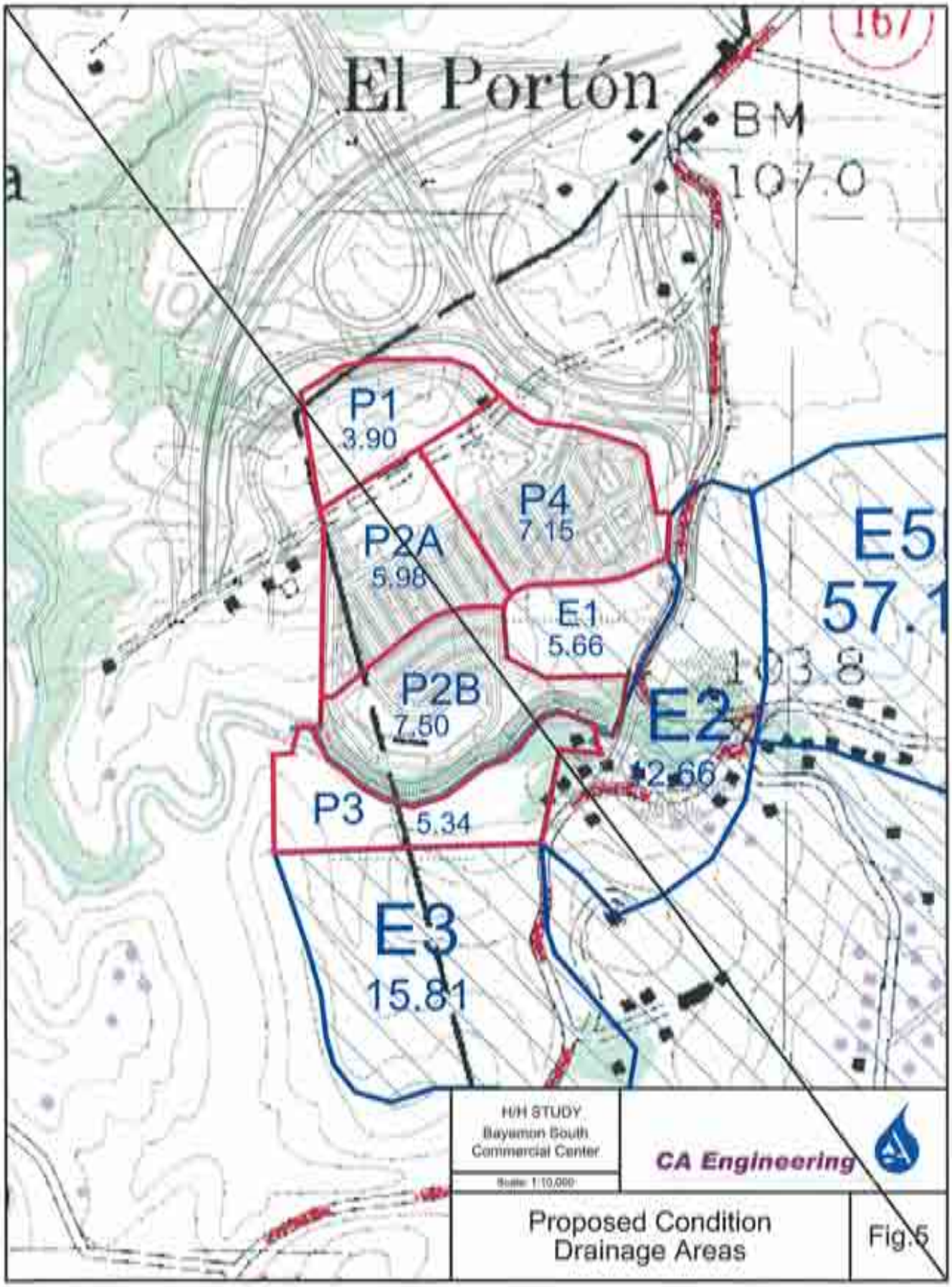
CA Engineering
Proposed Development Layout
Fig.2

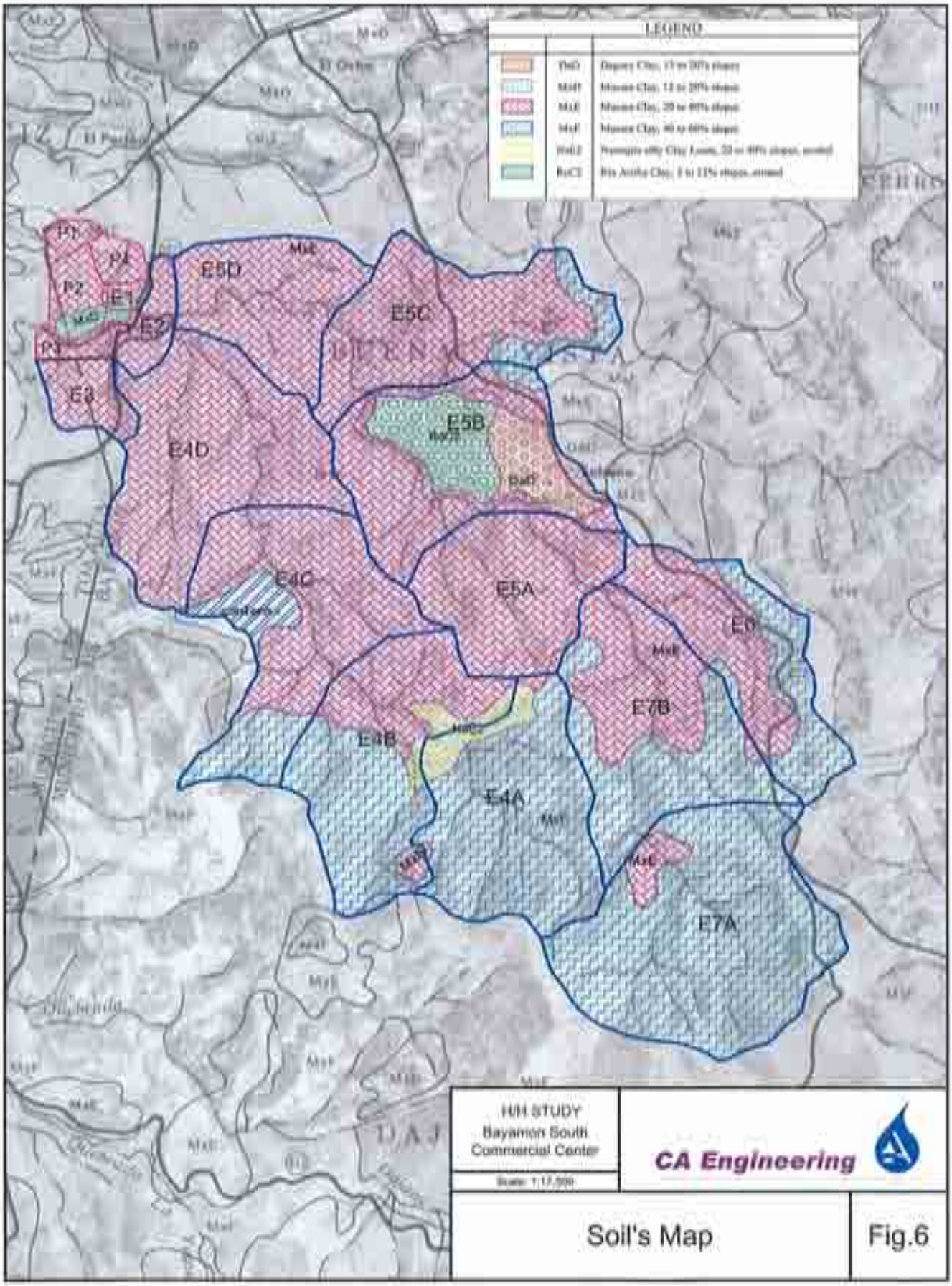


Existing Topography of the Site

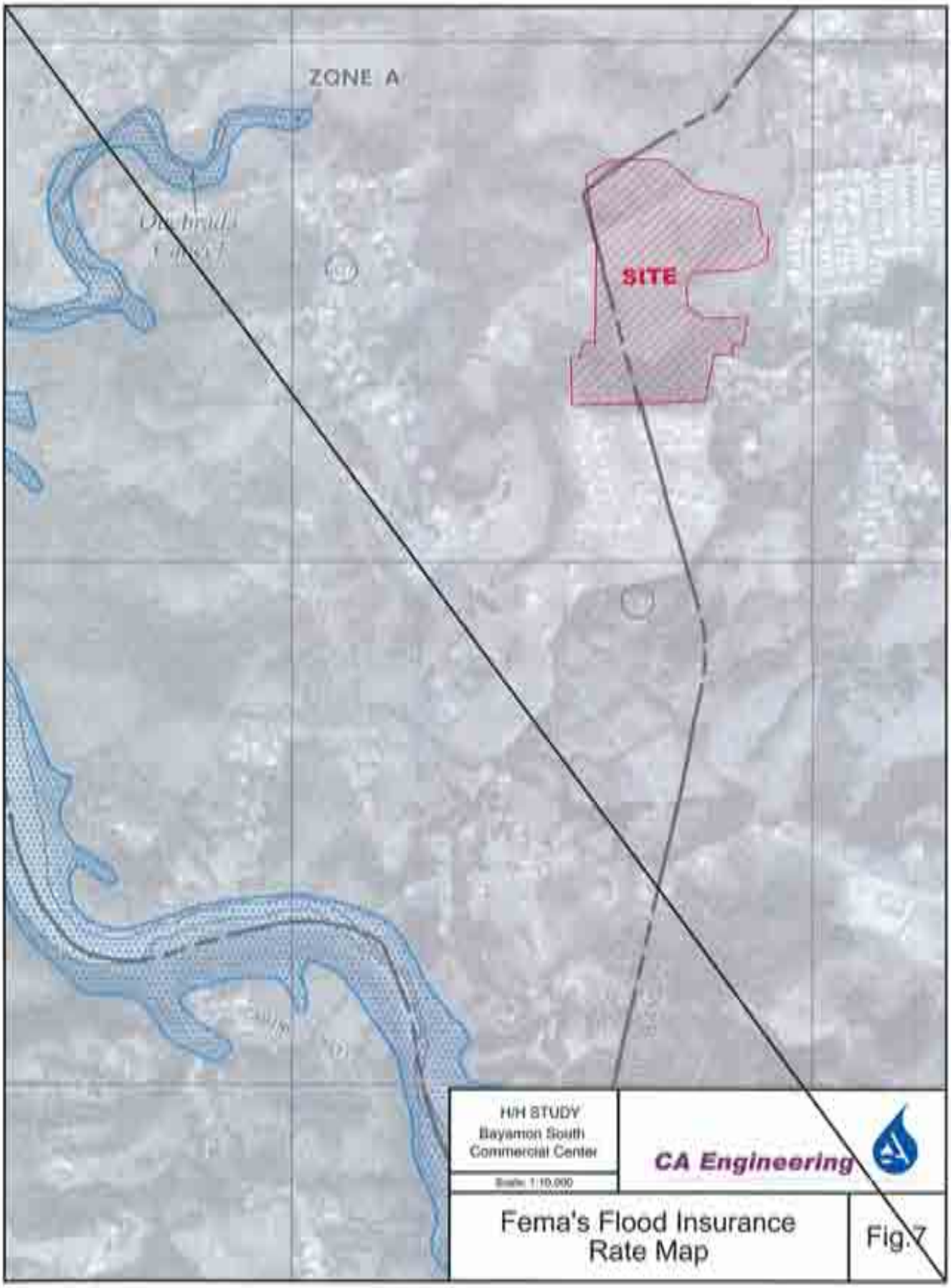
Fig.3


E5D
57.19
Cancel
E5C
87.76
B U E N A V I S T A
E3
15.81
E5B
99.52
Sabana
E4D
104.81
Alba
E4C
103.96
E5A
69.28
E6
69.64
E7B
99.56
E4B
95.97
E4A
95.73
E7A
142.4
Quebrada
Quebrada La Yegua
H/H STUDY
Bayamon South
Commercial Center
Scale: 1:17,000
CA Engineering
Existing Condition
Drainage Areas
Fig.4


El Portón
BM
107.0
P1
3.90
P4
7.15
P2A
5.98
E1
5.66
P2B
7.50
E2
2.66
P3
5.34
E3
15.81
E5
57.1
H/H STUDY
Bayamon South
Commercial Center
Scale: 1:10,000
CA Engineering
Proposed Condition
Drainage Areas
Fig.5



HH STUDY Bayamon South Commercial Center Scale: 1:17,500	CA Engineering
Soil's Map	Fig.6



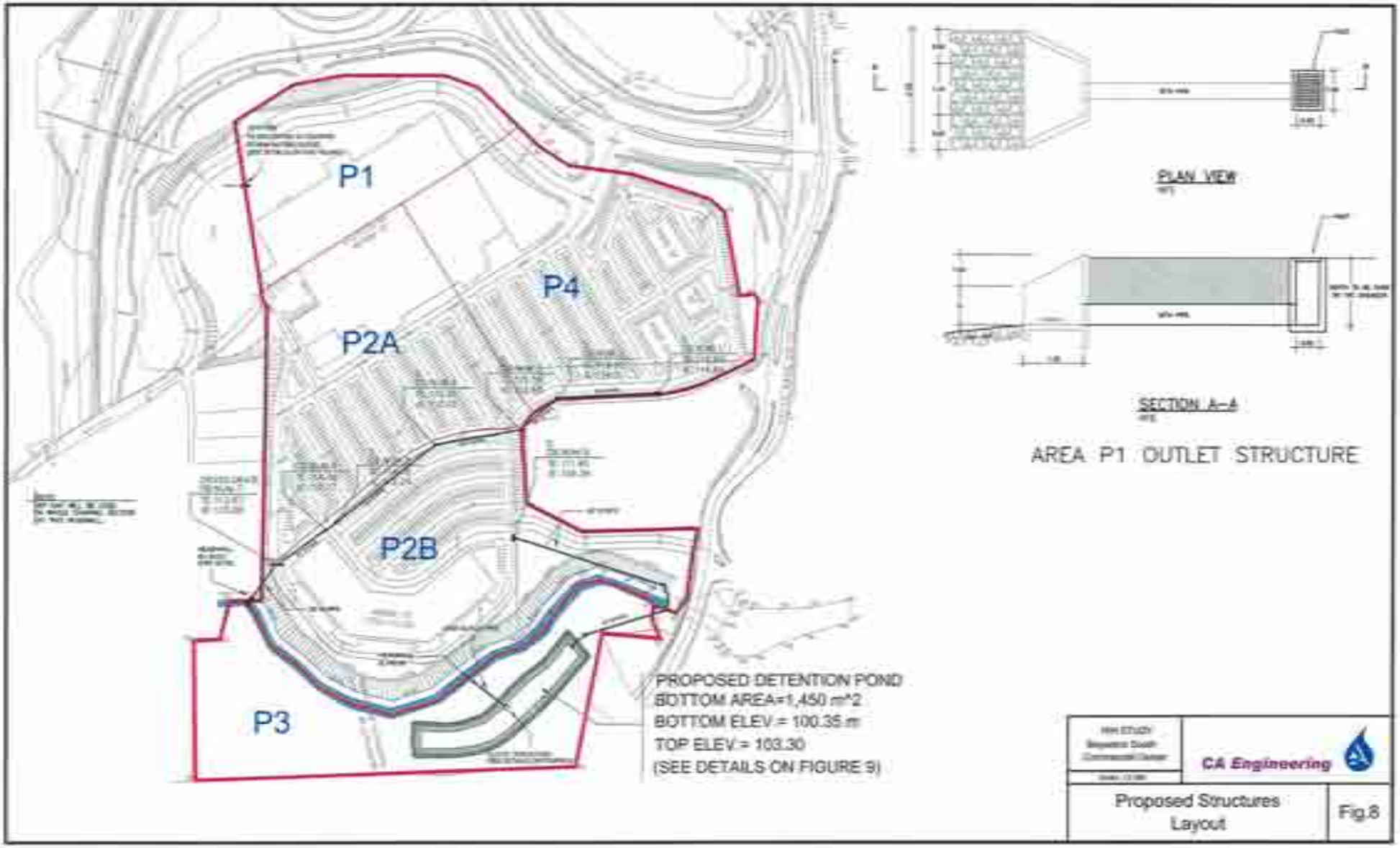
H/H STUDY
Bayamon South
Commercial Center

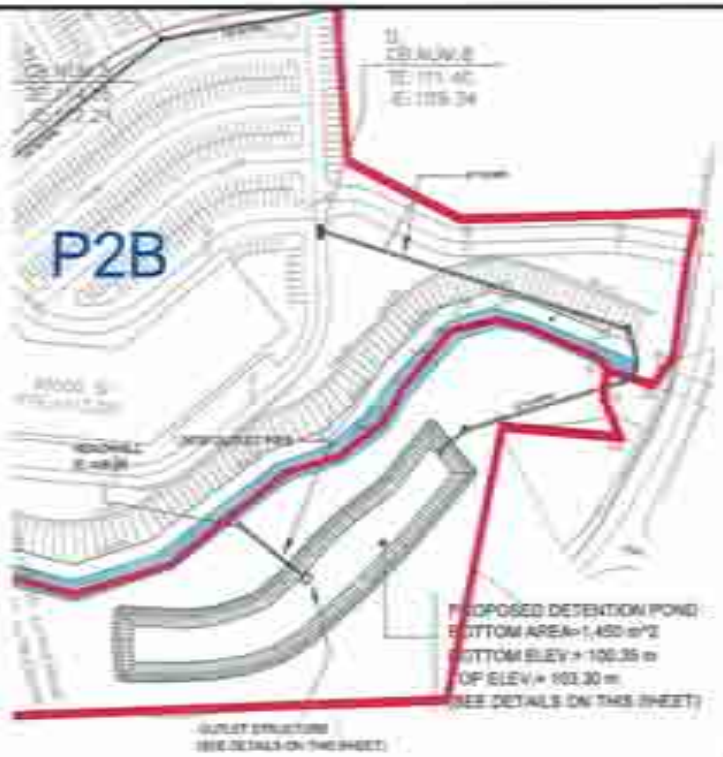
Scale: 1:10,000

CA Engineering

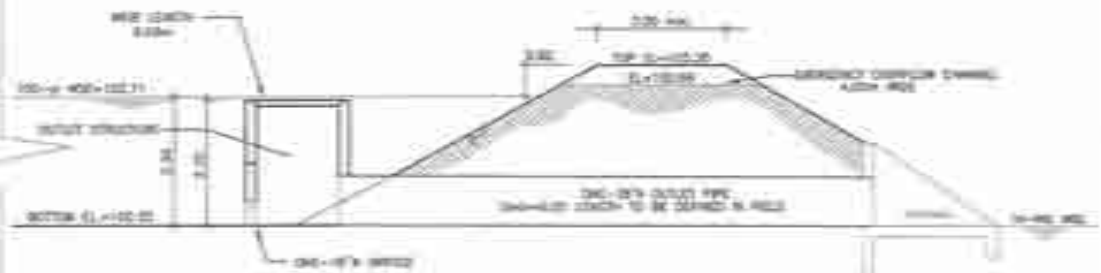
Fema's Flood Insurance
Rate Map

Fig.7


P1
P2A
P2B
P3
P4
PROPOSED DETENTION POND
BOTTOM AREA=1,450 m^2
BOTTOM ELEV = 100.35 m
TOP ELEV = 103.30
(SEE DETAILS ON FIGURE 9)
PLAN VIEW
SECTION A–A
AREA P1 OUTLET STRUCTURE
CA Engineering
Proposed Structures Layout
Fig.8



PLAN VIEW
NTS



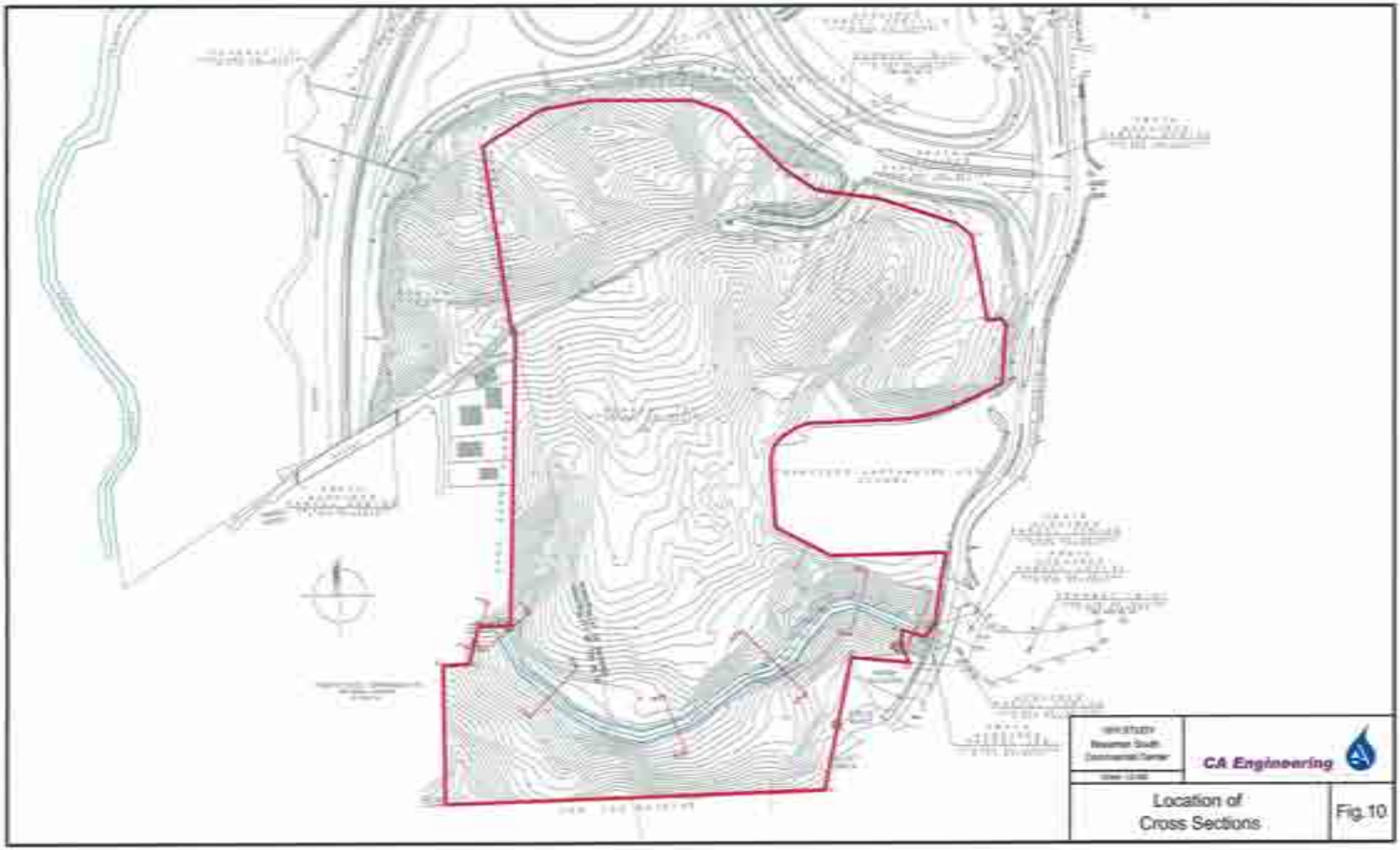
SECTION A–A
NTS

OUTLET STRUCTURE

CA Engineering

Detention Pond Schematics

Fig.9


CA Engineering
Location of
Cross Sections
Fig.10

CA Engineering
100 yrs.
Flood Footprint
Fig.11

APPENDIXES