FLOOD INSURANCE STUDY

VOLUME 1 OF 5

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

COMMUNITY NAME	COMMUNITY NUMBER
COMMONWEALTH OF PUERTO RICO	720000
MUNICIPALITY OF BAYAMÓN	720100
MUNICIPALITY OF PONCE	720101

REVISED:
NOVEMBER 18, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
72000CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this countywide FIS may be revised and republished at any time. In addition, part of this countywide FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial countywide FIS Effective Date: April 19, 2005

Revised countywide FIS Dates: November 18, 2009

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FLOOD INSURANCE STUDY
COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

1.0 INTRODUCTION

1.1 Purpose of Study

This commonwealthwide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards for the geographic area of the Commonwealth of Puerto Rico, including the municipalities of Bayamón and Ponce (hereinafter referred to collectively as the Commonwealth of Puerto Rico and Municipalities) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The new format reflects the status of the Municipality of Bayamón and the Municipality of Ponce as National Flood Insurance Program communities. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this commonwealthwide FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

For this revision, the information contained in all previously printed FIS reports was compiled into one FIS report. Table 1, "Study Contractors," provides information about the authority and acknowledgments for each basin within the Commonwealth of Puerto Rico.

The authority and acknowldgments for Río Orocovis in the Pueblo de Orocovis were taken from the April 1980 FIS report for the Pueblo de Orocovis (Flood Insurance Study, Pueblo de Orocovis, Puerto Rico, Federal Emergency Management Agency [FEMA], 1980). The pueblo is a part of the Río Grande de Manatí Basin. The hydrologic and hydraulic analyses were performed by the U.S. Geological Survey (USGS) under Inter-Agency Agreement No. IAA-H-20-74, Project Order No. 17. That work was completed in February 1978.

TABLE 1 - STUDY CONTRACTORS

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Camuy	March 1, 1983	Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) and Lebron, Sanfiorenzo & Fuentes	H-4734	October 1981
Lower Río Grande de Arecibo	April 1980	U.S. Army Corps of Engineers (USACE), Jacksonville District	IAA-H-16-75, Project Order (PO) No. 8; IAA-H-7-76, PO No. 25; and IAA-H-10-77, PO No. 4	September 1977
Río Cibuco	April 1980	USACE, Jacksonville District	IAA-H-7-76, PO No. 25; and IAA-H-10-77, PO No. 4	August 1978
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Río de Bayamón	March 2, 1981	USACE, Jacksonville District	IAA-H-10-77, PO No. 25, Amendment No. 1	January 1979
	April 19, 2005	Dewberry & Davis and URS Greiner Woodward Clyde	EMW-95-C-4678	June 1999
Río Piedras	August 5, 1986	PBS&J (in association with Lebron Associates)	H-4734	June 1982
	December 15, 1990	USACE, Jacksonville District	*	March 1988

*Data not applicable

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Culebrinas	March 16, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	March 1981
	January 6, 1994	USACE, Jacksonville District (revisions to the hydraulic analyses were prepared by Dewberry & Davis [D&D])	EMW-89-2294, PO No. 1	January 1989
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Río Espíritu Santo	July 2, 1982	USACE, Jacksonville District	IAA-H-16-75, PO No. 8	February 1976
	December 15, 1990	Gregory L. Morris & Associates	*	March 1989
Río Mameyes	March 2, 1981	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	November 1979
	May 18, 1992	Dr. Aurelio Mercado, of the Department of Marine Sciences, University of Puerto Rico for CMA Architects & Engineers	*	August 1990

*Data not applicable

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Fajardo	March 2, 1981	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	September 1979
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Río Blanco	March 16, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	March 1980
Río Yaguez	December 5, 1983	USGS, Water Resources Division	IAA-H-9-77, PO No. 17	December 1980
Río Grande de Añasco	May 17, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	July 1980
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Upper Río Grande de Arecibo	February 1978	USGS	IAA-17-76, PO No. 2	February 1976
Río Grande de Manatí	March 16, 1982	USACE, Jacksonville District	IAA-H-18-78, PO No. 42	July 1980
	November 18, 2009	URS Group, Inc. and Dewberry	EMW-2000-CO-0247	May 2008
Río Orocovis	April 1980	USGS	IAA-H-20-74	February 1978

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río de la Plata	March 16, 1982	USGS	IAA-H-9-77, PO No. 9	April 1979
	April 19, 2005	Dewberry & Davis and URS Greiner Woodward Clyde	EMW-95-C-4678	June 1999
Río Grande de Loíza	March 2, 1981	USACE, Jacksonville District	IAA-H-7-76, PO No. 25, IAA-H-10-77, PO No. 4, Amendment No. 8	July 1979
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Río Anton Ruíz	March 16, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	July 1980
Río Daguao	March 16, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	July 1980
Río Humacao	April 16, 1984	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	April 1982
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Guanajibo	December 5, 1983	Puerto Rico Department of Natural Resources	IAA-H-3948	October 1980
	January 2, 1992	USACE, Jacksonville District	EMW-89-2294	December 1989
	September 20, 1996	USACE, Jacksonville District	EMW-91-E-3529, PO No. 1	March 1993
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008
Lajas Valley	December 5, 1983	USACE, Jacksonville District	EMW-E-0105, PO No. 9	February 1982
Río Yauco	February 1978	USGS	IAA-H-8-76, PO No. 17	March 1976
Río Guayanilla	April 1980	USACE, Jacksonville District	IAA-H-7-76, PO No. 25; and IAA-H-10-77, PO No. 4	September 1978
Río Tallaboa	March 2, 1981	USACE, Jacksonville District	IAA-H-18-78, PO No. 42	August 1979
Rĩo Matilde	June 2, 1999	USACE, Jacksonville District	IAA-H-10-77, PO No. 25	February 1978
	November 18, 2009	Medina Consultants	EMN-2003-CO-005	May 2008

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Jacaguas	Mach 16, 1982	PBS&J and Lebron, Sanfiorenzo & Fuentes	H-4734	July 1980
	May 2009	Medina Consultants	EMN-2003-CO-005	May 2008
	November 18, 2009	URS Group, Inc. and Dewberry	EMW-2000-CO-0247	May 2008
Río Coamo	March 1, 1983	USGS	IAA-H-9-77, PO No. 9	April 1979
	April 19, 2005	Dewberry & Davis and URS Greiner Woodward Clyde	EMW-95-C-4678	June 1999
Río Majada	August 5, 1986	USACE, Jacksonville District	EMW-E-0105, PO No. 8	March 1982
Río Grande de Patillas and Río Guamani	August 5, 1986	USGS	IAA-17-3-26-67	May 1981

TABLE 1 - STUDY CONTRACTORS - continued

River Basin	FIS Report Date	Study Contractor	Contract/ Inter-Agency Agreement No.	Date Completed
Río Grande de Patillas and Río Guamani	May 18, 1992	USACE, Jacksonville District (the hydraulic analyses for the downstream portion of Río Nigua was revised by D&D. In addition, the ineffective flow area on the Río Guamani at the Camino Pozo Hondo was revised by D&D in December 1990.)	EMW-88-E-2768, PO No. 1	October 1990
	April 19, 2005	Dewberry & Davis and URS Greiner Woodward Clyde	EMW-95-C-4678	June 1999
Río Guayanes	November 18, 2009	Medina Consultants	EMN-2003-CO-005	June 2007
Río Maunabo	March 2, 1981	USACE, Jacksonville District	IAA-H-18-78, PO No. 24	November 1979
Quebrada La Mina	November 18, 2009	URS Group, Inc. and Dewberry	EMW-2000-CO-0247	May 2008

The authority and acknowledgments for Río Grande de Jayuya, Río Zamas, and Río Caricaboa in the Town of Jayuya were taken from the February 1978 FIS report for the Town of Jayuya (Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands, U.S. Department of Commerce [DOC], 1961). The town is a part of the Upper Río Grande de Arecibo Basin. The hydrologic and hydraulic analyses were performed by the USGS under Inter-Agency Agreement No. IAA-17-76, Project Order No. 2. That work was completed in February 1976.

The authority and acknowledgments for the February 1978 basins of Río Guajataca, Río Matilde, Río Pastillo Portugués, Río Cañas, Río Bucana, and Río Guayanes are not included because there were no previously printed FIS reports for those basins.

The 1999 revision reflected the February 1978 study of the Río Matilde Basin. The hydrologic and hydraulic analyses of Río Matilde, Río Cañas, Río Pastillo, and Quebrada del Agua for the 1978 study were performed by the USACE, Jacksonville District, for the Federal Insurance Administration under Inter-Agency Agreement No. IAA-H-10-77, PO No. 25.

For the 1999 revision, the coastal storm surge analysis was performed by the Department of Marine Sciences at the University of Puerto Rico for FEMA under Contract No. EMW-84-R-1744. As part of this contract, Greenhorne and O'Mara computed the wave setup component of the base (1-percent annual chance) flood along the shorelines of Puerto Rico and the U.S. Virgin Islands. That work was completed in September 1990. Wave height analyses, beach erosion, runup computations and coastal high hazard delineations were performed by Dewberry and Davis (D&D) under agreement with FEMA.

For the 2005 revision, updated or new riverine hydrologic and hydraulic analyses were performed by Dewberry & Davis and URS Greiner Woodward Clyde for FEMA under Contract No. EMW-95-C-4678. This work was completed in June 1999 and includes new analyses for Río de Bayamón, Río Coamo (at Velazsquez), Río Guamani, Río de la Plata, and Río Nigua.

For this revision, updated or new riverine hydrologic and hydraulic analyses were performed by Medina Consultants for FEMA under Contract No. EMN-2003-CO-005. New analyses for Quebrada Honda (Río Cibuco Basin), Río Matilde, Río Cañas (Río Matilde Basin), Río Pastillo, Río Jacaquas, Río Jacaquas (at Villalba), and Río Guayo were completed in May 2007. New analyses for Río Culebrinas, Río Culebrinas (at San Sebastian), Río Culebrinas (at San Sebastian) Tributary, Río Guatemala, Río Fajardo, Río Sabana, Río Grande de Añasco, Río Grande de Loíza Reach 1, Río Grande de Loíza Reach 2, Río Gurabo, Río Valenciano, Río Bairoa, Río Caguitas, Río Turabo, Quebrada Cambute, Río Humacao, Quebrada Mabu, Quebrada Mariana, Quebrada Mariana Tributary, Río Guanajibo, Quebrada Honda (Río Guanajibo Basin), Río Guayanes (Río Guayanes Basin), and Río Limones were completed in June 2007.

New analyses for Río Grande de Manati, Río Inabon, Quabrada la Mina, and Quebrada la Mina Tributary were performed by URS Group, Inc., and Dewberry for FEMA under contract no. EMW-2000-CO-0247. This work was completed in October 2007.

As part of this revision, a new coastal storm surge and wave height analysis was performed by Dewberry under subcontract to Medina Consultants for FEMA.

The projection used in the preparation of the maps was Universal Transverse Mercator (UTM) Zone 19. The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

For Community Orthophoto Coverage, base map information shown on these FIRMs was provided in digital format by the USDA, contracted by the St. Louis District of the USACE, for the Commonwealth of Puerto Rico. The information was developed for the Land Information Systems Project, Center for Municipal Tax Revenues of Puerto Rico. This information was compiled at scales of 1:6,000 for developed areas and 1:12,000 for undeveloped areas from digital orthophotos of all of Puerto Rico, Vieques, Culebra, Mona, and Desecheo, dated September 21, 2004. The Coordinate System used was GRS 80, NAD 83, UTM Zone 19N, meters. These data have a resolution of 1 meter, 8-bit pixel depth.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study and is attended by representatives of FEMA, the Commonwealth, and the study contractor. The tabulation below lists the initial and final CCO meetings for the basins within the Commonwealth of Puerto Rico.

Basin	Initial Meeting	Final Meeting
Río Camuy	March 1978	September 23, 1982
Lower Río Grande de Arecibo	January 29, 1975	October 26, 1977
Río Cibuco	September 2, 1976	December 6, 1978
Río de Bayamón	May 26, 1977	April 23, 1979
Río Piedras	July 1987	*
Río Culebrinas	March 1978	September 29-30, 1981
Río Espíritu Santo	January 28, 1975	May 18, 1976
Río Mameyes	March 1978	September 23, 1980
Río Fajardo	March 1978	September 22, 1980
Río Blanco	March 1978	August 11, 1981
Río Yaguez	April 1, 1975	June 14, 1983

*Data not available

Basin	Initial Meeting	Final Meeting
Río Grande de Añasco	March 1978	April 30, 1981
Río Grande de Manatí	**	February 17, 1981
Río de la Plata	April 1, 1975	February 17-18, 1981
Río Grande de Loíza	September 1, 1976	September 23-24, 1980
Río Anton Ruíz	March 1978	August 11, 1981
Río Daguao	March 1978	August 11, 1981
Río Humacao	March 1978	June 16, 1983
Río Guanajibo	May 27, 1977	September 23, 1982
Lajas Valley	March 24, 1980	June 14, 1983
Río Yauco	February 3, 1976 and March 24, 1976	February 10, 1977
Río Guayanilla	September 3, 1976	December 5, 1978
Río Tallaboa	1979	July 22, 1980
Río Jacaguas	March 1978	April 28, 1981
Río Coamo	February 15, 1978	September 22, 1982
Río Majada	March 24, 1980	*
Río Grande de Patillas and Río Guamani	*	May 3, 1977
Río Maunabo	February 15, 1970	September 25, 1980

*Data not available
**No initial meeting held

For the Town of Jayuya, which is part of the Upper Río Grande de Arecibo Basin, a final CCO meeting was held on May 18, 1976. For the Pueblo de Orocovis, which is part of the Río Grande de Manatí Basin, a final CCO meeting was held on August 24, 1978.

For the 1999 revision, FEMA notified the Commonwealth of Puerto Rico by letter dated May 3, 1994, that the FIS was being revised.

For the 2005 revision, FEMA held an initial CCO meeting with the Puerto Rico Planning Board on October 4, 2001. A final CCO meeting was held on February 10, 2004, and was attended by representatives of the Commonwealth and FEMA.

For this revision, FEMA held an initial CCO meeting on April 18-21, 2005. These meetings were attended by representatives of the Puerto Rico Planning Board, Autonomous Municipality of Ponce, FEMA, Puerto Rico Regulation and Permits Administration (ARPE), Medina Consultants, Dewberry, Sanborn, and URS.

An intermediate meeting was held on September 18, 2007, to clarify scope.

A final CCO meeting was held on July 11, 2007, and was attended by representatives of the Puerto Rico Planning Board, Autonomous Municipality of Ponce, Commonwealth of Puerto Rico, FEMA Caribbean Office, Puerto Rico

ARPE, Puerto Rico Department of Natural Resources, Medina Consultants, and Dewberry.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the Commonwealth of Puerto Rico and its Municipalities of Bayamón and Ponce. Table 2, "Flooding Sources Studied by Detailed Methods," lists all of the flooding sources that have been studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and/or on the FIRM (Exhibit 2).

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS

Atlantic Ocean
Caribbean Sea
Río Camuy Basin
Río Camuy
Lower Río Grande de Arecibo Basin
Río Grande de Arecibo
Caño Tiburones
Río Cibuco Basin
Río Cibuco
Río Indio
Quebrada Honda
Río de Los Negros
Río Morovis
Río de Bayamón Basin
Río de Bayamón
Río Guaynabo
Río Hondo
Quebrada Santa Catalina
Río Piedras Basin
Canal Puerto Nuevo
Río Piedras
Quebrada Margarita
Quebrada Dona Ana
Quebrada Josefina
Quebrada Guaracanal
Quebrada Cepero
Quebrada Juan Mendez
Caño de Martin Pena
Río Culebrinas Basin
Río Culebrinas
(Downstream Reach)
Río Culebrinas (at San Sebastián)
Río Culebrinas Tributary
Río Guatemala
Caño Madre Vieja
Río Guayabo
Río Culebra
Caño Guayabo
Unnamed Stream
Río Espíritu Santo Basin
Río Espíritu Santo
Río Grande
Río Mameyes Basin
Río Mameyes
Río Fajardo Basin
Río Fajardo
Río Sabana
Río Blanco Basin
Río Blanco
Río Santiago
Río Santiago Lateral Branch
Río Yaguez Basin
Río Yaguez at Mayaguez
Río Grande de Añasco Basin
Río Grande de Añasco
Upper Río Grande de Arecibo Basin
Río Grande de Jayuya
Río Zamas
Río Caricaboa
Río Grande de Manatí Basin
Río Grande de Manatí
Río Orocovis
Río de la Plata Basin
Río de la Plata Overflow
Río de la Plata (at Toa Baja)
Río de la Plata (at Toa Alta)

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Río de la Plata (at Comerio)
Río de la Plata (at Cayey)
Río de la Plata Tributary No. 1
Río Guavate
Quebrada Santo Domingo
Río de Aibonito Tributary No. 1
Río Guadiana

Río Grande de Loíza Basin
Río Grande de Loíza Reaches 1 and 2
Río Cañovanas
Río Cañovanillas
Quebrada Cambute
Río Gurabo
Río Valenciano
Río Bairoa
Quebrada Muertos
Quebrada Algarrobo
Río Caguitas
Río Caguitas Tributary 1
Río Caguitas Tributary 2
Río Turabo
Río Herrera
Río Canaboncito

Río Anton Ruíz Basin
Río Anton Ruíz
Quebrada Mambiche
Quebrada de las Mulas

Río Daguao Basin
Río Daguao
Quebrada Aguas Claras
Quebrada Aguas Claras Tributary
Quebrada Ceiba

Río Humacao Basin
Río Humacao
Quebrada Mabu
Quebrada Mariana
Quebrada Mariana Tributary

Río Guanajibo Basin
Río Guanajibo
Quebrada Honda
Río Cruces
Quebrada Mendoza
Quebrada Las Tunas
Concepción Channel
Quebrada Pileta

Lajas Valley Basin
Río Loco

Río Yauco Basin
Río Yauco
Quebrada Berrenchin
Quebrada Berrenchin Tributary No. 1

Río Guayanilla Basin
Río Guayanilla
Río Macana

Río Tallaboa Basin
Río Tallaboa
Río Guayanes

Río Matilde Basin
Río Matilde
Río Cañas
Río Pastillo
Quebrada del Agua

Río Jacaguas Basin
Río Jacaguas
Río Jacaguas (at Villalba)
Río Inabon
Río Guayo
Canal de Juana Díaz

Río Coamo Basin
Río Coamo (at Velazsquez)
Río Coamo (at Paso Seco)
Río Descalabrado

Río Majada Basin
Río Nigua

Río Grande de Patillas and Río Guamani Basin
Río Grande de Patillas
Quebrada Mamey
Río Nigua (at Arroyo)
Río Nigua (at Pitahaya)
Río Guamani
Río Melania
Río Seco

Río Maunabo Basin
Río Maunabo
Quebrada Arenas
Quebrada Branderi
Río Jacaboa

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Río Guayanes Basin
Río Guayanes
Río Limones

Río Candelero Basin
Río Candelero
Quebrada #1
Quebrada #2
Quebrada #4

Quebrada La Mina Basin
Quebrada La Mina
Quebrada La Mina Tributary

For the 1999 revision, the Atlantic Ocean and the Caribbean Sea were restudied for their entire shorelines within the Commonwealth. In addition, the following streams were newly studied by detailed methods: Río Matilde, from its confluence with the Caribbean Sea to the confluence of Río Cañas and Río Pastillo; Río Cañas, from its confluence with Río Matilde to a point approximately 0.4 kilometer upstream of Las Delicias Bridge; Río Pastillo, from its confluence with Río Matilde to a point approximately 0.12 kilometer upstream of PR Highway 132; and Quebrada del Agua, from its confluence with the Caribbean Sea to a point approximately 3.45 kilometers upstream.

For the 2005 revision, the following streams were restudied by detailed methods within the Commonwealth: Río de Bayamón, from PR Highway 2 to approximately 20 kilometers upstream of PR Highway 174; Río de la Plata, from its mouth to approximately 0.25 kilometer upstream of PR Highway 824; Río Coamo, from its mouth to approximately 0.4 kilometer upstream of Ponce y Guayama railroad; Río Nigua, from its mouth to approximately 0.6 kilometer downstream of confluence of Río Majada; and Río Guamani, from its mouth to just upstream of PR Highway 10.

In this revision, the Atlantic Ocean and the Caribbean Sea were restudied for their entire shorelines within the Commonwealth. In addition, the following streams were restudied or newly studied by detailed methods within the Commonwealth: Quebrada Honda (Río Cibuco Basin), from approximately 2,800 meters upstream from the confluence with Río Cibuco to approximately 2,331 meters upstream of PR Highway 2; Río Culebrinas (downstream reach), approximately 95 meters upstream of PR Highway 2 to approximately 1,209 meters upstream of Carretera 110 (Camino Las Brujas); Río Culebrinas (at San Sebastian), from approximately 1,117 meters downstream of Calle Jose Torres Pino to approximately 1,154 meters upstream of Carretera 119; Río Guatemala, from the confluence with Río Culebrinas (at San Sebastian) to approximately 1,646 meters upstream of Carretera 111; Río Culebrinas (at San Sebastian) Tributary, from the confluence with Río Culebrinas (at San Sebastian) to approximately 709 meters upstream of Calle Hostos Cabrera; Río Fajardo, from approximately 1,142 meters upstream of the confluence with Caribbean Sea to approximately 2,045 meters upstream of Carretera 977; Río Sabana, from approximately 875 meters above the confluence with Atlantic Ocean to approximately 1,041 meters upstream of Carretera 983; Río Grande de Añasco, from approximately 296 meters upstream of the confluence with Atlantic Ocean to approximately 2,363 meters upstream of Carretera 406; Rìo Grande de Manati, from approximately 130 meters upstream of confluence with Atlantic Ocean to approximately 98 meters upstream of PR Route 145; Río Grande de Loíza Reach 1, from approximately 176 meters downstream of PR Highway 3 to approximately 3,557 meters upstream of PR Highway 181; Río Grande de Loíza Reach 2, from approximately 3,640 meters downstream of PR Highway 30 to approximately 2,703 meters upstream of Carretera 183; Río Gurabo, from the confluence with Río Grande de Loíza Reach 2 to approximately 1,790 meters upstream of Carretera 31; Río Valenciano, from the confluence with Río Guarabo to approximately 1,030 meters upstream of Carretera 31; Río Bairoa, from the confluence with Río Grande de Loíza Reach 2 to approximately 288 meters upstream of Calle Gardenia; Río Caguitas, from the confluence with Río Grande de Loíza Reach 2 to approximately 1,814 meters upstream of Calle Canaboncito; Río Turabo, from the confluence with Río Grande de Loíza Reach 2 to approximately 7,489 meters upstream of Calle Georgetti; Quebrada Cambute, from the confluence with Río Canovanillas to approximately 786 meters upstream of confluence with Río Canovanillas; Río Humacao, from approximately 229 meters above the confluence with Caribbean Sea to approximately 1,921 meters upstream of Carretera 914; Quebrada Mabu, from the confluence with Río Humacao to approximately 455 meters upstream of Calle B; Quebrada Mariana, from the confluence with Río Humacao to approximately 3,383 meters upstream of PR Highway 30; Quebrada Mariana Tributary, from the confluence with Quebrada Mariana to approximately 109 meters upstream of Camino Manolo Lopez; Río Guanajibo, from approximately 48 meters downstream of Carretera 102 to approximately 2,139 meters upstream of Carretera 368; Quebrada Honda (Río Guanajibo Basin), from the confluence with Río Guanajibo to approximately 919 meters upstream of Sector Jeraldo; Río Matilde, from the confluence with the Caribbean Sea to the confluence of Río Cañas and Río Pastillo; Río Cañas, from the confluence with Río Matilde to approximately 524 meters upstream of Avendia Ponde de Leon; Río Pastillo, from the confluence with Río Matilde to approximately 79 meters upstream of PR Highway 132; Rìo Jacaguas, from approximately 46 meters upstream of confluence with Atlantic Ocean to approximately 162 meters upstream of PR Highway 149; Rìo Inabon, from the confluence with Rìo Jacaguas to approximately 5,391 meters upstream of PR Highway 14; Rìo Guayo, from the confluence with Rìo Inabon to approximately 44 meters upstream of PR Highway 512; Río Guayanes (Río Guayanes Basin), from approximately 450 meters above the confluence with Caribbean Sea to approximately 4,319 meters upstream of Carretera 182; Río Limones, from the confluence with Río Guayanes to approximately 117 meters upstream of Carretera 902; Quebrada la Mina, from the confluence 755 meters upstream from the confluence with Quebrada la Mina, from the confluence with Atlantic Ocean to a point approximately 233 meters upstream of PR Highway 201; and Quebrada la Mina Tributary, from the confluence with Quebrada la Mina to approximately 755 meters upstream from the confluence with Quebrada la Mina.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

Additionally this revision incorporates the determinations of the Letters of Map Revision issued by FEMA, which are listed in the following tabulation:

Community	Identifier	Flooding Source(s)	Date of Letter
Commonwealth of Puerto Rico	Las Estancias II Development in Municipality of Vega Baja	Río Cibuco	March 10, 2006
Commonwealth of Puerto Rico	Los Prados Development Phase II	Quebrada Algarrobo	June 14, 2006
Commonwealth of Puerto Rico	Parque de Candelero Development in Municipality of Humacao	Quebrada #1 Quebrada #2 Quebrada #4	July 26, 2006
Commonwealth of Puerto Rico	Palmas Del Mar Development in Municipality of Humacao	Río Candelero	March 16, 2007
Commonwealth of Puerto Rico	R. Ortiz Site, Hatillo	Río Camuy	April 25, 2007
Commonwealth of Puerto Rico	Paseo Del Mar	Río Coamo	October 31, 2007
Commonwealth of Puerto Rico	Palmas Del Mar Development in Municipality of Humacao	Río Candelero	January 31, 2008

Numerous flooding sources within the Commonwealth were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Commonwealth.

2.2 Community Description

The population of the Commonwealth of Puerto Rico was 3,808,610 in 2000. Puerto Rico comprises a total land area of 8,871 square kilometers. It is bordered by the Atlantic Ocean on the north and east and the Caribbean Sea on the south and west. Puerto Rico is crossed by mountain ranges, the most notable of which is the Cordillera Central, which rises to 1,388 meters.

The climate in Puerto Rico is generally tropical. The average summer and winter temperatures in tropical areas of Puerto Rico are 32.2 degrees Celsius (°C) and 18.3°C, respectively. Average annual precipitation varies from approximately 1.52 meters near the coast to over 2.03 meters in the mountains (Monthly Averages of Temperature and Precipitation for the Commonwealth of Puerto Rico, DOC). However, the mean annual precipitation in the rain forest of the Río Espíritu Santo Basin is 5.08 meters. The wettest period of the year, the hurricane season, occurs in late summer and early fall.

Río Camuy Basin

Río Camuy is one of the six rivers that cross the north coast limestone area in Puerto Rico. Río Camuy flows underground for a straight-line distance of approximately 6.4 kilometers. In the Río Camuy Basin, drainage is largely subsurface, except for the upstream river portion.

The Río Camuy watershed can be divided into two principal zones: the volcanic terrain zone and the limestone terrain zone ("Water Resources of the North Coast Limestone Area, Puerto Rico," U.S. Department of the Interior [DOI], Geological Survey, 1976; Unpublished Data and Results for Camuy Basin, DOI, Torres, Geological Survey, 1978). The volcanic terrain zone extends from the upper part of the Río Camuy watershed to approximately 2 kilometers upstream of the point where the river turns underground (Blue Hole Cave). Drainage in this zone is principally via surface runoff. There is no appreciable subsurface ground-water outflow from this zone, nor is there an appreciable constriction to flood flow from water that has infiltrated the soil cover.

The limestone terrain zone extends approximately from Blue Hole Cave to the river mouth (DOI, February 1976). The two principal drainage components in this zone are direct runoff and infiltration. Infiltration has three components: deep ground-water circulation that may enter the stream as base flow or may leave the basin as ground-water flow; shallow circulation that may enter the stream slowly as base flow; and shallow circulation that may reach the stream rapidly and become part of the flood flow. The latter is found wherever a shallow network of solution channels provides a high permeability path to water. In these areas, a significant portion of the water is then able to reach the stream in hours, rather than days or weeks.

The drainage area boundary of the limestone zone is difficult to delineate because of the complex subsurface drainage patterns. The boundary has been determined approximately, indicating a drainage area of approximately 83.1 square kilometers (DOI, Torres, 1978).

Land use has historically been pasture, cropland, and other miscellaneous uses (including urban and industrial developments). The primary developed areas affected by floods in Río Camuy are the municipalities of Camuy and Hatillo.

Lower Río Grande de Arecibo Basin

The Río Grande de Arecibo originates on the northern slopes of the Cordillera Central (the central mountain range of Puerto Rico) and flows to the northwest coast of Puerto Rico. The river flows northwesterly through a belt of limestone hills, typified by karst terrain; through a narrow, canyon-like valley; across an alluvial plain, and finally empties into the Atlantic Ocean. The estimated drainage area of the river at its mouth is 541 square kilometers. The alluvial plain averages approximately 4 kilometers in width and extends from the river mouth to a point approximately 11.2 kilometers upstream. A great part of the alluvial plain is used for growing sugar cane.

The primary developed area in the Río Grande de Arecibo Basin below Dos Bocas Dam is the Town of Arecibo. The floodplain is comprised mostly of residential development and relatively little commercial development.

The most important economic activity of the area is growing sugar cane. The sugar cane harvest of Arecibo represents approximately 10 percent of the total sugar cane production in Puerto Rico. Another flourishing industry is paper manufacturing, which converts sugar cane bagasse into paper.

Río Cibuco Basin

The Río Cibuco Basin is located in the Municipalities of Vega Baja, Vega Alta, Dorado, Morovis, and Corozal, on the north-central coast of Puerto Rico.

The total drainage area of the Río Cibuco Basin is approximately 276 square kilometers. The exact drainage area is indeterminate due to the karst topography of the region. The Río Cibuco rises in the northern foothills of Puerto Rico at an elevation of approximately 600 meters, flows northward, and enters the Atlantic Ocean approximately 30 kilometers west of the capital city, San Juan. The stream slope in the upper reaches of the Río Cibuco averages approximately 25 meters per kilometer and, in the coastal floodplain, approximately 1 meter per kilometer.

The floodplains of the Río Cibuco Basin consist of lowlands adjacent to the streams. The primary land use in the floodplains is agriculture, with most of the area planted in sugar cane, and some areas used as pasture for cattle. Some swampy areas in the coastal floodplain also exist.

Río de Bayamón Basin

The Río de Bayamón Basin is located in the Municipalities of Aguas Buenas, Bayamón, Catano, Cidra, Guaynabo, San Juan, and Toa Baja, on the north-central coast of Puerto Rico. The major cities in the basin are Bayamón, Catano, and Guaynabo.

Río de Bayamón originates in the central mountains of Puerto Rico, where small tributaries collect at the Lago Cidra before emerging into a narrow valley. The river flows north through this valley, with an average slope of approximately 16 meters per kilometer for approximately 22.5 kilometers, and drains an area of 250 square kilometers. Before reaching the coastal floodplain, Río de Bayamón is joined by Río Guaynabo. Río de Bayamón enters the Bayamón Express Channel at the PR Highway 2 bridge. The Bayamón Express Channel is a flood control facility constructed by the Commonwealth of Puerto Rico and completed in 1972.

Río Hondo was a tributary to Río de Bayamón prior to its channelization in 1977. Presently, Río Hondo enters a flood control channel, the Río Hondo Local Channel, which is adjacent to, but independent of, the Bayamón Express Channel. Both channels direct flood flow to the Atlantic Ocean and are capable of conveying and containing the 1-percent annual chance frequency flood. Quebrada Santa Catalina, with a drainage area of approximately 7 square kilometers, is a tributary of Río Hondo.

Río Piedras Basin

The Río Piedras Basin is located on the north coast of Puerto Rico, in the eastern metropolitan area of San Juan. Downstream of Avenida Jesus T. Pinero, Río Piedras is called Canal Puerto Nuevo. Río Piedras and Canal Puerto Nuevo were analyzed as one stream for this countywide FIS. As of 1974, 70 percent of the basin was urbanized. Rapid urbanization has caused substantial increases in wet weather discharges in the river system.

Most of the basin is occupied by residential and commercial development. A significant portion of the drainage network consists of man-made channels and networks. The water quality is poor because of poor dry weather circulation in certain stream reaches, salt water intrusion, and storm water runoff.

In the upper portions of the study area, the soils are of the Mucara-Caguabo association. These are moderately deep to shallow, moderately steep to very steep, well-drained soils. In the lower portion near Laguna San Jose, the soils are of the Almirante-Vega Alta-Matanzas association. These are deep, gently sloping to sloping, well-drained soils (Soil Survey of San Juan Area of Puerto Rico, U.S. Department of Agriculture [USDA], November 1978).

Río Culebrinas Basin

The Río Culebrinas Basin is located in the northwestern part of Puerto Rico. The headwaters of the Río Culebrinas lie in the western part of the Cordillera Central, at an elevation of approximately 450 meters (Puerto Rico Drainage Basins and Coastal Areas Cooperative Study, U.S. Army Corps of Engineers [USACE] and the Commonwealth of Puerto Rico, August 1974). From here, the stream flows westerly for approximately 44 kilometers to its mouth, where it discharges into the Bay of Aguadilla on Mona Passage. The Río Culebrinas watershed is located approximately 3.5 kilometers south of the Town of Aguadilla.

The most important urbanized areas affected by floods in the Río Culebrinas Basin are the municipalities of San Sebastián, Aguadilla, and Aguada.

Río Espíritu Santo Basin

Río Espíritu Santo Basin is located on the northeastern coast of Puerto Rico. Río Espíritu Santo originates in the northern slopes of the Sierra de Luquillo. The Caribbean National Forest is also located in the Sierra de Luquillo and is also known as the Luquillo Rain Forest. The headwater areas of Río Espíritu Santo Basin exhibit the extremely steep slopes and high precipitation rates characteristic of the Rain Forest Region. The greatest tributary of Río Espíritu Santo is the Río Grande, whose mouth is located just downstream from the bridge crossing at PR Highway 3, east of the Town of Río Grande. Quebrada Guzman is a tributary to the Río Grande that flows from the west to join with the Río Grande just before it empties into Río Espíritu Santo.

Before reaching the ocean, Río Espíritu Santo flows through a low-lying coastal area between PR Highway 3 and the ocean. This coastal plain is approximately 5 kilometers wide, and a great part of it is covered with mangrove swamp forests. A network of artificial canals drains these areas. On the eastern side of the coastal plain, Quebrada Gonzalez and Quebrada Suspiro also drain their storm runoff into Río Espíritu Santo through a network of drainage canals. Adjacent and west of Río Espíritu Santo lies the Herrera River, which also originates in the Sierra de Luquillo and is interconnected with Río Espíritu Santo through the network of drainage canals.

Río Mameyes Basin

The Río Mameyes Basin is located in northeastern Puerto Rico, approximately 37 kilometers east of San Juan. The primary developed area in the Río Mameyes Basin is the Mameyes (Palmer) community. There are pasture lands and small farms in the area; other areas are being developed for summer vacation homes. Much of the upper basin is too steep for any kind of development (USACE and the Commonwealth of Puerto Rico, August 1974). Sugar cane is grown in the floodplain areas.

Río Mameyes drains a northern segment of the Sierra de Luquillo and discharges into the Atlantic Ocean. The steepness of the upstream basin combined with intense rainfalls gives the basin a high potential for producing runoff (Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands, DOC, 1961). The headwaters lie in the Yunque Rain Forest, approximately 950 meters above sea level.

The topography of the Río Mameyes Basin is diverse, ranging from very steep slopes in the mountains to relatively flat pastureland in the low-lying areas. Soils in the upland areas of the Río Mameyes Basin are of the Caguabo-Mucara-Naranjito association. These consist of shallow to moderately deep soils that are well drained. In the floodplain, the soils are of the Coloso-Toa-Bajura association. These are deep, and moderately well drained to poorly drained. In the coastal embayment area, the soils are of the Swamps-Marshes association. These are deep, very poorly drained soils (Soil Survey of Humacao Area of Eastern Puerto Rico, USDA, Soil Conservation Service [SCS], 1977).

Vegetation in the Río Mameyes Basin is diverse and includes dense rain forest in the highlands, sugar cane in the floodplain areas, and swamps and marshes along the coastal embayment.

Río Fajardo Basin

The Río Fajardo Basin is in northeastern Puerto Rico, approximately 61 kilometers east of San Juan. It is directly east of the Río Mameyes Basin, and north of the Río Daguao Basin.

The Municipality de Fajardo is the principal area of development in the Río Fajardo Basin. Rapid urban, industrial, and recreational development has occurred in the floodplain areas of Río Fajardo.

The basin contains very diverse terrain in a relatively small area. The headwaters of Río Fajardo lie in the Sierra de Luquillo Mountains, at an elevation of 1,036 meters. From here, the stream flows northeasterly for approximately 24 kilometers into the Atlantic Ocean near the Municipality de Fajardo and reaches the sea 0.5 kilometer south of Punta Fajardo. There is no coastal plain in this basin; however, there is a small alluvial valley associated with the lower reach of the stream. The mountain area is mostly forested and lies in the Caribbean National Forest, which is renowned for its rain forest where rainfall exceeds 5.087 meters annually. The channel slopes of Río Fajardo are very steep, and stream velocities are extremely high in the mountains. The slopes become less steep from the foothills to its mouth.

Soils in the upland areas of the Río Fajardo Basin are of the Caguabo-Mucara-Naranjito association. These consist of moderately deep and well-drained soils. In the floodplain, soils are of the Coloso-Toa-Bajura association. These soils are deep, and moderately well to poorly drained. In the coastal areas, soils are of two associations: Mabi-Río Arriba-Cayagua and Catano-Aguadilla. Of these two, the former is somewhat poorly drained; the latter is excessively well drained (USDA, 1977).

Vegetation ranges from thick rain forest to sugar cane fields to coastal marshes. Sugar cane is grown in the flat lands, and there is some light agricultural development on the intermediate slopes.

Río Blanco Basin

Río Blanco Basin is located in eastern Puerto Rico. Elevations in the basin vary from a maximum of approximately 200 meters to a minimum of approximately 1.0 meter at the banks of streams.

Río Blanco and Río Santiago flow southeasterly from their headwaters in the foothills of the Sierra de Luquillo into a coastal floodplain, which is 3.2 kilometers wide and extends 1.6 kilometers inland to the Town of Naguabo, and then empty into the Atlantic Ocean.

There are two types of soils in Río Blanco Basin. In the floodplain, soils are of the Coloso-Toa-Bajura association. These are deep and moderately well drained to poorly drained. In the uplands, soils are the Mabi-Río Arriba-Cayaguaba association. These are deep and somewhat poorly drained to moderately well drained soils.

The primary developed sites in the study are the Municipality of Naguabo and Suromar Residential Development. Land use is predominantly agricultural, except in the upper elevations where forests predominate. Cattle raising and sugar cane cultivation are the main agricultural activities.

Río Yaguez Basin

The Río Yaguez Basin is located in west-central Puerto Rico. Río Yaguez originates in the western slopes of the Cordillera Central and flows westerly into Bahia de Mayaguez. The drainage basin is narrow, having a length-width ratio of approximately 10 to 1 and a total drainage area of 35.5 square kilometers.

The average slope of Río Yaguez is approximately 0.025 percent upstream from the study area and less than 0.004 percent within the study area. This is a change in average slope from a drop of 25 meters per kilometer to less than 4 meters per kilometer.

The City of Mayaguez, through which Río Yaguez flows, is the third largest in Puerto Rico. It is located 110 kilometers southwest of San Juan.

Río Grande de Añasco Basin

The Río Grande de Añasco Basin is located in west-central Puerto Rico, in the municipalities of Adjuntas, Añasco, Lares, Las Marias, Maricao, Mayaguez, and San Sebastián.

The Río Grande de Añasco Basin encompasses an area of 467.7 square kilometers, of which over 90-percent of the area is mountaineous and the remaining area is flat land. The principal communities affected by floods within the study area are the residential developments of the Añasco Municipality. The floodplain comprises approximately three-fourths of the flat land.

Río Grande de Añasco has its headwaters at an elevation of approximately 1,204 meters and flows westerly 74 kilometers to the coast, where it discharges into the Bay of Añasco and Mona Passage. Río Daguey, a tributary of Río Grande de Añasco, flows westerly to Río Grande de Añasco, passing near the east side of the City of Añasco.

The land uses on the Río Grand de Añasco watershed are distributed as follows: 278 square kilometers are used for cropland; 114 square kilometers are in pasture; 85 square kilometers are forest and woodland; 33 square kilometers are idle; and 13 square kilometers are in miscellaneous uses (including urban development) (Supplemental Watershed Work Plan – Añasco River Watershed, USDA, July 1973). The vegetation in the floodplain is primarily sugar cane. Soils in the floodplain are clay loams (Unpublished Soil Borings in Añasco Basin, Lebron, Sanfiorenzo & Fuentes, 1974).

The entire Río Grande de Añasco watershed is in the humid, mountainous physiographic area of Puerto Rico. The Atalaya Mountains extend from the coastline eastward along the north side of the floodplain, merging with dissected plateau remnants at slightly lower elevations, north of the City of Añasco. The Atalaya Mountains have a maximum elevation of approximately 300 meters. The Cordillera Central, which rises out of an elevated dissected highland area south of the Atlaya Mountain range, varies in elevation from 915 meters to almost 1,220 meters.

Upper Río Grande de Arecibo Basin

The topography of the area is diverse, including mountains, foothills, and small valleys. There are volcanic rocks of Cretaceous age in the mountains, volcanic rocks of Tertiary age in the foothills and Quaternary clay and gravel in the valleys.

Río Grande de Jayuya rises on the Cordillera Central and flows in a westerly direction, passing through the Town of Jayuya and emptying into Río de Caonillas above Lago de Caonillas.

A natural rock constriction located approximately 1,768 meters upstream from the bridge on PR Highway 144 extends for a reach of 183 meters. The effect of backwater caused by this constriction extends approximately 152 meters upstream from the constriction.

There are only a few residential and commercial developments located in the floodplain at the present time; however, economic development within the study area is expected to continue, and pressures which will lead to intensified floodplain use will undoubtedly accompany such development.

Río Grande de Manatí Basin

The Río Grande de Manatí Basin is located on the north-central coast of Puerto Rico, in the Municipalities of Corozal, Naranjito, Orocovis, Ciales, Morovis, Manatí, Barceloneta, and Arecibo.

Río Grande de Manatí originates on the northern slopes of the Cordillera Central, on the northwest coast of Puerto Rico. The river flows slightly northwesterly through a belt of limestone hills typified by karst terrain, through a narrow canyon-like valley, and across an alluvial plain before finally emptying into the Atlantic Ocean. The alluvial plain averages approximately 2 kilometers wide and extends from the coastal ridge inland approximately 25 kilometers. A great part of it is used for growing sugar cane.

The primary developed area in the Río Grande de Manatí Basin is the Town of Manatí. The Town of Manatí is located near the northern coast of Puerto Rico approximately 55 kilometers west of San Juan. The town is located on the east ridge of the Río Grande de Manatí Basin and is not in the floodplain. The Town of Barceloneta is located in the Río Grande de Manatí floodplain.

The soils in the Río Grande de Manatí Basin consist of deposits of sand, clay, and gravel in the coastal plain, and limestone overlain by strata of clay slates and sands in the mountain areas.

The Pueblo de Orocovis is located in the center of Puerto Rico, approximately 31 kilometers southwest of Bayamón and 32 kilometers northeast of Ponce. The economy consists predominantly of agricultural pursuits, and some small industries exist as well.

The Río Orocovis, which flows through the center of the town, is a small river that rises on the northern slopes of the Cordillera Central, flows northward through Orocovis, and empties into the Río Grande de Manatí.

Commercial areas and residential structures are located along the Río Orocovis on the steep slopes down to the river channel.

Río de la Plata Basin

The Río de la Plata Basin is located in central Puerto Rico. It is the largest drainage basin in Puerto Rico.

Seven areas of Río de la Plata Basin have had substantial development. These include the communities of Toa Baja, Toa Alta, Comerio, Cayey, Aibonito, Naranjito, and Barranquitas.

Río de la Plata flows northerly from the rugged Cordillera Central and Sierra de Cayey into the Atlantic Ocean near Dorado, west of San Juan. The headwater areas exhibit extremely steep slopes and narrow stream channels.

The terrain of the northern portion of the basin consists of a low alluvial coastal plain. Proceeding south, the terrain rises through an area of karst topography, rolling foothills, and finally climbs to the northern slope of the Cordillera Central and the northern and western slopes of the Sierra de Cayey.

Vegetation is abundant throughout the basin. Alluvial soils cover the valleys, and clays prevail in the hills and mountains.

Río Grande de Loíza Basin

The Río Grande de Loíza Basin is located on the northeastern coast of Puerto Rico in the Municipalities of Aguas Buenas, Carolina, Caguas, Gurabo, Juncos, Las Piedras, Loíza, Río Grande, San Lorenzo, and Trujillo Alto.

Río Grande de Loíza originates in east-central Puerto Rico on the northern slopes of the Sierra De Cayey. The river flows northerly to the Atlantic Ocean. Nearly all of the major upstream tributaries join Río Grande de Loíza near the upstream end of Lago Loíza and in the Caguas area. The primary exception is Río Valenciano, which joins Río Gurabo at Juncos.

The region consists of three major physiographic areas: the nearly level to sloping coastal plain; the haystacks or limestone hills with karst topography; and the extensive igneous upland. The headwater areas consist generally of the Mucaro-Caguabo soils that are deep to shallow, moderately steep to very steep, well drained soils of the humid mountainous areas. The central part of the basin consists chiefly of Mabi soils that are deep, somewhat poorly drained, slowly permeable, clayey soils. The downstream areas generally consist of the Toa-Bajura-Coloso soils that are deep, nearly level, well drained to poorly drained soils on floodplains. In addition, the floodplain areas contain Estacion soils and the deep, well drained, sandy Reilly soils and areas of riverwash (USDA, 1978).

In recent years, the lower Río Grande de Loíza Basin has changed from agricultural use to residential, commercial, and industrial use. The major cities in the basin are Caguas, Carolina, and Trujillo Alto. Smaller cities located in the basin are Gurabo, Juncos, and San Lorenzo.

Vegetative cover in the basin consists chiefly of improved pasture such as pangola-grass, star grass, and merker grass. Most of the pastureland is used for beef and dairy cattle. Farming is important, and the principal cash crops in the basin are plantains, tanniers, yams, and tobacco (USDA, 1978).

Río Anton Ruíz Basin

Río Anton Ruíz Basin is located in southeastern Puerto Rico. The communities primarily affected by floods on Río Anton Ruíz are Punta Santiago, Bajandas, Pasto Viejo, and Anton Ruíz.

The headwaters of Río Anton Ruíz lie between the Sierra de Luquillo and Sierra de Cayey. The topography of the basin varies from a maximum elevation of approximately 280 meters to a minimum elevation of 1.0 meter at the banks of the river. Río Anton Ruíz flows southeasterly to Pasto Viejo, then northeasterly, emptying into the Atlantic Ocean near Punta Santiago. Major tributaries are Quebrada Mambiche, Quebrada Tinajeras, Quebrada Icacos, and Quebrada de las Mulas. The channel slopes of Río Anton Ruíz are very steep, and stream velocities are extremely high in the mountains. The slopes become less steep from the foothills to its mouth.

Quebrada Mambiche flows southerly and then easterly to its confluence with Río Anton Ruíz.

Quebrada de las Mulas flows southeasterly, then southerly to its confluence with Río Anton Ruíz.

The lower portion of the study area contains a broad, flat coastal plain, approximately 4.8 kilometers wide and extending inland 3.2 kilometers from the coast. Approximately 2.56 square kilometers of this coastal plain are occupied by mangrove swamps through which Río Anton Ruíz flows (USDA, 1977).

After this study was completed, drainage pumps located in the sugar cane fields in this lower area were stopped because of litigation. Subsequently, ponding areas have resulted from the rise in the water table and other factors. Since it is unknown whether this ponding will be temporary or permanent, the study was not modified.

Soils in the upland areas of the Río Anton Ruíz Basin are of the Caguabo-Mucara-Naranjito association. They are shallow to moderately deep and well drained. In the floodplain, the soils are of the Coloso-Toa-Bajura association. These are deep and moderately well drained to poorly drained. In the swampy portion of the floodplain, soils are of the Swamps-Marshes association. These are deep, very poorly drained soils (USDA, 1977).

Río Daguao Basin

The Río Daguao Basin is located on the eastern coast of Puerto Rico. Elevations in the basin vary from sea level to a maximum of approximately 200 meters.

Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, and Quebrada Aguas Claras Tributary are streams, whose headwaters lie within a range of foothills of the Sierra de Luquillo. These streams are situated in a wide coastal plain traversed by separate alluvial valleys. The basins are ideally oriented to catch rainfall produced by northeasterly winds that push moist air masses up the slopes of the Sierra de Luquillo. The lower portions of these streams pass through mangrove swamps and flow into the Atlantic Ocean at Sonda de Vieques.

Soils in the upland areas of the Río Daguao Basin are of the Caguabo-Mucara-Naranjito association. These are shallow to moderately deep and well drained. In the marshy coastal floodplain, the soils are of the Swamps-Marshes association. These are deep, very poorly drained soils. In some portions of the floodplain, soils are of the Coloso-Toa-Bagura association. These are deep and moderately well drained to poorly drained (USDA, 1977).

The primary developed areas in the basin are the Municipalities of Ceiba, Aguas Claras, and Daguao. Land uses are principally residential and agricultural. Some manufacturing industries exist in the basin, but the major activity is tied to the Roosevelt Roads Naval Reservation.

Río Humacao Basin

The Río Humacao Basin and the Isla de Vieques are located in southeastern Puerto Rico.

The headwaters of Río Humacao lie between the Sierra de Luquillo and Cayey Mountains, approximately 450 meters above sea level. Río Humacao flows generally northeastward and then southeastward through the deeply weathered plutonic rock of the interior uplands and enters the alluvial floodplain at the Town of Humacao, 6 kilometers upstream from its mouth. Major tributaries are Quebrada Mabu, Quebrada Catano, and Quebrada Mariana. In the mountain areas, the channel slopes of Río Humacao are very steep, and stream velocities are extremely high. The slopes become less steep from the foothills to its mouth. The coastal plain becomes progressively wider downstream from Humacao and is approximately 3.2 kilometers wide at the coast. Quebrada Mabu, a tributary flowing southward to Río Humacao.

Quebrada Mariana is a tributary flowing eastward to Río Humacao.

Soils in the basin are of three types. In the floodplain near the mouth of Río Humacao, the soils are of the Coloso-Toa Bajura association. These soils are deep, moderately well drained to poorly drained, and nearly level. Along coastal strips on both sides of the mouth, the soil association is Catano-Aguadilla, which are deep, excessively drained, and nearly level to gently sloping. Near the town and upstream of Humacao, the association is Caguabo-Mucara-Naranjito; it consists of shallow and moderately deep, well drained, sloping to very steep soils on volcanic uplands (USDA, 1977).

Land use has historically been for growing sugar cane, with some pastureland. In the coastal plain and foothills, changes in land use are beginning to appear; scattered industrial and urban development has occurred. The primary developed area in the Río Humacao Basin is the Municipality de Humacao.

Río Guanajibo Basin

The Río Guanajibo Basin originates in the Cordillera Central of western Puerto Rico. It rises approximately 10 kilometers northeast of Sabana Grande at an elevation of approximately 800 meters. The river flows south into the Town of Sabana Grande and then west to northwest for approximately 30 kilometers into Mayaguez Bay on Mona Passage.

The topography of the area is diverse, including mountains, foothills, and valleys. The Río Guanajibo valley is approximately 27 kilometers long and is fan-shaped, with a width varying from approximately 0.6 kilometer in the area located between the Towns of Sabana Grande and San German, to approximately 5.2 kilometers in the Cabo Rojo and Hormigueros region, and approximately 2.8 kilometers in the valley outlet, near the mouth.

The Río Guanajibo Basin is subdivided into sub-basins for each principal tributary that has its origin in the mountains on the northern boundary of the basin. These tributaries are Río Rosario, Río Duey, Río Cain, Río Cupeyes, Río Cruces, and Río Loco. To the south, the drainage area is limited and comprised of relatively small tributaries. Río Viejo is the largest of these streams.

Urban development is limited primarily to the areas around Sabana Grande, San German, Cabo Rojo, Hormigueros, and the southern portion of the City of Mayaguez. Agriculture is the primary economic activity of the region, with sugar cane grown principally in the lowlands. Large portions of the northern uplands are forested, including parts of the Maricao State Forest. At present, land use in the Guanajibo River Basin can be divided into three main groups: agricultural, 59 percent; forested, 33 percent; and residential, 8 percent.

The head of the Guanajibo Valley lies just east of Sabana Grande. The predominant rocks in this area are serpentinite and volcanic-related. The lowland extends westward along Río Guanajibo and narrows north of San German. In this area, the predominant rocks along the northern border of the valley are volcanic-related. In the south, serpentinite predominates in a strip along the border. A short distance westward from San German the valley again widens to form a triangle, which in its northwest corner once again narrows, finally opening into the Mayaguez Playa. Along the southern and northern borders of the triangle, volcanic-related rocks are predominant. Along the western side of the triangle there are good exposures of weathered volcanic-related rocks and serpentinite. In the lower part of the valley, which opens out into the Mayaguez Playa, the rocks along the southern border of the valley near Punta Guanajibo consist of weathered serpentinite, with some volcanic-related rocks. Siltstone is found along the southern border of the valley in this area.

Lajas Valley

The Lajas Valley study area is located on the southwestern coast of Puerto Rico in the Municipalities of Guanica, Lajas, Yauco, and Sabana Grande.

Agriculture is the most important economic activity in the Lajas Valley. Sugar cane is the principal crop. The Central Guanica Sugar Mill, located approximately 2 kilometers west of the City of Guanica, is the main industry in the valley. Income is also provided from dairy products. Part of the area is irrigated, and it is this portion that is devoted to sugar cane production. The non-irrigated portion supports livestock, including dairy cows. In recent years, some land use has changed from cultivation of sugar cane to fruits and vegetables.

The study area comprises the eastern region of Lajas Valley and the Río Loco Basin. The eastern Lajas Valley is separated from the western Lajas Valley by a line running north-south and parallel to, but west of, PR Highway 116. This defines the western limit of the study area. The primary stream draining the eastern Lajas Valley is Canal Este de Drenaje del Valle de Lajas.

Río Loco is located approximately 32.2 kilometers west of Ponce. The watershed is approximately 3.3 kilometers long and has a fairly uniform width of approximately 0.45 kilometer. The upper half of the watershed is mountainous, with elevations as high as 762 meters. The lower half is mostly floodplain and alluvial lowlands bordered by some steep hills. The river discharges into Bahia de Guanica.

The detailed study covers the lower 13.78 kilometers of Río Loco from its confluence with Bahia de Guanica. The stream slope upstream from the detailed study area averages approximately 60 meters per kilometer and in the study area approximately 4 meters per kilometer.

In the detailed studied area of the Río Loco Basin, soils vary from Teresa clay, tidal flats, and swamp in the coastal areas, to thick alluvial deposits of sand, clay, and gravel in the primary floodplains just upstream, to silty clay loams and clay loams farther upstream in the areas near Presada Loco.

In 1955, the Puerto Rico Water Resources Authority implemented an extensive drainage and irrigation system affecting the Lajas Valley and Río Loco Basin. Much of the water in the eastern Lajas Valley had previously drained to the east into two large lagoons, which were subsequently drained.

Río Yauco Basin

The Río Yauco Basin is located in southwestern Puerto Rico. Río Yauco flows southerly from the rugged southern slopes of Cordillera Central and empties into Bahia de Guayanilla and the Caribbean Sea. The headwater areas of the Río Yauco Basin exhibit extremely steep slopes and narrow stream channels. The largest tributary to the Río Yauco is Río Duey, whose mouth is located approximately 2 kilometers upstream from the detailed study area of Río Yauco.

Río Yauco flows through steep gorges in the mountains upstream from the Pueblo of Yauco, then through the alluvial valley across the coastal plain downstream from the Pueblo of Yauco, before reaching its mouth. The low-lying coastal plain is devoted principally to the production of sugar cane.

The primary developed area within the Río Yauco basin is the Pueblo of Yauco. Yauco is located approximately 26 kilometers west of Ponce. The entire drainage basin of Río Yauco is located within the Municipality de Yauco.

The old part of Pueblo Yauco sits on a hill. More recent development has extended primarily to the west, with a lesser amount of development to the east and south. Commercial and residential development is greatest along old PR Highway 2, to the southwest of Yauco. Much of the newer development is above the floodplain.

Most of the housing in the floodplain is medium to lower income housing. A small amount of commercial and Commonwealth Government development exists on the floodplain, primarily along Quebrada Berrenchin and at its confluence with Río Yauco. A sports stadium and a National Guard Armory are also situated on the floodplain between the old and new PR Highways 2, east of Río Yauco.

The climate of the Río Yauco basin is semiarid. Vegetation varies from dense brush in the upper mountainous part of the basin to desert type vegetation in the lower part of the basin.

Río Guayanilla Basin

The Río Guayanilla Basin is located in the Municipality of Guayanilla, in southwestern Puerto Rico.

The economy of the area centers around agriculture, chiefly sugar cane, and processing the product into raw sugar and miel (molasses). Agricultural use of the floodplain is prevalent outside the Town of Guayanilla. During the 1970s, Puerto Rico experienced rapid industrial development. Guayanilla shared in this development through the establishment of several oil refineries nearby, along with their satellite petrochemical plants. These industries are located outside the drainage basin, approximately 5 kilometers east of the Town of Guayanilla. Residential development has occurred on the floodplain within the Town of Guayanilla.

Two major rivers, Río Guayanilla and Río Macana, flow through the basin.

Río Guayanilla's headwaters are in the Cordillera Central. It flows generally southerly via a winding, well-defined channel, which passes through the Town of

Guayanilla. The stream slope in the upper reach averages approximately 44 meters per kilometer and in the lower reach approximately 3.4 meters per kilometer. Río Macana flows southerly and, at its mouth, flows through Playa de Guayanilla.

The soils in the Río Guayanilla Basin consist of thick, alluvial deposits of sand, clay, and talus in the coastal plain, and limestone overlain by strata of clay slates and sands in the mountain areas. The native vegetation consists of mangrove, tamarind, Jerusalem-thorn, Puerto Rico royal palm, and tropical grasses and plants (Ecological Life Zones of Puerto Rico, USDA, 1973).

Río Tallaboa Basin

The Río Tallaboa Basin is located on the southwestern coast of Puerto Rico, in the Municipality of Penuelas. The Río Tallaboa Basin is a subbasin of the Río Guayanilla Basin.

Heavy industry is located in the lower portion of the basin. The largest industrial plant, Commonwealth Oil Refining Company (CORCO), refines crude oil, which is the raw material for the next largest industry in the basin, Union Carbide Caribe. Union Carbide uses products supplied by CORCO to make ethylene glycol and other chemicals. The industries that are not part of the petrochemical complex are small.

Río Tallaboa, Río Guayanes (Río Tallaboa Basin), and Río Limones headwaters are in the Cordillera Central. Río Tallaboa is approximately 23 kilometers long from its source to its mouth. The stream slope in the upper reach averages 160 meters per kilometer, and in the lower reach 9.5 meters per kilometer. Río Guayanes is approximately 8 kilometers long from its source to its mouth. The stream slope in the upper reach averages 120 meters per kilometer, and in the lower reach 15 meters per kilometer.

The soils in the Río Tallaboa Basin consist of thick, alluvial deposits of sand, clay, and gravel in the coastal plain, and limestone overlain by strata of clay slates and sands in the mountains. Native vegetation consists of mangrove, tamarind, Puerto Rico royal palm, and tropical grasses and plants (USDA, 1973).

Río Matilde Basin

Ponce is the second largest city on the island of Puerto Rico. The original settlement in Ponce was built on a favorable, fertile plain on the relatively arid south coast. This plain is crossed by three main rivers: the Río Bucana, the Río Portugués, and the Río Matilde. The Río Matilde is formed from two major tributaries: the Río Pastillo and the Río Cañas. These streams, which originate in the central range where yearly rainfall is heavy, brought the fertile soil required for rich abundant crops grown by early settlers. The coastal plains of Puerto Rico produce sugar cane, while the slopes on the Cordillera Central near Ponce produce a rich and unique coffee variety. The area around the junction of the Río Pastillo and Río Cañas was originally agricultural because of its rich alluvial soils. The area has now been overcome by the urban sprawl of Ponce. Parts of Ponce are situated on alluvial fans which resulted from thick deposits of sand and gravel being deposited on the floodplains.

Flows in the Río Matilde are intermittent and streamflow in the lower reaches are maintained by industrial wastewater discharges. During heavy rains, the Río Matilde is a contributor to flooding in the metropolitan and suburban areas of Ponce lying in the floodplain. The average slope of the Río Matilde from its juncture with the Río Pastillo and Río Cañas to the Caribbean Sea is 2.5 meters per kilometer.

The Río Pastillo and Río Cañas headwaters are located in the Cordillera Central and flow perennially only in the uplands. Flows leaving the mountains either immediately infiltrate upper portions of the alluvium or are partly diverted for irrigation. In the detail study area, the average slope of the Río Pastillo is about 6.7 meters per kilometer and the Río Cañas is about 6.8 meters per kilometer.

Quebrada del Agua headwaters are located about 7.5 kilometers northwest of the Río Matilde. Flows in Quebrada del Agua are also intermittent and a portion is contained in a closed conduit. In the detail study area, the average slope of the Quebrada del Agua is about 5.2 meters per kilometer.

Most of the existing development in the floodplain is located within the Ponce city limits along the Río Matilde and includes residential, commercial, and industrial areas. The Río Pastillo, Río Cañas, and Quebrada del Agua include residential, commercial, and agricultural areas within the floodplain. The entire study area is undergoing rapid development, both in and out of the floodplain.

<u>Río Jacaguas Basin</u>

The Río Jacaguas Basin is located on the south-central coast of Puerto Rico along the Caribbean Sea.

Río Jacaguas, Río Inabon, and Río Guayo comprise the major drainage systems in Río Jacaguas Basin. Río Inabon shares a common floodplain with Río Jacaguas in the coastal area.

The Río Jacaguas Basin in characterized by three basic types of topography: the steep, high mountains; the foothills; and the coastal plain.

Nearly 20 percent of the study area lies at an elevation of less than 50 meters and slopes gently toward the sea, constituting the coastal floodplain. The remaining 80 percent occupied by river valleys, foothills, and mountains, is characterized by generally steeper slopes (USACE, August 1974).

The land use of the study area is influenced by the soils and the relief and is almost exclusively agricultural. The steep slopes found in the higher elevations (located mostly in the Municipality of Villalba) are planted with coffee, vegetables, bananas, citrus, and other tropical fruit trees. At intermediate elevations, mostly in the Municipality of Juana Díaz, the land is used primarily for cattle and dairy farming; areas are cultivated for forage without irrigation. The irrigated coastal plain is planted primarily with sugar cane; however, a few hundred acres are devoted to growing tomatoes. There is presently no heavy industry in the area. Mining is limited to limestone extraction in a few locations.

In the humid uplands near PR Highway 143, the soils are of the Humatas-Maricao-Los Guineos association. These are well-drained clayey soils located over both weathered and consolidated rock. Closer to the Caribbean Sea, soils in the humid uplands are of the Caguabo-Mucara-Quebrada association, which has very similar characteristics to the previously mentioned association (Soil Survey of Ponce Area of Southern Puerto Rico, USDA, 1979).

The semiarid area consists of a band approximately 9.7 kilometers wide, beginning at the coast. In the portion of this area that is farthest from the coast, the soils are of the Callabo association, which consist of well-drained, loamy soils. The central portion of this band is comprised of soils of the Fraternidad-Paso Seco associations, which are moderately well-drained clayey soils. Finally, in the portion of the band adjacent to the coast, the soils are of the Constancia-Jacaguas-San Anton association. These are nearly level, loamy and clayey soils containing gravel, which have varying drainage characteristics. Limestone bedrock underlies these soils (USDA, 1979).

There are numerous communities located throughout the study area that may be affected by the floods caused by Río Jacaguas and Río Inabon; the Towns of Villalba and Juana Díaz are the two most important urban areas affected.

Río Coamo Basin

The Río Coamo Basin is located in the Santa Isabel-Juana Díaz Coamo area on the south coastal plain of Puerto Rico. The three river basins in the area are Río Coamo, Río Descalabrado, and Río Cañas. The basins lie in the southern slopes of the Cordillera Central.

The main development within the study area is the Pueblo of Santa Isabel, which is located approximately 24 kilometers east of Ponce and 1.5 kilometers north of the Caribbean Sea coastline. Four of its barrios (wards) are included in the study area: Velazquez, Paso Seco, Playita Cortada, and Descalabrado. Their locations from the Pueblo of Santa Isabel are approximately 2.0 kilometers northwest, 4.5 kilometers north, 4.5 kilometers, and 5.7 kilometers northwest, respectively. Three barrios, Pastilla, Capitanejo, and Pastillito, which belong to the Municipality of Juana Díaz, are also within the study area; all three are located approximately 9.5 kilometers northwest of the Pueblo of Santa Isabel.

Housing developments are geared towards low to moderate income families. The rate of commercial and residential growth of the area is almost zero.

Industrial development in the Pueblo of Santa Isabel is low. The main income source is agriculture, with sugar cane the most important crop. The area depends on groundwater withdrawals and surface water diversions to sustain sugar cane.

The terrain of the lower parts of the three basins is primarily alluvial coastal plain.

Río Coamo, Río Descalabrado, and Río Cañas flow southward from the rugged Cordillera Central into the Caribbean Sea, west of Santa Isabel.

Río Majada Basin

The Río Majada Basin is located in south-central Puerto Rico. The major stream in the basin, Río Nigua, empties into the Caribbean Sea at Bahia de Rincon near the community of Salinas. Salinas is located 39 kilometers east of the City of Ponce, and 24 kilometers west of the City of Guayama. The basin is located in the Municipalities of Salinas, Guayama, and Cayey, but lies almost entirely within Salinas.

The lowlands of the Río Majada Basin are almost totally in sugar cane. The uplands are mostly semiarid, devoted to pastures and minor crops.

The two primary tributaries forming Río Nigua are Río Lapa and Río Majada. They both rise on the Cordillera Central and join Río Nigua approximately 8 kilometers upstream from the Town of Salinas. The highest point in the watershed is approximately 860 meters. The detailed study area covers the lower 9.5 kilometers of Río Nigua. The stream slope in the detailed study area is approximately 70 meters per kilometer upstream on Río Lapa, and approximately 45 meters per kilometer upstream of Río Majada.

The soils in the Río Majada Basin consists of shallow soils of the Cordillera Central, shallow soils of the semiarid alluvial plains (usually coarse sands and gravels), and deep alluvial deposits consisting of clay and silt from both upland and marine sources in the coastal areas.

Río Grande de Patillas and Río Guamani Basin

The area referred to as Río Grande de Patillas and Río Guamani Basin actually encompasses several basins that empty into the Caribbean Sea from Bahia de Jobos to Punta Viento in southeastern Puerto Rico. For this countywide FIS, these basins are grouped together under the names of the two major drainage basins in the study area.

Río Grande de Patillas originates at Sierra de Cayey on the southeastern slope of the Cordillera Central, approximately 38 kilometers south of San Juan. It flows southerly to its mouth at the Caribbean Sea at Puerto Patillas.

Quebrada Mamey originates in the foothills of the Cordillera Central and flows parallel to Río Grande de Patillas to its mouth at Río Chico.

Río Nigua flows south from the Cordillera Central through the Town of Arroyo and empties into the Caribbean Sea. Its drainage area lies within the Municipality of Arroyo. The topography of the basin is characterized by a gently sloping plain near the coast and extremely hilly uplands. The land area of the upland portion of the basin is approximately 19.1 square kilometers. The main tributaries of Río Nigua are Quebrada Jacana, Quebrada Palmarejo, and Quebrada Majagual. Quebrada Antigues is a tributary to Quebrada Jacana and originates at Cerro Tombrado at an elevation of 751 meters.

Río Guamani originates on the southern slopes of Sierra de Cayey in the southeastern part of the Cordillera Central and flows in a southern direction into the Caribbean Sea.

Río Melania rises in the foothills of the Cordillera Central and flows southward into a mangrove swamp at Bahia de Jobos.

Río Seco originates in the foothills of the Cordillera Central and flows southward into the Caribbean Sea at Bahia de Jobos.

The headwaters of these streams exhibit extremely steep slopes and narrow channels. They flow from the mountains through rugged topography into the alluvial fans of the lower floodplains before reaching the Caribbean Sea.

The Pueblo of Patillas is located approximately 50 kilometers south of San Juan. It lies in a narrow valley of approximately 3 square kilometers. The valley is surrounded by mountains with high peaks and features rolling hills in the lower part near the coastal plain. The valley topography is gentle.

The Town of Arroyo is located on the coast approximately 52 kilometers south of San Juan and is bordered on the south by the Caribbean Sea. Pitahaya, a barrio of Arroyo, is located approximately 3.5 kilometers north of Arroyo. Arroyo and Pitahaya are located on the eastern edge of the Ponce-Patillas alluvial plain and feature a semiarid climate.

The Town of Guayama is located approximately 52 kilometers south of San Juan in the southern coastal lowlands. Guayama lies in the southeastern Ponce-Patillas alluvial plain, which is probably the most fertile land on the island. The economy, which a few years ago was agricultural, is at present predominantly industrial. A petrochemical complex and light industry are absorbing the labor force in Guayama and the adjacent communities. The land that was mostly planted with sugar cane is now used for pasture and small crops.

The Villages of Jobos and Villodas are located within the Municipality of Guayama. Jobos is located approximately 4.7 kilometers southwest of the Town of Guayama. Villodas lies approximately 2.0 kilometers northwest of Jobos.

These communities share similar climatological conditions and vegetation with Guayama. The economies of these villages are derived mainly from the nearby industrial complex in the Town of Guayama. A few workers harvest sugar cane, cultivate small crops, and raise cattle.

Río Maunabo Basin

The Río Maunabo Basin is located on the southeastern coast of Puerto Rico, in the Municipalities of Maunabo and Patillas.

Agriculture is the most important economic activity in the watershed, and sugar cane is the principal crop. However, manufacturing is rapidly replacing agriculture as the principal economic activity.

The Río Maunabo Basin lies between two mountain ranges, Sierra de Guardarraya and Cuchillas de Panduras. The two ranges come together just above the headwaters of Río Maunabo approximately 12 kilometers from the Caribbean Sea. The highest point in the watershed is Cerro La Torrecilla, 607 meters.

The slope of the streams decreases greatly as they enter the area studied in detail. Río Maunabo has an average slope of 40 meters per kilometer in the upper reach and 4 meters per kilometer in the detailed study area; Quebrada Arenas has average slopes of 150 meters and 7 meters, respectively; and Río Jacaboa has average slopes of 45 meters and 8 meters, respectively.

The soils in the Río Maunabo Basin consist of deposits of sand, clay, and gravel in the coastal plain and limestone overlain by strata of clay slates and sands in the mountain areas.

Vegetation in Río Maunabo Basin is associated with the subtropical moist forest zone in the lower part of the basin and the subtropical wet forest zone in the upper portion of the basin. The subtropical moist forest zone contains remnant vegetation and includes trees of up to 20 meters in height with rounded crowns. Many of the wood species are deciduous. Epiphytes are common, but seldom cover branches and trunks completely. Grasses in both natural and improved pastures form the dominant landscape in the unforested areas. In the subtropical wet zone, the vegetation reflects the abundant rainfall: epiphytic ferns, bromeliads, and orchids are common. The forests are relatively rich in species, and the growth rates of successional trees are rapid.

2.3 Principal Flood Problems

Floods can occur in Puerto Rico any time during the year; however, they are most frequent from May through December. The most severe flooding generally occurs because of hurricanes and tropical storms as they pass through or near the study area. Cloudburst storms can occur any time during the year and, because of the steep slopes of the tributary streams, the excess rainfall is delivered downstream quickly, producing flash floods.

Río Camuy Basin

No data are available concerning historical flooding in the Río Camuy Basin. Inquiries in the area indicated that flooding is not a major problem in most of the watershed. Only a portion of the lower watershed is likely to flood. Rainfall runoff from storms or tropical disturbances contributes to both ground-water and surface-water flooding.

Lower Río Grande de Arecibo Basin

The Town of Arecibo has been subject to floods that have affected the development of the area. Major damaging floods occurred in August 1899 (Hurricane San Ciriaco), September 1928 (Hurricane San Felipe Segundo), September 1932 (San Ciprian Hurricane), October 1954 (Hurricane Hazel), September 1975 (Hurricane Eloise), October 1985 (Tropical Storm Isabel), September 1996 (Hurricane Fran), and September 1998 (Hurricane Georges). Sufficient data are unavailable to define the recurrence intervals of these floods.

Records indicate that Hurricane Georges induced flood discharges in the Río Grande de Arecibo Basin that were the largest on record.

Río Cibuco Basin

The dates of known floods on the Río Cibuco at the downstream side of the PR Highway 2 bridge, for which data are available, are shown in the following tabulation (Floods in the Vega Alta and Vega Baja Area, Puerto Rico, DOI, 1968):

Date	Observed Elevation (Meters)
May 4, 1959	7.40
September 6, 1960	7.26
December 6, 1961	7.52
May 23, 1963	7.34
December 11, 1965	8.00
April 20, 1966	7.83

Río de Bayamón Basin

The dates and discharges of recorded floods on Río de Bayamón at the downstream side of PR Highway 2 bridge (Old Highway 167 bridge), for which data are available, are shown in the following tabulation (DOI, 1962):

Date	Elevation (Meters)	Discharge (cms*)
August 8, 1899	9.20	1,983
August 15, 1914	8.90	1,275
September 13, 1928	8.80	1,133
August 4, 1945	9.30	2,266
August 11, 1956	8.70	1,020
August 27, 1961	8.70	1,020

*Cubic Meters Per Second

Río Piedras Basin

A USGS study notes that little historical information is available concerning floods in the Río Piedras Basin (Hydrologic Investigations Map Series 1, Flooding Along the Río Piedras in the San Juan Area, Puerto Rico, DOI, 1971). According to newspaper articles, flooding occurred on May 23, 1958; November 12, 1961; October 12, 1963; September 16, 1966; June 17, 1970; and October 6, 1970. Of these floods, water elevation data are available only for the latter two. The extent of the June 1970 flood was delineated by the USGS (Hydrologic Investigations Map Series 1, Flooding Along the Río Piedras in the San Juan Area, Puerto Rico, DOI, 1971). The flood resulted from a total rainfall of 25.79 centimeters spread over a 3-day period.

Peak discharge measurements made during June and October 1970 at the bridge on Avenida Jesus Pinero were 282 cms and 221 cms; respectively. According to the USGS, the return periods were 8 years for the June flood and 5 years for the October flood (Hydrologic Investigation Map Series 1, Flooding Along the Río Piedras in the San Juan Area, Puerto Rico DOI, 1971). The June 1970 flood is the largest flood of record. It is noted that no historical flood information was found for Quebrada Juan Mendez.

Hurricanes David and Frederick affected the island of Puerto Rico in the fall of 1979. The USGS indicated that the USACE identified some high watermarks along Canal Puerto Nuevo, but elevations have not been determined. At the time of these two hurricanes, the USGS was obtaining elevations for high watermarks produced by Tropical Storm Eloise in September 1975 in the western and southern parts of the island. There were no high watermarks identified for the Río Piedras Basin or Quebrada Juan Mendez for the 1975 hurricane.

Río Culebrinas Basin

Most floods in the Río Culebrinas Basin are produced by riverine flooding. The coastal plain portion of the basin may also be subject to flooding from hurricane-induced tides. However, hurricane tides on the western coast of Puerto Rico are not as significant as hurricane tides elsewhere on the island. Riverine flooding is more significant than hurricane flooding in these coastal areas.

Flooding in various parts of the basin is a serious problem. Urban developments were affected by floods at the San Sebastián, Aguadilla, and Aguada municipalities.

The greatest known flood occurred in September 1978. Only a few high watermarks could be recovered, and, consequently, the floodplain boundaries could not be defined for that flood. The flood of November 1968 was only approximately 0.1 meter lower than the flood of 1928, and many high watermarks were recovered by the USGS immediately after the flood.

The record of floods on Río Culebrinas is fragmented and not of sufficient length to determine a reliable flood-frequency relationship. It is estimated that the flow of 850 cms occurring in 1968 has a recurrence interval of 5 years (HA-457, Floods in the Aguadilla-Agurada Area, Puerto Rico, DOI, 1972).

Río Espíritu Santo Basin

Adjacent to and west of Río Espíritu Santo lies Río Herrera and the Río Grande de Loíza. Severe flooding has occurred along the north coastal plains located between the Río Grande de Loíza and Río Espíritu Santo. During floods, the overflow of the Río Grande de Loíza (the largest river on Puerto Rico), Río Herrera, and Río Espíritu Santo interconnect, leading to the inundation of a vast coastal zone called the "Carolina-Río Grande Coastal Plain." This zone extends from the present levee system at the divide between Quebrada Plasina and the Río Grande de Loíza to the eastern edge of Río Espíritu Santo Basin. Flood depths throughout the region have been approximately 1 to 2 meters during the most floods of 1960 and 1970.

Río Mameyes Basin

The history of flooding on the streams in the Río Mameyes Basin indicates that flooding may occur during any season of the year. Most major floods in the Río Mameyes Basin are produced by high-intensity rainfall, usually in the upper portion of the watershed and generally in conjunction with tropical disturbances or storms in the mountains. Flood stages in the lower part of this basin occur shortly after an intense rainfall. The lag time, or period from the most intense period of rainfall to the resultant peak discharge downstream is short for the Río Mameyes Basin. Thus, rainfall lasting only a few hours can produce floods.

There have been a number of major floods on Río Mameyes. Four of the worst floods that have occurred since 1966 and that have been recorded at the USGS gaging station (drainage area approximately 31 square kilometers) occurred in January 1969, October 1972, August 1973, and October 1974. The discharges of these events are 629 cms, 635 cms, 680 cms, and 742 cms, respectively, and the recurrence intervals for floods of these magnitudes are 11, 12, 13, and 18 years, respectively ("Guidelines for Determining Flood Flow Frequency," Water Resources Council, 1976; Floods in Puerto Rico, Magnitude and Frequency, DOI and the Commonwealth of Puerto Rico, 1979).

Hurricanes David and Frederick affected the island of Puerto Rico in the fall of 1979. Contacts with the USGS indicated that Río Mameyes is not one of the basins where high watermarks have been obtained. Therefore, the effect of these storms on flooding in the community cannot be ascertained.

In 1985, a tropical depression, which later became Tropical Storm Isabel, dropped a total of 625 millimeters of rain in 24 hours. A hillslope in Barrio Mameyes, saturated by this rainfall, failed and more than 120 people died as an entire hillside covered with homes slid downslope.

Historical peak discharges were exceeded during the rains of Hurricane Hugo in 1998 along Río Mameyes.

Río Fajardo Basin

In the lower reaches of Río Fajardo, floods are attributed to hurricane tide surges, runoff from upper reach rainfall, or a combination of the two. Most floods in the Río Fajardo Basin are produced by high intensity rainfall, usually in the upper reaches of the watershed and generally in conjunction with tropical disturbances or storms in the mountains. Flood stages in the vicinity of the Municipality de Fajardo occur shortly after an intense rainfall. The lag time, or period from the most intense rainfall to the resultant peak discharge downstream is short for the basin. Thus, rainfall lasting only a few hours can produce floods.

The history of flooding in the Río Fajardo Basin indicates that streams may flood in any season of the year. There have been a number of major floods on Río Fajardo. Since 1960, four of the worst floods recorded at the USGS gaging station on Río Fajardo (drainage area 22.8 kilometers) occurred in September 1960, May 1969, October 1974, and September 1975 (Water Resources Data for Puerto Rico, Part I, Surface-Water Records, DOI, 1961 to present). The discharges of these events are 411 cms, 380 cms, 555 cms, and 482 cms, respectively. The return periods for floods of these magnitudes are 6, 5, 15, and 19 years, respectively. These floodwaters have damaged buildings and bridges within the low-lying areas in the Municipality of Fajardo and the Playa de Fajardo developments.

Hurricanes David and Frederick affected the island of Puerto Rico in the fall of 1979. Contacts with the USGS indicated that high watermarks have been identified in the basin. However, elevation determinations were not available.

Historical peak discharges were exceeded during the rains of Hurricane Hugo in 1998 along Río Farjardo.

Río Blanco Basin

The history of flooding within the Río Blanco Basin indicates that flooding may occur during any season. The majority of floods are produced by high-intensity rainfall, usually in the upper reaches of the watershed and generally associated with tropical disturbances or storms in the mountains.

Flooding is a principal problem in the area of Naguabo and Suromar. The worst flood observed in this area occurred in 1899; the second worst in 1928. The worst flood in recent years for which data are available occurred on September 6, 1960. Other significant floods occurred in 1932, 1940, 1956, 1961, 1962, and 1970 (DOI, 1961 to present; HA-584 Floods in the Naguabo Area, Eastern Puerto Rico, DOI, 1978). Except for the September 1960 and October 1970 floods, records of these floods are too fragmentary to determine accurate water-surface profiles and recurrence intervals.

Discharges have been recorded at USGS stream gages on Río Blanco at Florida (drainage area of 28.5 square kilometers) since 1965, and on Río Santiago at Naguabo (drainage area 12.9 square kilometers) since 1968. The recorded discharge for the October 9, 1970, flood on Río Blanco at Florida was 422 cms; on Río Santiago at Naguabo, the recorded discharge was estimated to be 397 cms. The recurrence intervals for these floods were 30 and 70 years, respectively. The recurrence interval for the 1960 flood on Río Blanco was estimated to be 50 years.

Río Yaguez Basin

The largest known flood on Río Yaguez occurred on March 3, 1933. A 24-hour precipitation total of 44.2 centimeters was recorded at Mayaguez by the National Oceanic and Atmospheric Administration (NOAA) on that date. This resulted in a flood with a peak discharge of 708 cms and a recurrence interval of 75 years.

Other large floods (noted with discharges and recurrence intervals, respectively) occurred on August 8, 1899 (unknown); September 13, 1928 (unknown); December 6, 1960 (156 cms, 3.4 years); July 30, 1963 (130 cms, 3 years); and September 17, 1966 (178 cms, 4.5 years).

Río Grande de Añasco Basin

Flood problems in this study area are serious and widespread. Periodic flood damage to sugar cane, pastureland, roads, and a number of residential areas is significant. Floodwaters have inundated the main Río Grande de Añasco floodplain 17 times in a period of 31 years, an average of approximately once every 2 years.

According to the USGS Hydrologic Investigation Atlas for the area, the floodplain of lower Río Grande de Añasco has been inundated extensively at least six times during the period 1899-1975 (HA-375, Floods of the Añasco Area, Puerto Rico, DOI, 1971). The one of greatest known floods occurred in September 1975. Another great flood was that of September 1928. Other major floods occurred in September 1932, September 1952, October 1970, August 1899, and September. The USGS estimated the peak flow for the September 12, 1975, flood to be 3,965 cms. This is based on a preliminary flood map and investigation conducted by the USGS (Río Añasco – Hurricane Eloise Flood Map – 1975, DOI, Unpublished). It is estimated that the recurrence interval for this flow is approximately 100 years, based on a regional analysis that incorporated Río Grande de Añasco gage records (Procedures for Puerto Rico Hydrology, Post, Buckley, Schuh & Jernigan [PBS&J], Inc./Lebron, Sanfiorenzo & Fuentes, 1979). The USGS estimated the peak discharge for the September 1928 flood at El Espino to be 992 cms (HA-375, Floods of the Añasco Area, Puerto Rico, DOI, 1971). The recurrence interval for this discharge is approximately 7 years, based on the regional analysis incorporating the Río Grande de Añasco gage records (PBS&J, et. al, 1979).

Records indicate that in September 1998, Hurricane Georges, induced flood discharges in the Río Grande de Arecibo Basin that were the largest on record.

Upper Río Grande de Arecibo Basin

Río Grande de Jayuya and the two main tributaries within the study area, Río Zamas and Río Caricaboa, are all perennial streams and have well-defined channels.

Information obtained from surrounding areas and from local residents indicate that the Town of Jayuya, which is located in the Upper Río Grande de Arecibo Basin, was severely inundated in 1960, 1970, and 1975 (HA-261, Floods in the Prone Area, Puerto Rico, DOI, 1967).

Río Grande de Manatí Basin

The largest flood of record on Río Grande de Manatí before the publication of the March 16, 1982, FIS for the Río Grande de Manatí Basin occurred on October 9, 1970 (Water Resources Bulletin 12, Floods of October 5-10, 1970 in Puerto Rico, DOI, 1972). This flood had a recurrence interval of 49 years, as estimated by the USGS. The peak discharges for this flood at the USGS gaging stations at Ciales (No. 50-0350) and PR Highway 2 (No. 50-0381) were determined to be 3,541 cms and 3,371 cms, respectively.

Other large floods in the Río Grande de Manatí Basin for which some records exist occurred in September 1932, August 1945, August 1956, May 1959, September 1960, August 1961, December 1965, October 1970, and September 1975 (HA-261, Floods at Barceloneta and Manatí, Puerto Rico, DOI, 1967). The discharge of the 1960 flood at the Ciales gage was determined to be 2,190 cms and for the 1965 flood at PR Highway 2, 1,122 cms (Water Resources Bulletin 12, Floods of October 5-10, 1970 in Puerto Rico, DOI, 1972).

Río Orocovis is a perennial stream with a well-defined channel. No flood record is available for the Río Orocovis, but records are available for the Río Grande de Manatí, the parent stream of Río Orocovis. Floodmarks for the flood of October 9, 1970, were obtained and their locations and elevations were determined along Río Orocovis in the study area. A profile of the floodmarks was used to aid in determining the flood profiles for Río Orocovis in this countywide FIS. The October 9, 1970, flood was determined to have had a recurrence interval of 70 years.

The Río Grande de Manatí Basin experienced flooding during Hurricane Georges in September 1998.

Río de la Plata Basin

There have been seven major floods on Río de la Plata. The dates of these events and their peak discharges in cms, as determined at the USGS gaging station at Toa Alta (No. 50046000), are shown in the following tabulation:

Date	Peak Discharge (cms)
September 13, 1928	3,400
September 6, 1960	2,700
June 16, 1943	2,300
August 22, 1916	2,000
August 27, 1961	1,900
October 14, 1943	1,500

The August 8, 1899, and the September 13, 1928, floods are considered 1- and 2-percent annual chance floods, respectively, at the Toa Alta gaging station.

Río de la Plata is the principal source of flooding in the coastal plains of the basin. During high floods, Río de la Plata spreads over the entire valley, crossing PR Highway 165 and flowing easterly into Cienaga San Pedro. Several communities in the vicinity of Toa Baja are subject to severe flooding. These include Dorado, Campanilla, El Polvorin, and Mameyal.

Río de la Plata is also the principal source of flooding in Toa Alta and Comerio. The river and its tributaries border Cayey to the east and inundate extensive areas of the La Plata Valley, which at present is mainly dedicated to agriculture. The future expansion of the community will undoubtedly use this land. The main source of flooding in the Cayey urban area is Quebrada Santo Domingo and three small tributaries. Río de Aibonito Tributary No. 1 and Río Guadiana are the principal sources of flooding in Aibonito and Naranjito, respectively.

Río Grande de Loíza Basin

The largest known flood to occur on Río Grande de Loíza at the stream gage near PR Highway 189 at Caguas was on August 4, 1945. It had a discharge of 2,410 cms. On the Río Gurabo, at Gurabo, the largest flood occurred on September 6, 1960, with a discharge of 2,110 cms. These floods were previously assigned preliminary recurrence intervals of 70 and 30 years, respectively, for the gaging stations at Caguas and Gurabo (Regulations for the Control of Buildings and Land Development in Floodable Zones, Commonwealth of Puerto Rico, 1971).

However, based on this detailed study, it appears that these floods would have recurrence intervals of approximately 30 to 40 years at Caguas and 80 years at Gurabo.

Other notable floods occurred on Río Grande de Loíza on September 6, 1960; August 4, 1961; August 10, 1965; and October 9, 1970, with discharges of 2,025 cms, 1,370 cms, 990 cms, and 1,780 cms, respectively.

The most recent flood on Río Gurabo occurred on October 9, 1970, with a discharge of 1,810 cms.

The following are brief descriptions of the two most severe floods that have occurred in the Río Grande de Loíza Basin:

> September 6, 1960:
>
> On September 6, 1960, Hurricane Donna passed approximately 85 miles north of Puerto Rico. After passage of the hurricane, a severe thunderstorm developed over eastern Puerto Rico and was accompanied by torrential rains. Record high discharges were recorded on Río Valenciano and Río Turabo, both tributaries to Río Grande de Loíza. For this flood, a peak outflow of 4,760 cms was recorded at Loíza Dam. The USGS measured a peak discharge of 5,580 cms at the PR Highway 3 bridge. The September 1960 flood was the most severe flood experienced on the lower Río Grande de Loíza Basin in recent years.
>
> October 4 through 10, 1970:
>
> A tropical depression passed through the Lesser Antilles south of Puerto Rico and across the eastern Dominican Republic causing extensive flooding over most of Puerto Rico. Amounts of precipitation ranged from approximately 0.13 meter in western Puerto Rico to more than 0.89 meter in the southern and eastern regions of the island. A discharge of 4,160 cms was estimated at Loíza Dam.

<u>Río Anton Ruíz Basin</u>

The flood of September 13, 1928, is the greatest known in the study area since 1889. Other large floods, in order of decreasing magnitude, occurred in September 1960, October 1970, and August 1956. These floods were associated with hurricanes, except for the flood of October 9, 1970. The 1970 flood was caused by a slowly moving tropical depression that stagnated approximately 480 kilometers south of Puerto Rico. The earliest and largest flood for which definitive elevation data are available occurred on September 6, 1960.

Major floods have occurred at least three times since 1960. Río Anton Ruíz Basin shares a common floodplain in the lower reaches with Río Blanco and Río Santiago Basin. Discharge measurements are unavailable along Río Anton Ruíz, but Río Blanco, to the north, was surveyed in the 1970 flood. The USGS reported recurrence interval values at Río Blanco for the 1960 and the 1970 floods as 37 and 25 years, respectively (HA-584, Floods in the Naguabo Area, Eastern Puerto Rico, DOI, 1978). As no data are available, the recurrence intervals at Anton Ruíz could be assumed to be similar to those at Río Blanco for the 1960 and 1970 floods.

Hurricanes David and Frederick affected Puerto Rico in the fall of 1979. Contacts with the USGS indicated that Río Anton Ruíz Basin is not one of the basins where high watermarks have been obtained. At the time of these two hurricanes, the USGS was obtaining elevations for high watermarks produced by Tropical Storm Eloise in 1975 in the western and southern parts of Puerto Rico.

Río Daguao Basin

The history of flooding on the streams within the Río Daguao Basin indicates that flooding can happen during any time of the year. The major floods in the basin are produced by high-intensity rainfall associated with hurricanes. A flood in October 1970 was caused by a slow-moving tropical depression that stagnated approximately 480 kilometers south of Puerto Rico. The lag time, or period from the most intensive rainfall to the resultant peak discharge downstream, is short for this area. Thus, flood-producing rainfall need be only a few hours duration.

Floods that have inundated the study areas since 1899, for which some water-surface elevation data are available, occurred in 1928, 1932, 1940, 1956, 1960, 1961, 1962, 1969, and 1970. Records are too fragmentary to determine accurate water-surface profiles for any of the aforementioned floods, except those of September 6, 1960, and October 9, 1970.

Peak discharge measurements made in the study area during the floods of March 1969, August 1970, and October 1970 are 255 cms, 227 cms, and 74 cms, respectively. These discharges were measured at the USGS gaging station located at Daguao on Río Daguao, which has a drainage area of 5.95 square kilometers at this point. The recurrence intervals for floods of these magnitudes are 100, 70, and 7 years, respectively (DOI, 1961 to present).

Hurricanes David and Frederick affected the Island of Puerto Rico in the fall of 1979. The USGS is identifying high watermarks and determining elevations for these storms and for Tropical Storm Eloise, which struck in 1975.

Río Humacao Basin

The majority of floods in the Río Humacao Basin are produced by high-intensity rainfall. This usually occurs in the upper reaches of the watershed in conjunction with tropical disturbances or storms in the mountains. Flood stages in the vicinity of Humacao occur soon after an intense rainfall because the lag time from the highest intensity rainfall to the resultant peak discharge downstream is short.

There have been a number of major floods on Río Humacao. Three of the worst floods recorded at USGS gaging station No. 50081800 on Río Humacao (drainage area 25.9 square kilometers, recorded from 1960 to 1975) occurred in September 1960, August 1961, and May 1962. The discharges of these events at USGS gaging station No. 50082000 at PR Highway 3 (drainage area 44.8 square kilometers, recorded from 1960 to 1970) are 1,134 cms, 482 cms, and 99 cms, respectively (HA-265, Floods at Humacao, Puerto Rico, DOI, 1967). The estimated return period for the September 1960 flood at gage No. 50082000 is approximately 100 years (PBS&J, et. al, 1979). These major floods have caused damage to buildings and bridges within the low-lying areas in the Town of Humacao.

Río Guanajibo Basin

Although the Río Guanajibo Basin is relatively large (316.2 square kilometers), the available hydrological data are scant. No continuous records of discharges are available for the main stream; instead, only sparse annual measurements are available.

Information on the historic floods of the basin may be found in the USGS Hydrologic Investigation Atlas HA-456 (HA-456, Floods in the Río Guanajibo Valley, Southwestern Puerto Rico, DOI, 1972). One of the greatest floods ever recorded in the basin was caused by Tropical Storm Eloise, which occurred on September 15-17, 1975, and had a recurrence interval of approximately 100 years. Unfortunately, no efforts have been directed toward obtaining sufficient data to do flow-frequency analyses. Of the known floods, the event of August 9, 1899, was the largest, followed by the flood of September 13, 1928. Both floods were associated with the passing of a hurricane over the island. Water-surface elevations recovered from these floods were not sufficient to adequately define the floodplain boundaries (HA-456, Floods in the Río Guanajibo Valley, Southwestern Puerto Rico, DOI, 1972). Other significant floods occurred on the following dates: September 2, 1952; September 5-6, 1954; March 6, 1958; December 3-4, 1960; May 17-18, 1963; July 30, 1963; November 27, 1968; and September 15-17, 1975.

The July 30, 1963, flood was delineated by the USGS (HA-456, Floods in the Río Guanajibo Valley, Southwestern Puerto Rico, DOI, 1972). The discharge at a location approximately 805 meters upstream from Río Cain and 965 meters north of San German was estimated by the USGS at approximately 325.59 cms.

Lajas Valley

Historical records and interviews with residents reveal that the September 16, 1975, flood was the worst in the eastern region of Lajas Valley and Río Loco Basin and was approximately 0.7 meter higher than the flood of September 13, 1928. It was particularly damaging in the area around the City of Guanica, destroying two bridges over Río Loco and extensively damaging sugar cane crops.

The USGS has assigned the 1928 flood a frequency rate of 45 years (HA-532, Floods in Eastern Lajas Valley and the Lower Río Loco Basin, Southwestern Puerto Rico, DOI, 1974).

Other large floods for which some records exist occurred in June 1956, November 1956, December 1960, and August 1963 (HA-532, Floods in Eastern Lajas Valley and the Lower Río Loco Basin, Southwestern Puerto Rico, DOI, 1974). Although a frequency has been assigned to the 1928 flood, records are generally fragmentary and not of sufficient length to establish reliable flood-frequency relationships.

Río Yauco Basin

The earliest flood known on the Río Yauco occurred in 1867 during Hurricane San Narcisco. The greatest known flood to occur in the basin was in August 1899. This flood had an estimated frequency of approximately 100 years. Other major floods have occurred in 1926, 1928, 1960, and 1975.

The Pueblo of Yauco was built on a hill, but has expanded into the floodplains of Río Yauco and Quebrada Berrenchin. The housing developments along the east side of the Río Yauco floodplain are subject to inundation. The development to the west, along the Quebrada Berrenchin floodplain, is subject to inundation. The flood of September 16, 1975, was approximately a 50-year flood, and the flood damage in the Pueblo of Yauco was estimated by the Civil Defense Office at $2,133,000. This flood resulted from Tropical Storm Eloise, which produced more than 0.5 meter of rain over much of the Río Yauco Basin over 3 days.

Río Guayanilla Basin

Flooding in the area located adjacent to the Caribbean Sea could result from either the overflow of the rivers or from the storm tide effect of a hurricane or tropical storm.

The dates of known floods on Río Guayanilla at the upstream side of the PR Highway 127 bridge (km 4.93), for which data are available, are shown in the following tabulation (HA-414, Floods in the Guayanilla-Yauco Area, Puerto Rico, DOI, 1971):

Date	Elevations (meters MSL)	Discharge cms
August 8, 1899	22.0	1,105
September 12, 1928	20.9	652
September 21, 1932	21.3	793
October 13, 1954	20.5	510
May 6, 1958	19.4	181

Date	Elevations (meters MSL)	Discharge cms
September 14, 1961	18.5	79
September 16, 1975	N/A	779

Río Tallaboa Basin

The worst flood of record occurred in September 1975, the result of Tropical Storm Eloise. The storm caused severe flooding in Peñuelas and extensive flood damage throughout Río Tallaboa Basin. The September 1975 flood has an estimated recurrence interval of 20 years (Floods of September 1975 in Tallaboa Valley, Puerto Rico, DOI, 1978).

Río Matilde Basin

The earliest flood in the Ponce area for which records exist occurred in 1852, as reported in the USGS "Hydrologic Investigation Atlas HA-261, 1967" (HA-261, Floods in the Ponce Area, Puerto Rico, DOI, 1967).

The dates of known floods on the Río Matilde, upstream side of old PR Highway 2 bridge, for which data are available are shown in the following tabulation (HA-261, Floods in the Ponce Area, Puerto Rico, DOI, 1967):

Date	Elevations (meters MSL)	Discharge cms
October 13, 1954	6.0	--
May 6, 1958	6.4	--
August 27, 1961	6.0	2,570
August 28, 1963	6.3	2,780

Río Jacaguas Basin

The flood problems in the Río Jacaguas Basin are serious and widespread because of extensive urban development along the valley streams and, to a lesser extent, in the coastal plain. At the Town of Villalba, there is a flooding problem from overflow of Río Jacaguas.

The history of flooding in the area indicates that flooding occurs principally from May through November. The worst flood in recent years for which preliminary data are available occurred in September 1975. Other significant floods have occurred in 1932, 1940, 1956, 1961, 1965, 1969, and 1970 (HA-448, Floods in the Santa Isabel Area, Puerto Rico, DOI, 1971).

Discharge measurements at Río Jacaguas are available for the 1940 and 1970 floods. The flow values recorded at Lago Guyabal (drainage area of 114.5 square kilometers) for these floods were 2,210 cms and 1,527 cms, respectively. The recurrence intervals estimated for these flows are 95 and 28 years, respectively

(PBS&J, et. al., 1979). Discharges measured for the floods of 1956, 1961, 1965, and 1969 were 623 cms, 180 cms, 113 cms, and 283 cms, respectively.

Discharges at Río Inabon were measured for the 1961 and 1970 floods. The values recorded at the USGS gaging station located near Coto Laurel Community (Drainage area of 33.3 square kilometers) were 74.8 cms and 247 cms, respectively. The recurrence intervals for floods of these magnitudes were estimated by the USGS at 2 and 7 years, respectively (HA-448, Floods in the Santa Isabel Area, Puerto Rico, DOI, 1971).

At Río Guayo, discharge amounts are available only for the 1970 flood. The discharge recorded at the USGS gaging station located near Coto Laurel Community (drainage area of 30.2 square kilometers) was 584 cms. The recurrence interval associated with that flood was estimated by the USGS at 55 years (HA-448, Floods in the Santa Isabel Area, Puerto Rico, DOI, 1971).

Río Coamo Basin

The largest flood of record since 1928 occurred in October 1970, followed by the November 1969 flood. Records at the USGS gaging station near Coamo (No. 501065000) indicate that the discharge of the October 1970 flood was 22,000 cms, with a recurrence interval of 15 years. The discharge of the November 1969 flood was 16,300 cms, with a 10-year recurrence interval.

The principal flooding source in the area is the combined floodwaters of Río Coamo, Río Descalabrado, and Río Cañas, which coalesce in the lower floodplain. During high floods, Río Jacaguas flows over PR Highway 149 between Fort Allen and Barrio Capitanejo, merging with Río Cañas flow to cause flooding in the area.

Río Majada Basin

The Río Majada Basin, and the Salinas area in particular, have had some serious flood problems. The entire community of Salinas has been inundated during large floods occurring in September 1928, September 1933, August 1956, October 1970, and September 1975. Additional flooding of a lesser scope also occurred in 1960. The flood of September 1928 was the flood of record. Playa de Salinas at the coast, part of Coco, and other small settlements also suffer flooding problems. Although there have been floods with higher stages than that of October 1970, this storm was particularly damaging because of its duration and volume of runoff. The main highway between Ponce and Guayama was closed for nearly 3 weeks because of high water and washouts. The USGS Hydrologic Investigation Atlas HA-447 covers the October 1970 flood (HA-447, Floods in the Salinas Area, Puerto Rico, DOI, 1971).

Río Grande de Patillas and Río Guamani Basin

The main sources of flooding in the urban area of Patillas are Quebrada Mamey and Río Grande de Patillas, which flow together in high floods. Quebrada Mamey was channelized through part of the town, but overtops the channel in high floods. Major floods have occurred in Río Grande de Patillas in 1899, 1941, 1950, 1958, 1960, 1961, 1970, 1973, and 1975. Discharges before 1944 are unknown.

Stream gages have been located on Río Grande de Patillas: gage No. 50093000 at Lago Patillas, operated intermittently over the period from 1944 to 1961 by the Puerto Rico Water Resources Authority (discharges calculated by the USGS), with a drainage area of 66.3 square kilometers; and gage No. 50092000 upstream of Lago Patillas, operated by the USGS from 1966 to 1979, with a drainage area of 47.4 square kilometers. Peak discharges for these two gages are summarized in the following tabulation (DOI, 1979):

Gage No.	Date	Discharge (cms)
50093000	September 22, 1950	351
50093000	July 21, 1958	773
50093000	September 6, 1960	716
50093000	August 27, 1961	575
50092000	October 7, 1970	317
50092000	October 11, 1973	671
50092000	September 16, 1975	419

The recurrence interval for the August 1961 flood is estimated at 10 years.

The main source of flooding in the Town of Arroyo and Barrio Pitahaya is Río Nigua, which borders Pitahaya on the west side and meanders through the urban area of Arroyo to its mouth on the east side of the town.

Tropical Storm Eloise, in September 1975, caused the flood of record in the Town of Arroyo. Río Grande de Patillas, near Patillas, had a record discharge of 1,457 cms on September 16, 1975. This discharge was determined using the non-recording rainfall stations of Carite Dam and Carite Plant No. 1, based on the recording rainfall station at Yabucoa 1NNE. There was no rainfall recorded in the five days preceding the storm; therefore, the basin was calculated to be AMC Condition I, with a curve number of 49.

The San Juan Star reported that Tropical Storm Eloise completely wiped out the plantain, banana, and sweet potato crops in Patillas, Arroyo, Maunabo, and Guayama.

The second highest known flood since 1928 was the flood of June 1957; the third highest occurred in October 1970. Based on historical evidence, the approximate recurrence intervals for the 1928, 1957, and 1970 floods would be 50, 25, and 12 years, respectively. The peak discharge of the October 1970 flood was 164 cms at Pitahaya. Sufficient data are unavailable to determine the 1957 flood flow.

The main source of flooding in the urban area of Guyama is Río Guamani. According to historical data and records of USGS gaging station No. 50095500, the first and second highest floods occurred in the 43-year period from 1928 to 1970. The highest flood occurred on August 27, 1961, with a discharge of 566 cms, and the second highest occurred on October 6, 1970, with a discharge of 156 cms.

The main source of flooding in Jobos is Río Melania, which is an intermittent stream with a poorly defined channel. The October 1970 flood, which caused shallow inundation of a large part of the community of Jobos, was only slightly higher than the August 1961 flood, as shown in USGS Hydrologic Investigations Atlas HA-446 (HA-446, Floods in Guayama Area, Puerto Rico, DOI, 1971).

Río Seco is an intermittent stream with a deep, well-defined channel upstream of PR Highway 3 and a poorly defined channel downstream of the highway. Major floods occurred in 1928, 1961, and 1970. The historical data available in Hydrologic Investigations Atlas HA-446 show the August 1961 and October 1970 floods as the first and second highest floods since 1928. Based on these data, the recurrence intervals for the 1928, 1961, and 1970 floods would be approximately 50, 25, and 12 years, respectively.

Río Maunabo Basin

Floods on Río Maunabo occurred in August 1935, September 1954, and October 1970. The September 1954 flood was the flood of record. The peak discharge of Río Maunabo at the inland edge of the alluvium during the flood of October 1970 was 7,400 cfs. At a site farther downstream in the valley, a peak discharge of 4,900 cfs was determined, indicating the attenuation of flood flow produced by temporary storage in the lower valley. High watermarks at various locations along Río Maunabo for the August 1935 and October 1970 floods were obtained by the USGS. The approximate inundated area and flood profiles for the 1935 and 1970 floods were published in the 1971 USGS Hydrologic Investigations Atlas HA-445 (HA-445, Floods in Patillas-Maunabo Area, Puerto Rico, DOI, 1971). Information on the recurrence frequency of past floods on Río Maunabo is not available.

The flood of record for Río Jacaboa occurred in October 1970. Information on the flood discharge and recurrence frequency is not available. High watermarks at various locations along Río Jacaboa were obtained by the USGS. The approximate inundated area and a flood profile were published in the 1971 USGS Hydrologic Investigation Atlas HA-445 (HA-445, Floods in Patillas-Maunabo Area, Puerto Rico, DOI, 1971).

2.4 Flood Protection Measures

Development of floodplain areas in Puerto Rico is controlled by Puerto Rico Planning Board Regulation No. 13 and amendments (Commonwealth of Puerto Rico, 1971).

Lower Río Grande de Arecibo Basin

The impoundments of Garzas, Caonillas, and Dos Bocas were constructed for water supply and hydroelectric power generation, and they have no provision for flood storage.

Río de Bayamón Basin

Flood protection projects exist in the study area. Lago Cidra, with 5,000 acre-feet of storage, regulates runoff in the upper basin. The lower reaches of Río de Bayamón have been channelized into two separate channel systems: the Río Bayamón Express Channel and the adjacent Río Hondo Local Channel. The channels are separated by a levee, and are independent systems for conveying flood flows to the Atlantic Ocean. The Bayamón Express Channel is a trapezoidal earth channel having a bottom width of 100 meters for its entire 6.9 kilometer length, and an average depth of 6.1 meters. Future changes in the watershed may produce greater discharges than anticipated, and lack of channel maintenance would reduce the channel's capacity.

Flood runoff from Río Hondo and Quebrada Santa Catalina have been directed into the Río Hondo Local Channel. The local channel is a trapezoidal earth channel having a bottom width of 50 meters and an average depth of approximately 5.5 meters. Río Hondo Local Channel is approximately 5.3 kilometers long and has sufficient capacity to convey and contain the 1-percent annual chance flood under existing hydrologic conditions. A portion of the Río Hondo, between the entrances to the Río Hondo Local Channel and the PR Highway 2 bridge, has been channelized with an underground concrete rectangular channel that will convey flood flows into the Río Hondo Local Channel.

Río Piedras Basin

According to a 1974 USACE study, there are numerous water resource projects in the Río Piedras Basin; however, these projects are all small in scale (USACE, et al., August 1974). Aljibe Las Curias is a 1.7 million cubic meter reservoir of Quebrada Las Curias, a tributary to Río Piedras. This reservoir has been used for water supply. Various channel modifications exist throughout the basin. The study suggested that needed recreational areas could be provided by preserving flood-prone lands along several tracts of undeveloped land.

In 1982, the USACE investigated flooding conditions as well as various possible channel modifications to alleviate flooding (USACE, et al., August 1974).

A small dam is located on an unnamed tributary of Canal Puerto Nuevo. The tributary flows into Canal Puerto Nuevo from the east upstream of PR Highway 1. The dam has no effect on flooding because of its small capacity.

FEMA specifies that all levees must have a minimum of 0.91 meter freeboard against 1-percent annual chance flooding to be considered safe flood protection structures. The levees located in the low-lying areas along Canal Puerto Nuevo do not meet FEMA criteria with respect to freeboard and are, therefore, not considered to provide protection from the 1-percent annual chance flood.

Río Yaguez Basin

In 1968, a flood protection project for the City of Mayaguez was started. The total project consisted of a channel and a reservoir to protect the city from floods. The channel with the existing structures has a capacity of 326 cms. There are plans to rebuild some of these structures, thereby increasing the capacity of the channel; however, only the current capacity of the channel was considered for this countywide FIS.

Río Grande de Añasco Basin

In 1982, there was a proposed flood protection project in the study area, sponsored jointly by the Commonwealth of Puerto Rico Department of Natural Resources, the Commonwealth of Puerto Rico Department of Agriculture, and the Soil Conservation Districts of the southwest area of Puerto Rico. The project was designed by the Soil Conservation Service (SCS) and consisted of four floodwater retarding structures, eight debris basins located in the northwest portion of the basin along PR Highway 402, and 30.14 kilometers of channel works (USDA, July 1973). Of those measures, only one floodwater retarding structure had the funds assigned by 1982 and was expected to be finished. This retarding structure was designed to store the runoff from a 1-percent annual chance frequency event. The upstream drainage area that will be affected by the structure is approximately 1.4 square kilometers; however, since this drainage area is a negligible portion of the entire drainage area of the watershed, the structure will not affect the discharges used in this countywide FIS.

Río Grande de Manatí Basin

In June 1970, a flood control report was prepared by Flavio Acaron & Associates for the Puerto Rico Board and the Department of Public Works (Flood Control Study of Río Grande de Manatí, Manatí & Barceloneta, Puerto Rico, Flavio Acaron & Associates, 1970). The report presented various alternatives for channel improvements and/or levee construction from the mouth to PR Highway 642.

Río de la Plata Basin

There are three dams and reservoirs located on Río de la Plata. Lago Carite is located in the extreme headwater and has a drainage area of 13 square kilometers and a storage capacity of 13.9 cubic hectometers. Water is diverted to Río Guamani on the south slope of Sierra de Cayey for hydropower generation. The dam has a fixed crest spillway and has little or no effect on floods on Río de la Plata.

Two low-head hydropower dams, one near Cayey and the other near Comerio, have small reservoirs and insufficient storage to affect flood peaks.

In Cayey, Quebrada Santo Domingo and three tributaries were channelized by the USACE. The channelization protects the community, except in the vicinity of the lower end of Quebrada Santo Domingo. The continuous expansion of the urban area has encroached on this lower end of Quebrada Santo Domingo.

Río Grande de Loíza Basin

Río Grande de Loíza has been channelized from the Atlantic Ocean to a point just upstream from the confluence of Río Cañovanas, a distance of approximately 6.4 kilometers. The river was channelized for drainage and flood control.

The impoundment at Loíza Dam, located at river kilometer 26.83, was built in 1956 for water supply and hydroelectric generation, not as a flood protection measure. The reducing effect of the reservoir on flood flows through the dam is relatively small. Approximately 1,360 hectare-meters are available for flood storage. This represents approximately 0.03 meter of runoff from the contributing drainage area of 536 square kilometers.

A flood control project on Río Caguitas Tributary 1 at Caguas was completed in late 1972. It consists of a concrete-lined channel with a minimum width of 6.1 meters and extends from the PR Highway 156 bridge upstream for approximately 0.6 kilometer. Limited channel modifications have been made in other areas near newly constructed bridges and in connection with land-use changes. One such modification is located on Río Caguitas between the PR Highways 30 and 1 bridges and extends for approximately 0.6 kilometer.

All of the flood protection measures in the Río Grande de Loíza Basin mentioned above have little effect on the 1- and 0.2-percent annual chance floods.

Río Anton Ruíz Basin

Dikes were constructed along the lower reach of the Río Anton Ruíz to confine flood flows within the mangrove area. There are breaks in the dikes, and, therefore, the structures do not provide protection, as originally intended, from the 1- and 0.2-percent annual chance floods.

Río Humacao Basin

The only protective measure in the study area is the channelization of Río Humacao from PR Highway 3 to the river mouth. This channelization also includes the downstream reaches of Quebrada Cantano and Quebrada Mabu from its mouth to downstream of PR Highway 3. This channel was designed in 1975 by the Puerto Rico Department of Transportation and Public Works to provide protection against a flood with a recurrence interval of approximately 100 years ("Humacao River Channelization, First Construction Stage", Commonwealth of Puerto Rico, 1975). However, silting has reduced the flood-carrying capacity of the channel. The levees on each side of the channel can be overtopped or are lacking adequate freeboard to protect against the 1-percent annual chance flood.

Río Guanajibo Basin

In the early 1980s, the SCS was working to develop flood control structures throughout the Bajura Watershed, another name for the Río Guanajibo Basin. This work is intended mainly to protect agricultural lands, with some degree of protection for urban areas. As of 1983, there were no set dates for the construction of these flood control structures, nor have they been included in the analyses for this countywide FIS.

In the early 1980s, the Flood Control Area of the Department of Natural Resources of the Commonwealth of Puerto Rico was working on a flood protection project for Quebrada Mendoza at Cabo Rojo. The first stage is limited to the portion of river between PR Highways 102 and 103. The hydraulic capacity provided for this project is for the 50-year discharge of Quebrada Mendoza. These flood-control projects and improvements have been considered in the analyses presented in the original report.

FEMA specifies that all levees must have a minimum of 0.9-meter freeboard above the 1- percent annual chance flood flood level to be considered a safe flood protection structure. The Blas Conterras Levee meets all of FEMA's minimum requirements for flood protection. The criteria used to evaluate protection against the 1-percent annual chance flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Levees that do not protect against the 1-percent annual chance flood are not considered in the hydraulic analysis of the 1-percent annual chance floodplain.

Lajas Valley

Upstream of the detailed study area of Río Loco is the Loco Dam, a structure used primarily for water supply. Since the reservoir created by the dam is kept full, it has no significant impact on the flooding in the study area.

Río Guayanilla Basin

Portions of the Río Guayanilla main channel were modified by the Commonwealth of Puerto Rico since the flooding caused by Tropical Storm Eloise in 1975. These improvements have relatively no significance in reducing flooding.

Río Tallaboa Basin

Water development of the Río Tallaboa Basin consists of two hydroelectric plants, irrigation diversions, and wells. The two hydroelectric plants receive water from the Garzas hydroelectric power project, located on the north slope of the Cordillera Central. Because no storage reservoir exists between the two plants, they are operated simultaneously. Several irrigation diversions exist on Río Tallaboa and Río Guayanes. Also, the USGS has records of 112 water wells in lower Río Tallaboa Basin.

Río Matilde Basin

In the 1970s, Congress authorized the Portugués and Bucana multiple-purpose flood control and water supply project. The project consisted of constructing two multiple-purpose reservoirs, channelization of the Río Portugués and the Río Bucana, through the City of Ponce, and diverting the Río Portugués to the Río Bucana. One of the reservoirs is located on the Río Portugués and the other is located on the Cerrillos River, a tributary to the Río Bucana.

This was a joint project of the USACE and the Commonwealth of Puerto Rico. The first phase, which consisted of channelization of the lower reaches of the Río Bucana, was completed in October 1976. The second phase, which consisted of additional channelization of the lower reach of the Río Bucana and a diversion channel between the Río Portugués and the Río Bucana was completed in 1978. The third phase, which consisted of the construction of a high velocity concrete channel and stilling basin upstream of PR Highway 1 on the Río Bucana was completed in 1981.

As of 1999, the USACE had partially completed a flood control project which did mitigate some of the effects of flooding along Río Bucana and Río Portugues.

Río Jacaguas Basin

There are two reservoirs within the Río Jacaguas Basin upstream of the Town of Juana Díaz, which are used for irrigation and water supply. Lago Guyabal, which has a storage capacity of 880 hectare-meters, receives water from the drainage area of Río Jacaguas and Río Toa Vaca, a tributary of Río Jacaguas (HA-448, Floods in the Santa Isabel Area, Puerto Rico, DOI, 1971). Lago Toa Vaca was constructed as part of the major water-supply system for transporting water from the north coast to the south coast of Puerto Rico. It receives water from the drainage area of the Río Tao Vaca and has a storage capacity of 6,277 hectare-meters, much greater than the annual runoff from Río Tao Vaca. The storage capacities of the Guyabal and Toa Vaca Dams are not used for flood control (USACE, August 1974).

Río Grande de Patillas and Río Guamani Basin

There is one dam and reservoir on Río Grande de Patillas. Lago de Patillas is located approximately 1.5 kilometers north of Patillas with a total storage capacity of 15 cubic hectometers. The water is diverted through Canal de Patillas for irrigation. Because of the means of water use, it is not possible to predict to what extent the storage availability of the reservoir would attenuate the effects of a flood. The dam has a fixed crest spillway and has little or no effect on floods of high magnitude such as the 1- and 0.2-percent annual chance floods.

Lago Carite, a reservoir located on the extreme headwaters of Río de la Plata, has a drainage area of approximately 13 square kilometers and a storage capacity of 13.9 cubic hectometers. It diverts water into Río Guamani for hydropower generation. The water diverted into Río Guamani is restricted to the capacity of the tunnels, 1.2 meters wide by 1.8 meters high, and will have a negligible effect on flood peaks. Based on these facts, the drainage area upstream of Lago Carite was not included in the computation for the discharge of Río Guamani.

Levees have been constructed surrounding an oil refinery and satellite plants on the west overbank of Río Guamani. It is anticipated that these levees can provide protection against floods of a magnitude of 500 years.

Lago Melania, a small reservoir in the Río Melania Basin, is located near the inland edge of the coastal plain. It is partially silted and does not have the storage capacity to have more than a negligible effect on floods.

The partial channelization of Quebrada Mamey in the Town of Patillas does not offer any protection against major floods.

This revision reflects an earthen levee, constructed by the USACE, which is approximately 5,200 meters long, around the Town of Barceloneta. In addition, approximately 3,190 meters of Río Grande de Manati channel was relocated and the flow redirected through a newly constructed channel 1,550 meters long. The levee construction was physically completed in August 2007. However, certified plans and other information necessary to certify the levee as giving protection against the 1-percent annual chance flood are not available as of the date of this publication.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in Puerto Rico, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this countywide FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Riverine Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the Commonwealth.

Precountywide Analysis

For Río Camuy, a USGS gaging station on Río Camuy, located approximately 2.1 kilometers upstream of the PR Highway 2 bridge has approximately 10 years of records, but its drainage area is given as "indeterminate" (DOI, 1961 to present). The reason given is that the records are poor because of upstream diversion for water supply. Because of the special characteristics of this basin, including surface/ground-water interaction, the hydrologic calculations were based on the regional analysis method with adjustments based on previous studies (PBS&J, et al, 1979). These adjustments were made in consultation with the USGS in Puerto Rico (Unpublished Data and Results for Camuy Basin, DOI, 1978).

For Río Culebrinas, Río Mameyes, and Río Fajardo, gaging information was taken from discharge records covering 10 years at the Culebrinas gaging station, the Mameyes gaging station (No. 50066000), and the Río Fajardo gaging station (No. 50071000), respectively (DOI, 1961 to present). For Río Blanco and Río Santiago (including Río Santiago Lateral Branch), the discharge-frequency relationships were based on statistical analyses of discharge records covering 9 years at the Río Blanco at Florida gaging station (No. 50075500), and on Río Santiago at Naguabo (No. 50007400), which has 6 years of record (DOI, 1961 to present). For Río Grande de Añasco, analyses were based on records from 1963 to 1976 at the Añasco gaging station (No. 50144000) (DOI, 1961 to present). The analysis for Río Daguao was based on 8 years of records (1965 to 1974, excluding 1966 and 1972) at the Daguao gaging station (No. 50073200) (DOI, 1961 to present). For Río Humacao, the relationships were based on 11 years of records at the Humacao gaging station (No. 50082000) (DOI, 1979). For Río Jacaguas, the analysis was based on 29 years of records (1949 to 1977) at Río Jacaguas gaging station (No. 50111300), which is located outside the detailed study area. Discharge-frequency information for Río Inabon was based on 13 years of discharge records (1964 to 1977) at gaging station No. 501125-00, which is located near PR Highway 511 at Hacienda La Concordia (DOI, 1961 to present).

All of the above gaging stations are operated by the USGS (DOI, 1961 to present). The analyses followed the standard log-Pearson Type III method as outlined by the U.S. Water Resources Council (Water Resources Council, 1976). Because of the short period of record, the statistical analyses were modified by combining the above data with the regional analysis, as presented in the publication entitled Floods in Puerto Rico, Magnitude and Frequency, prepared by the USGS and the Commonwealth of Puerto Rico (DOI, et al, 1979). Floods in Puerto Rico, Magnitude and Frequency is a regional analysis based on statistical computations of discharge records at 37 sites in Puerto Rico, with 10 or more years of record, regressed against basin characteristics.

For Quebrada Juan Mendez, discharge-frequency relationships were also based on the USGS regional analysis; however, they were modified to account for urbanization (DOI et al, 1979). Modifications to the Quebrada Juan Mendez regional analysis were made according to USGS Report No. 77-57, Preliminary Flood-Frequency Relations for Urban Streams, Metropolitan Atlanta, Georgia (Report No. 77-57, Preliminary Flood-Frequency Relations for Urban Streams, Metropolitan Atlanta, Georgia, DOI). This involved applying an "urban adjustment ratio," which is defined in terms of the percentage of impervious area and the percentage of the area served by storm sewers. These data were obtained from aerial photographs developed during the North Metropolitan Area-wide Waste Management Plan (North Metropolitan Area-Wide Waste Management Plan, Commonwealth of Puerto Rico, 1976-1977). These maps, at a scale of 1:10,000, show the urbanized areas served by storm sewers and the "natural" (non-urbanized) areas.

For Río Anton Ruíz, Quebrada Mambiche, and Quebrada de las Mulas, discharges were also determined using the regional analysis as presented in the publication entitled Floods in Puerto Rico, Magnitude and Frequency (DOI, et al, 1979).

For Río Camuy, Río Culebrinas, Río Mameyes, Río Fajardo, Río Blanco, Río Santiago, Río Santiago Lateral Branch, Río Grande de Añasco, Río Anton Ruíz, Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, Quebrada Aguas Claras Tributary, Quebrada Mabu, and Quebrada Mariana, the regional analysis is based on statistical computations of discharge records at 37 sites in Puerto Rico, with 10 or more years of record, regressed against basin characteristics. Drainage area and mean annual rainfall proved to be the only independent variables at the 95 percent confidence level. The 0.2-percent annual chance discharge values were extrapolated from the lower frequency floods.

For the Río Culebrinas, it was determined that during large floods significant flooding occurs along Caño Madre Vieja, a small stream located in the coastal floodplain of the Río Culebrinas Basin. Caño Madre Vieja is a small ill-defined stream, whose channel is mostly dry during dry weather. Its length is approximately 2.1 kilometers. Even though Caño Madre Vieja was not defined as an area of detailed study in the study contract, some detailed information about flooding along this stream is provided in this report.

The floodplain located between PR Highway 2 and the mouth of Río Culebrinas is subject to significant flow storage effects; therefore, its hydraulic analysis was conducted using an unsteady-state, two-dimensional model ("Real-Time Flow in Unstratified Shallow Water," Journal of the Waterways, Port, Coastal and Ocean Division-ASCE, J.D. Wang, 1978). The two-dimensional model allocated the flows between two floodplains: the main branch of Río Culebrinas and Caño Madre Vieja. At PR Highway 2, flow hydrographs were developed using Snyder's method for the 10-, 2-, 1-, and 0.2-percent annual chance floods (Flood-Hydrograph Analyses and Computations, USACE, 1959). These hydrographs were used to input data for the two-dimensional model.

For other locations on Río Humacao, discharges for the various frequencies were computed by transferring the values computed at the gaging station. The transfer formula accounts for drainage area and mean annual precipitation above the various locations.

Peak discharges for Canal Puerto Nuevo, Río Piedras, Quebrada Margarita, Quebrada Dona Ana, Quebrada Josefina, Quebrada Guaracanal, and Quebrada Cepero were determined by the USACE. The USACE used three models to obtain independent estimates of discharges: the USACE HEC-1 Flood Hydrograph Package; the SCS Technical Release No. 20; and the Massachusetts Institute of Technology Catchment Model (HEC-1 Flood Hydrograph Package, USACE, 1990; Technical Release No. 20, Computer Program, Project Formulation, Hydrology, USDA, 1965; User Manual for the MIT Transient Water-Quality Network Model Including Nitrogen-Cycle Dynamics for Rivers and Estuaries, Massachusetts Institute of Technology [MIT], 1976). The SCS Technical Release No. 20 results best matched historical data and were, therefore, used in this study. For the tributaries of Río Piedras, the available Technical Release No. 20 discharges were used to estimate discharges at additional locations along the streams. The drainage areas of these locations were determined by PBS&J, Inc., and the discharges were computed based on a nonlinear function of the ratios of drainage areas.

Discharge-frequency curves for key locations in the Lower Río Grande de Arecibo Basin and the Río Espíritu Santo Basin were derived using digital computer simulation models. The simulation models represent a specific hydrologic process from rainfall through runoff. These models allow for a wide range of rainfall conditions and permit a thorough analysis of the stream and floodplain behavior under various conditions.

The process by which rainfall is generated involves the analysis of observed storm events to determine the statistical properties of monthly storm events with respect to the following considerations: time between storm events, storm depth and duration for each event, and distribution of rainfall within each event. Using this analysis, future storm events can be generated. This approach is based on the assumption that this historical record is only one sample function from the infinite array of possible sequences that could have occurred during that period. The synthetic sequences allow a broader range of possible future storm events and produce more reliable estimates of rare events. Generated events were assumed to be spatially distributed over the Río Espíritu Santo Basin in accordance with the mean annual distribution of rainfall. Details of the procedure used in the Río Espíritu Santo Basin are described in a report by Resource Analysis, Inc., prepared for Flavio Acaron and Associates (Resource Analysis, Inc. Río Espíritu Santo Hydrologic Section, 1975).

The location and length of record of stream gages in the Río Espíritu Santo Basin are shown in the following tabulation.

Location	Drainage Area (sq. km.)	Length of Record
Río Espíritu Santo near El Verde (Station No. 0633)	5.78	March 1967 - present
Río Espíritu Santo near Río Grande (Station No. 0638)	22.33	August 1966 -present
Río Grande near El Verde (Station No. 0642)	18.93	May 1967 - December 1970 January 1972 - present

For the Río Grande de Arecibo Basin, due to the lack of adequate gaging records, the standard log-Pearson Type III method was not applicable. Therefore, the Lower Río Grande de Arecibo Basin was subdivided into 16 subbasins; synthetic unit hydrographs were developed for each subbasin. The various flood frequency hydrographs were generated for each subbasin by supplying frequencies of rainfall from U.S. Weather Bureau Technical Paper 42 (DOC, 1961). These rainfall data were updated by the USACE, Jacksonville District, for the Lower Río Grande de Arecibo Basin. The various flood frequency hydrographs in the Lower Río Grande de Arecibo Basin were then routed to and through Dos Bocas Reservoir and included the Río Grande de Arecibo and Caño Tiburones.

Stream gage records in the Río Cibuco and Río de Bayamón Basins were unavailable. A review of rainfall data and analysis of gage records in adjacent and surrounding basins was, therefore, incorporated. The Río Cibuco Basin was divided into five contributing subbasins: Río Cibuco, Río Indio, Quebrada Honda, Río de Los Negros, and Río Morovis. The Río de Bayamón Basin was subdivided into 4 subbasins: Río de Bayamón, Río Hondo, Quebrada Santa Catalina, and Río Guaynabo. The 10-, 2-, and 1-percent annual chance recurrence interval inflows to the floodplain were developed using rainfall-frequency relationships and unit hydrographs. The rainfall frequency-duration relationships were derived from Technical Paper 42 (DOC, 1961). The computations for unit hydrograph development were carried out using the USACE HEC-1 computer program (USACE, Hydrologic Engineering Center, 1990). The 0.2-percent annual chance discharge was determined by extrapolating the frequency curve of a plot of the 10-, 4-, 2-, and 1-percent annual chance flows.

No gages are located along Río Guayo, which is located in the Río Jacaguas Basin; hydrologic analyses were based on discharges obtained from the Regional Analysis Equation in the report entitled Procedures for Puerto Rico Hydrology (PBS&J, et al, 1979).

The Canal de Juana Díaz area was divided into subareas, in which runoff flows essentially perpendicular to the canal. For each subarea, the 1-percent annual chance flow was computed using the Regional Analysis method.

The USACE HEC-1 computer program was used to determine rainfall runoff for the Caño de Martin Pena watershed (USACE, 1990). Hydrographs were computed using the SCS dimensionless unit hydrograph method. Soil type and land use produced an average runoff curve number of 85 for wet antecedent conditions. Time of concentration was determined using a lag equation. Procedures in SCS Technical Release No. 55 were used to correct lag time for urban conditions (Urban Hydrology for Small Watersheds, USDA, 1975).

To analyze the discharges for the Río Guayabo, the Río Culebra, Caño Guayabo, and Unnamed Stream, the drainage area of the Río Guayabo Basin was divided into subbasins. The 10-, 2-, 1-, and 0.2-percent annual chance discharges were calculated for each subbasin using the HEC-1 Flood Hydrograph computer program (USACE, 1990). Calculated discharges compared closely to regional analysis equations discharges and those from prior studies.

For Río Yaguez at Mayaguez, Río Orocovis, Río Yauco, Quebrada Berrenchin, and Quebrada Berrenchin Tributary No. 1, a regional flood-frequency report prepared by the USGS in 1977 was used to determine discharges for the 10-, 2-, and 1-percent annual chance (Open-File Report, Regional Flood Frequency for Puerto Rico, DOI, 1977). The regional flood-frequency report was based on log-Pearson Type III analyses of individual station records (Water Resources Data for Puerto Rico, Part I, Water Surface Records, DOI, 1960 to present). Regionalization was developed using multiple regression techniques. The discharge for the 0.2-percent annual chance flood was determined by extrapolation of a log-probability graph of the discharges computed for the 10-, 2-, and 1-percent annual chance floods (Techniques of Water Resources Investigations of the United States Geological Survey: Measurement of Peak Discharge by the Slope-Area Method, DOI).

For the Río Yauco Basin and Upper Río Grande de Arecibo Basin, a regional flood-frequency report by Lopez and Fields, published by the USGS in cooperation with the Commonwealth of Puerto Rico, was used to determine flood frequencies of up to 50 years (A Proposed Streamflow-Data Program for Puerto Rico, DOI, 1970).

The regional flood-frequency report by Lopez and Fields was based on log-Pearson Type III analysis of individual station records, and the regionalization was developed using multiple regression techniques ("A Uniform Techniquie for Determining Flood Flow Frequency," Water Resources Council, 1967). Discharges for the 1- and 0.2-percent annual chance floods of all streams in these basins were determined by extrapolation of a log-probability graph of flood discharges computed for frequencies of up to 50 years. The equations to compute the discharges used in this frequency graph are:

$$Q_{10} = 2230\ DA^{0.60}$$
$$Q_{50} = 3230\ DA^{0.71}$$

To define frequency-discharge data for Río Yauco, an indirect measurement of the peak discharge was made for the flood of September 16, 1975, just upstream from the detailed study reach. Also, the peak discharge was determined and furnished for flow over the fixed crest spillway at Antonio Luchetti Dam by the Puerto Rico Water Resources and Aqueduct and Sewer Authorities. The peak discharge of the September 16, 1975, flood, based on the regional flood-frequency analyses, had a recurrence interval of 52 years at Antonio Luchetti Dam and 48 years at the upper end of the detailed study reach on Río Yauco.

For Río Grande de Manatí, Río Tallaboa, Río Guayanes (Río Tallaboa Basin), Río Maunabo, Quebrada Arenas, Río Jacaboa and Río Loco, as adequate stream gage records in the study area were unavailable, the 10-, 2-, and 1-percent annual chance recurrence interval inflows to the floodplain were developed using a rainfall-frequency relationship and unit hydrographs. The rainfall frequency-duration relationships were obtained from Technical Paper 42 (DOC, 1961). The computations for unit hydrograph and flood hydrograph development were carried out using the USACE computer program HEC-1 (USACE, 1990). The 0.2-percent annual chance discharge was determined by extrapolating the frequency curve plot of the 10-, 4-, 2-, and 1-percent annual chance flows.

An unpublished USGS regional flood-frequency report was used to determine flood frequencies up to the 1-percent annual chance recurrence interval for Río de la Plata Tributary No. 1, Río Guavate, Quebrada Santo Domingo, Río de Aibonito Tributary No. 1, and Río Guadiana (Regional Flood Frequency for Puerto Rico, DOI, Unpublished). The report was based on a log-Pearson Type

III analysis of individual station records; regionalization was developed using multiple regression techniques (Water Resources Council, 1976). Discharges for the 0.2-percent annual chance flood was determined by extrapolation of a log-probability graph of the flood discharges computed for frequencies up to 1-percent annual chance recurrence interval.

A published USGS regional flood-frequency report was used to determine flood frequencies up to the 1-percent annual chance recurrence interval for the Río Coamo (at Paso Seco) and the Río Descalabrado (DOI, et al, 1979). The report was based on log-Pearson Type III analyses of individual station records; regionalization was developed using multiple-regression techniques (Water Resources Council, 1976). Comparisons with actual peak discharge records for Río Coamo (at Paso Seco) and Río Descalabrado indicate the flood-frequency discharges are reasonable. The discharge for the 0.2-percent annual chance flood was determined by extrapolation of a log-probability graph of the flood discharges computed for frequencies up to the 1-percent annual chance recurrence interval.

For the Río Guayanilla Basin, rainfall estimates for the 2- and 1-percent annual chance recurrence intervals were obtained from Technical Paper 42 (DOC, 1961). Values for the 10-percent annual chance recurrence interval were obtained by an update of Technical Paper 42 values, using a statistical analysis of rain gage data, since Technical Paper 42 was published in 1961. This resulted in slightly lower values than those in Technical Paper 42. Results of the rainfall analysis are summarized in Table 3, "Summary of Rainfall."

TABLE 3 - SUMMARY OF RAINFALL

FLOODING SOURCE AND LOCATION	DURATION (Hours)	RAINFALL (millimeters)		
		10-PERCENT	2-PERCENT	1-PERCENT
RÍO GUAYANILLA				
At PR Highway 127				
(KM 4.93)	1	79	124	140
	2	94	165	190
	3	109	190	211
	6	142	236	274
	12	178	299	343
RÍO MACANA				
At PR Highway 2	1	79	114	127
	2	94	152	178
	3	109	178	201
	6	142	231	254
	12	178	279	307
	24	203	330	355

The amount of rainfall that will runoff (rainfall excess) from a particular basin is less than the rainfall absorbed due to soil permeability, vegetation cover, and other characteristics. To estimate the rainfall excess, the USACE has developed loss rates for similar basins in Puerto Rico (Basic Hydrology, Design Memorandum No. 1 Portuguése and Bucana Rivers, Puerto Rico USACE, 1972). Rainfall losses used for this countywide FIS are summarized in the following tabulation:

Percent Annual Chance Recurrence Interval	Initial Loss (Millimeters)	Infiltration Rate (Millimeters per hour)
10	36	5
2	25	3
1	13	2

The hydrology for the Río Guayanilla Basin was calculated using Snyder's unit-hydrograph method (Flood Prediction Techniques, USACE, 1957). Snyder's method relates basin characteristics to flood flows and allows the calculation of volumes and peak rates of storm runoff at a desired location for storms of any recurrence interval. USACE computer program HEC-1 was used to apply rainfall of storms having recurrence intervals of 10-, 2-, and 1-percent annual chance to the unit hydrographs after subtracting rainfall losses (USACE, 1990). Graphical extrapolation was then used to determine the characteristics of the 0.2-percent annual chance flood.

A hydrologic analysis can be made based on flood flow records for a given locality or by developing the flood flow hydrographs by synthetic methods. Records of floods are rarely obtained for high-frequency events, especially for a predetermined recurrence interval, and their frequency rating will vary as physical development (such as urbanization or other changes in land use) transforms the hydrologic response of a watershed.

Rainfall is the driving mechanism of hydrologic cycle and causes the hydrologic response of a particular watershed. Hydrologic response to a given storm is highly dependent upon antecedent soil moisture conditions, storm frequency, duration and depth.

Information on storm frequency, duration, and depth has been compiled for Puerto Rico by NOAA. The results appear in U.S. Weather Bureau Technical Paper 42 (DOC, 1961). This report presents rainfall data for durations up to 24 hours for return periods from 1 to 100 years, and was the source for the rainfall depth-frequency data used in this study.

A number of methods are currently being used for computing peak discharge rates and synthetic hydrographs of flood runoff. They range from the simplistic Rational Method to various complex and sophisticated overland flow models. For Quebrada Mendoza, Quebrada Las Tunas, Concepción Channel, and Quebrada Pileta, the SCS method as described in the National Engineering Handbook was used (National Engineering Handbook, USDA, 1964). This method models the hydrologic response of the basin to varying land use conditions and various frequency-duration storms.

The USACE HEC-1 hydrograph package was used to compute discharges for the Río Guanajibo (USACE, 1990).

For Río Grande de Loíza, Río Cañovanas, Río Cañovanillas, Río Gurabo, Río Valenciano, Río Bairoa, Quebrada Muertos, Río Caguitas, Río Caguitas Tributary 1, Río Caguitas Tributary 2, Río Turabo, and Río Herrera, because adequate stream gage records in the study area were not available, this study incorporated a review of rainfall data and analysis of gage records in adjacent basins (Water Resources Data for Puerto Rico, Part I, Surface-Water Records, DOI, 1967 to present). The following gages were considered in the hydrologic analysis:

Gage Number	Flooding Source and Location	Record
50055000	On Río Grande de Loíza, at bridge on PR Highway 189, 1.9 kilometers downstream from Río Turabo	February 1959 - present
50057000	On Río Gurabo, on left bank at bridge on PR Highway 181	January 1959 - present

Gage Number	Flooding Source and Location	Record
50062500	On Río Herrera, on right bank at bridge on PR Highway 958	March 1967 - present
50061800	On Río Cañovanas, at bridge on paved secondary road, 0.64 kilometer northeast of junction of PR Highways 185 and 186	March 1967 - present
50061300	On Río Cañovanillas, on left bank, 1.13 kilometers downstream from Quebrada Limones and 3.38 kilometers southwest of Loíza	January 1967 - present

The 10-, 2-, and 1-percent annual chance recurrence interval inflows to the floodplain were developed using a rainfall-frequency relationship and unit hydrographs. The rainfall frequency-duration relationships were derived from U.S. Weather Bureau Technical Paper 42 (DOC, 1961). The computations for unit hydrograph development were carried out using the HEC-1 computer program (USACE, 1990). The 0.2-percent annual chance discharge was determined by extrapolating the frequency curve of a plot of the 10-, 4-, 2-, and 1-percent annual chance flows.

A USGS regional flood frequency report was used to determine flood frequencies up to 100 years for Río Grande de Patillas, Quebrada Mamey, Río Melania, and Río Seco (DOI, et al, 1979). The regional flood-frequency report was based on a log-Pearson Type III analyses of individual station records (Water Resources Council, 1976). Regionalization was developed using multiple-regression techniques. Discharges for 0.2-percent annual chance floods were determined by extrapolation of a log-probability graph of the flood discharges computed for frequencies up to the 1-percent annual chance recurrence interval.

The Río Grande de Patillas watershed, near Patillas, was modeled to determine the curve number for Río Nigua, because of a lack of streamflow data for Río Nigua (at Arroyo). It was assumed that the characteristics of the Río Nigua watershed are similar to those of the Río Grande de Patillas watershed. The precipitation data for the 10-, 2-, and 1-percent annual chance storms were calculated using Weather Bureau Technical Paper No. 40 (Rainfall Frequency Atlas of the United States, DOC, 1963). Hourly rainfall increments were obtained from Weather Bureau Technical Paper 42 and were arranged in the order that produced the most conservative estimate of runoff (DOC, 1961). The hourly increments for a 24-hour probable maximum precipitation of 40 inches produced the most critical runoff. The runoff for the watershed was computed using SCS curve numbers. The determination of the antecedent moisture conditions was computed using the 5-day total antecedent rainfall. It was assumed that the 1-percent annual chance storm would occur under wet conditions, the 2-percent annual chance storm under normal conditions, and the 10- and 20-percent annual chance recurrence interval storms under dry conditions.

June 2, 1999, Revision

For the 1999 revision, stream gage records for the Río Matilde, Río Cañas, Río Pastillo, and Quebrada del Agua in the study area were not available. The study incorporated a review of rainfall data and analysis of gage records in adjacent and surrounding basins. The detail study area was divided into four (4) contributing subbasins—the Río Matilde, Quebrada del Agua, Río Pastillo, and Río Cañas. The 10-, 2-, and 1-percent annual chance recurrence interval inflows to the floodplain were developed using a rainfall-frequency relationship and unit hydrographs. The rainfall frequency-duration relationships were derived from Technical Paper 42 (DOC, 1961). The computations for unit hydrograph development were carried out using the computer program HEC-1 (USACE, 1990). The 0.2-percent annual chance discharge was determined by extrapolating the frequency curve of a plot of the 10-, 4-, 2-, and 1-percent annual chance flows.

The drainage area-peak discharge relationships for the Río Espíritu Santo, Río Grande, Río Grande de Jayuya, Río Zamas, and Río Caricaboa are shown in Figure 1, "Frequency-Discharge Drainage Area Curves."

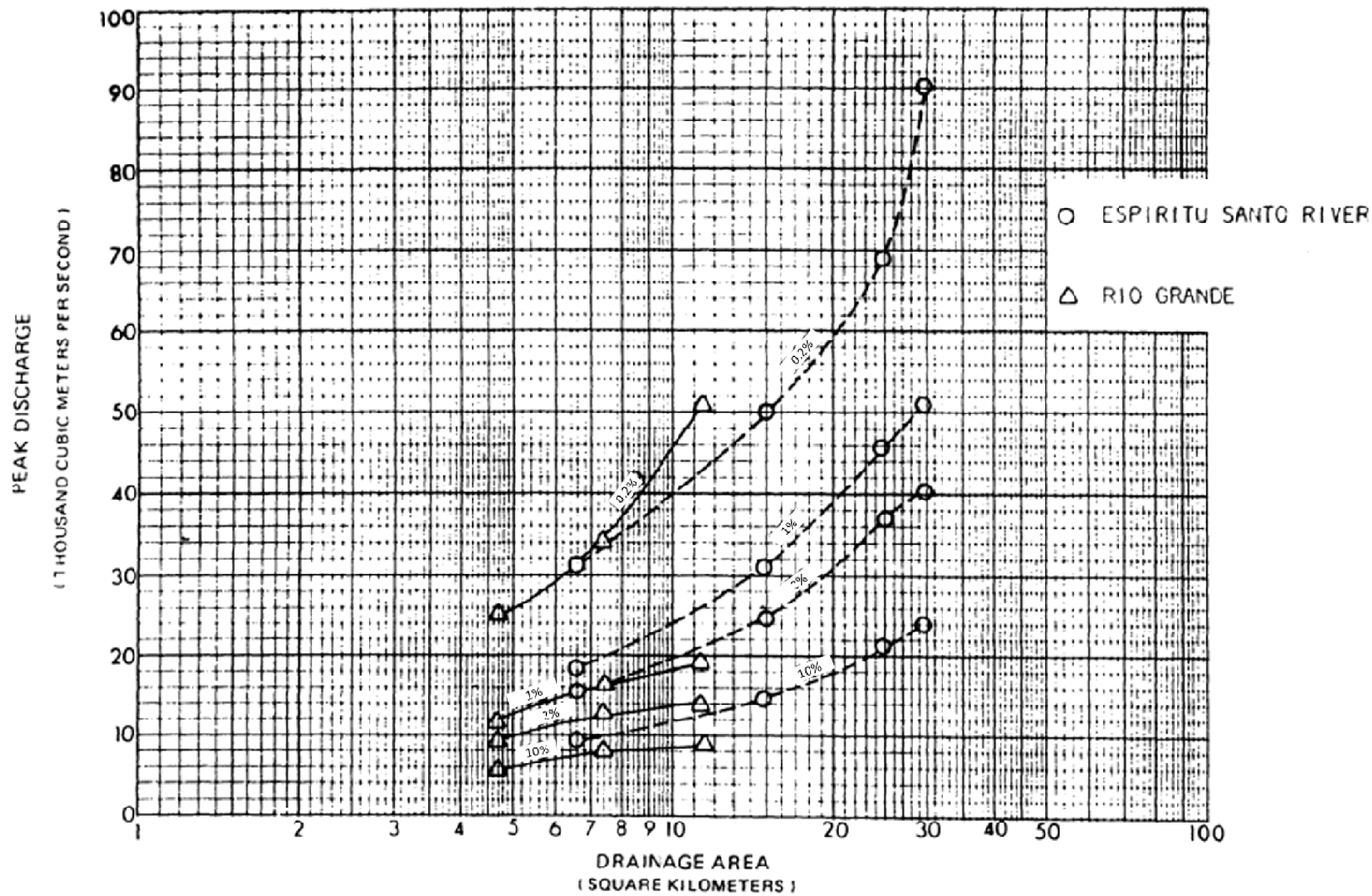


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ESPIRITU SANTO RIVER, RIO GRANDE

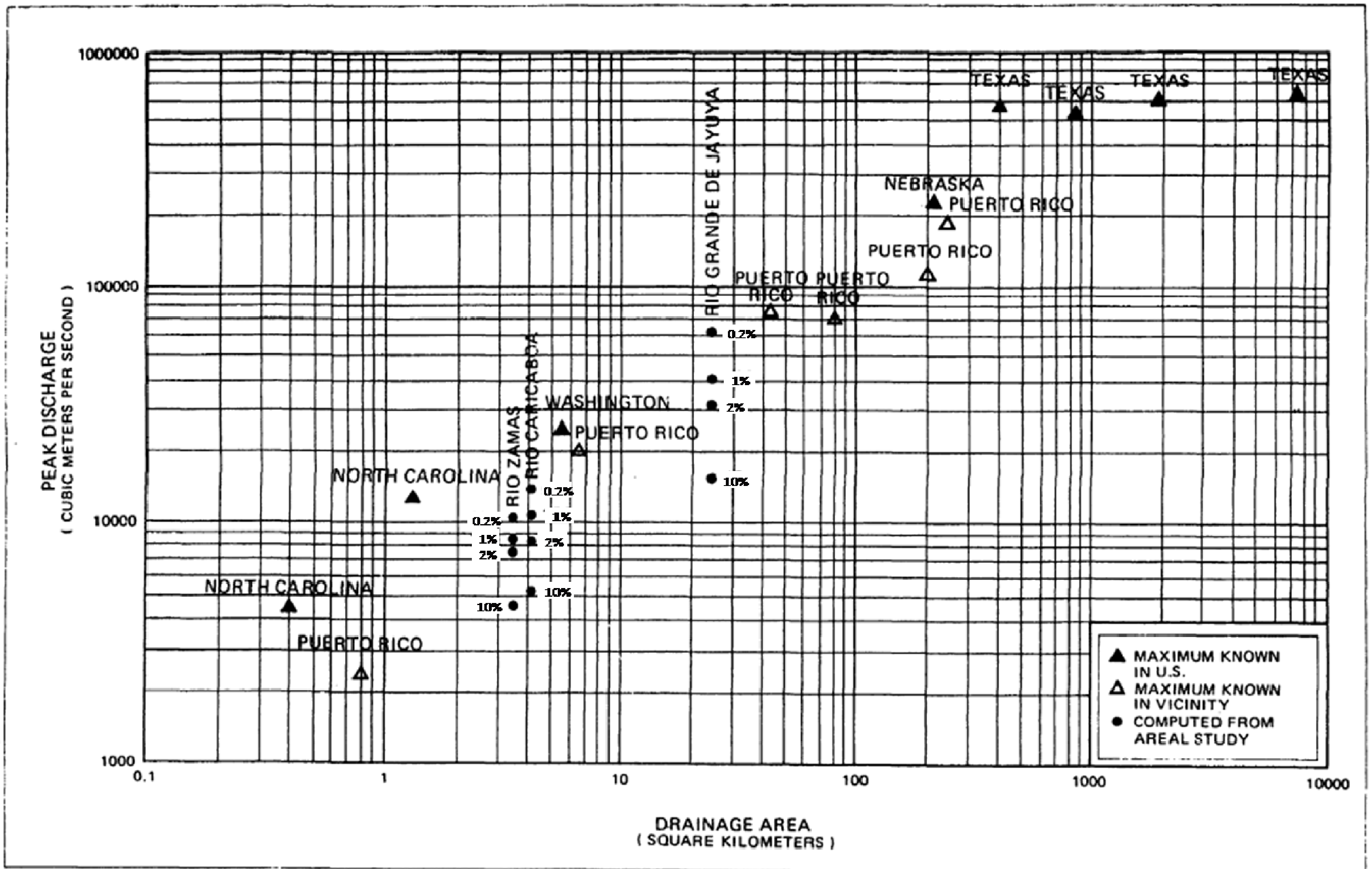


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

RIO GRANDE DE JAYUYA, RIO ZAMAS, RIO CARICABOA

April 19, 2005, Revision

For the 2005 revision, the 10-, 2-, and 1-percent annual chance recurrence interval inflows to the floodplains for Río de Bayamón, Río Goamo (at Velazsquez), Río Guamani, Río de la Plata, and Río Nigua were developed using rainfall-runoff frequency relationship and unit hydrographs as adequate stream gage records were unavailable in this study area. The rainfall frequency-duration relationships were obtained from Technical Paper 42 (DOC, 1961). The computations for unit hydrograph and flood hydrograph development were carried out using the USACE computer program HEC-1 (USACE, 1990). The 0.2-percent annual chance discharge was determined by extrapolating the frequency curve plot of the 10-, 4-, 2-, and 1-percent annual chance recurrence interval flows.

This Revision

For this revision, flow locations were selected at various points along the studied stream reaches and were determined based upon prior FEMA studies and to ensure a uniform drainage analysis was achieved within the select basin. All discharges for the studied reaches were determined in accordance with the procedures outlined in Estimation of Magnitude and Frequency of Floods for Stream in Puerto Rico: New Empirical Models (USGS). The drainage area for the flow locations was delineated based upon USGS 7 ½ minute quadrangle maps. In addition, the calculated Mean Annual Rainfall (MAR) was compared against the previous 1994 USGS study for gage locations and the newly calculated MAR was determined to be more representative of the drainage areas. Where available, historical annual peak rainfall for USGS gage locations were obtained from the USGS. A PEAKFQ analysis was calculated for each gage location in accordance with Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines. A regression analysis was performed for each flow location to calculate the discharge at each flow location. In instances where differences resulted when comparing the regression equation against the gage locations, a weighted correction was applied using the Water-Resources Investigations Report 95-4224- Magnitude and Frequency of Floods in Arkansas.

A detailed hydrologic analysis of streams is as follows:

- Quebrada Honda – Tributary to Río Cibuco
- Río Culebrinas
    - Río Guatemala – Tributary to Río Culebrinas
    - Río Culebrinas (at San Sebastian) Tributary
- Río Fajardo
- Río Sabana
- Río Grande de Añasco
- Río Grande de Manati
- Río Grande de Loíza Reach 1
- Río Grande de Loíza Reach 2

- Río Gurabo – Tributary to Río Grande de Loíza Reach 2
  - Río Valenciano – Tributary to Río Gurabo
- Río Bairoa – Tributary to Río Grande de Loíza Reach 2
- Río Caguitas – Tributary to Río Grande de Loíza Reach 2
- Río Turabo – Tributary to Río Grande de Loíza Reach 2

- Quebrada Cambute
- Río Humacao
- Quebrada Mabu
- Quebrada Mariana
  - Tributary to Quebrada Mariana
- Río Guanajibo
  - Quebrada Honda – Tributary to Río Guanajibo
- Río Matilde
  - Río Cañas – Tributary to Río Matilde
  - Río Pastillo – Tributary to Río Matilde
- Río Jacaguas
- Río Inabon
  - Río Guayo – Tributary to Río Inabon
- Río Guayanes
- Rio Limones
- Quebrada La Mina
  - Quebrada La Mina Tributary

All discharges for the stream shown above were calculated in accordance with the procedures outlined in the publication by the USGS, entitled "Estimation of Magnitude and Frequency of Floods for Streams in Puerto Rico: New Empirical Models" also referred to as Water Resources Investigations (WRI) Report 99-4142.

Flow locations were selected at various points along the reaches of the stream. Locations were first selected based on prior documented FEMA flow locations for prior studies of the drainage basin. Additional flow locations were added along the stream to provide a uniform drainage analysis of the study area.

Based on WRI Report 99-4142, the variables governing the peak stream flows for each of the flow locations are the contributing drainage area (CDA), depth-to-rock (DR), and mean annual rainfall (MAR). With the flow locations selected, the CDA to each of the locations was delineated based on the USGS 7.5-minute quadrangle map.

The DR at the flow locations was based on their proximity to known gage locations per WRI Report 99-4142, and the Soil Surveys of Puerto Rico prepared by the U.S. Department of Agriculture.

The MAR was calculated based on the Puerto Rico Mean Annual Precipitation 1971-2000 map, which maps the variations in rainfall across the Commonwealth of Puerto Rico. This map was overlaid on the delineated drainage basins for all of the streams. The rainfall for each of the incremental drainage areas was estimated.

Calculations were then performed to determine the weighted MAR for each flow location's drainage basin.

A regression analysis was then performed for the 10-, 2-, 1-, and 0.2-percent annual chance flood at each of the flow locations in accordance with WRI Report 99-4142 to calculate flood discharges. The regression analysis was performed based on the CDA, DR, and MAR variables previously calculated. For each gage location, the PEAKFQ discharges were weighted against the regression analysis of that gage location. For each flow location within 50% of the drainage area upstream or downstream of a gage location, the calculated gage flow was weighed against the calculated regression analysis. For flow locations outside of the 50% range of a gage location, the calculated regression flow is utilized as the discharge for the flow location.

In some instances when the regression equation was weighted against the gage location the resultant would be incorrect. For example, a peak flow at a point downstream of a gage location would be less than that of the gage location for a given flood frequency. In the event that such values were calculated, a weighted correction equation was utilized in accordance with "Magnitude and Frequency of Floods in Arkansas" WRI Report 95-4224.

East Coast Reaches	West Coast Reaches
Río Sabana	Río Guanajibo
Río Fajardo	Quebrada Honda
Río Humacao	Río Grande de Añasco
Quebrada Mariana	Río Culebrinas
Tributary to Quebrada Mariana	Río Guatemala
Quebrada Mabu	Unnamed Tributary to Río Culebrinas
Río Guayanes (Río Guayanes Basin)	
Río Limones	

The east coast basins have a total drainage area of 349 square kilometers and the west coast basins have a total drainage area of 1,106 square kilometers. These basins are all unregulated. The peak flow discharges were computed using the statistical analyses of seven stream gages and the USGS regression equations in accordance with WRI Report 99-4142, "Estimation of Magnitude and Frequency of Floods for Streams in Puerto Rico: New Empirical Models." Effective peak flow discharges for the Río Fajardo, Río Humacao, Río Culebrinas, and Río Grande de Añasco basins were based on stream gage analysis and USGS regression equations. Effective peak flow discharges for the streams in the Río Guanajibo basin were based on a HEC-1 watershed model. The Río Sabana and Río Guayanes basins were studied in the April 19, 2005 Flood Insurance Study (FIS) by approximate methods.

A total of five USGS gages are located in the four east coast basins. One gage located on Río Fajardo did not meet the minimum 10 years of historical record to be used for annual rainfall analysis. In addition, a gage located on Río Guayanes was not used because the last year of record was 1984. Therefore, three gages were used in this study, with one each located on Río Humacao, Río Sabana, and Río Fajardo.

In the three west coast basins, a total of six USGS stream gages are available. One stream gage on Río Culebrinas was excluded because it contained fewer than 10 years of historical record, and a gage in the Río Guanajibo basin was excluded because it is located on Río Rosario, a tributary. Therefore, this study utilized one gage on Río Culebrinas, one gage on Río Grande de Añasco, and two gages on Río Guanajibo.

Hydrologic analysis of Lake Loíza is not included in the scope of this study.

Where Río Jacaguas floodplain combines with that of Río Inabon, flows are calculated based on the combination of both drainage basin areas along with the surrounding area that a 1-percent annual chance floodplain would inundate. This is based on the fact that the effective drainage basin outline becomes larger as the floodwater spreads across the coastal floodplain.

There are seven USGS gages located within 3 basin areas: five gages along Río Jacaguas, one gage along Río Matilde, and one gage along Río Guayo. Information was available for all gage locations, however, only one gage observed the minimum 10 years of historical record to be used for annual rainfall frequency analysis. USGS Gage 50111500 at Juana Diaz located along Río Jacaguas has 22 years of record. Records for 1991, 1993, 1994, 1996, and 1997 were disregarded due to the discharges being affected by regulation and/or diversion. The historical annual peak rainfall was downloaded from the USGS web site in the form of a WATSTORE file. A PEAKFQ analysis was run in accordance with the "Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines."

No urban variable was added to the studied streams. The WRI Report 99-4142 regression equations were derived with peak discharge data from 57 gaged stations that incloude those with up to 40% urbanized watershed areas. The Quebrada Honda basin, the most developed in this study, is estimated to have urbanization influence of +/- 26%. The addition of an urban variable will overestimate the peak discharges for the various events.

Hydrologic analyses for Río Inabón were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals along the stream, located in the south-central region of Puerto Rico. The peak flow discharges used in the analysis were developed for Río Inabón at four locations within the study reach. The discharges are based on the log-Pearson Type III statistical analysis of systematic annual peak flow data recorded at stream gage 50112500 at Real Abajo and on gage transfer equations defined in the National Flood Frequency program.

Hydrologic analyses for Río Grande de Manati were carried out to establish the peak flow discharge-frequency relationship for 10-, 2-, 1-, and 0.2-percent annual chance flood events.

Discharges for lower Río Grande de Manati were developed using statistical analysis of stream gage data and discharge transfer equations. Annual peak flow data available for USGS stream gages at Ciales and at PR Highway 2 were used in the hydrologic analysis. Station skew gages at Ciales and at PR Highway 2 were used in the hydrologic analysis. Station skew was used in computing the peak flow discharges at the stream gage locations. Downstream of PR Highway 2, Río Grande de Manati splits and flows into Cano Tiburones in the west and through an unnamed flow path to the east. Split flow discharges were computed in the hydraulic analysis.

Peak flow discharge computations were developed for the lower reach of Río Grande de Manati for the 10-, 2-, 1-, and 0.2-percent annual chance events using statistical analysis of stream gage data and discharge transfer equations. Peak flow discharges and the hydrologic analysis were presented in the Rio Grande de Manati Hydrology Report dated April 2006 (Dewberry, 2006). Rio Grande de Manati splits and flows into Caño Tiburones in the west and an unnamed flow path in the east. Flows for the lower section Rio Grande de Manti from PR Highway 2 were calculated using the optimized split model.

A summary of the drainage area-peak discharge relationships for all of the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

TABLE 4 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO CAMUY					
At PR Highway 2	88.1[1]	263	318	366	515
RÍO GRANDE DE ARECIBO					
At confluence of Río Tanama	487	2,890	4,550	5,680	8,640
Downstream of Dos Bocas Dam	415	2,520	4,050	4,930	7,650
CAÑO TIBURONES					
At mouth	46	84	144	189	322
RÍO CIBUCO					
Approximately 6.9 kilometers above mouth	240	750	1,187	1,469	2,170
RÍO INDIO					
At mouth	95.9	272	453	636	907

[1]Represents an approximate drainage area

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
QUEBRADA HONDA (Río Cibuco Basin)					
At mouth	16.2	160	240	270	370
At limit of detailed study	13.1	140	200	230	310
RÍO DE LOS NEGROS					
Approximately 1.70 kilometers above mouth	26.2	7,240	11,300	12,800	17,500
RÍO MOROVIS					
Approximately 8.56 kilometers above mouth	4.9	2,300	3,650	4,200	5,700
RÍO DE BAYAMÓN					
At Mouth	216.06	1,428	2,037	2,447	3,172
At PR Highway 22	188.99	1,319	1,877	2,265	2,974
At PR Highway 5	180.96	1,292	1,836	2,220	2,889
At PR Highway 2	127.04	968	1,370	1,678	2,237
At PR Highway 177	107.28	862	1,211	1,481	1,897
At PR Highway 883	82.88	706	976	1,194	1,529
At PR Highway 174	68.97	587	810	990	1,246
At Unnamed Residential Road approximately 5 kilometers upstream of PR Highway 174	48.38	385	527	640	810
RÍO GUAYNABO					
At mouth	50.8	513	694	796	1,076
QUEBRADA SANTA CATALINA					
Approximately 0.5 kilometer above mouth	7.1	147	190	218	283
CANAL PUERTO NUEVO					
At Avenida John F. Kennedy	62.80	715.0	880.8	68.6	1,120.0
Upstream of confluence of Quebrada Margarita	52.88	625.0	790.1	77.9	1,030.0
Upstream of confluence of Quebrada Dona Ana	41.45	490.0	637.2	19.3	870.0

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO PIEDRAS					
Upstream of confluence of Quebrada Buena Vista	33.86	413.0	543.8	620.2	770.0
Upstream of confluence of Quebrada Guaracanal	22.80	293.9	388.0	41.3	600.2
Approximately 65 meters upstream of Avenida Winston Churchill	20.91	278.5	367.7	18.2	566.3
Downstream of confluence of Quebrada Los Guanos	19.12	263.2	348.3	95.4	537.9
Approximately 2.2 kilometers upstream of Avenida Winston Churchill	15.10	227.0	301.5	41.2	484.1
QUEBRADA MARGARITA					
Upstream of confluence with Canal Puerto Nuevo	9.22	170.3	215.7	241.4	292.0
Upstream of Expreso de Diego	7.72	158.8	201.1	224.8	272.0
Upstream of PR Highway 23	4.72	109.9	137.9	153.5	198.2
At PR Highway 19	1.32	36.40	45.0	49.8	64.8
Upstream of confluence of Quebrada El Marques	0.73	20.0	24.7	27.3	35.4
QUEBRADA DONA ANA					
Upstream of confluence with Canal Puerto Nuevo	9.92	188.7	236.6	263.6	353.9
Upstream of confluence of Quebrada Josefina	4.48	103.7	129.6	144.0	186.9
Downstream of Avenida Jose de Diego	3.34	84.4	105.2	116.8	152.9
QUEBRADA JOSEFINA					
Upstream of confluence with Quebrada Dona Ana	4.69	81.6	102.5	114.1	147.2
Downstream of PR Highway 21	4.25	72.3	90.8	101.1	130.2
QUEBRADA GUARACANAL/ QUEBRADA CEPERO					
Upstream of confluence with Río Piedras	7.41	154.1	194.0	216.2	277.5

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
QUEBRADA JUAN MENDEZ					
At mouth	7.80	181.4	226.7	315.4	416.4
At Calle Vergel	6.24	119.6	172.5	197.8	255.0
At Avenida Jose de Diego	3.24	84.7	128.3	142.5	189.0
CAÑO DE MARTIN PENA					
At confluence with Canal Puerto Nuevo	51.26	*	*	48.6	*
RÍO CULEBRINAS (DOWNSTREAM REACH)					
At PR Highway 21	272.31	1,642[1]	3,200[1]	4,063[1]	5,759[1]
At USGS Gage No. 50148890	251.82	1,214	1,734	1,948	2,449
Downstream of confluence of Río Caño	247.23	1,203	1,713	1,923	2,416
Upstream of confluence of Río Caño	226.63	1,146	1,613	1,808	2,268
Upstream of confluence of Del Pueblo	216.03	1,116	1,560	1,748	2,190
Downstream of confluence of Quebrada Grande	214.38	1,111	1,551	1,738	2,177
Upstream of confluence of Quebrada Grande	201.86	1,072	1,485	1,663	2,080
At upstream limit of detailed study	200.81	1,069	1,479	1,657	2,072
RÍO CULEBRINAS (AT SAN SEBASTIÁN)					
At downstream limit of detailed study	74.58	509	749	851	1,120
Downstream of confluence of Río Guatemala	74.07	507	745	846	1,114
Upstream of confluence of Río Guatemala	46.34	366	526	594	774
Downstream of confluence of unnamed tributary	42.60	345	494	557	725
Upstream of confluence of unnamed tributary	38.72	323	460	518	673
At upstream limit of detailed study	31.13	277	391	439	567

*Data not computed

[1]Unrevised data taken from the 1994 FIS

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO CULEBRINAS (AT SAN SEBASTIÁN) TRIBUTARY					
At mouth	3.88	64	81	89	110
At San Sebastian	3.37	58	73	80	98
Downstream of confluence of Unnamed Tributary	3.29	57	72	78	96
Upstream of confluence of Unnamed Tributary	0.53	16	18	19	23
Upstream limit of detailed study	0.16	7	8	8	9
RÍO GUATEMALA					
At mouth	27.73	252	353	396	511
At upstream limit of detailed study	24.14	228	318	356	457
RÍO GUAYABO					
At mouth	32.0	183	251	342	599
RÍO CULEBRA					
At confluence with Río Ingenio	13.29	153	208	268	395
At PR Highway 411	9.82	108	152	202	292
CAÑO GUAYABO					
At confluence with Río Culebra	2.34	36	50	61	80
RÍO MAMEYES					
At mouth	45	702	1,020	1,161	1,501
Downstream of confluence of unnamed tributary	40	697	1,187	1,456	2,054
Upstream of confluence of unnamed tributary	36	674	1,099	1,323	1,799
Downstream of confluence of Quebrada Anon	35	668	1,088	1,308	1,784
Upstream of confluence of Quebrada Anon	31	623	994	1,187	1,601
At USGS Gage No.50066000	31	618	986	1,179	1,586
Downstream of confluence of Quebrada Tabonuco	30	612	977	1,167	1,572
Upstream of confluence of Quebrada Tabonuco	24	515	818	977	1,303
Approximately 1.1 kilometers upstream of confluence of Quebrada Tabonuco	24	504	805	960	1,275

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO FAJARDO					
At mouth	68.89	556	885	1,032	1,432
At PR Highway 3	59.26	516	813	945	1,306
At USGS gage No. 50071000	38.63	436	644	739	981
Upstream of Quebrada Rincon	29.58	367	548	626	826
Downstream of Quebrada Juan Diego	28.51	346	504	571	740
Upstream of Quebrada Juan Diego	24.03	301	436	490	629
Approximately 7.5 kilometers upstream of limit of detailed study	23.65	293	419	470	598
RÍO SABANA					
At mouth	18.67	147	355	398	516
At PR Highway 3	18.13	151	349	391	506
Near PR Highway 991	15.95	167	321	359	464
Approximately 4 kilometers upstream of PR Highway 3	12.68	183	282	316	409
Approximately 1.5 kilometers upstream of PR Highway 3	11.51	185	265	296	382
At USGS Gage No. 500670000	10.11	184	242	270	348
Upstream of confluence of Unnamed Tributary	7.85	141	209	234	301
Near Sabana	6.82	121	191	212	273
Upstream of confluence of Río Del Cristal	3.09	59	73	80	98
RÍO BLANCO					
At mouth	63.73	473.1	895.2	1,136.0	1,813.0
Downstream of confluence of Quebrada Maizales/ approximately 3.89 kilometers above mouth	62.36	464.6	878.2	1,116.1	1,742.2
At river approximately 6.94 Kilometers above mouth	53.42	407.9	783.3	981.6	1,529.7
RÍO SANTIAGO					
At mouth	17.98	228.0	449.0	583.6	963.2
Downstream of abandoned railroad at river kilometer 2.11	13.45[1]	178.5[1]	352.7[1]	457.5[1]	736.5[1]
At Divergence of Río Santiago Lateral Branch at river kilometer 4.01	12.93	172.8	339.9	441.9	713.9

[1]Includes Río Santiago Lateral Branch

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO YAGUEZ AT MAYAGUEZ					
At mouth	35.4	292	595	770	1,289
RÍO GRANDE DE AÑASCO					
At mouth	467.73	1,809	3,797	5,130	10,542
Downstream of bridge for PR Highway 2	465.36	1,801	3,785	5,112	10,505
Downstream of confluence of Río Daguey	464.35	1,798	3,779	5,105	10,489
Upstream of confluence of Río Daguey	455.82	1,769	3,729	5,036	10,342
Downstream of confluence of Río Cañas	454.39	1,765	3,721	5,024	10,319
Upstream of confluence of Río Cañas	417.30	1,639	3,496	4,715	9,666
Downstream of confluence of Río Casey	414.88	1,631	3,481	4,695	9,624
Upstream of confluence of Río Casey	385.26	1,527	3,289	4,432	9,070
Approximately 400 meters upstream of PR Highway 406	383.44	1,521	3,278	4,416	9,037
Upstream of confluence of Quebrada Noriega	360.26	1,437	3,121	4,201	8,587
At USGS Gage No. 50144000	347.33	1,390	3,031	4,078	8,329
Downstream of confluence of Quebrada La Balza	343.86	1,382	3,007	4,046	8,261
Downstream of confluence of Quebrada Alto Sano	340.40	1,351	2,900	3,886	7,875
Downstream of confluence of Quebrada Pepinero	331.08	1,329	2,837	3,801	7,697
Upstream of confluence of Quebrada Cinfrona	301.63	1,255	2,634	3,525	7,126
Upstream of confluence of Río Mayaguecilla	277.77	1,192	2,466	3,297	6,654
Upstream of confluence of Quebrada Las Canas	264.05	1,155	2,370	3,166	6,384
Upstream of confluence of Río Guaba	174.51	896	1,763	2,307	4,610

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GRANDE DE MANATÍ					
At mouth	518.0	2,201	4,824	6,400	11,405
At USGS Gage No. 50038100	510.23	2,176	4,766	6,315	11,259
At bridge for PR Highway 2	427.35	2,176	4,766	6,315	11,259
Approximately 12 kilometers upstream of PR Highway 2	406.63	1,974	4,506	6,112	11,574
Downstream of confluence of Rìo Cialtios	393.68	1,935	4,409	5,977	11,308
At USGS Gage No. 50035200 (discontinued)	349.65	1,798	4,070	5,507	10,385
At USGS Gage No. 50035000	347.06	1,798	4,049	5,479	10,330
RÍO OROCOVIS					
At Cross Section A	22.3	141.6	269.1	339.9	538.2
At Cross Section J	15.7	104.8	198.3	246.5	382.4
At Cross Section P	11.8	85.0	153.0	189.8	294.6
At Cross Section R	N/A	85.0	153.0	189.8	294.6
RÍO DE LA PLATA					
At Pinas	478.86	3,072	4,333	5,193	6,740
At Tao Alta	510.23	3,055	4,295	5,160	6,680
At Bridge for PR Highway 2	531.72	3,027	4,275	5,142	6,620
At Tao Baja	544.16	3,004	4,239	5,116	6,560
At Mameval	559.70	2,851	4,028	4,850	6,360
RÍO DE LA PLATA (AT COMERIO)					
At Passarrel and Pina bridge	189.00	910	2,125	2,830	5,235
RÍO DE LA PLATA (AT CAYEY)					
At PR Highway 753	96.45	525	1,075	1,385	2,350
At PR Highway 1	75.89	430	890	1,130	1,925
At PR Highway 52	55.66	340	680	880	1,445
RÍO DE LA PLATA TRIBUTARY NO. 1					
Approximately 0.41 kilometer above mouth	8.08	50	90	110	160
At Access Road	3.32	25	40	50	70
Approximately 2.96 kilometers above mouth	1.76	15	25	30	45

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GUAVATE					
At PR Highway 52	18.00	105	200	250	395
QUEBRADA SANTO DOMINGO					
Approximately 1.58 kilometers above mouth	9.48	75	140	175	270
At footbridge	7.46	65	110	140	205
Approximately 2.40 kilometers above mouth	5.59	50	85	105	160
RÍO DE AIBONITO TRIBUTARY NO. 1					
At mouth	5.13	93.9	132.4	155.2	263.8
At Avenida Wheeler	3.78	20	35	45	70
RÍO GUADIANA					
Approximately 4.67 kilometers above mouth	20.41	150	280	350	550
Approximately 5.36 kilometers above mouth	13.55	105	195	245	375
Downstream of Quebrada Rivera	12.72	100	185	225	350
Upstream of Quebrada Rivera	11.34	95	165	200	310
At Caserio Candelario Torrea Bridge	10.10	85	150	180	275
RÍO GRANDE DE LOÍZA REACH 1					
Downstream of PR Highway 31	536.1[1]	3,200[1]	4,670[1]	5,460[1]	7,170[1]
At Carolinas	625.02	3,575	6,772	8,241	12,248
Upstream of Quebrada Maracuto	590.79	3,564	6,493	7,896	11,721
At Trujillo Alto	575.00	3,554	6,363	7,735	11,475
At USGS Gage No.50059050	541.31	3,522	6,074	7,377	10,925
At Mouth of Lago Loíza	480.31	3,063	5,588	6,776	10,014
RÍO GRANDE DE LOÍZA REACH 2					
Upstream of confluence of Río Gurabo	279.49	1,765	3,108	3,712	5,216
Upstream of confluence of Río Baiora	277.60	1,701	2,952	3,522	4,936
Above PR Highway 30	235.29	1,559	2,609	3,106	4,338
At USGS Gage No. 50055000	232.58	1,539	2,581	3,071	4,287

[1]Unrevised data from the 1981 FIS

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GRANDE DE LOÍZA REACH 2 (continued)					
Upstream of confluence of Río Turabo	149.35	1,080	1,858	2,199	3,042
Upstream of confluence of Quebrada J	132.66	985	1,700	2,009	2,773
Above corporate limit of Gurabo - San Lorenzo	124.12	936	1,618	1,910	2,633
Below Roosevelt	116.45	891	1,543	1,820	2,505
At San Lorenzo	107.45	838	1,453	1,712	2,352
Upstream of confluence of Río Cayaguas	69.83	620	1,162	1,426	2,183
At USGS Gage No. 50051800	64.75	591	1,096	1,341	2,041
RÍO CAÑOVANAS					
At PR Highway 3	44.2	626	894	992	1,161
RÍO CAÑOVANILLAS					
At PR Highway 3	43.6	500	660	760	990
RÍO GURABO					
At mouth	181.55	1,456	2,919	3,595	5,470
At PR Highway 941	172.95	1,447	2,815	3,465	5,267
At Gurabo	163.17	1,433	2,695	3,315	5,033
At USGS Gage No. 50057000	155.94	1,419	2,606	3,202	4,858
Below limits of Gurabo-Juncos	141.67	1,270	2,425	2,977	4,507
Above limits of Gurabo-Juncos	136.32	1,266	2,357	2,891	4,373
Below Villa Graciela	131.41	1,166	2,293	2,812	4,250
Upstream of confluence of Río Valenciano	80.14	688	1,585	1,931	2,888
At PR Highway 31	65.62	534	985	1,209	1,808
At USGS Gage No. 50055750	57.78	455	874	1,070	1,597
RÍO VALENCIANO					
At mouth	49.33	636	1,121	1,337	1,922
Below Juncos	48.55	635	1,108	1,321	1,898
At USGS Gage No. 50056400	42.50	620	1,004	1,195	1,713
RÍO BAIROA					
At mouth	19.72	258	438	533	796
Below PR Highway 30	16.96	223	391	475	708
At USGS Gage No. 50055390	13.21	176	324	392	581
Below Las Carolinas	9.97	152	263	318	467

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
QUEBRADA CAMBUTE					
At mouth	2.85	67	106	125	178
QUEBRADA MUERTOS					
At mouth	1.1	48	62	71	96
RÍO CAGUITAS					
At mouth	42.31	440	798	971	1,465
At Villa Blanca	40.11	424	767	932	1,405
Above PR Highway 52	36.87	399	720	875	1,316
Upstream of confluence of Río Canaboncito	22.16	280	492	594	884
Upstream of confluence of Quebrada Naranjito	18.89	238	374	451	651
At USGS Gage No. 50055100	13.73	160	294	354	506
RÍO CAGUITAS TRIBUTARY 1					
At mouth	1.8	48	76	93	140
RÍO CAGUITAS TRIBUTARY 2					
At mouth	0.5	11	20	23	37
RÍO TURABO					
At mouth	77.04	668	1,249	1,531	2,339
Above Villa del Rey	73.87	648	1,210	1,483	2,264
At Villa del Rey	68.27	614	1,141	1,397	2,129
Upstream of La Esperanza	63.48	583	1,080	1,322	2,011
Upstream of confluence of Quebrada de las Quebradillas	44.69	457	831	1,012	1,529
Below Villa Boriquen	29.31	340	607	735	1,100
At USGS Gage No. 50053025	18.52	273	501	622	1,002
RÍO HERRERA					
At PR Highway 3	10.0	220	280	317	390
RÍO CAÑABONCITO					
At confluence with the Río Cagüitas	33.9	*	*	658	*
At 0.1 kilometer upstream of confluence with the Río Cagüitas	8.8	*	*	186	*

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO ANTON RUÍZ					
At downstream limit of detailed study	46.37	361.2	726.6	944.8	1,529.7
At 2.7 kilometers upstream of downstream limit of detailed study	39.25	314.4	637.4	828.6	1,359.7
Downstream of confluence of Quebrada de las Mulas	31.94	256.4	534.0	694.1	1,133.1
Upstream of confluence of Quebrada de las Mulas	25.96	222.4	450.4	583.6	991.5
Downstream of confluence of Quebrada Icacos	18.89	171.4	345.6	447.6	728.0
Upstream of confluence of Quebrada Icacos	12.12	116.1	239.4	310.2	509.9
At 1.3 kilometers downstream of confluence of Quebrada Collores and Quebrada Mambiche	11.22	109.1	223.8	289.0	467.4
Downstream of confluence of Quebrada Mambiche and Quebrada Collores	9.69	96.3	198.3	257.8	424.9
QUEBRADA MAMBICHE					
At confluence with Río Anton Ruíz and Quebrada Collores	3.91	45.3	93.5	120.4	198.3
At 1.5 kilometers upstream from confluence with Río Anton Ruíz and Quebrada Collores	3.08	36.8	76.5	90.3	164.3
At upstream limit of detailed study	2.23	28.3	59.5	76.5	130.3
QUEBRADA DE LAS MULAS					
At confluence with Río Anton Ruíz	5.98	65.2	130.3	167.1	274.8
Downstream of confluence of unnamed tributary	4.33	49.5	102.0	131.7	218.1
Upstream of confluence of unnamed tributary	2.88	35.4	72.2	93.5	153.0
At PR Highway 927	2.12	27.0	55.0	71.0	116.0
At PR Highway 938	1.40	19.0	38.0	50.0	81.0
At upstream limit of detailed study	0.67	11.3	21.2	28.3	45.3

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO DAGUAO					
At mouth	18.65	249.3	504.2	677.1	1,303.1
Downstream of Rural Bridge (at river kilometer 3.69)	7.41	116.1	235.1	314.4	594.9
Upstream of PR Highway 3 (at river kilometer 5.40)	5.85	96.3	192.6	257.7	453.3
Upstream of upstream crossing of PR Highway 974	3.37	62.3	121.8	161.5	283.3
QUEBRADA CEIBA					
At mouth	6.42	87.8	191.2	262.0	481.6
At PR Highway 3	5.57	77.9	167.1	229.5	424.9
At downstream crossing of PR Highway 975	4.20	68.0	140.2	188.4	317.3
At upstream crossing of PR Highway 975	1.94	35.4	73.7	99.2	175.6
At downstream crossing of PR Highway 977	0.26	7.1	14.2	18.4	31.2
QUEBRADA AGUAS CLARAS					
At mouth	5.88	73.7	165.7	216.7	396.6
At river kilometer 0.43	5.34	68.0	153.0	201.1	348.4
Upstream of Quebrada Aguas Claras Tributary	3.76	51.0	114.7	150.1	269.1
At abandoned railroad	2.12	32.6	72.2	93.5	161.5
QUEBRADA AGUAS CLARAS TRIBUTARY					
At mouth	1.58	25.5	56.7	73.7	130.3
At PR Highway 3	1.30	21.2	46.7	62.3	104.8
At river kilometer 1.92	0.26	6.4	14.2	18.4	31.2
RÍO HUMACAO					
At mouth	77.00	825	1,709	2,171	3,552
1.5 kilometers upstream of mouth	71.30	784	1,619	2,053	3,354
Downstream of Quebrada Catano	58.79	672	1,346	1,692	2,719
Upstream of Quebrada Catano	54.37	638	1,273	1,598	2,564
Downstream of Quebrada Mabu	51.84	618	1,230	1,544	2,474
Upstream of Quebrada Mabu	46.63	577	1,142	1,431	2,288
Downstream of Quebrada Mariana	45.22	551	1,067	1,329	2,098
Upstream of Quebrada Mariana	30.61	421	801	992	1,553
Downstream of Unnamed Tributary (near PR Highway 30)	28.72	394	732	901	1,392

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO HUMACAO (continued)					
Upstream of Unnamed Tributary (near PR Highway 30)	26.60	374	692	851	1,313
At PR Highway 30	26.22	370	685	842	1,299
At upstream limit of detailed study	21.34	297	581	748	1,307
QUEBRADA MABU					
At mouth	5.21	119	212	258	394
At 490 meters upstream of mouth	5.08	117	208	253	387
At PR Highway 3	4.68	110	195	238	363
At PR Highway 924	3.66	90	155	187	281
Downstream of Cruz Ortiz Stella Street	3.17	82	140	168	251
Upstream of Miguel Casillas Street	2.91	77	131	157	235
At 2.96 kilometers upstream of mouth	2.49	69	116	140	208
Downstream of 1 Street (Colinas del Este)	2.00	59	99	118	175
At upstream limit of detailed study	1.47	47	75	89	129
QUEBRADA MARIANA					
At mouth	14.61	248	455	558	861
Downstream of Unnamed Tributary (approximately 1.32 kilometers upstream of mouth)	13.88	240	438	538	828
Upstream of Unnamed Tributary (approximately 1.32 kilometers upstream of mouth)	9.46	185	331	404	617
At confluence of Río Mariana Near Humacao	8.96	173	305	369	557
At upstream limit of detailed study	7.28	150	261	316	474
QUEBRADA MARIANA TRIBUTARY					
At mouth of Unnamed Tributary	4.42	106	184	222	334
Approximately 1.8 kilometers upstream of Unnamed Tributary	1.81	58	95	114	168

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GUANAJIBO					
At mouth	329.65	1,352	3,896	5,745	14,294
Upstream of confluence of Quebrada Maga	313.94	1,252	3,751	5,528	13,739
At USGS Gage No. 50138000	310.53	1,215	3,637	5,343	13,196
Downstream of confluence of Río Rosario	303.04	1,206	3,507	5,137	12,620
At Unnamed road	263.96	1,218	3,186	4,658	11,408
Near PR Highway 114	188.40	1,116	2,435	3,545	8,623
Near Del Ferrocarril	180.51	1,101	2,358	3,432	8,341
Near Bridge for PR Highway 347	135.65	909	1,835	2,383	4,194
Near confluence of Cain Bajo	124.70	837	1,724	2,237	3,929
Upstream of confluence of Río Cain	96.61	636	1,382	1,789	3,127
At USGS Gage No. 50131900	91.39	604	1,325	1,713	2,991
Upstream of confluence of Río Cupeyes	73.11	535	1,114	1,437	2,497
Upstream of confluence of Río Cruces	45.51	407	766	939	1,439
At Bridge for PR Highway 2	37.84	362	674	825	1,259
Downstream of confluence of Quebrada Honda	37.13	358	666	815	1,242
Upstream of confluence of Quebrada Honda	25.34	279	508	619	936
At upstream limit of detailed study	19.46	234	420	510	767
QUEBRADA HONDA (Río Guanajibo Basin)					
At mouth	11.79	151	267	322	480
Downstream of confluence of Río Coco	10.18	137	240	290	430
Upstream of confluence of Río Coco	4.40	73	124	148	216
At PR Highway 368	2.43	48	79	94	135
RÍO CRUCES					
At confluence of Río Flores	19.2	*	*	650	*
Just downstream of PR Highway 2	14.0	*	*	460	*

*Data not computed

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
QUEBRADA MENDOZA-QUEBRADA LAS TUNAS					
At mouth	8.0	63	136	190	335
Downstream of Concepción Channel	7.7	61	132	185	326
Upstream of Concepción Channel	6.0	55	114	157	272
CONCEPCIÓN CHANNEL					
At confluence with Quebrada Mendoza-Quebrada Las Tunas	1.7	11	24	34	61
At PR Highway 307	1.1	8	17	23	41
QUEBRADA PILETA					
At mouth	1.0	17	27	36	48
At PR Highway 102	0.7	12	19	24	34
RÍO LOCO					
At mouth	207.2	415	611	731	1,045
At PR Highway 116	204.9	415	611	731	1,045
At PR Highway 332	53.4	398	586	703	1,009
At PR Highway 2	29.3	302	439	520	702
At Loco Dam	21.8	189	268	309	415
RÍO YAUCO					
Downstream from Quebrada Berrenchin	93.71	540	1,130	1,500	2,690
Upstream from Quebrada Berrenchin	86.14	510	1,100	1,360	2,040
QUEBRADA BERRENCHIN					
At old PR Highway 2	4.79	91	140	160	220
Above Quebrada Berrenchin Tributary No. 1	2.02	54	76	88	110
QUEBRADA BERRENCHIN TRIBUTARY NO. 1					
At mouth	1.27	41	55	62	76
RÍO GUAYANILLA					
Approximately 4.93 kilometers above mouth	55	538	765	1,161	1,558

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO MACANA					
Approximately 0.81 kilometer above mouth	26	397	548	737	1,048
RÍO TALLABOA					
At mouth	84.2	509.0[1]	759.0[1]	920.0[1]	1,360.0[1]
At PR Highway 2	77.7	567.0	821.0	973.0	1,558.0
At USGS Gage No. 50121000	62.7	552.0	825.0	983.0	1,388.0
Approximately 10.78 kilometers above mouth	26.1	349.0	495.0	611.0	1,020.0
RÍO GUAYANES					
At mouth	21.3	326.0	494.0	594.0	907.0
At kilometer 2.35 above mouth	18.4	302.0	459.0	546.0	793.0
RÍO MATILDE					
At mouth	72.3	390.35[2]	560.39[2]	654.35[2]	828.15[2]
Upstream of Quebrada del Agua	55.8	330.35[2]	450.39[2]	504.35[2]	658.15[2]
Downstream of Río Cañas and Pastillo	49.6	300.35[2]	420.39[2]	484.35[2]	578.15[2]
RÍO CAÑAS					
At mouth	22.0	170.36[3]	210.57[3]	224.39[3]	257.09[3]
Approximately 690 meters downstream of limit of detailed study	19.4	170	250	280	370
At limit of detailed study	16.7	150	220	250	340
At Corral Viejo	9.4	100	150	170	220
RÍO PASTILLO					
At mouth	27.6	200	310	340	450
Upstream of Unnamed Tributary	24.5	180	270	310	420
Approximately 2.0 kilometers downstream of limit of detailed study	21.7	170	250	280	370
At limit of detailed study	18.9	160	230	260	340
Upstream of Unnamed Tributary	8.1	88	120	140	180
QUEBRADA DEL AGUA					
Approximately 3.4 kilometers above mouth	13.5	83.7	117.4	148.0	194.0

[1]Discharges decrease while the drainage area increases due to attenuation of flow in the overbanks
[2]Discharges reflecting net flows due to flow diversion from Río Cañas to Río Portugues basin
[3]Reduction is due to flow diversion from Río Canas to Río Portugues basin

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO JACAGUAS-RÍO INABON (Combined Flow)					
At mouth of Río Jacaguas/ Caribbean coastline	267.4[1]	1,400	3,100	4,000	6,500
At PR Highway 1	243.1[1]	1,300	2,800	3,700	5,700
RÍO JACAGUAS					
At mouth	158.0	1,100	2,200	2,800	4,800
At PR Highway 1	156.1	1,000	2,200	2,700	4,500
Approximately 1,180 meters upstream of PR Highway 1	153.4	1,000	2,100	2,700	4,500
Approximately 2,525 meters downstream of Quebrada Guanabana	149.6	990	2,000	2,500	4,200
At USGS Gage No. 50111750	146.4	990	2,000	2,500	4,200
At USGS Gage No. 50111700	136.6	960	1,900	2,400	4,000
At USGS Gage No. 50111500	130.3	930	1,800	2,300	3,700
At Las Lomas	125.6	930	1,800	2,200	3,700
Approximately 150 meters upstream of PR Highway 149	112.3	880	1,700	2,100	3,400
RÍO JACAGUAS (AT VILLALBA)					
At limit of detailed study by Villalba	35.4	340	620	760	1,100
Upstream of Quebrada Achiote	23.2	250	450	540	790
Upstream of Unnamed Tributary	14.3	180	310	370	510
RÍO INABON					
Approximately 400 meters upstream of the Ponce & Guayama Railroad	82.36	570.27	949.86	1,120.55	1,586.40
Downstream of Confluence of Río Guayo	67.86	531.90	900.19	1,068.71	1,533.47
Upstream of Confluence of Río Guayo	35.48	193.21	438.15	577.49	1,178.66
At cross section "AG"	N/A	180.52[2]	409.38[2]	539.55[2]	1,101.24[2]
Upstream of PR Highway 14	N/A	174.60[2]	390.86[2]	516.33[2]	1,040.84[2]
At USGS Gage No. 50112500	25.12	156.00	343.54	455.14	903.00

[1]Drainage area includes Río Jacaguas basin, Río Inabon basin, and portions of surrounding watershed areas affected by combined 1-percent annual chance flood

[2]These two peak discharge entries were coded in the hydraulic model. Cross section AQ, which is half the sum of flows estimated at the USGS gage station and cross section upstream of confluence with Rio Guayo. The second estimate is based on the flow yield of watershed upstream of confluence with Rio Guayo.

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GUAYO					
At mouth	34.6	340	620	740	1,100
At USGS Gage No. 50113100	30.5	310	540	650	990
Approximately 80 meters upstream of PR Highway 512	25.1	270	480	570	820
Downstream of Quebrada Indalecia	17.7	210	370	420	590
Upstream of Quebrada Indalecia	8.5	130	200	240	340
RÍO COAMO					
At Velasquez	181.95	2,000	2,290	3,218	4,275
RÍO DESCALABRADO					
At downstream limit of detailed study	46.6	150	452	670	1,458
RÍO NIGUA					
At mouth	140.01	1,641	2,376	3,265	4,245
At PR Highway 52	127.06	1,549	2,246	3,101	4,031
At Coco	116.55	1,465	2,121	2,942	3,825
RÍO GRANDE DE PATILLAS					
At cross section A	74.3	544	1,198	1,583	2,747
QUEBRADA MAMEY					
At cross section A	4.1	39	87	116	207
At cross section H	1.0	26	60	80	145
RÍO NIGUA (AT ARROYO)					
At mouth	21.60	342	478	547	*
At PR Highway 178	20.75	340	474	542	*
At PR Highway 3	20.44	336	469	536	*
RÍO NIGUA (AT PITAHAYA)					
Downstream of Canal de Patillas	19.09	326	455	521	*
Downstream of PR Highway 751	17.53	303	422	483	*
Downstream of PR Highway 753	14.27	241	336	384	*

*Data not computed

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GUAMANI					
At mouth	33.26	536	791	907	1,179
At Camino Pozo Hondo	24.53	552	813	934	1,214
At PR Highway 15	22.25	502	732	850	1,105
At PR Highway 179	19.45	483	702	820	1,066
At upstream limit of detailed study	10.83	337	490	573	745
RÍO MELANIA					
At cross section A	6.4	59	154	218	425
RÍO SECO					
At cross section A	28.8	139	363	513	991
RÍO MAUNABO					
At mouth	48.4	620	880	1,010	1,370
Approximately 7.27 kilometers above mouth	22.5	310	434	500	680
QUEBRADA ARENAS					
Approximately 0.80 kilometer above mouth	6.5	120	170	190	260
Approximately 2.68 kilometers above mouth	2.8	80	110	120	160
QUEBRADA BRANDERI					
At a point approximately 1.14 kilometers downstream of PR Highway 744	0.33	*	*	59.1	*
RÍO JACABOA					
At mouth	13.2	280	390	440	600
Approximately 3.1 kilometers above mouth	7.0	160	220	250	340
RÍO GUAYANES					
At mouth	132.80	1,304	2,959	3,863	6,653
Approximately 2.35 kilometers above mouth	124.78	1,252	2,832	3,693	6,352
Approximately 3.75 kilometers above mouth	109.60	1,148	2,578	3,357	5,758
Downstream of PR Highway 3	90.53	978	2,129	2,745	4,626
At PR Highway 3	84.33	934	2,026	2,610	4,391
Downstream of confluence of Río Limones	80.21	904	1,956	2,518	4,232
Upstream of confluence of Río Limones	52.50	646	1,342	1,706	2,806
At PR Highway 182	46.36	595	1,228	1,559	2,556

*Data not computed

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RÍO GUAYANES (continued)					
Downstream of confluence of unnamed tributary near Playita	43.59	540	1,068	1,338	2,136
Upstream of confluence of unnamed tributary near Playita	40.73	502	970	1,206	1,901
Downstream of confluence of Quebrada Guayabo	38.68	472	893	1,103	1,715
Upstream of confluence of Quebrada Guayabo	27.80	363	651	792	1,196
Approximately 4 kilometers upstream of PR Highway 182	24.69	328	575	694	1,035
Downstream of confluence of Río Arenas	19.20	269	458	548	804
RÍO LIMONES					
At mouth	27.71	440	901	1,144	1,879
At bridge in Martorell	20.36	348	687	862	1,389
Downstream of unnamed Tributary near Martorell	17.02	309	603	756	1,212
Upstream of unnamed tributary Near Martorell	9.23	198	367	453	708
Approximately 200 meters upstream of PR Highway 902	8.11	176	319	390	601
RÍO CANDELERO					
Approximately 2.97 kilometers downstream of PR Highway 906	18.01	331	450	515	705
QUEBRADA #1					
At PR Highway 53	0.3	*	*	18.0	*
QUEBRADA #2					
At PR Highway 53	0.5	*	*	20.0	*
QUEBRADA #4					
At confluence with Unnamed Tributary to Río Candelero	0.7	*	*	30.0	*

*Data not computed

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. kilometers)	PEAK DISCHARGES (cms)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
QUEBRADA LA MINA					
At Mouth	6.2	79.83	147.08	192.21	281.41
Upstream of PR Highway 997	6.2	81.75	150.76	195.41	290.87
Confluence with Quebrada Pilón	6.0	84.50	157.24	203.57	304.26
Upstream of PR Highway 996	2.0	32.14	59.86	77.42	115.73
Confluence with Quebrada La Mina Tributary	1.3	22.34	41.40	53.52	79.83
Upstream of Confluence with Quebrada La Mina Tributary	0.8	10.76	19.96	25.82	37.04
QUEBRADA LA MINA TRIBUTARY					
At Mouth	N/A	11.92	22.00	28.43	40.69

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded 0.1-meter elevations and may not exactly reflect the elevations shown on the Flood Profile or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the revised FIRM (Exhibit 2). Along certain portions of the watercourses, a profile base line is shown on the maps to represent channel distances as indicated on the flood profiles and floodway data tables; this was necessary due to the meandering nature of the low-flow streambeds.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.15 meter for floods of the selected recurrence intervals (Exhibit 1).

Precountywide Analyses

In the Río Piedras Basin, a floodway was calculated for Caño de Martin Pena; however, no profile was delineated because the 1-percent annual chance elevation is controlled by the surge elevation.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Cross Sections

Land elevations for Río Camuy were determined using topographic maps developed from aerial photography flown in November 1979 (Topographic Maps, Continental Aerial Surveys, Inc., 1979). Stream geometry data were obtained by field measurement.

For Río Camuy, in the two-dimensional model, triangular-shaped finite elements (cells) were used instead of cross sections. For profiles plotting, the water elevations were plotted at the finite element nodes that lay on or very near to the river channel. Therefore, no cross sections are shown on the profiles.

For Canal Puerto Nuevo, Río Piedras, Quebrada Margarita, Quebrada Dona Ana, Quebrada Josefina, Quebrada Guaracanal, Quebrada Cepero, Quebrada Juan Mendez, Río Guayo, and Canal de Juana Díaz, cross sections for the backwater analyses upstream of the USACE study areas were obtained from aerial photographs flown in November 1978, at a scale of 1:5,000 with a contour interval of 1 meter (Continental Aerial Surveys, Inc., 1979). The below-water sections were obtained by field measurement.

Cross sections for Río Mameyes, Río Blanco, Río Santiago, Río Santiago Lateral Branch, Río Anton Ruíz, Quebrada Mambiche, Quebrada de las Mulas, Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, Quebrada Aguas Claras Tributary were obtained from aerial photographs flown in November 1978 enlarged to a scale of 1:5,000 (Continental Aerial Surveys, Inc., 1978). The below-water sections were obtained by field measurement. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry (Unpublished Field Book and Cross Section Data, Lebron, Sanfiorenzo & Fuentes, Engineering, Architecture and Planning Consultants).

Cross sections for Río Guayanilla and Río Macana were obtained from photogrammetric interpretation of 1-meter contour mapping developed from aerial photographs taken in May 1976 (Aerial Photographs, Río Guayanilla Basin, Puerto Rico, Kucera and Associates, Incorporated, 1976).

Cross sections for Río Maunabo, Quebrada Arenas, and Río Jacoboa were based on maps obtained by aerial photogrammetric methods (Topographic Maps, USACE, Jacksonville District, 1979).

Cross sections for Río Grande de Jayuya, Río Zamas, Río Caricaboa, Río Orocovis, Río Guavate, Quebrada Santo Domingo, Río de Aibonito Tributary No. 1, Río Guadiana, Río Yauco, Quebrada Berrenchin, and Quebrada

Berrenchin Tributary No. 1 were obtained from field surveys (Storm Tide-Frequency Analysis for the Coast of Puerto Rico, DOC, 1975).

Cross sections for Río Coamo (at Paso Seco) and Río Descalabrado were obtained from conventional surveying techniques. Topographic maps at a scale of 1:20,000, with contour intervals of 1, 5, or 10 meters were used to extend the overbank areas of some cross sections (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.).

Cross sections for Río Loco were obtained from field and aerial surveys (Aerial Photography for Lajas and Majada Basins, Cardan Mapping Systems Corporation, 1981).

Cross sections for Río Grande de Loíza Reach 1 downstream of PR Highway 3, Río Cañovanas, Río Cañovanillas, Quebrada Muertos, Río Caguitas Tributary 1, Río Caguitas Tributary 2, and Río Herrera were obtained from field surveys.

Cross-section data for Quebrada Mendoza, Quebrada Las Tunas, Concepción Channel, and Quebrada Pileta were obtained from aerial photographs and by conventional surveying methods (Aerial Photographs, Mark Hurd Aerial Survey, 1978). Along certain portions Quebrada Mendoza, and Quebrada Las Tunas, a profile base line is shown on the maps to represent channel distances as indicated on the flood profiles and floodway data tables. These lines are intended to show the paths that flood flows will take in a flood event when the natural channels are overtopped.

Cross sections for Río Espíritu Santo, Río Grande, Río Grande de Arecibo, Caño Tiburones, Río Cibuco, Río Indio, Río de Los Negros, Río Morovis, Río Guaynabo, Río Hondo, Quebrada Santa Catalina, Río Yaguez at Mayaguez, Río Tallaboa, Río Guayanes (Río Tallaboa Basin), Río Grande de Patillas, Quebrada Mamey, Río Melania, and Río Seco were field surveyed and were located at close intervals above and below bridges to compute the significant backwater effects of these structures in the highly urbanized areas.

Cross sections for Río Guayabo, Río Culebra, Caño Guayabo, and the Unnamed Stream in Río Culebrinas Basin were obtained from topographic maps and field survey.

All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Water-Surface Elevations

The following water-surface elevations were determined using the USACE HEC-2 step-backwater computer program (HEC-2 Water Surface Profiles, Users Manual, USACE, Hydraulic Engineering Center, 1984):

Río Cibuco (upstream of
PR Highway 2
at Río Indio)
Río Indio
Quebrada Honda
Río de Los Negros
Río Morovis
Río Guaynabo
Río Hondo
Quebrada Santa Catalina
Canal Puerto Nuevo
(portions of)
Río Piedras (portions of)
Quebrada Margarita
(portions of)
Quebrada Dona Ana
(portions of)
Quebrada Josefina
Quebrada Guaracanal
Quebrada Cepero
Quebrada Muertos
Río Caguitas Tributary 1
Río Caguitas Tributary 2
Río Herrera (upstream of
PR Highway 3)
Río Anton Ruíz
Quebrada Mambiche
Quebrada de las Mulas
Río Daguao
Quebrada Ceiba
Quebrada Aguas Claras
Quebrada Aguas Claras
Tributary
Quebrada Juan Mendez
Río Guayabo
Río Culebra
Caño Guayabo
Unnamed Stream (in the Río
Culebrinas Basin)
Río Espíritu Santo
Río Grande
Río Mamayes
Río Blanco
Río Santiago
Río Santiago Lateral Branch
Río Cañovanas
Río Cañovanillas
Quebrada Mendoza
Quebrada Las Tunas
Concepción Channel
Quebrada Pileta
Río Loco
Río Tallaboa
Río Guayo
Río Maunabo
Quebrada Arenas
Río Jacaboa

In the lower area of Río Culebrinas, modeled with the two-dimensional model, triangular finite elements (cells) were used instead of cross sections. For Río Guayabo, Río Culebra, Caño Guayabo, and an Unnamed Stream, an aerial photograph flown in 1987 prepared by the USACE was used along with a 1960 USGS quadrangle map to show recent development along the floodplain.

In the Canal de Juana Díaz area, it was determined through hydraulic computations (including preliminary HEC-2 runs) that this canal (which was designated for irrigation) is capable of carrying only a negligible portion of the storm runoff. Due to this limited capacity, storm-water runoff moves as overland sheetflow in a direction that is essentially perpendicular to the canal. The Manning equation was applied in each subarea to determine the water depth. Aerial photographs were used in estimating appropriate values of Manning’s "n". For all subareas, the computed water depth was well below 0.3 meter.

For Río Camuy, water-surface elevations of floods of the selected recurrence intervals were computed using a two-dimensional, unsteady-state Finite Element computer program (Wang, 1978).

For Río Camuy, flow hydrographs were computed at the PR Highway 2 bridge (the upstream portion of the study area) for the various selected recurrence intervals. These hydrographs were provided as input data to the two-dimensional model. Because the Regional Analysis methodology yields only peak flows, not flow hydrographs, it was necessary to develop these hydrographs using another method. It was decided to develop hydrographs whose peak coincided with the Regional Analysis peaks by proportionally adjusting the ordinates of the hydrographs from the TR-20 computer analysis ("Hydrologic and Hydraulic Studies of the Camuy River at PR Highway 2, Camuy Municipality," Hidalgo y Alejandro Consultants, 1980). In that analysis, different flow hydrographs had been developed to correspond to different rainfall durations. The six-hour rainfall duration always resulted in the highest peak flow for every recurrence interval. Accordingly, these hydrographs were selected for adjustment. For each recurrence interval, the TR-20 hydrograph ordinate values were multiplied by the ratio (Regional Analysis peak flow/TR-20 peak flow) to obtain the adjusted hydrograph. The 0.2-percent annual chance adjusted hydrograph was obtained by extrapolation from the 1-percent annual chance adjusted hydrograph.

For Río Camuy, a steep drop in the 1-percent annual chance water-surface occurs approximately 150 meters upstream from the mouth of Río Camuy. This is due to the abrupt narrowing of the floodplain, which causes a large volume of water to pass through a narrow constriction prior to its entering the Atlantic Ocean.

In the coastal floodplain area of the Río Piedras Basin, the USACE used its two-dimensional BISBY model to determine water-surface elevations (Río Puerto Nuevo Survey Investigation, USACE, 1982). The BISBY analysis covers Canal Puerto Nuevo from Las Americas Expressway to the upstream limit of detailed study, Río Piedras to a point approximately 2.0 kilometers upstream of Avenida Jesus T. Pinero, Quebrada Margarita to a point approximately 4.3 kilometers upstream of its mouth, and Quebrada Dona Ana to a point approximately 0.6 kilometer upstream of its mouth. Water-surface elevations of floods of the selected recurrence intervals for the remaining detailed study along these streams were computed using the USACE HEC-2 step-backwater computer program (USACE, Hydrologic Engineering Center, 1984).

In the lower reaches of Canal Puerto Nuevo and Quebrada Margarita, and Caño de Martin Pena, flood elevations are attributed to hurricane tidal surges, runoff from storm rainfall, and a combination of the two. Caño de Martin Pena is subject to flooding from rainfall runoff from the Laguna San Jose area and coastal surge from passing tropical cyclones. Runoff from the Laguna San Jose area was routed through Caño de Martin Pena using a rating curve developed from a range of HEC-2 steady flow water-surface profiles and topographic data of the completed dredging of the Caño de Martin Pena navigation project (USACE, Hydrologic Engineering Center, 1984). Backwater analyses were carried out for the 1-percent annual chance flood discharge on Caño de Martin Pena.

In the lower reaches of Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, Río Anton Ruíz, Río Blanco, and Río Santiago, flood elevations are attributed to hurricane tide surges, runoff from storm rainfall, or a combination of the two. The hurricane tidal surge elevations were obtained by routing the tidal surges from the coast up Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, Río Anton Ruíz, Río Blanco, and Río Santiago, respectively. These estimates were based on computations using the Massachusetts Institute of Technology estuary model in two other Puerto Rico Basins with similar characteristics (Río Mameyes and Río Culebrinas) (MIT, Harleman, D.R.F., et. al. 1976). These computations indicated essentially horizontal profiles, a reasonable result considering the small size of the estuarine areas.

A portion of Río Santiago flows as two separate channels for the 10-year and greater recurrence intervals. This division occurs approximately 400 meters upstream of PR Highway 31 and extends downstream to approximately 250 meters downstream of the abandoned (formerly C. Brewer) railroad. Hydraulic analysis of this divided flow region consisted of an iterative division of the total discharge to establish the proportion of the total flow in each channel through the use of the HEC-2 computer program (USACE, Hydraulic Engineering Center, 1984). This flow division was done to achieve an equal change in water-surface elevation in the main channel and the lateral branch.

Flows in Río Santiago Lateral Branch are not necessarily directed by the low-flow channel of the unnamed tributary to the east. Therefore, stream distances have been measured along the approximate centerline of the 1-percent annual chance flow. On the maps, this flow line, used to establish respective profile distances, is delineated and labeled as the Profile Base Line.

For the Río Grande de Arecibo and Caño Tiburones in the Lower Río Grande de Arecibo Basin, the water-surface elevations of the selected recurrence intervals were developed using the USACE HEC-6 step-backwater computer program (HEC-6 Gradually Varied Unsteady Flow Profiles, Generalized Computer Program, USACE, Hydrologic Engineering Center, 1966). This digital model will simulate complex unsteady flow conditions, considering both friction and inertia forces. The model is an explicit finite difference scheme for the numerical solution of the St. Venant equations. The employment of this technique for the hydraulic analysis of the Lower Río Grande de Arecibo Basin was pertinent because runoff volume is the prime source of flooding. The lower basin was modeled by field surveys (cross sections) with sufficient density to adequately estimate maximum water-surface elevations.

In the lower reaches of the Río Grande de Arecibo, high floods are likely to overtop the levee and spill into the Caño Tiburones Basin. Flow patterns in that area on Caño Tiburones are significantly dependent on the time of such spill as well as the time of arrival of peak flows in Caño Tiburones itself. The flood profiles for Caño Tiburones reflect the peak elevations over length of time as computed by use of the unsteady state model (USACE, Hydrologic Engineering Center, 1966).

Water-surface elevations for Río Cibuco in the broad coastal area downstream of PR Highway 2, Río Guayanilla, Río Macana, Río Grande de Loíza Reach 1 (downstream of PR Highway 3), and Río Herrera in the broad coastal area downstream of PR Highway 3, were computed using a variation of a two-dimensional hydraulic model called SWMM (Modified Version of the Receiving Water Quantity Block of the SWMM Model, USACE, Hydrologic Engineering Center, Unpublished). Because of the flat nature of the floodplain and the transient nature of inflow, the flooding phenomenon was best modeled by means of this two-dimensional hydraulic model, as opposed to a one-dimensional steady state model such as HEC-2. Topography used for the analysis of Río Cibuco was determined from photogrammetric interpretation (Aerial Photographs, Río Cibuco Basin, Puerto Rico, Kucera and Associates, Incorporated, 1977). The SWMM model describes the hydrodynamics of the coastal areas by means of an interconnected link-node network and uses an explicit numeric computation scheme to solve the unsteady flow equations. The links are defined by the length, width, cross-sectional area, hydraulic radius (depth), and a friction factor. Nodes are characterized by surface area, depth, and volume. For Río Guayanilla, Río Macana, Río Grande de Loíza Reach 1 (downstream of PR Highway 3), and Río Herrera, topography used for this analysis was determined from photogrammetric interpretation of 1-meter contour maps developed from aerial photography (Aerial Photographs, Río Guayanilla Basin, Puerto Rico, Kucera and Associates, Incorporated 1976; Topographic Maps of Río Grande de Loíza Basin, Puerto Rico, Kucera and Associates, Incorporated, 1976).

Additional water-surface elevation information for Río Herrera was obtained from the Hydrologic Investigation Atlas HA-533 (HA-533, Floods in the Carolina-Río Grande Area, Northeastern Puerto Rico, DOI, 1975).

Water-surface elevations for Río Grande de Jayuya, Río Zamas, Río Caricaboa, Río Yauca, Quebrada Berrenchin, and Quebrada Berrenchin Tributary No. 1 were computed using the USGS E-431 step-backwater computer program (Open-File Report, Computer Program E431, Users Manual, Computer Applications for Step-Backwater and Floodway Analyses, DOI, 1976). Supercritical flow-routing procedures were used to compute water-surface elevations in a few sections of the upper two profiles in parts of all three streams in the study area.

On Quebrada Arenas, from its confluence with Río Maunabo to approximately 50 meters downstream of cross section A, the elevations were taken from the Río Maunabo, as this area is influenced by the Río Maunabo.

For determining flood elevations caused by storm rainfall runoff, Río Anton Ruíz and Quebrada Mambiche were considered as one stream.

Water-surface elevations for Río Orocovis, Río de la Plata Tributary No. 1, Río Guavate, Quebrada Santo Domingo, Río de Aibonito Tributary No. 1, Río Guadiana, Río Coamo (at Paso Seco), Río Descalabrado, Río Grande de Patillas, Quebrada Mamey, Río Guamani, Río Melania, Río Seco, Río de la Plata (at Toa Alta), Río de la Plata (at Comerio), and Río de la Plata (at Cayey) were computed using the USGS J635 step-backwater computer program (DOI, 1977). For reaches where the flow was found to be critical or supercritical, the flow was routed downstream by the J635 computer program using supercritical-flow, step-backwater techniques to determine the water-surface elevation. This elevation was used to determine the sequent-depth, subcritical flow elevation for the selected discharge of the cross section. Thus, the final profiles for the selected recurrence intervals are for subcritical flow conditions.

The hydraulic model for Río Grande de Patillas was calibrated to historic information for the 1961 flood. The hydraulic models for Río Melania were calibrated to historic information for the 1970 flood. The hydraulic model for Río Seco was calibrated to historic information for the 1928, 1961, and 1970 floods.

Average shallow flooding depths for Río Melania were determined from the results of the preliminary J635 computer analysis (DOI, 1977). However, because of shallow flooding depths, topography, and complex urban development, standard step-backwater computations were judged to be inappropriate for determining detailed flood elevations and boundaries in this area. For Río Melania, the preliminary hydraulic analyses showed the difference between the 10- and 1-percent annual chance floods to be small through the shallow flooding reach. Hydrologic Investigation Atlas HA-446 provides historic data for the 1970 flood, which had a recurrence interval estimated at slightly less than 10 years (HA-446, DOI, 1971).

Water-surface profiles for Río Yauguez (at Mayaguez) were developed using the USGS J635 step-backwater computer program (DOI, 1977). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals upstream of PR Highway 2. Downstream of PR Highway 2, the floodwaters spread in all directions through streets, passages between houses, and buildings, with a depth of 0.9 meter or less. Shallow flooding zones were assigned to this area.

High watermarks were recovered from floods in 1928, 1960, and 1970 on Río de la Plata (at Comerio). However, only those from the 1960 flood defined a useful reach to compare with the computed profiles. The peak discharge over the spillway at the Comerio Dam for the September 6, 1960, flood was computed as 2,900 cms. The profiles of the 1960 flood compare well with the computed 1-percent annual chance profiles using a discharge of 2,830 cms.

Río Yaguez, Quebrada Sabalos, and Caño Majagual contribute to substantial flooding north of Villa del Oeste, San Jose, and Brisas del Mar. This flooding is partially separated from the main floodplain at Río Guanajibo by an elevated road (Calle Duarte). Water-surface elevations are continuous across both areas however due to a bridge opening that allows floodwaters to mix between the two floodplains.

For riverine flooding calculations in the Río Mameyes Basin, the storage provided by the wide coastal floodplain near the mouth of Río Mameyes was accounted for by performing a reservoir routing using the modified Puls method. A discharge rating curve was developed for the cross sections located at the mouth of the river. Inflow hydrographs for the various flood frequencies were developed at the upstream end of the floodplain. These hydrographs were routed using the flow rating curve at the mouth, and a depth-area capacity curve was developed for the floodplain area from topographic maps (Topographic Maps, Río Grande de Añasco Basin, Río Grande de Manatí Basin, Río Anton Ruíz Basin, Continental Aerial Surveys, Inc., 1978). The validity of this procedure was confirmed by comparing the results to historical water-elevation data. Backwater computations were begun at the upstream end of the coastal floodplain.

Starting Water-Surface Elevations

Starting water-surface elevations for Río Camuy, was based on 1-year storm tide. Elevations of the 1-year storm tide and the 10-year storm tide are approximately equal.

For Río Blanco, Río Santiago, and Río Santiago Lateral Branch, the 1-year tidal elevation of 0.61 meter, obtained from a report by NOAA, was used as the starting water-surface elevation for the backwater analysis for all recurrence intervals (Tide Tables 1979-East Coast of North and South America, DOC, no date).

Starting water-surface elevations for Río Piedras were determined by an interpolation between two cross sections from the USACE HEC-2 analyses.

Starting water-surface elevations for Quebrada Margarita were determined by an interpolation between two USACE BISBY nodes.

For Caño de Martin Pena, a recorded high tide of 0.73 meter was used as the starting water-surface elevation at the Bahia de San Juan.

The starting elevation for Río Mameyes is the estimated 1-year tide occurring at the Atlantic coast. The tide values were obtained from a NOAA report, entitled Tide Tables 1979-East Coast of North and South America (Tide Tables, DOC).

Starting water-surface elevations for Río Anton Ruíz, Quebrada Mambiche, Quebrada Ceiba, and Quebrada Aguas Claras was a maximum 1-year tidal elevation of 0.61 meter based on 4 years of tide records in a NOAA report (Tide Tables, DOC). Río Anton Ruíz and Quebrada Mambiche were considered one stream; therefore, the starting water-surface elevation for both was considered in the starting water-surface elevation for Río Anton Ruíz. For Quebrada Aguas Claras Tributary, starting water-surface elevations were taken from a discharge rating curve established at its confluence with Quebrada Aguas Claras.

For Río Daguao, it was considered desirable to begin the hydraulic backwater computations at a point downstream of the lower limit of detailed study (vicinity of PR Highway 979) to obtain a better estimate of the initial water elevation at the lower limit. Trial computations indicated that, due to rapidly changing geometry near the lower limit of detailed study, it would be best to begin the computations at the mouth of Río Daguao, 3.96 kilometers downstream of the lower limit of study. At the mouth, the 1-year tidal elevation of 0.61 meter was used as the starting water-surface elevation. Topographic information for the area downstream of the lower limit of detailed study was obtained from topographic maps at a scale of 1:20,000, with contour intervals of 1, 5, and 10 meters (7.5 Minute Series, Topographic Maps, DOI, 1957, etc.). This procedure involved development of flood discharges resulting from runoff from the Quebrada Seca Ward area, which drains into Río Daguao below the downstream limit of study, as well as for the lower portion of Río Daguao. These discharges were obtained from the regional analysis described in Section 3.1.

For Quebrada Dona Ana, Quebrada Josefina, Quebrada Guaracanal, Quebrada Cepero, Río Guayabo, Río Culebra, Caño Guayabo, an Unnamed Stream (in Río Culebrinas Basin), Quebrada Juan Mendez, Río Orocovis, Río Guayo, Río de Los Negros, and Río Morovis, starting water-surface elevations for the backwater computations were determined using the slope/area method. For Río Guayabo, Río Culebra, Caño Guayabo, and an Unnamed Stream, 0.3 meter was added to the starting depth for floodway calculations.

Starting water-surface elevations for Río Nigua (at Arroyo) and Río Nigua (at Pitahaya) were determined using critical depth. The 1-percent annual chance stillwater elevation that influences Río Nigua is approximately 1.9 meters, and extends only a short distance upstream on Río Nigua; the 0.2-percent annual chance stillwater elevation is approximately 2.7 meters.

For Quebrada de las Mulas, the starting water-surface elevations were determined using the slope/area method beginning at the confluence with Río Anton Ruíz.

Starting water-surface elevations for the Río Espíritu Santo were developed using normal high-tide values for the Atlantic Ocean. Only backwater influence from Río Espíritu Santo was considered for the Río Grande.

The starting water-surface elevation for Río Indio was based on the computed water-surface elevations at the confluence with the receiving stream.

Starting water-surface elevations for Río Cibuco were based on elevations determined by NOAA (Aerial Photographs, Río Cibuco Basin, Puerto Rico, Kucera and Associates, Incorporated, 1976).

Starting water-surface elevations for Río Hondo, and Río Herrera were based on the computed water-surface elevations at the Atlantic Ocean from a NOAA publication (DOC, 1975).

Starting water-surface elevations for Río Guaynabo, Quebrada Santa Catalina, Río Cañovanas, Río Cañovanillas, Quebrada Muertos, Río Caguitas Tributary 1, and Río Caguitas Tributary 2, were based on the computed water-surface elevations of the receiving stream.

The starting water-surface elevations for Río Yaguez were determined by a rating analysis of the controlling features of PR Highway 2. Three distinct segments were identified by their hydraulic conditions and analyzed separately. The three segments are as follows:

> Main channel - The main channel is enclosed in vertical concrete walls above ground level. Channel capacity studies show that the 10-year flood is contained within the channel, and that at some point between the 10- and 50-year floods it will overtop the channel. The maximum capacity of the channel at the PR Highway 2 bridge is approximately 425 cms.
>
> Calle Mendez Vigo Overpass - The opening between the PR Highway 2 embankment and the natural topography creates a narrow constriction approximately 122 meters wide where, during large floods, critical flow occurs.
>
> PR Highway 2 overflows in the vicinity of main channel - Overflow will occur at an elevation of approximately 7.3 meters. The computation for this flow was accomplished using the highway profile section. It should be considered an estimate based on the complexity caused by handrails, guardrails, median dividers, and varying roadway elevations.

Starting water-surface elevations for Río Loco, Río Tallaboa, Río Maunabo, Río Jacaboa, and Río Nigua (Río Majada Basin) downstream of PR Highway 52, were based on the computed water-surface elevations at the Caribbean Sea from a NOAA publication (DOC, 1975). Starting water-surface elevations for Río Nigua (Río Majada Basin) upstream of PR Highway 52 were based on a slope/area calculation, and the results were calibrated of the SWMM model.

Starting water-surface elevations for Quebrada Arenas were based on the computed water-surface elevation at the end of influence from Río Maunabo.

Starting water-surface elevations for Río de la Plata (at Comerio), Río de la Plata (at Cayey), Río de la Plata Tributary No. 1, Río Guavate, Quebrada Santo Domingo, Río Guadiana, Río Descalabrado, Río Grande de Patillas, Quebrada Mamey, Río Melania, and Río Seco were determined using the slope/area method and adjusted by convergence patterns of the profiles obtained from J635 step-backwater computations (DOI, 1977). For Río de Aibonito Tributary No. 1, starting water-surface elevations were determined by means of a convergence run on a 488-meter reach of Río de Aibonito immediately downstream of the mouth of Río de Abonito Tributary No. 1.

Starting water-surface elevation information is not available for the following streams: Río Grande de Arecibo, Caño Tiburones, Canal Puerto Nuevo, Caño Madre Vieja, Río Grande de Jayuya, Río Zamas, Río Caricaboa, Río de la Plata Overflow, Río Yauco, Quebrada Berrenchin, Quebrada Berrenchin Tributary No. 1, Río Guayanilla, and Río Macana.

Roughness Coefficients

Roughness factors (Manning’s “n”) were chosen by engineering judgment and were based on field observations of the streams and floodplain areas, unless otherwise noted.

Because the Río Camuy and Río Culebrinas (Downstream Reach) downstream of PR Highway 2 were modeled using a two-dimensional model, they do not use roughness factors (Manning's "n"). Instead, this model uses a weir coefficient which is affected by floodplain roughness. For these streams, the weir coefficient used was 1.0. Because there are no historical floodwater profile data for the Río Camuy Basin, the acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by comparisons to similar basins in Puerto Rico.

For the portion of Río Cibuco in the broad coastal area downstream of PR Highway 2, roughness factors for the hydraulic computations were assigned on the basis of field inspection and aerial photographs (Aerial Photographs, Río Cibuco Basin, Puerto Rico, Kucera and Associates, Incorporated, 1976).

For Río Yauco, Quebrada Berrenchin, and Quebrada Berrenchin Tributary No. 1, roughness coefficients as low as 0.03 were selected for good channel conditions. Roughness coefficients as high as 0.25 were used where flow was through sugar cane fields. Manning’s “n” values were selected between these two extremes depending on observed field conditions.

Table 6, "Roughness Coefficients," shows the channel and overbank "n" values for the streams studied by detailed methods, except Río Matilde, Río Cañas, and Río Pastillo.

For the Río Piedras Basin, the acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic flood water profiles in the Río Piedras Basin documented in USGS Map Series 1 (Hydrologic Investigations Map Series 1, DOI, 1971).

For Río Mameyes, the reliability of all assumed hydraulic factors, cross sections, and hydraulic structure data were checked by computations that duplicated historic floodwater profiles (HA-545, Floods in the Fajardo-Luquillo Area, Northeastern Puerto Rico, DOI, 1975).

For Río Blanco and Río Santiago (including Río Santiago Lateral Branch) the reliability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles (HA-584, DOA, 1978).

For Río Anton Ruíz, Río Daguao, Quebrada Ceiba, Quebrada Aguas Claras, and Quebrada Aguas Claras Tributary, the acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles documented in USGS Hydrologic Investigation Atlas HA-584 (HA-584, DOI, 1978). The establishing agency for the high watermarks was the USGS, under an agreement with the Commonwealth of Puerto Rico.

During floods, debris collecting at bridges could decrease their carrying capacity and cause greater water depths (backwater effect) upstream of the structures. However, because the occurrence of and amount of debris are indeterminate factors and because the use of the present version of the unsteady state model has no provision for direct hydraulic analysis at a bridge, the total effect of bridges was not analyzed in the Lower Río Grande de Arecibo Basin. In this basin, there are essentially four major bridges: the dual PR Highway 2 bridges just east of the Town of Arecibo and the dual PR Highway 22 bridges, which cross the Río Grande de Arecibo at approximately river kilometer 4.5. The PR Highway 2 bridges are less than 1 kilometer from the Atlantic Ocean. Water levels here are directly influenced by the tide-frequency levels. Because volume is a major parameter for determining flood levels and because velocities were small, the bridges were not considered to affect flood levels significantly.

Approximate Methods

Water-surface elevations for Río Daguey were based on normal-depth calculations.

For the portion of the Río Grande de Arecibo that was studied by approximate methods, the approximate 1-percent annual chance flood elevation was determined by assuming uniform flow at selected cross sections. Those cross sections were obtained from topographic maps at a scale of 1:20,000 with contour intervals of 1, 5, and 10 meters (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.).

Approximate flooding from the Río Coamo upstream limit of detailed study to PR Highway 52 (at Lago Coamo) was determined by extrapolating the 1-percent annual chance flood profiles upstream of the Río Coamo limit of detailed study.

Flood elevations for the areas studied by approximate methods in Lajas Valley were determined, in part, by historical flood records and by use of previously published FIS information (HA-532, DOI, 1974; Flood Insurance Study, Commonwealth of Puerto Rico, U.S. Department of Housing and Urban

Development [HUD], August 1, 1978). Detailed elevations developed for this countywide FIS were also used in some cases to obtain water-surface elevations at the detailed/approximate area interface.

Historic flood records were used to approximate flooding on Río Majada from approximately 1.7 kilometers to 2.1 kilometers upstream of its mouth at Río Nigua (HA-445, DOI, 1971). Upstream of this historic data for Río Majada and for Río Lapa and Río Jajome, approximate flood depths were determined by normal depth calculations and engineering judgment.

Approximate 1-percent annual chance elevations for the west overbank of Río Seco were estimated from preliminary J635 computer analyses and from 1-percent annual chance elevations in the main channel (Step-Backwater and Floodway Analysis Computer Program J635, Users Manual, DOI, May 1977).

Río Coamo and Río Descalabrada originate in mountainous terrain. They empty onto a broad, shallow floodplain similar to alluvial fans and, in the lower reaches, they merge causing complex two-dimensional flow throughout the floodplain areas. This flow in the central reaches of Río Coamo and Río Descalabrado was determined by approximate methods. Elevations were determined by extrapolating the 1-percent annual chance flood profiles downstream of the riverine limits of detailed study, and from flooding determined previously for a USGS hydrologic atlas and USGS flood-prone area maps (HA-448, DOI, 1971; Map of Flood-Prone Areas, Quadrangle Maps, DOI, 1966, etc.).

June 2, 1999, revision

For the 1999 revision, water-surface elevations of floods of the selected recurrence intervals for Río Matilde, Río Cañas, Río Pastillo, and Quebrada del Agua were computed through use of a two-dimensional transient hydraulic model called LATIS (Journal of the Hydraulics Division Proceedings, American Society of Civil Engineers, 1974). Because of the flat nature of the floodplain and the transient nature of inflow, the flooding phenomenon was best modeled by means of this two-dimensional transient hydraulic model, as opposed to a one-dimensional steady state model such as HEC-2 (USACE, Hydrologic Engineering Center, 1984). Starting water-surface elevations for Río Cañas and Río Pastillo were based on the computed water-surface elevations at the confluence with the receiving stream.

Cross sections for this analysis were determined from photogrammetric interpretation of aerial photography flown in May 1976. Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges and culverts were also surveyed to obtain elevation data and structural geometry.

Channel roughness factors (Manning's "n") for the backwater computations were assigned on the basis of field inspection and review of appropriate aerial photographs for each cross section. Roughness values for the Río Matilde, Río Cañas, Río Pastillo, and Quebrada del Agua ranged from 0.040 to 0.240 with 0.120 used most frequently for all floods of the selected recurrence intervals. The low values are representative of the stream channels while the higher values represent out-of-channel conditions. Values also vary both with depth and with channel overbank conditions.

April 19, 2005, Revision

Cross sections for Río de Bayamón, Río de la Plata, Río Coamo, Río Nigua, and Río Guamani were obtained from field surveys. Additional, cross-sectional data for Río de Bayamón were obtained from U.S. Quadrangle (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.). Field surveys were modified where cross-sections needed to be extended using the 7.5-minute USGS quadrangle maps for Bayamón and Naranjito. Cross sections were generated using the quadrangle maps from approximately just upstream of PR Highway 177 to the limit of detailed study because the surveyors were unable to obtain cross-section data in the field due to hazardous conditions. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the revised FIRM (Exhibit 2). Along certain portions of the watercourses, a profile base line is shown on the maps to represent channel distances as indicated on the flood profiles and floodway data tables; this was necessary due to the meandering nature of the low-flow streambeds.

Water-surface elevations of floods of the selected recurrence intervals for Río de Bayamón, Río de la Plata, Río Coamo, Río Nigua, and Río Guamani were computed using the USACE HEC-RAS step-backwater computer program (HEC-RAS River Analysis System, USACE, May 2003). Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.15 meter for floods of the selected recurrence intervals (Exhibit 1).

Starting water-surface elevations for Río de Bayamón, Río de la Plata, Río Coamo, Río Nigua, and Río Guamani were determined using critical depth.

This Revision

A Triangular Irregular Network (TIN) developed from Light Detection and Ranging (LiDAR) data was used to prepare the Rio Grande de Manati hydraulic model and a Digital Elevatin Model (DEM) was used for mapping the flood hazards lines. The datum of the TIN was Mean Sea Level (MSL). The DEM of cell size 5m x5m was generated from the TIN. Cross sections for Río Grande de Manati.were generated from the digital terrain model for the HEC-RAS Version 3.1.3 hydraulic model. Elevations obtained for locations along the cross sections where the vertices from the survey data and vertices from the TIN were adjacent provided further validations of the accuracy of the LiDAR data.

For all of the remaining revised streams, cross section data were obtained from field surveys. Additionally, cross-sectional data were supplemented by aerial photographs and LiDAR mapping technology. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the revised FIRM (Exhibit 2).

Channel roughness factors (Manning's "n") for the backwater computations were assigned on the basis of field inspection, review of appropriate aerial photographs, and LiDAR mapping technology for each cross section. Roughness values for the revised streams ranged from 0.040 in the flatter areas to 0.045 in the higher elevations. The banks above the low water line are covered with heavy grass and brush, so the roughness value of 0.100 was used in these areas.

Water-surface elevations of floods of the selected recurrence intervals for the revised streams were computed using the USACE HEC-RAS step-backwater computer program (HEC-RAS River Analysis System, USACE, May 2003). Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.15 meter for floods of the selected recurrence intervals (Exhibit 1).

A detailed hydraulic analysis is included of streams located in the south-central and north-central regions of Puerto Rico. Using aerial photographs and LiDAR mapping technology, topographic maps were developed for the river basin of each stream. The aerial information was supplemented with ground surveys of cross sections along each river to obtain detailed information on the river channel configuration and detailed geometric information of bridges, dams, and other structures.

Then using the HEC-RAS computer modeling program, a model was developed for each river. Based on the information obtained in the aerial survey and site inspections, several Manning's "n" values are used for the overbank areas, as follows:

0.015 – Concrete lined channel overbanks
0.030 – Bare soil or short grass
0.035 – Agricultural fields or tall grass
0.050 – Low density residential development
0.065 – Forest/trees with light undergrowth
0.100 – Heavy grass and brush
0.100 – Moderate density residential or light industrial development
0.150 – High density urban development
0.150 – Forest with dense undergrowth

Channel conditions vary from clean, slightly rocky bottom in the uplands to weedy, flat, and muddy bottom along the coast. Each cross section is assigned an "n" value based on site-specific information. Based on site inspections, a Manning's "n" value of 0.040 was assigned to the channels. Generally, the banks above the low water line are covered with heavy grass and brush, and thus have an "n" value of 0.100.

Per FEMA, the allowable encroachment rise is 1.0 foot (0.3 meter). As such, the HEC-RAS floodway model was set up to reflect the 0.3 meter maximum rise when fully encroached by development.

Quebrada Cambute
The study includes approximately 800 meters, upstream of the confluence with Rio Loíza Reach 1. There is one bridge or other structure on this section. The hydraulic analysis was performed using 14 river cross-sections.

Rĩo Grande de Loíza (Reach 1)
Rĩo Grande de Loíza discharges into the Atlantic Ocean on the north coast of Puerto Rico. The study of the northern section includes approximately 21,800 meters, upstream of the coast. There are seven (7) bridges or other structures on this section. The hydraulic analysis was performed using 99 river cross-sections.

Rĩo Grande de Loíza (Reach 2)
The southern section of Rĩo Grande de Loíza discharges into Lago Carraizo. The study of the southern section includes approximately 19,500 meters, upstream of the lake. There are eleven (11) bridges or other structures on this section. The hydraulic analysis was performed using 115 river cross-sections.

Rĩo Gurabo
Rĩo Gurabo discharges into Rĩo Grande de Loíza (Reach 2). The study of this section includes approximately 19,350 meters, upstream of the confluence. There are five (5) bridges or other structures on this section. The hydraulic analysis was performed using 86 river cross-sections.

Rĩo Turabo
Rĩo Turabo discharges into Rĩo Grande de Loíza (Reach 2). The study of this section includes approximately 9,350 meters, upstream of the confluence. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 52 river cross-sections.

Rĩo Valenciano
Rĩo Valenciana discharges into Rĩo Gurabo. The study of this section includes approximately 2,250 meters, upstream of the confluence. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 15 river crosssections.

Rĩo Caguitas
Rĩo Cagitas discharges into Rĩo Grande de Loíza Reach 2. The study of this section includes approximately 10,200 meters, upstream of the confluence. There are nine (9) bridges or other structures on this section. The hydraulic analysis was performed using 65river cross-sections.

Rĩo Bairoa
Rĩo Bairoa discharges into Rĩo Grande de Loíza Reach 1. The study of this section includes approximately 9,350 meters, upstream of the confluence. There are twelve (12) bridges or other structures on this section. The hydraulic analysis was performed using 78 river crosssections.

Rĩo Sabana
Rĩo Sabana discharges into the Atlantic Ocean on the east coast of Puerto Rico. The study includes approximately 5,300 meters, upstream of the coast. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 28 river crosssections. The Manning's "n" value in the channel is 0.040.

Rĩo Fajardo
Rĩo Fajardo discharges into the Atlantic Ocean on the east coast of Puerto Rico. The study includes approximately 13,800 meters, upstream of the coast. There are three (3) bridges or other structures on this section. The hydraulic analysis was performed using 47 river cross-sections. The Manning's "n" value in the channel is 0.045 upstream and 0.040 downstream.

Rĩo Humacao
Rĩo Humacao discharges into the Caribbean Sea on the east coast of Puerto Rico. The study includes approximately 10,800 meters, upstream of the coast. There are eight (8) bridges or other structures on this section. The hydraulic analysis was performed using 72 river cross-sections. The Manning's "n" value in the channel is 0.040.

Quebrada Mabu
Quebrada Mabu discharges into Rĩo Humacao. The study of Quebrada Mabu includes approximately 3,650 meters, upstream of the confluence. There are thirteen (13) bridges or other structures on this section. The hydraulic analysis was performed using 88 river crosssections. The Manning's "n" value in the channel is 0.045.

Quebrada Mariana
Quebrada Mariana discharges into Rĩo Humacao. The study of Quebrada Mariana includes approximately 4,100 meters, upstream of the confluence. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 25 river crosssections. The Manning's "n" value in the channel is 0.040.

Quebrada Mariana Tributary
The un-named tributary to Quebrada Mariana discharges into Quebrada Mariana. The study of Quebrada Mariana Tributary includes approximately 1,950 meters, upstream of the confluence. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 19 river cross-sections. The Manning's "n" value in the channel is 0.045.

Rĩo Guayanes
Rĩo Guayanes discharges into the Caribbean Sea on the east coast of Puerto Rico. The study includes approximately 16,300 meters, upstream of the coast. There are seven (7) bridges or other structures on this section. The hydraulic analysis was performed using 68 river cross-sections. The Manning's "n" value in the channel is 0.040.

Rĩo Limones
Rĩo Limones discharges into Rĩo Guayanes. The study of Rĩo Limones includes approximately 4,600 meters, upstream of the confluence. There are three (3) bridges or other structures on this section. The hydraulic analysis was performed using 32 river crosssections. The Manning's "n" value in the channel is 0.045.

Rĩo Guanajibo
Rĩo Guanajibo discharges into the ocean on the west coast of Puerto Rico. The study includes approximately 39,650 meters, upstream of the coast. There are fourteen (14) bridges or other structures on this section. The hydraulic analysis was performed using 85 river cross-sections. The Manning's "n" value in the channel is 0.045 upstream and 0.040 downstream.

Quebrada Honda
Quebrada Honda discharges into Rĩo Guanajibo. The study includes approximately 2,450 meters, upstream of the confluence. There are five (5) bridges or other structures on this section. The hydraulic analysis was performed using 35 river cross-sections. The Manning's "n" value in the channel is 0.040.

Rĩo Culebrinas (Downstream Reach)
Rĩo Culebrinas discharges into the ocean on the west coast of Puerto Rico. Two different sections are included in this study. Area A is the coastal area (unadjusted from the April 19, 2005, FIS) and Area B is located upstream of PR Highway 2. The study of Rĩo Culebrinas (Downstream Reach) includes approximately 14,000 meters, upstream of the coast. There are six (6) bridges or other structures on this section. The hydraulic analysis was performed using 64 river crosssections. The Manning's "n" value in the channel is 0.040.

Rĩo Culebrinas (at San Sebastiàn)
The study of Rĩo Culebrinas (at San Sebastiàn) includes approximately 5,300 meters, upstream of the coast. There are five (5) bridges or other structures on

this section. The hydraulic analysis was performed using 47 river crosssections. The Manning's "n" value in the channel is 0.040.

Rĩo Culebrinas (at San Sebastiàn) Tributary
The subject river is an unnamed tributary of Rĩo Culebrinas (at San Sebastiàn). For this study it is called Rĩo Culebrinas Tributary and discharges into Rĩo Culebrinas at San Sebastian. The study of Rĩo Culebrinas Tributary includes approximately 1,100 meters, upstream of the confluence. There are two (2) bridges or other structures on this section. The hydraulic analysis was performed using 16 river cross-sections. The Manning's "n" value in the channel is 0.045.

Rĩo Guatemala
Rĩo Guatemala discharges into Rĩo Culebrinas (at San Sebastiàn). The study of Rĩo Guatemala includes approximately 3,600 meters, upstream of the confluence. There are four (4) bridges or other structures on this section. The hydraulic analysis was performed using 34 river cross-sections. The Manning's "n" value in the channel is 0.040.

Río Guayo
Río Guayo discharges into Río Inabon on the south coast of Puerto Rico. The study includes approximately 8,500 meters, upstream of Río Inabon. There are eight bridges or other structures on this section. The hydraulic analysis was performed using 63 river cross sections. The Manning's "n" value in the channel is 0.040.

Quebrada Honda
Quebrada Honda discharges into Río Cibuco on the north coast of Puerto Rico. The study includes approximately 5,900 meters, upstream of Río Cibuco. There are eight bridges or other structures on this section. The hydraulic analysis was performed using 56 river cross sections. The Manning's "n" value in the channel is predominantly 0.040, with one section of concrete-lined channel where Manning's "n" value is 0.014.

Río Jacaguas
Río Jacaguas discharges into the Caribbean Sea on the south coast of Puerto Rico. The study of this section includes approximately 22,600 meters upstream of the coast. There are eight bridges or other structures on this section. The hydraulic analysis was performed using 79 river cross sections. The Manning's "n" value in the channel is 0.040.

Near the mouth of Río Jacaguas, the floodplain spreads broadly along the coastal plan and merges with the floodplain of Río Inabon. At this point, the two rivers, although their channels remain separate down to the coast, act together to flood the surrounding region. Therefore, the combined drainage basin for the two rivers is used as the source of flows below the point of joint influence. The combined flow from the two sources is used to model flood elevations across the entire coastal floodplain. Upstream of the point of joint influence, the drainage basin of Río Jacaguas has no outside influence.

Río Jacaguas (at Villalba)

Río Jacaguas en Villalba is a section of Río Jacaguas upstream of the Village of Villalba. The study of this section includes approximately 4,900 meters. There are four bridges or other structures on this section. The hydraulic analysis was performed using 31 river cross sections. The Manning's "n" value in the channel is 0.040.

Río Matilde

Río Matilde discharges into the Caribbean Sea on the south coast of Puerto Rico. The study of Río Matilde includes approximately 2,700 meters, upstream of the coast. There are two bridges or other structures on this section. The hydraulic analysis was performed using 14 river cross sections. The Manning's "n" value in the channel is 0.040.

Río Cañas

Río Cañas discharges into Río Matilde at the point of confluence with Río Pastillo. The study of Río Cañas includes approximately 4,100 meters, upstream of the confluence. There are four bridges or other structures on this section. The hydraulic analysis was performed using 30 river cross sections. The Manning's "n" value in the channel is 0.040.

At certain flood stages, floodwaters rise to the point where they are higher than the divide which separates the Río Cañas and Río Portugues basins. At these elevations, floodwaters leave Río Cañas and flow into the upland portions of the Cañas Portugues basin. These flows are modeled in HEC-RAS as lateral structure diversions on the left bank of Río Cañas. As stated in the "Guidelines and Specifications for Flood Hazard Mapping Partners (2003), Appendix C, Section C.3.4.5," this overflow path must remain unobstructed, as ensured by "a note on the FIRM stating that the overflow area remains unencroached until a detailed hydraulic analysis is performed to establish a regulatory floodway."

Río Pastillo

Río Pastillo discharges into Río Matilde at the point of confluence with Río Cañas. The study includes approximately 4,800 meters, upstream of the confluence. There are three bridges or other structures on this section. The hydraulic analysis was performed using 26 river cross sections. The Manning's "n" value in the channel is 0.040.

Río Inabon

Analysis of the hydraulic characteristics of Río Inabon was carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-RAS computer program.

Cross sections at the bridges were field surveyed in order to compute the backwater effect of these structures. Stream cross sections were obtained from recent field survey data and LiDAR data. A total of 40 hydraulic cross sections were cut from the digital terrain model for the HEC-RAS hydraulic model. Generally, the survey data were used to develop the channel portion of the cross-section geometry while the LiDAR was the source of overbank topography.

Starting water-surface elevations for Río Grande de Manati used in hydraulic analyses were mean high, high-water level recorded at San Juan, Puerto Rico, tidal gage (ID 9755371).

Roughness factors (Manning's "n") were chosen by engineering judgment and were based on field observations of the streams and floodplain areas, unless otherwise noted. Table 5, "Roughness Coefficients," shows the channel and overbank "n" values for all of the streams studied by detailed methods:

TABLE 5 - ROUGHNESS COEFFICIENTS

Stream	Channel "n"	Overbank "n"
Río Camuy **	**	
Río Grande de Arecibo	0.036	0.240
Caño Tiburones	0.019	0.150
Río Cibuco	0.040-0.200	0.040-0.200
Río Indio	0.040-0.200	0.040-0.200
Quebrada Honda	0.040-0.200	0.040-0.200
Río de Los Negros	0.040-0.200	0.040-0.200
Río Morovis	0.040-0.200	0.040-0.200
Río de Bayamón	0.025-0.040	0.050-0.080
Río Guaynabo	0.025	0.060
Río Grande de Manati	0.016-0.190	0.016-1.000
Río Hondo	0.025[1]	0.060
Quebrada Santa Catalina	0.025	0.060
Canal Puerto Nuevo	0.020-0.035[2]	0.016-0.200[2]
Río Piedras	0.020-0.035[2]	0.016-0.200[2]
Quebrada Margarita	0.020-0.035[2]	0.016-0.200[2]
Quebrada Dona Ana	0.020-0.035[2]	0.016-0.200[2]
Quebrada Josefina	0.020-0.035	0.016-0.200
Quebrada Guaracanal	0.020-0.035	0.016-0.200
Quebrada Cepero	0.020-0.035	0.016-0.200

**Data not available

[1]For the concrete portion of the Río Hondo flood control channel, an "n" value of 0.014 was used.

[2]These values were used in the HEC-2 analysis; in the BISBY analysis, roughness values for "links" along stream channels ranged from 0.020 to 0.040, and floodplain roughness values ranged from 0.080 to 0.200.

TABLE 5 - ROUGHNESS COEFFICIENTS – continued

Stream	Channel "n"	Overbank "n"
Quebrada Juan Mendez	0.020-0.035	0.016-0.200
Caño de Martin Pena	0.035	0.250
Río Culebrinas (Downstream Reach)	0.040	0.100
Río Culebrinas (at San Sebastián)	0.040	0.100
Río Culebrinas (at San Sebastián) Tributary	0.045	0.10
Río Guatemala	0.040	0.100
Caño Madre Vieja	**	**
Río Guayabo	0.040	0.055-0.190
Río Culebra	0.040	0.055-0.190
Caño Guayabo	0.040	0.055-0.190
Unnamed Stream	0.040	0.055-0.190
Río Espíritu Santo	0.035	0.035-0.200
Río Grande	**	**
Río Mameyes	0.040	0.100-0.300
Río Fajardo	0.040-0.045	0.100
Río Sabana	0.040	0.100
Río Blanco	0.020-0.060	0.080-0.500
Río Santiago (including Río	0.020-0.060	0.080-0.500
Santiago Lateral Branch)	0.020-0.060	0.080-0.500
Río Yaguez	0.030-0.050	0.150-0.200
Río Grande de Añasco	0.040	0.100
Río Grande de Jauyua	**	**
Río Zamas	**	**
Río Caricaboa	**	**
Río Grande de Manatí	0.025	0.200
Río Orocovis	0.060	0.250
Río de la Plata[1]	0.025-0.040	0.100-0.200
Río de la Plata Tributary No. 1	0.020-0.030	0.150-0.250
Río Guavate	0.020-0.030	0.150-0.250
Quebrada Santo Domingo	0.020-0.030	0.150-0.250
Río de Aibonito Tributary No. 1	0.020-0.030	0.150-0.250
Río Guadiana	0.020-0.030	0.150-0.250
Río Grande de Loíza Reach 1	0.045	0.100
Río Grande de Loíza Reach 2	0.045	0.100
Río Cañovanas	0.045-0.080	0.100-0.160
Río Cañovanillas	0.045-0.080	0.100-0.160
Río Gurabo	0.045	0.100
Río Valenciano	0.045	0.100
Río Bairoa	0.045	0.100
Quebrada Cambute	0.045	0.100
Quebrada Muertos	0.045-0.080	0.100-0.160
Río Caguitas	0.045	0.100

**Data not available

TABLE 5 - ROUGHNESS COEFFICIENTS – continued

Stream	Channel "n"	Overbank "n"
Río Caguitas Tributary 1	0.045-0.080	0.100-0.160
Río Caguitas Tributary 2	0.045-0.080	0.100-0.160
Río Anton Ruíz	0.020-0.060	0.100-0.300
Quebrada Mambiche	0.020-0.060	0.100-0.300
Quebrada de las Mulas	0.020-0.060	0.100-0.300
Río Daguao	0.020-0.060	0.020-0.330
Quebrada Ceiba	0.020-0.060	0.020-0.330
Quebrada Aguas Claras	0.020-0.060	0.020-0.330
Quebrada Aguas Claras Tributary	0.020-0.060	0.020-0.330
Río Humacao	0.040	0.100
Quebrada Mabu	0.045	0.100
Quebrada Mariana	0.040	0.100
Quebrada Mariana Tributary	0.045	0.100
Río Guanajibo	0.040-0.045	0.100
Quebrada Honda (Río Guanajibo Basin)	0.040	0.100
Quebrada Honda Tributary	0.045-0.100	0.030-0.150
Quebrada Mendoza-Quebrada Las Tunas	0.060-0.100[1]	0.100-0.150[1]
Concepción Channel	0.015-0.070	0.070-0.150
Quebrada Pileta	0.050-0.150	0.100-0.150
Río Loco	0.025-0.045	0.160
Río Yauco	0.030-0.250	0.030-0.025
Quebrada Berrenchin	0.030-0.250	0.030-0.025
Quebrada Berrenchin Tributary No. 1	0.030-0.250	0.030-0.025
Río Guayanilla	0.020-0.300	0.020-0.300
Río Macana	0.020-0.300	0.020-0.300
Río Tallaboa	0.040	0.100
Río Guayanes (Río Tallaboa Basin)	0.035	0.100
Río Jacaguas	0.050-0.090	0.050-0.300
Río Jacaguas (at Villalba)	0.050-0.090	0.050-0.300
Río Inabon	0.050-0.090	0.050-0.300
Río Guayo	0.050-0.090	0.050-0.300
Río Coamo	0.040	0.100-0.120
Río Descalabrado	0.035-0.060	0.100-0.250
Río Nigua	0.040-0.060	0.100
Río Grande de Patillas	0.040-0.100	0.050-0.350
Quebrada Mamey	0.040-0.100	0.050-0.350

**Data not available

[1]For the concrete-lined portions of Quebrada Mendoza-Quebrada Las Tunas from PR Highway 102 to PR Highway 103, the values ranged from 0.015 for the concrete to 0.150 for the natural overbank area.

TABLE 5 - ROUGHNESS COEFFICIENTS – continued

Stream	Channel "n"	Overbank "n"
Río Nigua (at Arroyo)	0.035-0.045	0.065-0.200
Río Nigua (at Pitahaya)	0.035-0.045	0.065-0.200
Río Guamani	0.040-0.060	0.070-0.100
Río Melania	0.040-0.100	0.050-0.350
Río Seco	0.040-0.100	0.050-0.350
Río Guayanes (Río Guayanes Basin)	0.040	0.100
Río Limones	0.045	0.100
Río Maunabo	0.030-0.045	0.150-0.200
Quebrada Arenas	0.030-0.045	0.150-0.200
Río Jacaboa 0.030-0.045	0.150-0.200	

All elevations are referenced to MSL. Qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS bench marks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned inclusion criteria.

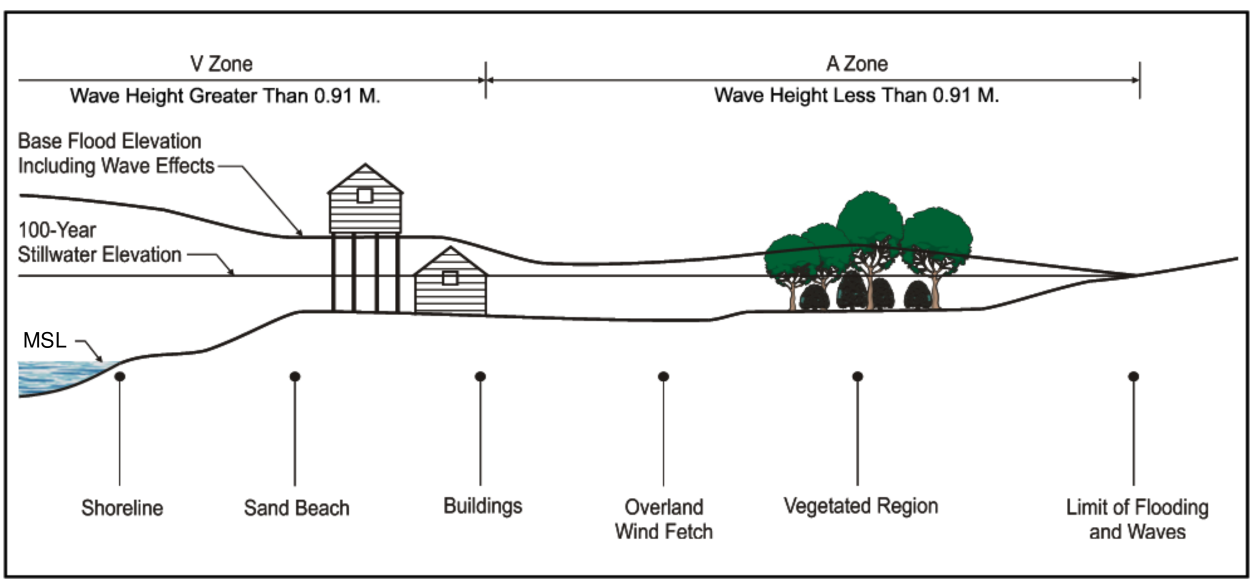
To obtain current elevation, description, and/or location information for bench marks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Coastal Analysis

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 0.9 meter breaking wave as the criterion for identifying the limit of coastal high hazard zones (USACE, 1975). The 0.9 meter wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame and brick veneer structures.

Figure 2 is a profile of a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave crest elevations being decreasasd by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Figure 3, "Transect Location Map," also illustrates the relationship between the local still water elevation, the ground profile and the location of the V/A boundary. This inland limit of the coastal high hazard area is delineated to ensure that adequate insurance rates apply and appropriate construction standards are imposed, should local agencies permit building in this coastal high hazard area.



TRANSECT SCHEMATIC Figure 2

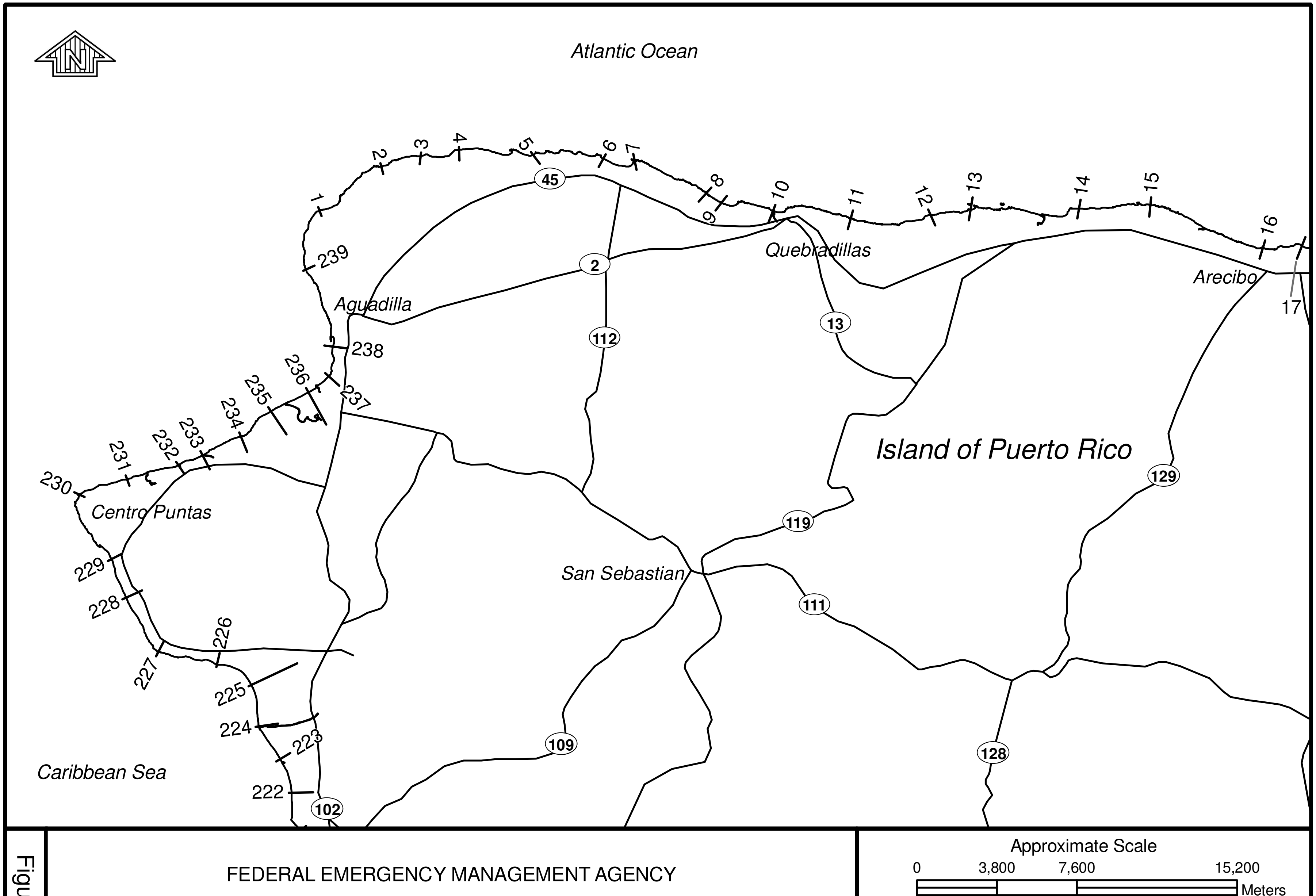


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

TRANSECT LOCATION MAP 1

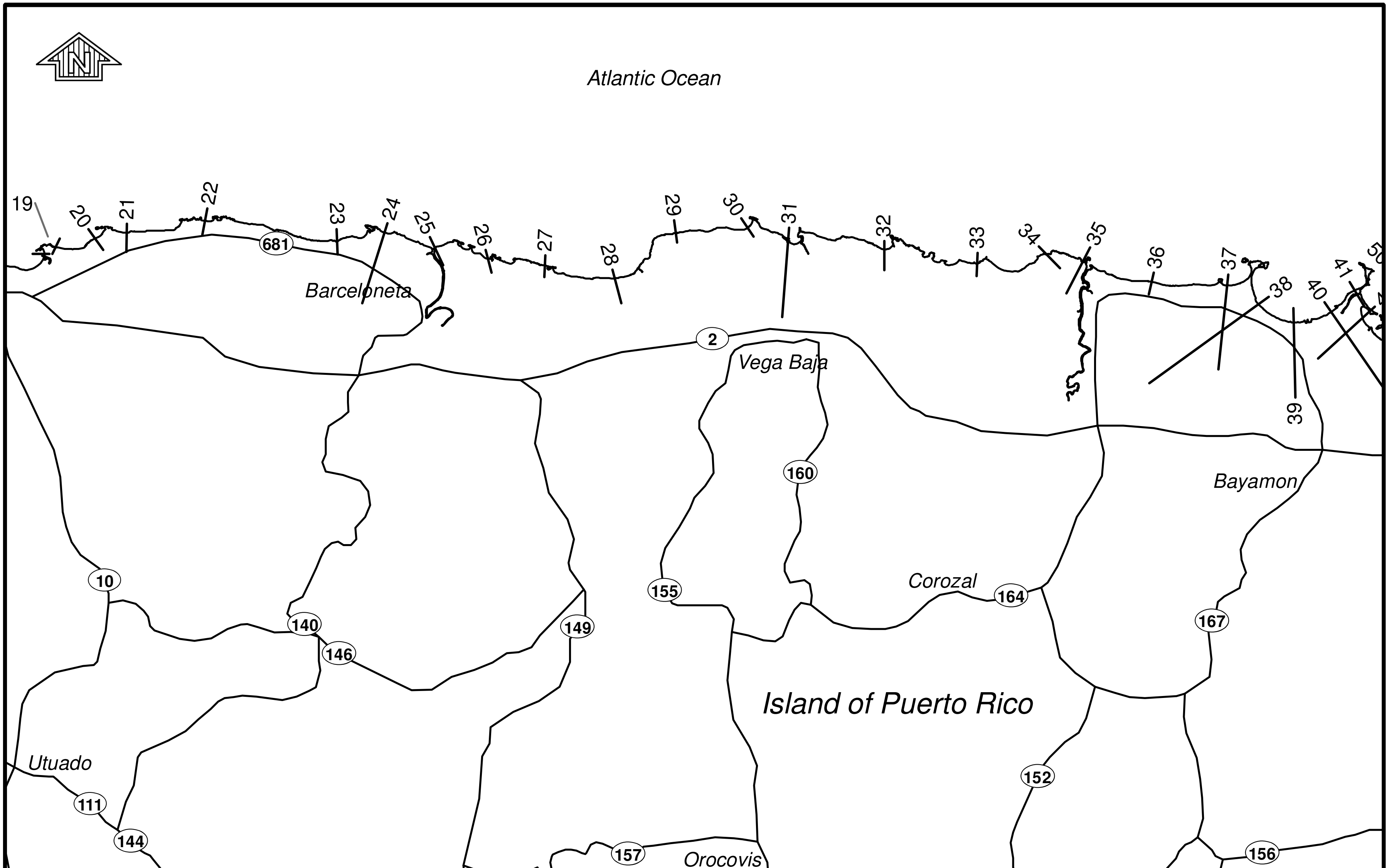


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

TRANSECT LOCATION MAP 2

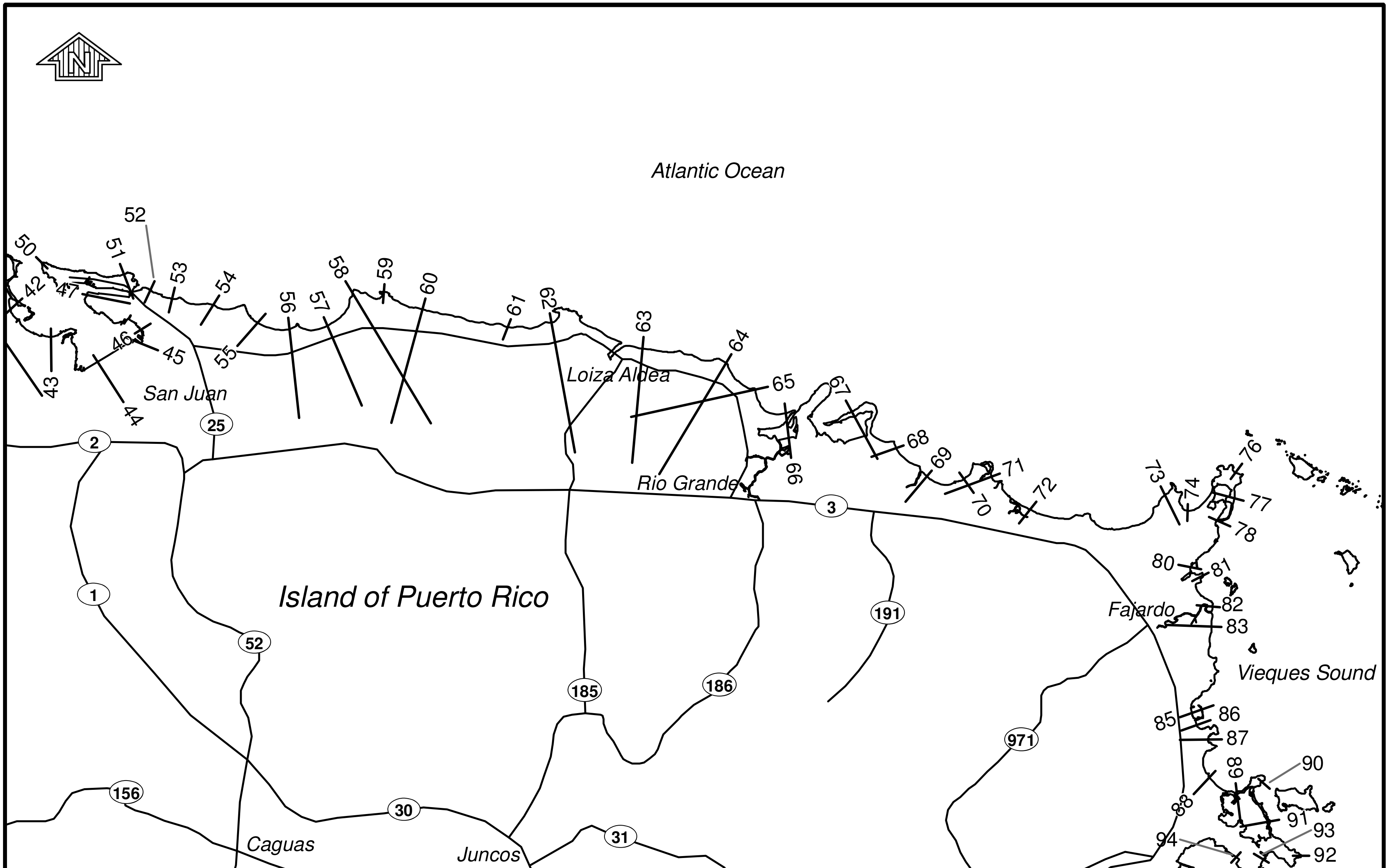


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0	3,750	7,500	15,000 Meters

TRANSECT LOCATION MAP 3

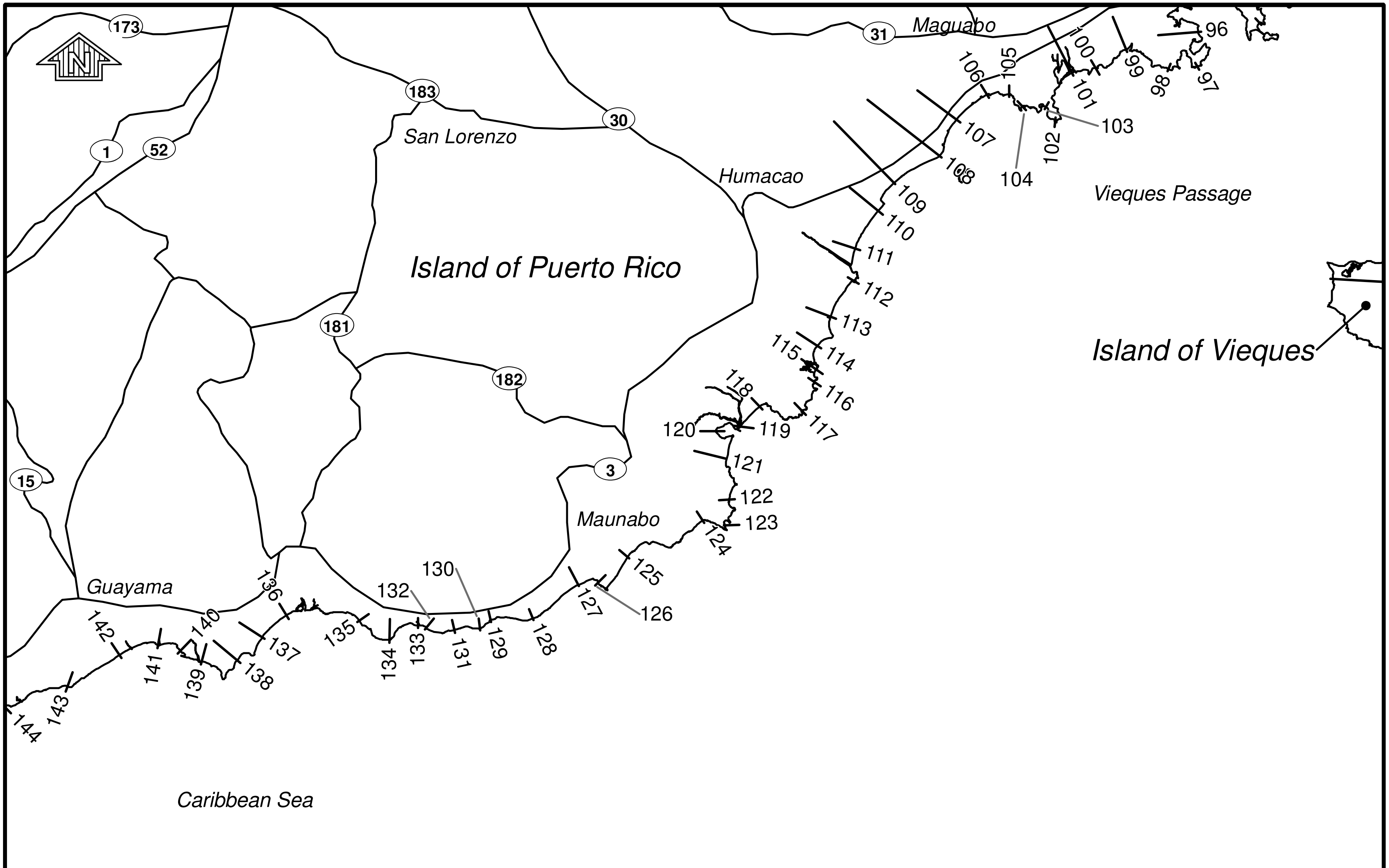


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

TRANSECT LOCATION MAP 4

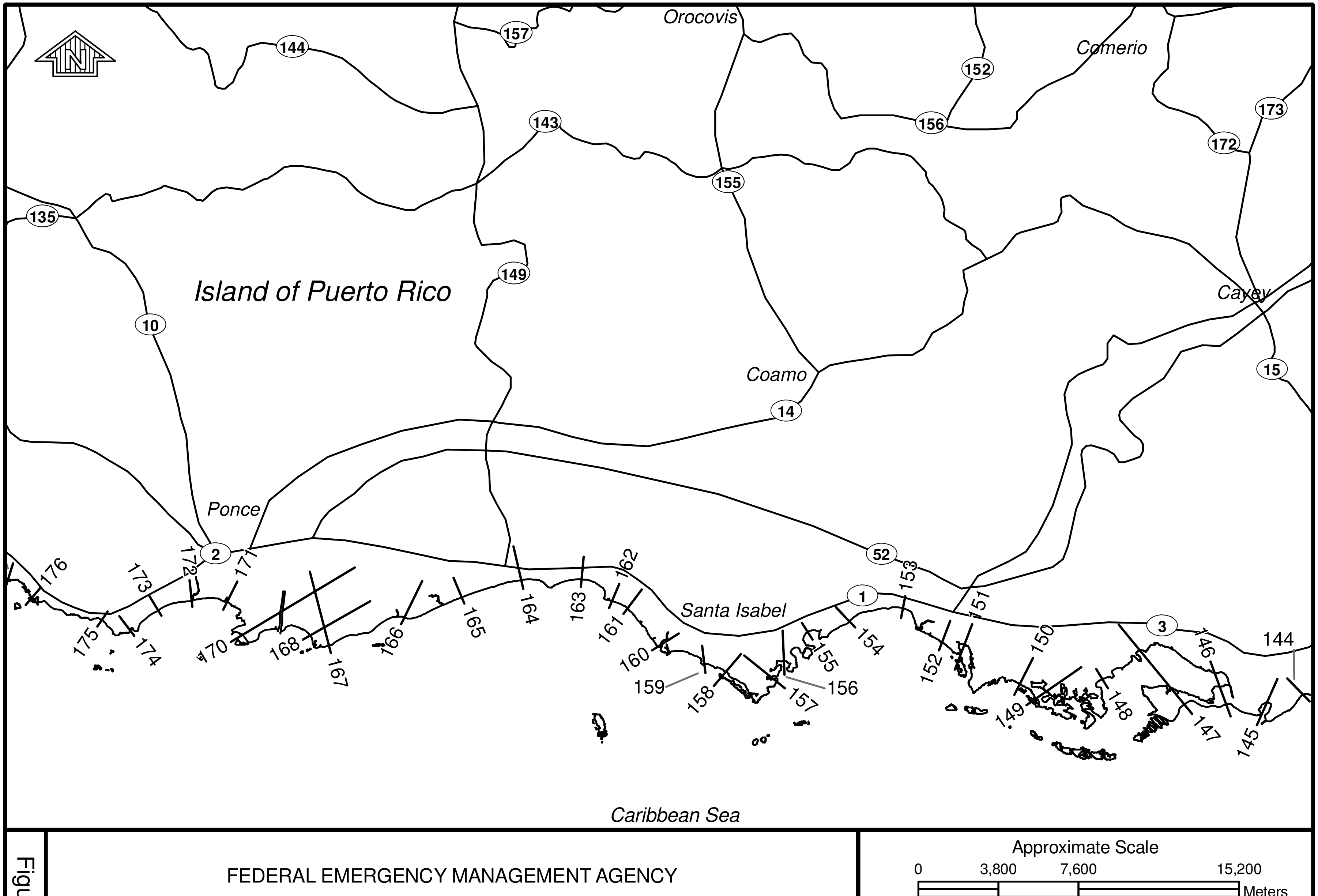


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

TRANSECT LOCATION MAP 5

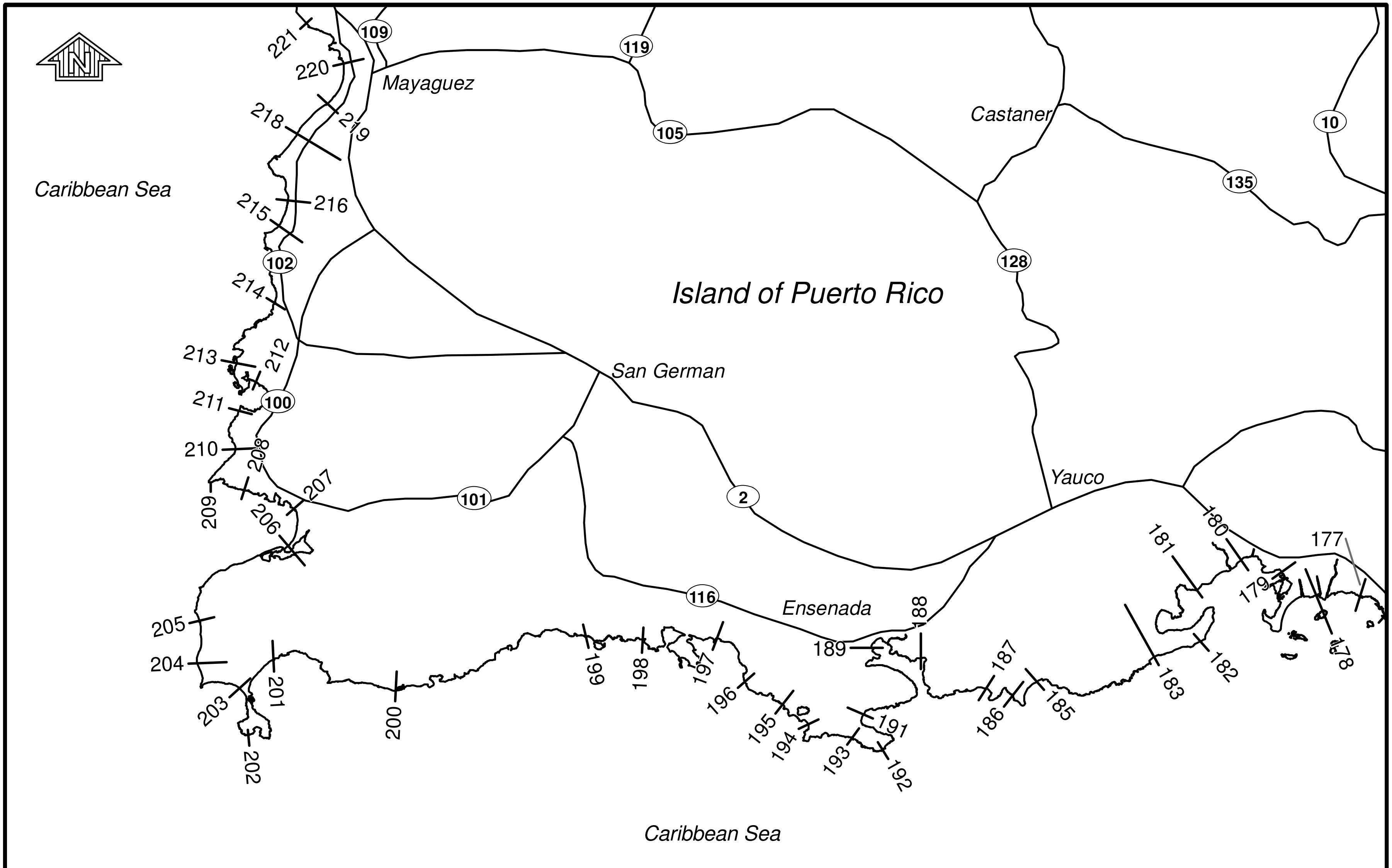


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,800 7,600 15,200 Meters

TRANSECT LOCATION MAP 6

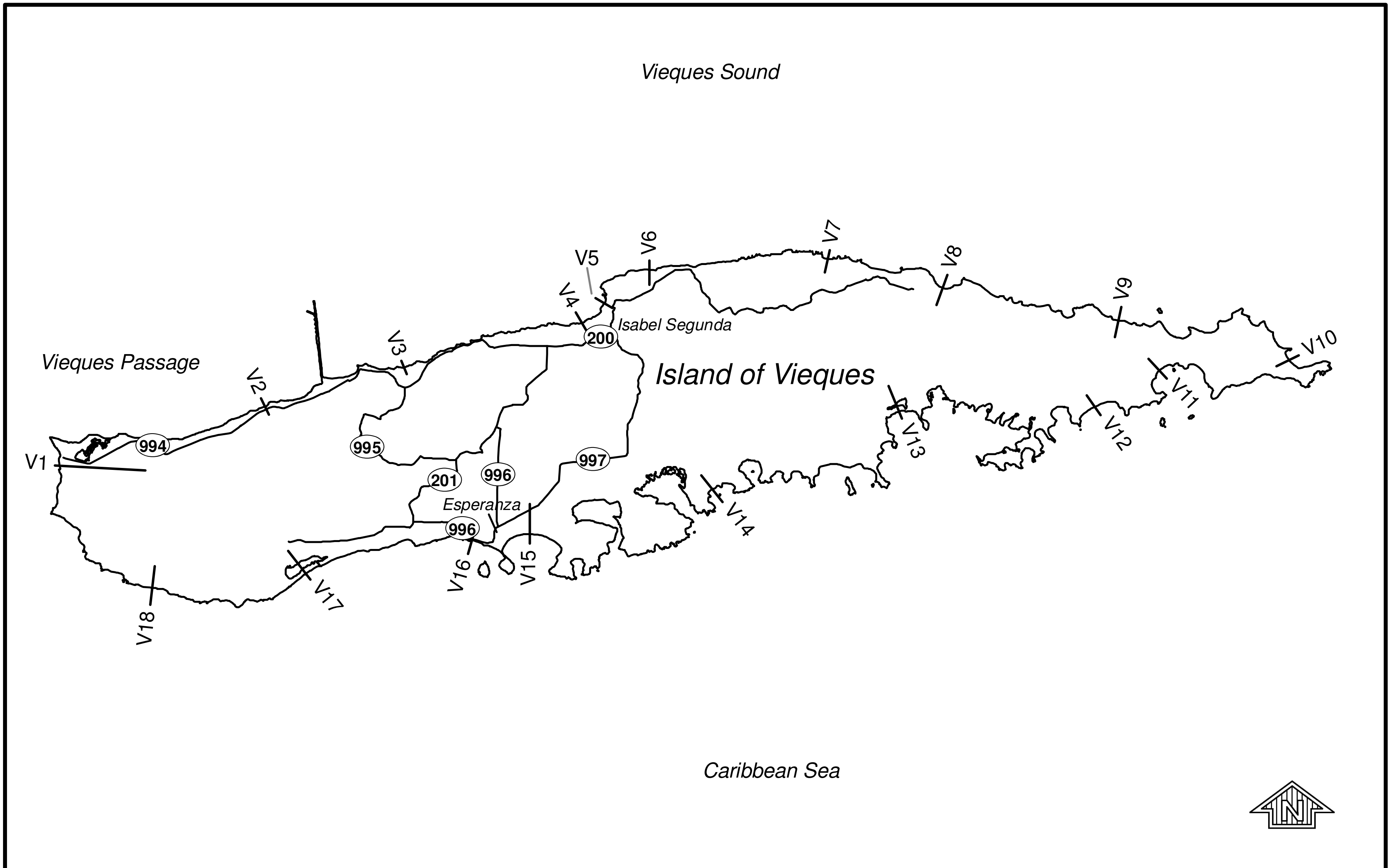


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO
ISLAND OF VIEQUES

Approximate Scale
0 2,050 4,100 8,200
Meters

TRANSECT LOCATION MAP 7

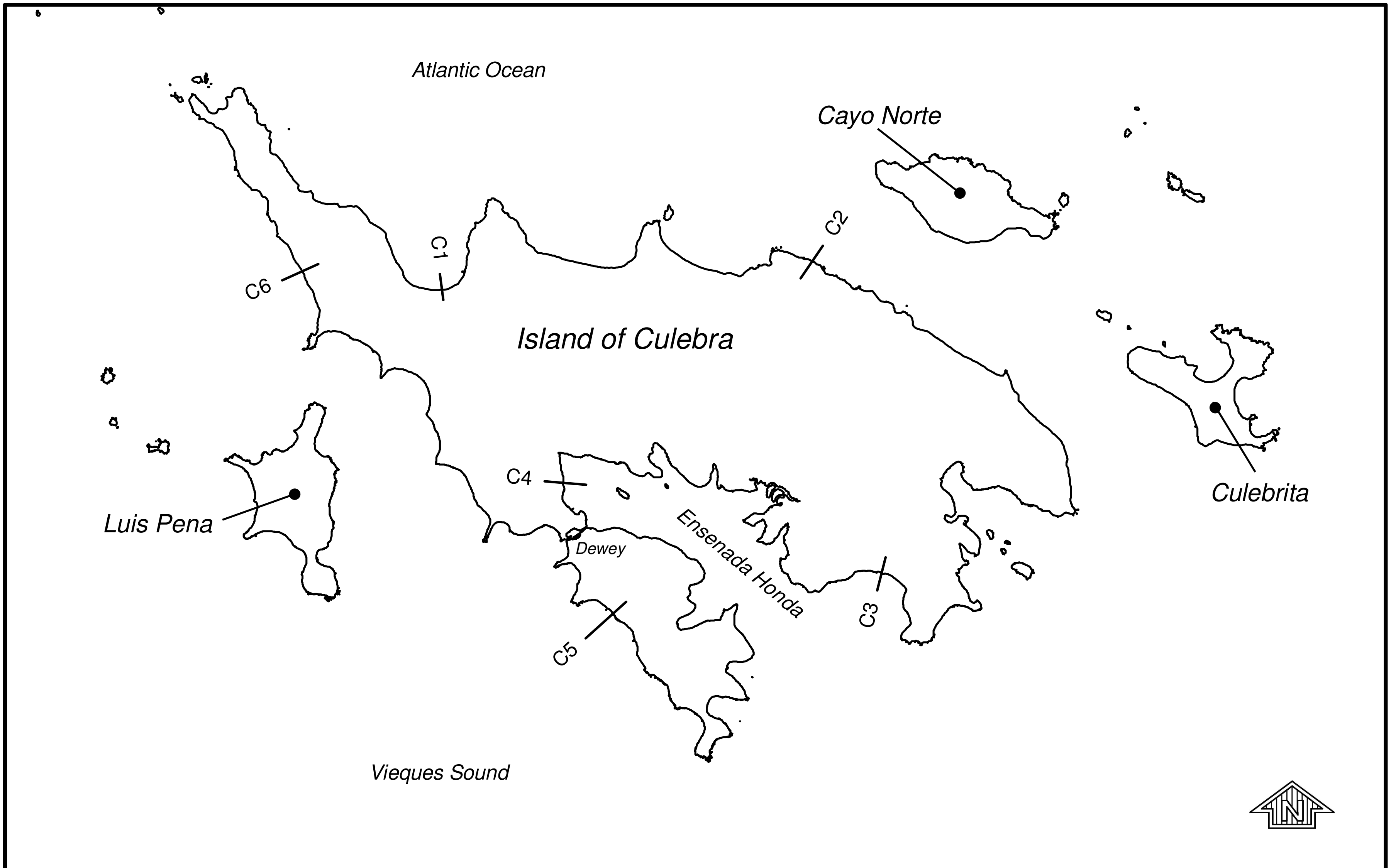


Figure 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

ISLAND OF CULEBRA

Approximate Scale

0 950 1,900 3,800 Meters

TRANSECT LOCATION MAP 8

Offshore wave characteristics representing a 1-percent annual chance storm were developed using the Shore Protection Manual (USACE, 1984) equations for slowly moving hurricanes. The storm statistics used in these equations were taken from NOAA Technical Memorandum NWS HYDRO-23 titled "*Storm Tide Frequency Analysis for the Coast of Puerto Rico*", (May 1975), and "*Final Report on Phase I of Storm-Surge Modeling for Puerto Rico and the U.S. Virgin Islands Using SLOSH*", (April 1984). Mean wave characteristics were determined as specified in the FEMA guidance for V Zone mapping:

$$H_{bar} = (h_s)(0.626)$$
$$T_{bar} = (T_s)(0.85)$$

Wave H_{bar} is the average wave height of all waves, H_s is the significant wave height or the average over the highest one third of waves, T_{bar} is the average wave period, and T_s is the significant wave associated with the significant wave height.

The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computer wave heights varied significantly between adjacent transects. Transects are shown on the FIRM panels for the Commonwealth of Puerto Rico (including the islands of Vieques and Culebra).

The transect profiles were obtained using bathymetric and topographic data from various sources. Bathymetric data consisted of NOAA surveys dating between 1962 and 2001. USACE hydrographic LiDAR data were used for the near shore, although a large gap existed along the south coast of Puerto Rico. Any remaining gaps between the NOAA hydrographic survey data and USACE hydrographic LiDAR were filled using NOAA navigational chart soundings. The topographic data sources included USACE topographic LiDAR data dated 2003, aerial photogrammetric topographic data dated 1996-1998 (where gaps in the USACE LiDAR dataset existed), and USGS National Elevation Dataset (west half of Vieques Island), dating to the 1970s and 1980s. All bathymetric and topographic data were brought to the MSL datum.

The Advanced Circulation model for Coastal Ocean Hydrodynamics (ADCIRC), (Luettich, 1995), developed by the USACE was selected to develop the stillwater elevations or storm surge from the Commonwealth of Puerto Rico. ADCIRC is a two-dimensional depth integrated, finite element, hydrodynamic model that solves the equations of motion for a moving fluid on a rotating earth. Water surface elevations are obtained from the solution of the depth-integrated continuity equation in the generalized wave continuity equation form, whereas velocities are obtained from the solution of the two-dimensional momentum equations. The model has the capability to simulate tidal circulation and storm surge propagation over large domains and is able to provide highly detailed resolution along the shoreline and other areas of interest.

The Empirical Simulation Technique (EST), also developed by the USACE Scheffner et al. (1999), was used to develop the stillwater frequency curves for the 10-, 2-, 1-, and 0.2-percent annual chance stillwater elevations.

An existing mesh developed by the USACE was refined around the islands of Puerto Rico, Vieques, and Culebra using bathymetric and topographic data from various sources. Bathymetric data consisted of NOAA surveys dating between 1962 and 2001. USACE hydrographic LiDAR data were used for the nearshore, although a large gap existed along the south coast of Puerto Rico. Any remaining gaps were filled using NOAA navigational chart soundings. The topographic portion of the ADCIRC mesh was populated with USACE topographic LiDAR data dated 2003, aerial photogrammetric topographic data dated 1996-1998, and USGS National Elevation Dataset, dating to the 1970s and 1980s. All bathymetric and topographic data were brought to the MSL datum.

In order to model storm surge using ADCIRC, wind and pressure fields are required for input. A model called the Planetary Boundary Layer model (PBL), developed by V.J. Cardone (Cardone, 1992), uses the statistics from a hurricane or storm to simulate the event and develop wind and pressure fields. The PBL model simulates hurricane-induced wind and pressure fields by applying the vertically integrated equations of motion. Oceanweather Inc., was contracted to run the PBL model and provide wind and pressure fields for each of the selected storms.

A total of 26 storms (shown in following table) were selected to represent the range of different storm magnitudes impacting the study area. Storms were selected using the following criteria: The event must have occurred after 1910; passed within 200 miles of any shoreline within the study area; been classified as a tropical storm or category 1-5 hurricane that may have caused considerable damage to the island. Hurricane Betsy was laterally shifted and ran two additional times for a total of 28 simulations.

Name of Storm	HURDAT ID#	Begin Date	End Date
Unnamed Storm of 1910	452	23-Aug	29-Aug
Unnamed Storm 2 of 1910	454	5-Sep	15-Sep
Unnamed Storm of 1916	483	10-Jul	22-Jul
Unnamed Storm 2 of 1916	486	21-Aug	25-Aug
Unnamed Storm 3 of 1916	593	6-Oct	15-Oct
Unnamed Storm of 1928	559	6-Sep	20-Sep
Unnamed Storm of 1930	566	31-Aug	17-Sep
Unnamed Storm of 1931	570	16-Aug	21-Aug
Unnamed Storm 2 of 1931	572	8-Sep	16-Sep
Unnamed Storm of 1943	588	27-Jun	7-Jul
Unnamed Storm 2 of 1943	695	11-Oct	17-Oct

Name of Storm	HURDAT ID#	Begin Date	End Date
Hurricane Betsy in 1956	825	9-Aug	19-Aug
Hurricane Donna in 1960	864	29-Aug	13-Sep
Hurricane Edith in 1963	888	23-Sep	29-Sep
Hurricane Inez in 1966	918	21-Sep	11-Oct
Hurricane Beulah in 1967	922	5-Sep	22-Sep
Hurricane Frederic in 1979	1046	29-Aug	14-Sep
Hurricane Gert in 1981	1067	7-Sep	15-Sep
Hurricane Klaus in 1984	1094	5-Nov	13-Nov
Hurricane Hugo in 1989	1139	11-Sep	25-Sep
Hurricane Luis in 1995	1198	27-Aug	12-Sep
Hurricane Marilyn in 1995	1199	12-Sep	1-Oct
Hurricane Hortense in 1996	1213	3-Sep	16-Sep
Hurricane Georges in 1998	1233	15-Sep	1-Oct
Hurricane Lenny in 1999	1352	13-Nov	23-Nov
Hurricane Jeanne in 2004	1320	13-Sep	29-Sep

The storm statistics were obtained from the Hurricane Database (HURDAT) developed by NOAA. The ADCIRC model was calibrated against predicted tidal cycles to calibrate the model and refine the grid. Tidal boundary conditions were obtained from a digital tidal constituent database (Le Provost, 1992). Model validation, which tests the model hydraulics and ability to reproduce events, was performed against Hurricanes Marilyn, Georges, and Hortense. Simulated water levels for each event were compared to observed water levels from NOAA tidal gauges.

The EST model was used for the stage-frequency analysis. The EST generates a large population of life-cycle databases that are processed to compute mean value frequencies. Input vectors describe the characteristics of each storm such as central pressure and maximum winds. The input response vector is the maximum surge elevation recorded at each station for each storm simulated with ADCIRC. The output is a stage-frequency curve for each station in the study area. The EST model performs a large number of simulations at each station. The mean value is selected from the entire EST simulation population at each station, and the return period elevation is the final resultant value.

Stillwater elevations for the Commonwealth of Puerto Rico (including the islands of Vieques and Culebra), obtained using the ADCIRC and EST models, are summarized in Table 6, "Summary of Coastal Stillwater Elevations." Locations of the surge stations for the three islands are shown in Figure 4 "Stillwater Station Location Maps 1 through 8." Please note that the identification labels for surge stations do not coincide with the transect identification labels.

Greater details of the storm surge modeling can be found in the Technical Data Support Notebook (TSDN) for this study.

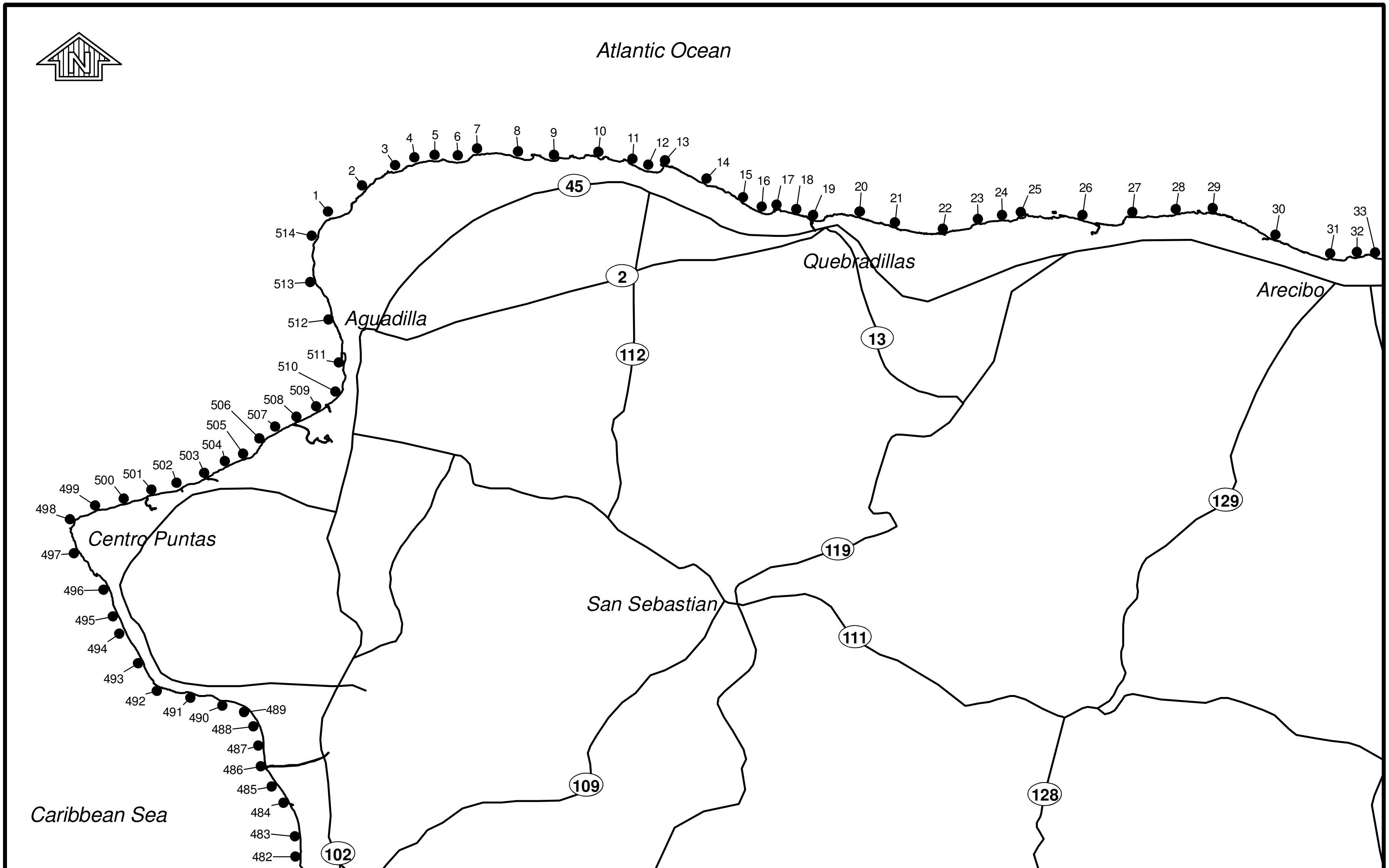


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 1

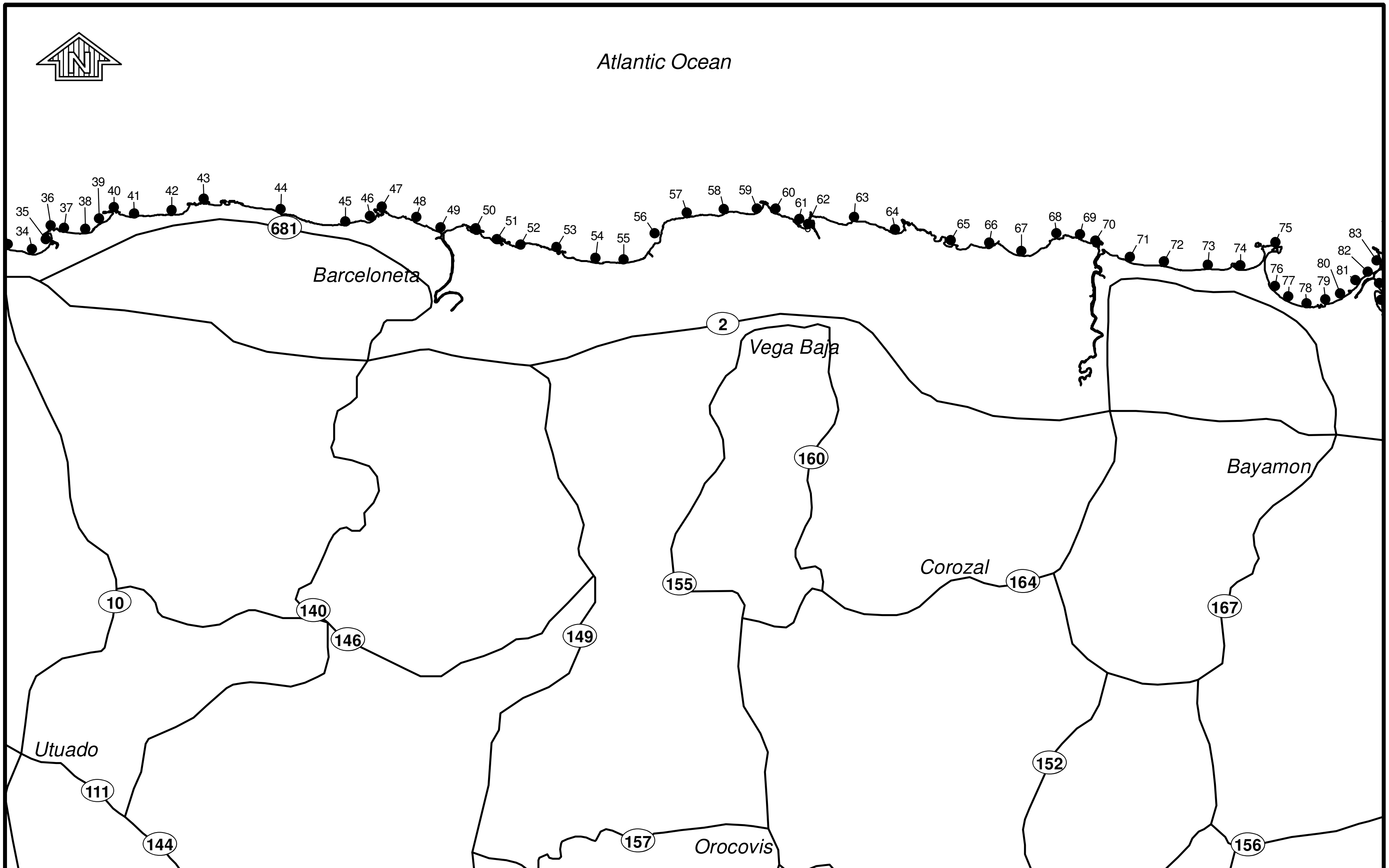


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 2

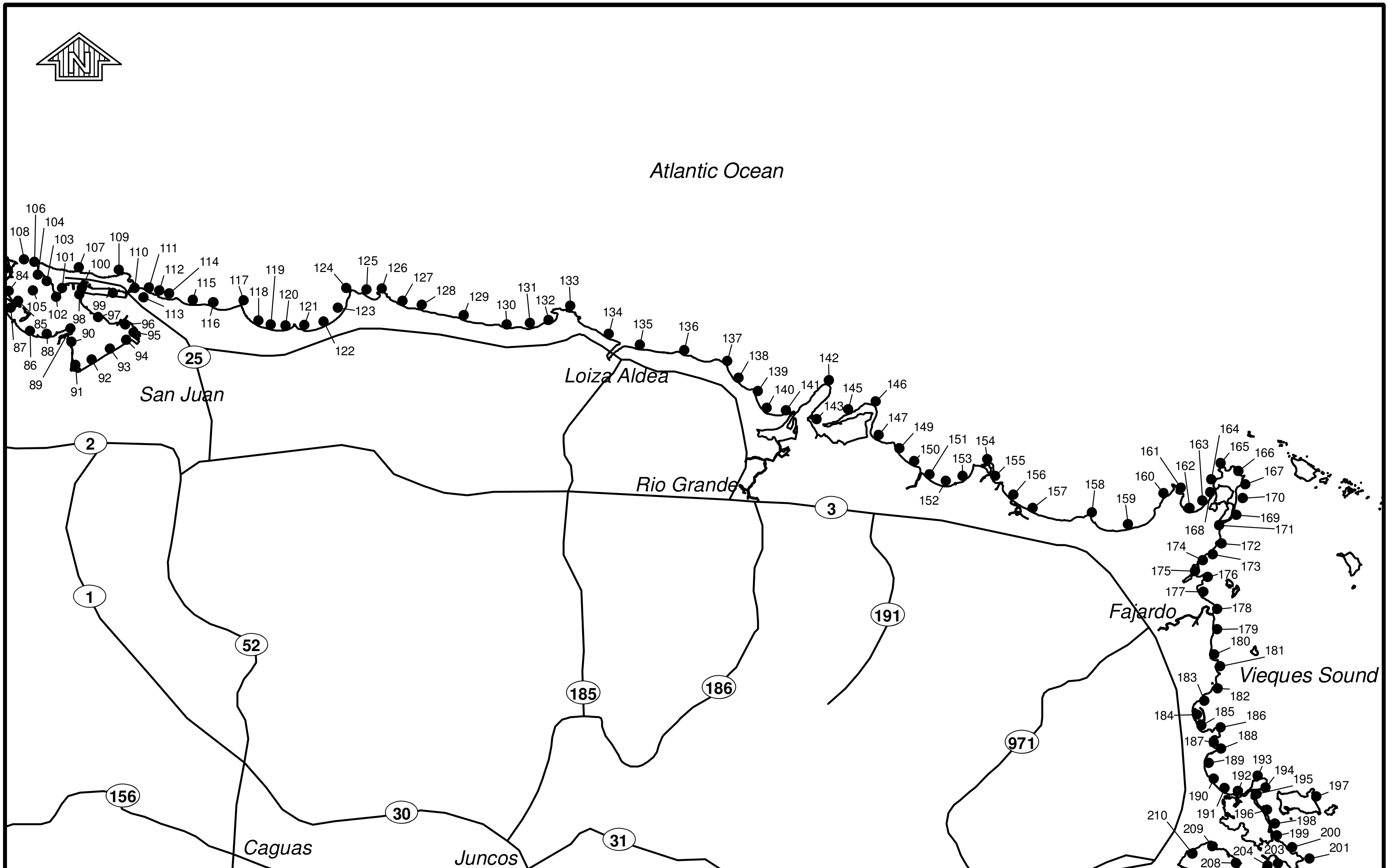


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 3

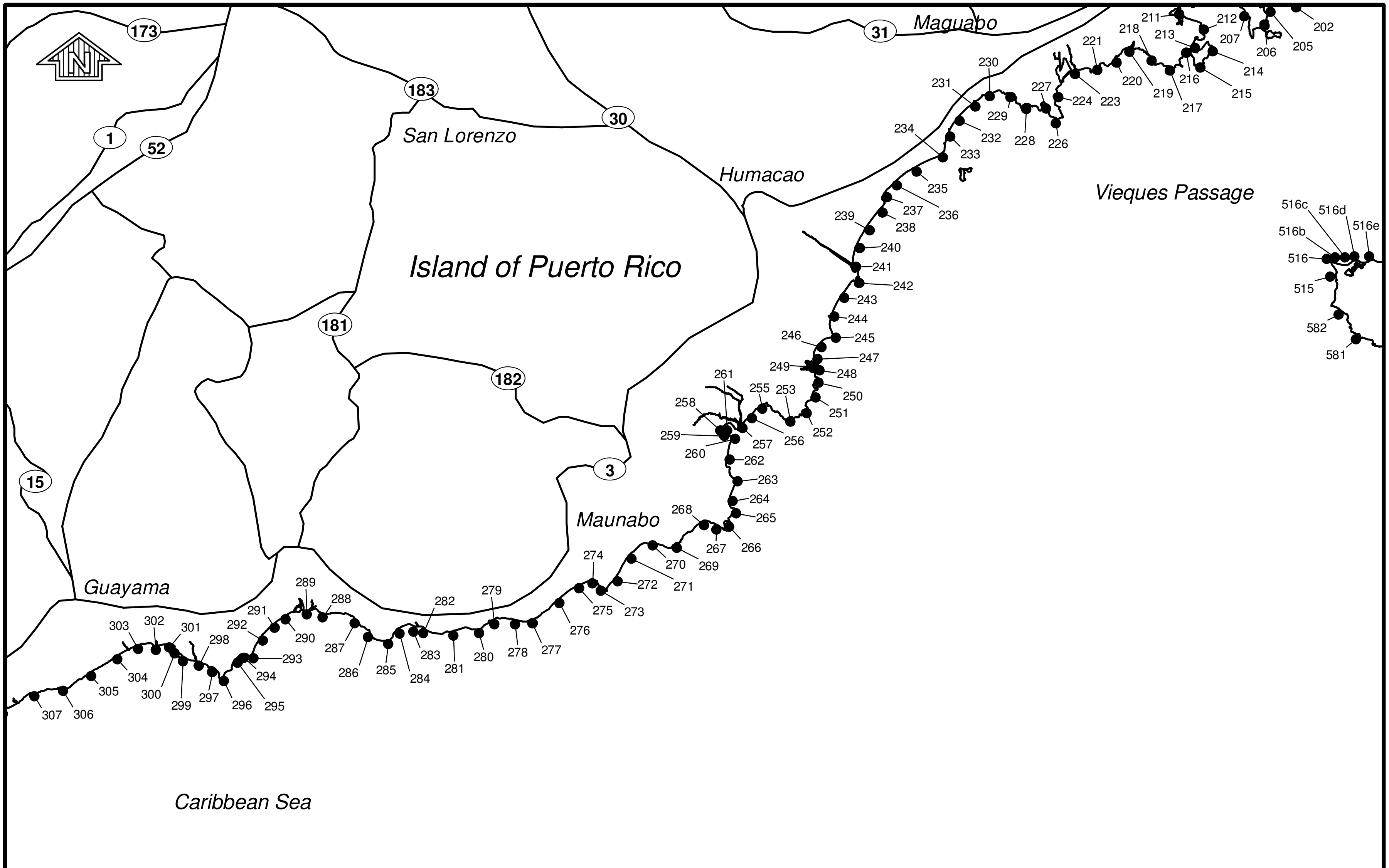


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 4

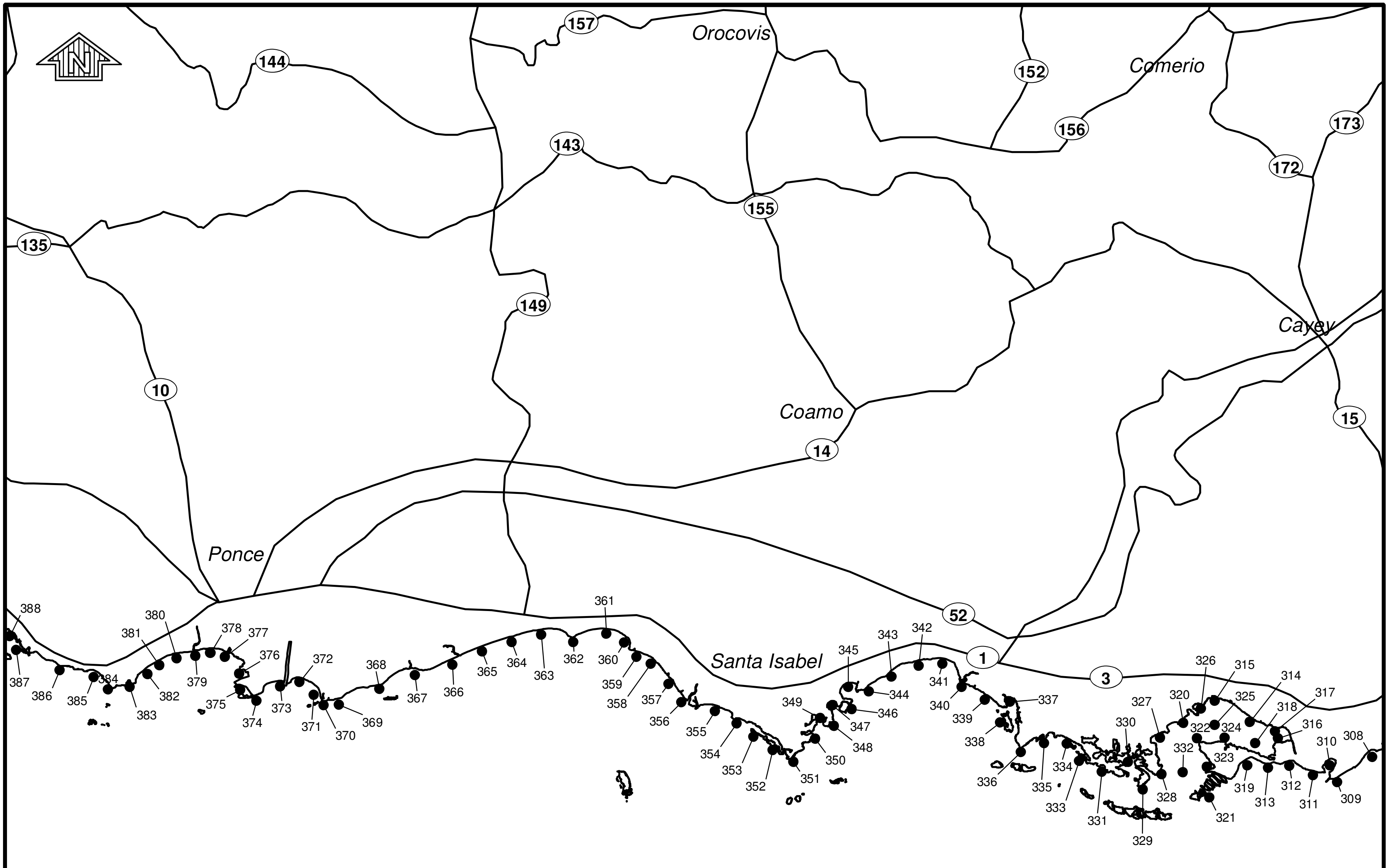


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 5

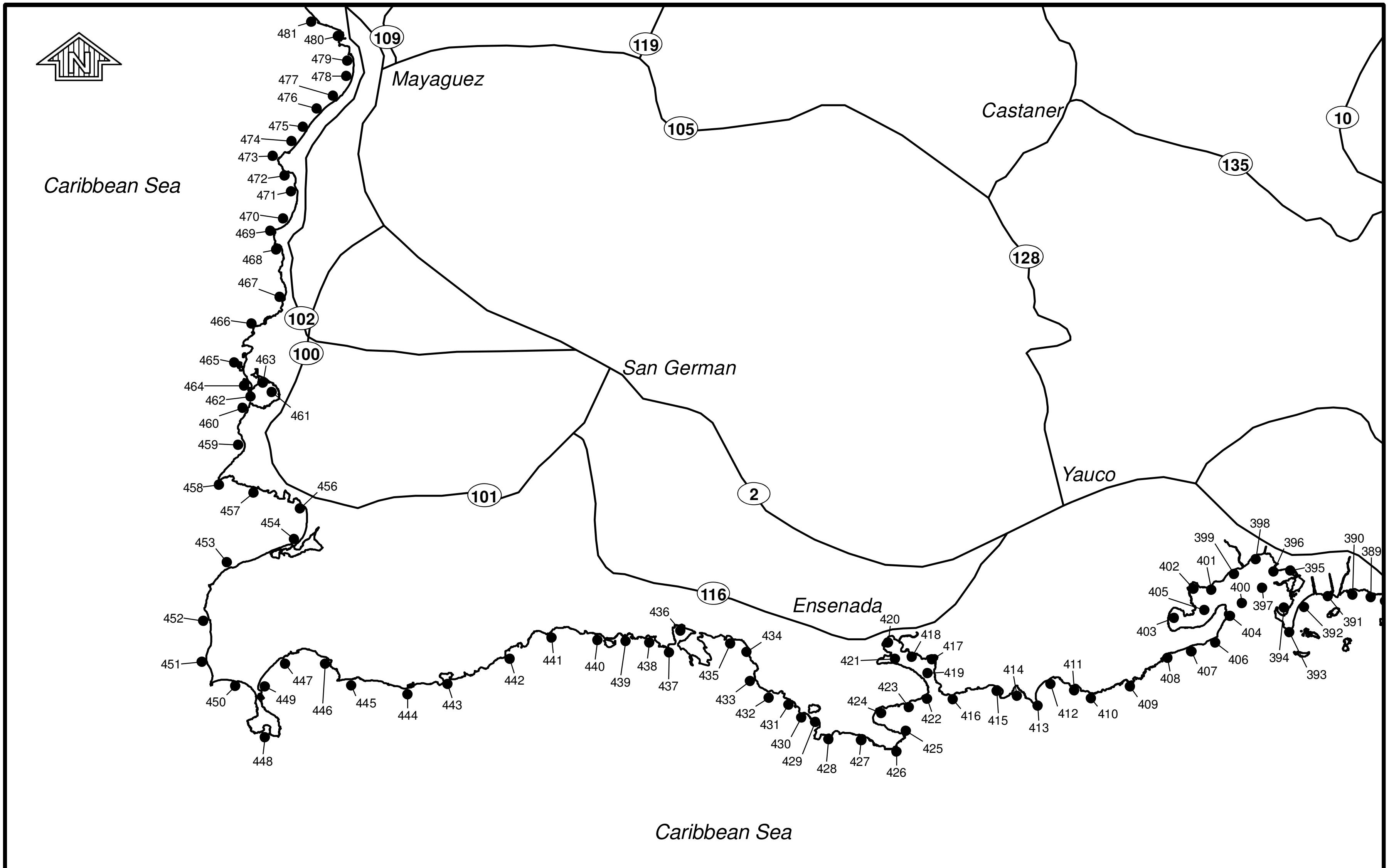


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO

Approximate Scale

0 3,750 7,500 15,000 Meters

STILLWATER STATION LOCATION MAP 6

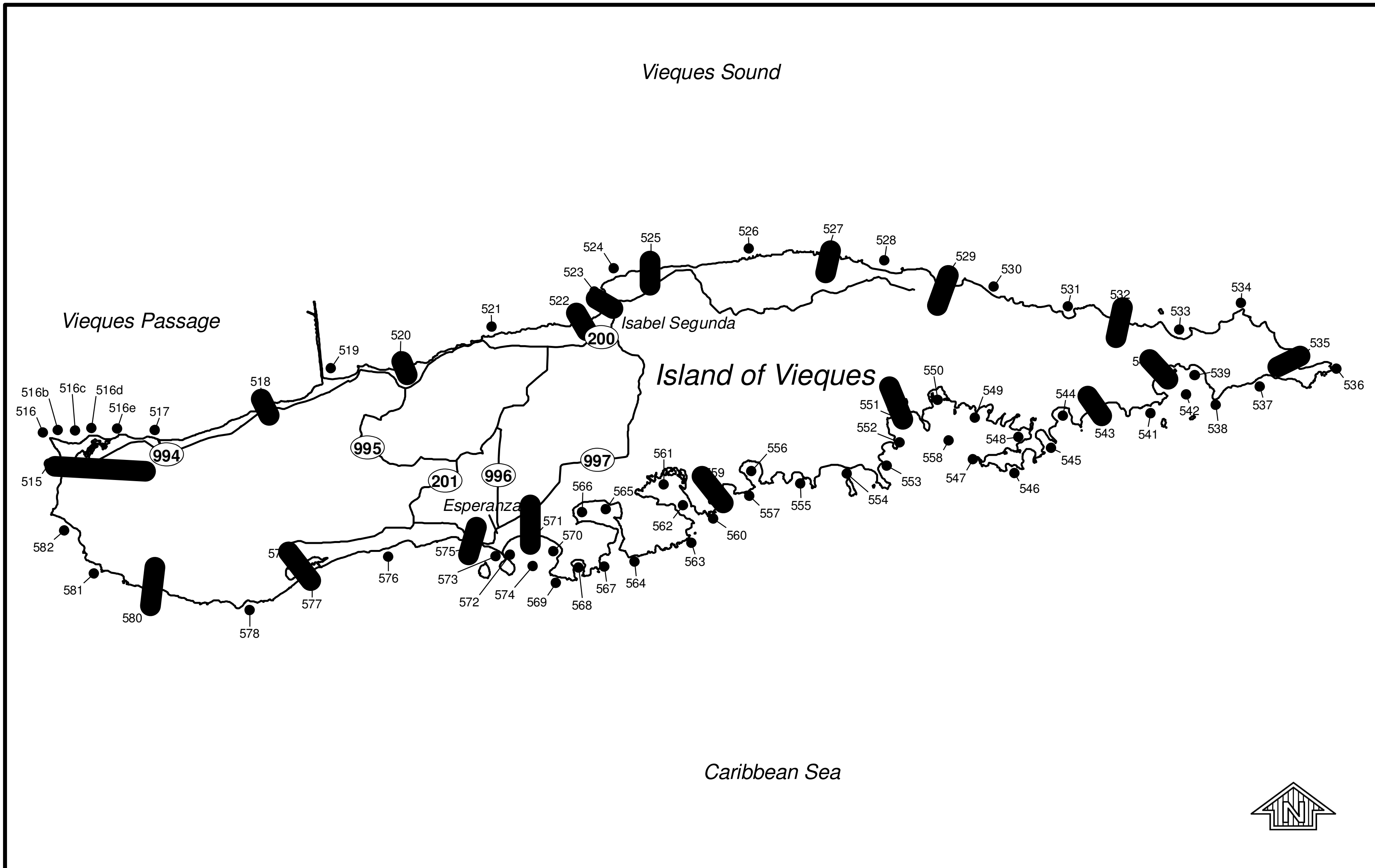


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO
ISLAND OF VIEQUES

Approximate Scale

0 2,050 4,100 8,200 Meters

STILLWATER STATION LOCATION MAP 7

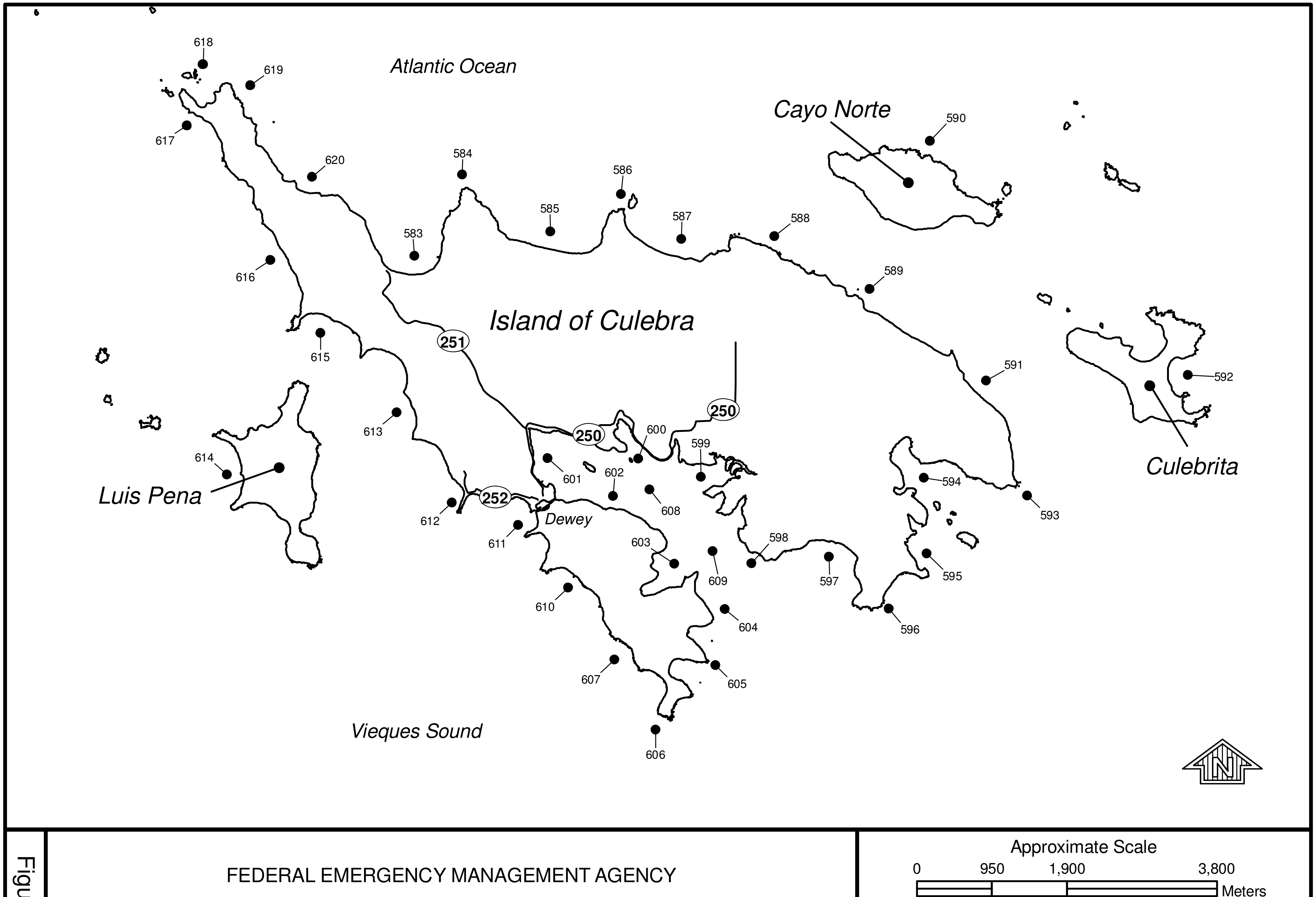


Figure 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO
ISLAND OF CULEBRA

STILLWATER STATION LOCATION MAP 8

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO						
Atlantic Ocean						
1	-67.16264	18.49199	0.2	0.6	1.1	2.3
2	-67.14834	18.50273	0.2	0.6	1.1	2.2
3	-67.13436	18.51079	0.3	0.7	1.2	2.3
4	-67.12617	18.51410	0.3	0.7	1.1	2.3
5	-67.11755	18.51506	0.3	0.7	1.2	2.3
6	-67.10774	18.51507	0.3	0.7	1.2	2.4
7	-67.09958	18.51779	0.3	0.7	1.2	2.4
8	-67.08213	18.51660	0.3	0.7	1.2	2.4
9	-67.06706	18.51532	0.3	0.7	1.2	2.4
10	-67.04808	18.51660	0.3	0.7	1.2	2.4
11	-67.03366	18.51381	0.3	0.7	1.2	2.4
12	-67.02699	18.51143	0.3	0.7	1.2	2.4
13	-67.01977	18.51334	0.3	0.7	1.2	2.4
14	-67.00215	18.50585	0.3	0.7	1.2	2.4
15	-66.98679	18.49830	0.3	0.7	1.3	2.5
16	-66.97865	18.49454	0.3	0.7	1.3	2.5
17	-66.97250	18.49538	0.3	0.7	1.3	2.5
18	-66.96411	18.49372	0.3	0.7	1.3	2.5
19	-66.95692	18.49133	0.3	0.7	1.2	2.5
20	-66.93728	18.49274	0.3	0.7	1.2	2.4
21	-66.92228	18.48835	0.3	0.7	1.3	2.4
22	-66.90205	18.48583	0.3	0.7	1.3	2.4
23	-66.88711	18.48991	0.3	0.7	1.2	2.5
24	-66.87691	18.49146	0.3	0.7	1.2	2.4
25	-66.86895	18.49265	0.3	0.7	1.2	2.4
26	-66.84280	18.49157	0.3	0.7	1.3	2.5
27	-66.82160	18.49279	0.3	0.7	1.2	2.3
28	-66.80302	18.49402	0.3	0.7	1.2	2.3
29	-66.78763	18.49440	0.3	0.7	1.2	2.3
30	-66.76088	18.48363	0.3	0.7	1.2	2.4
31	-66.73760	18.47622	0.3	0.7	1.2	2.3
32	-66.72641	18.47682	0.3	0.7	1.2	2.2
33	-66.71868	18.47649	0.3	0.7	1.2	2.3
34	-66.70844	18.47451	0.4	0.8	1.3	2.4
35	-66.70259	18.47840	0.3	0.7	1.1	2.1
36	-66.70056	18.48404	0.3	0.7	1.1	2.1
37	-66.69497	18.48315	0.3	0.7	1.2	2.2
38	-66.68581	18.48260	0.3	0.7	1.2	2.2
39	-66.68004	18.48693	0.3	0.7	1.0	2.0
40	-66.67383	18.49141	0.3	0.6	1.0	1.9
41	-66.66525	18.48888	0.3	0.7	1.1	2.1

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Atlantic Ocean (continued)						
42	-66.64920	18.49039	0.3	0.7	1.1	2.1
43	-66.63566	18.49496	0.3	0.6	1.0	1.9
44	-66.60303	18.49086	0.3	0.7	1.1	2.0
45	-66.57557	18.48574	0.4	0.8	1.2	2.2
46	-66.56511	18.48795	0.3	0.7	1.1	2.0
47	-66.56012	18.49174	0.3	0.7	1.0	1.9
48	-66.54541	18.48761	0.3	0.7	1.0	1.9
49	-66.53515	18.48338	0.3	0.7	1.1	2.0
50	-66.52039	18.48298	0.3	0.7	1.1	2.0
51	-66.51127	18.47857	0.3	0.7	1.1	2.1
52	-66.50132	18.47653	0.3	0.7	1.0	1.9
53	-66.48610	18.47550	0.3	0.7	1.0	1.9
54	-66.46968	18.47110	0.3	0.8	1.1	2.0
55	-66.45771	18.47039	0.4	0.8	1.1	2.1
56	-66.44444	18.48110	0.3	0.6	0.8	1.4
57	-66.43081	18.48942	0.3	0.7	0.9	1.6
58	-66.41515	18.49081	0.3	0.7	0.9	1.6
59	-66.40098	18.49112	0.3	0.7	1.0	1.6
60	-66.39316	18.49098	0.3	0.7	1.1	1.9
61	-66.38299	18.48677	0.4	0.8	1.1	1.9
62	-66.37935	18.48486	0.4	0.8	1.0	1.7
63	-66.35972	18.48761	0.3	0.7	0.9	1.6
64	-66.34262	18.48265	0.4	0.8	1.0	1.7
65	-66.31904	18.47830	0.3	0.8	1.0	1.9
66	-66.30260	18.47719	0.4	0.8	1.0	1.6
67	-66.28900	18.47379	0.4	0.9	1.2	2.1
68	-66.27412	18.48093	0.3	0.7	0.8	1.4
69	-66.26404	18.48064	0.3	0.7	0.9	1.6
70	-66.25761	18.47802	0.3	0.7	1.0	1.7
71	-66.24297	18.47133	0.4	0.8	1.1	2.0
72	-66.22842	18.46946	0.4	0.8	1.1	1.8
73	-66.20990	18.46819	0.4	0.9	1.1	1.8
74	-66.19615	18.46797	0.4	1.0	1.2	2.0
75	-66.18129	18.47721	0.3	0.6	0.8	1.2
76	-66.18145	18.45948	0.5	1.1	1.5	2.7
77	-66.17581	18.45529	0.5	1.1	1.4	2.6
78	-66.16809	18.45248	0.5	1.1	1.4	2.4
79	-66.16016	18.45409	0.5	1.0	1.3	2.1
80	-66.15381	18.45653	0.5	1.0	1.3	2.0
81	-66.14731	18.46185	0.4	0.9	1.1	1.7
82	-66.14212	18.46531	0.4	0.9	1.1	1.6

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Atlantic Ocean (continued)						
83	-66.13821	18.46981	0.4	0.8	1.0	1.5
84	-66.13732	18.46054	0.5	1.0	1.4	2.5
85	-66.13336	18.45655	0.5	1.1	1.4	2.4
86	-66.12830	18.44443	0.6	1.2	1.6	2.6
87	-66.13647	18.45378	0.5	1.2	1.7	3.2
88	-66.12112	18.44310	0.6	1.2	1.5	2.4
89	-66.11109	18.44534	0.5	1.0	1.2	1.8
90	-66.11071	18.43992	0.5	1.2	1.5	2.1
91	-66.10900	18.43056	0.6	1.3	1.7	2.5
92	-66.10204	18.43262	0.6	1.3	1.6	2.4
93	-66.09426	18.43707	0.6	1.2	1.5	2.1
94	-66.08750	18.44067	0.5	1.1	1.4	2.1
95	-66.08427	18.44359	0.5	1.1	1.4	2.1
96	-66.08792	18.44689	0.5	1.1	1.3	1.9
97	-66.09940	18.44997	0.4	1.0	1.2	1.7
98	-66.10724	18.45902	0.4	0.9	1.1	1.6
99	-66.09306	18.45968	0.4	0.9	1.1	1.5
100	-66.10618	18.46177	0.4	0.8	1.0	1.5
101	-66.11459	18.46174	0.4	0.8	1.1	1.6
102	-66.11716	18.45808	0.4	0.9	1.1	1.7
103	-66.12110	18.46455	0.4	0.8	1.0	1.5
104	-66.12487	18.46722	0.4	0.8	1.0	1.7
105	-66.12694	18.46081	0.4	0.8	1.1	1.8
106	-66.12637	18.47240	0.3	0.7	1.0	1.5
107	-66.10757	18.47019	0.3	0.7	0.8	1.3
108	-66.13077	18.47343	0.3	0.7	1.0	1.6
109	-66.09051	18.46900	0.3	0.7	0.8	1.2
110	-66.08375	18.46174	0.4	0.9	1.2	2.1
111	-66.07766	18.46193	0.4	0.8	1.1	1.7
112	-66.07342	18.46065	0.4	0.9	1.1	1.7
113	-66.08001	18.45785	0.5	1.0	1.3	2.0
114	-66.06910	18.45942	0.4	0.9	1.1	1.8
115	-66.05914	18.45677	0.4	0.9	1.1	1.8
116	-66.05052	18.45577	0.4	0.9	1.1	1.7
117	-66.03778	18.45660	0.4	0.8	1.0	1.4
118	-66.03147	18.44836	0.5	1.1	1.4	2.4
119	-66.02619	18.44672	0.5	1.1	1.4	2.2
120	-66.02004	18.44642	0.5	1.1	1.3	2.0
121	-66.01208	18.44643	0.5	1.1	1.3	2.0
122	-66.00391	18.44791	0.5	1.0	1.3	1.8
123	-65.99769	18.45357	0.4	0.9	1.1	1.5

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Atlantic Ocean (continued)						
124	-65.99404	18.46138	0.3	0.7	0.9	1.3
125	-65.98564	18.46082	0.3	0.8	0.9	1.4
126	-65.97896	18.46124	0.3	0.7	0.9	1.3
127	-65.97034	18.45631	0.4	0.8	1.0	1.5
128	-65.96219	18.45460	0.4	0.8	1.0	1.4
129	-65.94430	18.45037	0.4	0.8	1.0	1.5
130	-65.92609	18.44654	0.4	0.9	1.1	1.7
131	-65.91626	18.44706	0.4	0.9	1.1	1.6
132	-65.90847	18.44831	0.4	0.9	1.0	1.5
133	-65.89918	18.45403	0.3	0.8	0.9	1.4
134	-65.88297	18.44266	0.5	1.0	1.3	1.9
135	-65.86984	18.43806	0.5	1.1	1.3	1.9
136	-65.85099	18.43593	0.5	1.1	1.3	1.8
137	-65.83258	18.43140	0.5	1.0	1.2	1.7
138	-65.82786	18.42456	0.6	1.2	1.5	2.2
139	-65.81963	18.41929	0.6	1.2	1.4	2.2
140	-65.81598	18.41245	0.6	1.3	1.7	2.5
141	-65.80787	18.41131	0.6	1.3	1.6	2.2
142	-65.78954	18.42353	0.5	1.0	1.2	1.8
143	-65.79490	18.40776	0.9	1.9	2.3	3.6
145	-65.78133	18.41169	0.6	1.3	1.6	2.2
146	-65.76984	18.41474	0.5	1.0	1.3	1.8
147	-65.76858	18.40132	0.6	1.2	1.5	2.3
149	-65.75997	18.39590	0.6	1.2	1.5	2.2
150	-65.75373	18.39053	0.6	1.2	1.5	2.2
151	-65.74723	18.38508	0.6	1.3	1.5	2.2
152	-65.74031	18.38259	0.6	1.3	1.6	2.2
153	-65.73313	18.38447	0.6	1.2	1.5	2.0
154	-65.72261	18.39127	0.5	1.0	1.3	1.8
155	-65.71931	18.38440	0.5	1.1	1.4	2.1
156	-65.71170	18.37688	0.6	1.1	1.4	2.0
157	-65.70345	18.37131	0.6	1.2	1.4	2.0
158	-65.67829	18.36957	0.5	1.1	1.3	1.8
159	-65.66299	18.36471	0.6	1.2	1.4	1.9
160	-65.64791	18.37722	0.5	1.0	1.1	1.5
161	-65.64066	18.37933	0.5	1.1	1.3	1.7
162	-65.63710	18.37117	0.7	1.4	1.7	2.3
163	-65.63169	18.37402	0.6	1.3	1.5	2.0
164	-65.62771	18.38273	0.5	1.0	1.1	1.5
165	-65.62376	18.38927	0.4	0.9	1.0	1.4
166	-65.61618	18.38613	0.4	0.9	1.1	1.5

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Vieques Sound						
167	-65.61325	18.38070	0.4	1.0	1.2	1.7
168	-65.62831	18.37750	0.6	1.1	1.3	1.8
169	-65.61725	18.36831	0.5	1.2	1.5	2.3
170	-65.61446	18.37498	0.5	1.1	1.4	2.1
171	-65.62450	18.36415	0.6	1.4	1.8	2.9
172	-65.62341	18.35678	0.6	1.4	1.8	2.8
173	-65.62725	18.35221	0.6	1.5	1.9	3.0
174	-65.63147	18.34987	0.7	1.5	2.0	3.2
175	-65.63483	18.34549	0.7	1.7	2.2	3.4
176	-65.62950	18.34307	0.7	1.6	2.0	3.2
177	-65.63141	18.33713	0.8	1.7	2.2	3.5
178	-65.62546	18.33018	0.7	1.6	2.1	3.4
179	-65.62557	18.32195	0.7	1.7	2.2	3.5
180	-65.62678	18.31178	0.8	1.8	2.4	3.8
181	-65.62433	18.30686	0.7	1.6	2.2	3.5
182	-65.62539	18.29797	0.8	1.7	2.3	3.6
183	-65.63107	18.29287	0.8	1.9	2.5	3.9
184	-65.63440	18.28733	0.9	2.0	2.6	4.1
185	-65.63251	18.28289	0.9	2.0	2.7	4.2
186	-65.62421	18.28219	0.8	1.8	2.4	3.9
187	-65.62722	18.27609	0.9	2.0	2.6	4.2
188	-65.62404	18.27357	0.9	1.9	2.5	4.1
189	-65.62941	18.26769	1.0	2.2	2.8	4.6
190	-65.62731	18.26134	1.0	2.2	2.9	4.6
191	-65.62279	18.25747	1.1	2.2	2.9	4.5
192	-65.61702	18.25625	1.1	2.2	2.8	4.4
193	-65.60862	18.26238	0.9	1.9	2.5	3.9
194	-65.60542	18.25763	0.8	1.8	2.4	3.9
195	-65.60908	18.25512	0.9	2.0	2.6	4.2
196	-65.60480	18.24856	0.7	1.8	2.4	4.1
Vieques Passage						
197	-65.58380	18.25398	0.7	1.6	2.1	3.4
198	-65.60134	18.24303	0.6	1.6	2.2	3.9
199	-65.60063	18.23811	0.6	1.7	2.3	4.1
200	-65.59418	18.23331	0.6	1.5	2.1	3.6
201	-65.58678	18.22869	0.5	1.3	1.8	3.2
202	-65.59212	18.22315	0.5	1.2	1.7	3.1
203	-65.60023	18.22686	0.5	1.3	1.8	3.3
204	-65.60459	18.22606	0.5	1.3	1.8	3.4
205	-65.60305	18.22151	0.5	1.3	1.8	3.4
206	-65.60550	18.21593	0.6	1.4	2.0	3.6

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Vieques Passage (continued)						
207	-65.61399	18.21966	0.5	1.2	1.8	3.2
208	-65.61807	18.22703	0.5	1.3	1.8	3.4
209	-65.62815	18.23394	0.5	1.4	2.0	3.7
210	-65.63652	18.23097	0.6	1.6	2.3	4.1
211	-65.64152	18.22063	0.6	1.7	2.5	4.5
212	-65.63130	18.21446	0.6	1.5	2.1	3.9
213	-65.63512	18.20693	0.6	1.6	2.3	4.1
214	-65.62758	18.20556	0.5	1.2	1.8	3.3
215	-65.63283	18.19896	0.4	1.0	1.4	2.5
216	-65.63860	18.20498	0.5	1.2	1.7	3.1
217	-65.64563	18.19792	0.4	1.1	1.6	2.9
218	-65.65328	18.20196	0.5	1.2	1.7	3.1
219	-65.66263	18.20548	0.5	1.4	2.1	3.9
220	-65.66813	18.20110	0.5	1.4	2.1	3.8
221	-65.67641	18.19820	0.5	1.4	2.1	3.8
223	-65.68574	18.19657	0.6	1.6	2.4	4.4
224	-65.69286	18.18717	0.6	1.6	2.5	4.5
226	-65.69402	18.17658	0.4	1.1	1.6	2.8
227	-65.69810	18.18268	0.4	1.1	1.7	3.0
228	-65.70651	18.18247	0.5	1.2	1.8	3.3
229	-65.71324	18.18738	0.5	1.4	2.0	3.6
230	-65.72200	18.18778	0.5	1.5	2.2	4.0
231	-65.72815	18.18351	0.5	1.5	2.3	4.2
232	-65.73487	18.17784	0.6	1.5	2.4	4.4
233	-65.73873	18.17138	0.6	1.5	2.4	4.5
234	-65.74199	18.16311	0.4	1.3	2.0	3.6
235	-65.75305	18.15724	0.5	1.4	2.1	4.0
236	-65.76153	18.15161	0.5	1.4	2.3	4.3
237	-65.76567	18.14696	0.5	1.4	2.3	4.3
238	-65.76759	18.14069	0.5	1.4	2.2	4.2
239	-65.77298	18.13360	0.5	1.4	2.2	4.1
240	-65.77719	18.12627	0.5	1.4	2.2	4.3
241	-65.77869	18.11875	0.5	1.3	2.2	4.1
242	-65.77758	18.11215	0.4	1.0	1.7	3.2
Caribbean Sea						
243	-65.78371	18.10625	0.4	1.1	1.8	3.5
244	-65.78793	18.09855	0.5	1.1	1.9	3.6
245	-65.78737	18.08997	0.3	0.9	1.4	2.6
246	-65.79347	18.08627	0.4	0.9	1.5	2.8
247	-65.79513	18.08141	0.4	0.9	1.5	2.8

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
248	-65.79432	18.07674	0.4	0.9	1.4	2.8
249	-65.79701	18.07832	0.4	0.9	1.5	3.0
250	-65.79481	18.07175	0.4	0.9	1.4	2.6
251	-65.79616	18.06576	0.3	0.8	1.2	2.4
252	-65.79995	18.05954	0.3	0.8	1.2	2.2
253	-65.80678	18.05605	0.3	0.8	1.3	2.4
255	-65.81868	18.06139	0.4	0.9	1.5	2.9
256	-65.82306	18.05753	0.4	0.9	1.5	2.9
257	-65.82697	18.05349	0.4	0.9	1.5	2.8
258	-65.83655	18.05248	0.4	1.0	1.5	2.9
259	-65.83482	18.05040	0.4	0.9	1.5	3.0
260	-65.83024	18.04907	0.4	0.9	1.5	2.8
261	-65.83355	18.05247	0.4	1.0	1.6	3.0
262	-65.83244	18.04074	0.4	0.9	1.5	2.9
263	-65.82918	18.03203	0.4	0.8	1.4	2.6
264	-65.83137	18.02406	0.4	0.8	1.4	2.5
265	-65.82986	18.01893	0.3	0.8	1.2	2.2
266	-65.83288	18.01358	0.3	0.8	1.2	2.2
267	-65.83831	18.01248	0.3	0.8	1.2	2.3
268	-65.84346	18.01426	0.3	0.8	1.3	2.3
269	-65.85510	18.00505	0.3	0.8	1.3	2.4
270	-65.86532	18.00597	0.3	0.8	1.4	2.6
271	-65.87425	18.00066	0.4	0.8	1.4	2.6
272	-65.88005	17.99152	0.3	0.8	1.3	2.5
273	-65.88719	17.98770	0.3	0.8	1.3	2.4
274	-65.89076	17.99069	0.3	0.8	1.3	2.5
275	-65.89651	17.98870	0.3	0.8	1.3	2.4
276	-65.90472	17.98279	0.3	0.8	1.3	2.4
277	-65.91612	17.97466	0.3	0.8	1.3	2.4
278	-65.92340	17.97422	0.3	0.8	1.3	2.4
279	-65.93229	17.97429	0.3	0.8	1.3	2.4
280	-65.93880	17.97072	0.3	0.8	1.3	2.4
281	-65.94963	17.96965	0.3	0.8	1.3	2.4
282	-65.96235	17.97070	0.3	0.8	1.3	2.5
283	-65.96654	17.97140	0.3	0.8	1.3	2.5
284	-65.97245	17.97062	0.3	0.8	1.3	2.4
285	-65.97710	17.96638	0.3	0.8	1.3	2.5
286	-65.98564	17.96919	0.3	0.9	1.4	2.7
287	-65.99135	17.97486	0.4	0.9	1.5	2.8
288	-66.00500	17.97730	0.3	0.8	1.4	2.7
289	-66.01151	17.97838	0.4	0.9	1.4	2.8

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
			ISLAND OF PUERTO RICO (continued)			
Caribbean Sea (continued)						
290	-66.02069	17.97647	0.4	0.9	1.4	2.6
291	-66.02528	17.97302	0.4	0.9	1.4	2.6
292	-66.03033	17.96795	0.4	0.9	1.3	2.5
293	-66.03424	17.96068	0.3	0.8	1.3	2.5
294	-66.03830	17.96097	0.3	0.8	1.3	2.5
295	-66.04087	17.95891	0.3	0.8	1.3	2.4
296	-66.04669	17.95160	0.2	0.7	1.2	2.5
297	-66.05160	17.95508	0.3	0.8	1.4	2.6
298	-66.05716	17.95769	0.3	0.8	1.4	2.7
299	-66.06388	17.95954	0.3	0.8	1.4	2.7
300	-66.06749	17.96274	0.4	0.9	1.5	2.8
301	-66.06982	17.96514	0.4	0.9	1.5	2.9
302	-66.07533	17.96421	0.4	0.9	1.5	2.8
303	-66.08284	17.96468	0.4	1.0	1.5	2.8
304	-66.09162	17.96040	0.4	0.9	1.4	2.6
305	-66.10277	17.95371	0.4	0.9	1.3	2.5
306	-66.11468	17.94773	0.3	0.8	1.3	2.5
307	-66.12687	17.94555	0.4	0.9	1.3	2.4
308	-66.14019	17.93835	0.3	0.8	1.2	2.2
309	-66.15491	17.92813	0.2	0.7	1.1	2.1
310	-66.15803	17.93500	0.3	0.7	1.2	2.3
311	-66.16525	17.93104	0.3	0.7	1.1	2.2
312	-66.17514	17.93481	0.3	0.7	1.1	2.1
313	-66.18426	17.93401	0.3	0.7	1.1	2.0
314	-66.19180	17.95274	0.5	1.3	2.0	3.6
315	-66.20671	17.96119	0.5	1.4	2.1	3.8
316	-66.17996	17.94602	0.5	1.4	2.0	3.6
317	-66.18127	17.94881	0.5	1.4	2.0	3.7
318	-66.18970	17.94397	0.5	1.3	1.8	3.3
319	-66.19301	17.93512	0.4	0.8	1.1	2.0
320	-66.21982	17.95220	0.4	0.9	1.2	1.9
321	-66.20910	17.92208	0.3	0.9	1.6	3.0
322	-66.21419	17.94600	0.4	1.1	1.6	2.9
323	-66.21004	17.93453	0.4	1.0	1.5	2.7
324	-66.20263	17.94631	0.4	1.1	1.7	3.2
325	-66.20681	17.95149	0.4	1.2	1.8	3.3
326	-66.21253	17.95800	0.4	1.3	1.9	3.5
327	-66.22968	17.94624	0.4	1.0	1.5	2.8
328	-66.22909	17.93156	0.3	0.9	1.3	2.4
329	-66.23697	17.92533	0.3	0.7	1.1	2.1
330	-66.24337	17.93658	0.3	0.9	1.3	2.4

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
331	-66.25439	17.93258	0.3	0.8	1.2	2.2
332	-66.22004	17.93225	0.3	0.9	1.3	2.4
333	-66.26394	17.93703	0.3	0.8	1.2	2.2
334	-66.26923	17.94397	0.4	0.9	1.4	2.5
335	-66.27883	17.94412	0.4	0.9	1.2	2.2
336	-66.28862	17.94054	0.3	0.7	1.1	2.0
337	-66.29327	17.96092	0.4	1.1	1.6	3.1
338	-66.29751	17.95257	0.4	0.9	1.3	2.3
339	-66.30381	17.96167	0.4	0.9	1.4	2.6
340	-66.31361	17.96702	0.4	0.9	1.3	2.4
341	-66.32175	17.97643	0.4	1.0	1.5	2.7
342	-66.33177	17.97564	0.4	1.0	1.4	2.5
343	-66.34339	17.97121	0.4	1.0	1.3	2.2
344	-66.35301	17.96514	0.4	1.0	1.3	2.0
345	-66.36146	17.96694	0.5	1.1	1.4	2.2
346	-66.36010	17.95800	0.4	0.9	1.2	1.9
347	-66.36832	17.95954	0.5	1.1	1.4	2.1
348	-66.36769	17.95114	0.4	0.9	1.1	1.7
349	-66.37336	17.95434	0.5	1.0	1.3	2.0
350	-66.37565	17.94597	0.4	0.9	1.1	1.6
351	-66.38477	17.93652	0.2	0.6	0.8	1.3
352	-66.39350	17.94144	0.3	0.8	1.2	2.1
353	-66.40176	17.94680	0.3	0.8	1.2	2.2
354	-66.40887	17.95219	0.3	0.9	1.3	2.4
355	-66.41794	17.95720	0.3	0.9	1.3	2.4
356	-66.43226	17.96080	0.3	0.9	1.4	2.5
357	-66.43770	17.96822	0.4	1.0	1.5	2.8
358	-66.44518	17.97642	0.4	1.1	1.7	3.1
359	-66.45129	17.97914	0.4	1.1	1.6	2.9
360	-66.45632	17.98501	0.4	1.1	1.7	3.1
361	-66.46388	17.98863	0.4	1.2	1.7	3.1
362	-66.47791	17.98512	0.4	1.0	1.5	2.6
363	-66.49155	17.98812	0.4	1.0	1.5	2.7
364	-66.50389	17.98524	0.4	1.0	1.4	2.4
365	-66.51642	17.98129	0.4	0.9	1.3	2.2
366	-66.52902	17.97604	0.3	0.9	1.2	2.1
367	-66.54482	17.97181	0.3	0.8	1.1	1.9
368	-66.55974	17.96611	0.3	0.7	1.0	1.7
369	-66.57688	17.95977	0.3	0.6	0.9	1.5
370	-66.58338	17.95948	0.2	0.6	0.8	1.2
371	-66.58760	17.96368	0.3	0.7	1.0	1.8

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
372	-66.59378	17.96896	0.3	0.7	1.1	1.9
373	-66.60192	17.96711	0.3	0.7	0.9	1.6
374	-66.61188	17.96142	0.3	0.6	0.8	1.3
375	-66.61879	17.96581	0.3	0.7	1.0	1.8
376	-66.61913	17.97227	0.3	0.8	1.1	2.0
377	-66.62517	17.97915	0.3	0.8	1.1	2.0
378	-66.63124	17.98061	0.3	0.8	1.1	1.9
379	-66.63769	17.97954	0.3	0.7	1.0	1.7
380	-66.64563	17.97844	0.4	0.7	0.9	1.6
381	-66.65282	17.97570	0.4	0.7	0.9	1.5
382	-66.65779	17.97199	0.4	0.7	0.8	1.3
383	-66.66528	17.96692	0.3	0.6	0.7	1.1
384	-66.67453	17.96582	0.2	0.6	0.8	1.1
385	-66.68056	17.97083	0.3	0.7	1.0	1.8
386	-66.69503	17.97359	0.3	0.6	0.9	1.6
387	-66.71338	17.98183	0.3	0.7	0.9	1.6
388	-66.71621	17.98735	0.3	0.7	1.0	1.8
389	-66.72218	17.98891	0.3	0.7	0.9	1.6
390	-66.72992	17.98986	0.3	0.7	0.9	1.6
391	-66.74027	17.98934	0.4	0.7	0.9	1.4
392	-66.75042	17.98484	0.4	0.7	0.8	1.2
393	-66.75665	17.97456	0.2	0.5	0.7	1.0
394	-66.75905	17.98467	0.3	0.7	0.9	1.6
395	-66.75634	17.99961	0.3	0.8	1.1	1.9
396	-66.76339	17.99929	0.3	0.7	1.0	1.7
397	-66.76814	17.99263	0.3	0.7	0.9	1.5
398	-66.77084	18.00415	0.4	0.8	1.0	1.7
399	-66.78012	17.99814	0.4	0.7	0.9	1.4
400	-66.77675	17.98648	0.3	0.6	0.8	1.3
401	-66.78972	17.99176	0.4	0.8	0.9	1.2
402	-66.79714	17.99220	0.5	0.9	1.0	1.4
403	-66.80538	17.98043	0.6	1.2	1.5	2.2
404	-66.78177	17.98118	0.3	0.6	0.8	1.1
405	-66.79249	17.98353	0.4	0.8	0.9	1.3
406	-66.78788	17.97034	0.3	0.5	0.7	1.1
407	-66.79799	17.96673	0.3	0.6	0.8	1.2
408	-66.80810	17.96421	0.3	0.6	0.7	1.1
409	-66.82392	17.95251	0.3	0.5	0.6	1.0
410	-66.84027	17.94768	0.2	0.5	0.7	1.0
411	-66.84739	17.95086	0.3	0.6	0.8	1.2
412	-66.85741	17.95338	0.3	0.6	0.8	1.1

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
413	-66.86298	17.94458	0.3	0.5	0.5	0.7
414	-66.87166	17.94870	0.3	0.7	0.9	1.6
415	-66.88025	17.95061	0.3	0.7	0.9	1.6
416	-66.89884	17.94715	0.3	0.6	0.7	1.1
417	-66.90776	17.96331	0.4	0.7	0.9	1.4
418	-66.91626	17.96428	0.4	0.8	0.9	1.3
419	-66.90958	17.95783	0.3	0.7	0.8	1.2
420	-66.92625	17.97003	0.4	0.9	1.1	1.4
421	-66.92340	17.96359	0.4	0.8	1.0	1.3
422	-66.90969	17.94726	0.3	0.6	0.7	1.0
423	-66.91738	17.94399	0.3	0.6	0.8	1.0
424	-66.92915	17.94146	0.4	0.8	0.9	1.4
425	-66.91860	17.93441	0.3	0.6	0.7	1.0
426	-66.92267	17.92583	0.2	0.4	0.5	0.8
427	-66.93743	17.93052	0.2	0.5	0.7	1.0
428	-66.95115	17.93076	0.2	0.4	0.6	0.8
429	-66.95696	17.93789	0.3	0.7	1.0	1.7
430	-66.96280	17.93967	0.3	0.6	0.9	1.4
431	-66.96814	17.94485	0.3	0.7	0.9	1.6
432	-66.97668	17.94755	0.3	0.7	0.9	1.5
433	-66.98451	17.95438	0.3	0.7	1.0	1.8
434	-66.98610	17.96611	0.3	0.8	1.3	2.3
435	-66.99292	17.96960	0.3	0.9	1.2	2.2
436	-67.01403	17.97462	0.4	1.0	1.2	1.9
437	-67.01877	17.96593	0.3	0.7	0.9	1.6
438	-67.02722	17.96979	0.3	0.8	1.1	1.7
439	-67.03733	17.97039	0.3	0.8	1.0	1.6
440	-67.04926	17.97073	0.3	0.8	1.0	1.6
441	-67.06851	17.97176	0.4	0.9	1.1	1.5
442	-67.08615	17.96295	0.4	0.9	1.1	1.5
443	-67.11235	17.95265	0.4	0.9	1.1	1.5
444	-67.12934	17.94847	0.3	0.7	0.9	1.4
445	-67.15314	17.95199	0.3	0.7	0.9	1.3
446	-67.16432	17.96076	0.3	0.8	1.1	1.6
447	-67.18125	17.96076	0.4	1.0	1.2	1.5
448	-67.18954	17.93083	0.2	0.5	0.6	1.0
449	-67.18965	17.95144	0.4	1.0	1.2	1.7
450	-67.20232	17.95167	0.2	0.7	1.0	1.5
451	-67.21631	17.96141	0.2	0.6	0.9	1.5
452	-67.21573	17.97802	0.3	0.7	1.1	2.0
453	-67.20610	18.00174	0.4	1.0	1.4	2.5

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
454	-67.17757	18.01120	0.5	1.3	1.9	3.3
456	-67.17528	18.02368	0.5	1.3	1.8	3.5
457	-67.19482	18.03010	0.4	1.0	1.5	2.7
458	-67.20957	18.03316	0.3	0.9	1.3	2.3
459	-67.20147	18.04937	0.4	1.0	1.4	2.6
460	-67.19969	18.06437	0.4	0.9	1.4	2.7
461	-67.18730	18.07083	0.4	1.1	1.8	3.3
462	-67.19631	18.06892	0.4	1.0	1.5	3.1
463	-67.19105	18.07467	0.4	1.0	1.6	3.2
464	-67.19894	18.07332	0.3	0.9	1.4	2.7
465	-67.20322	18.08283	0.3	0.8	1.4	2.7
466	-67.19608	18.09862	0.4	1.0	1.4	2.7
467	-67.18419	18.10936	0.4	1.1	1.6	3.0
468	-67.18575	18.12860	0.4	0.9	1.5	2.9
469	-67.18826	18.13614	0.3	0.9	1.4	2.9
470	-67.18277	18.14125	0.4	1.1	1.7	3.2
471	-67.17940	18.15230	0.4	1.0	1.7	3.3
472	-67.18221	18.15858	0.3	0.9	1.6	3.1
473	-67.18724	18.16656	0.3	0.8	1.4	2.7
474	-67.17947	18.17258	0.4	0.9	1.5	2.8
475	-67.17467	18.17852	0.4	1.0	1.5	2.9
476	-67.16884	18.18594	0.4	1.0	1.5	2.9
477	-67.16193	18.19115	0.5	1.1	1.6	3.1
478	-67.15622	18.19919	0.5	1.1	1.7	3.2
479	-67.15579	18.20532	0.4	1.0	1.7	3.2
480	-67.15993	18.21523	0.4	0.9	1.4	2.8
481	-67.17114	18.22103	0.3	0.8	1.2	2.5
482	-67.17547	18.23043	0.3	0.7	1.2	2.2
483	-67.17560	18.23860	0.3	0.7	1.2	2.3
484	-67.18066	18.25220	0.3	0.7	1.2	2.2
485	-67.18569	18.25875	0.3	0.7	1.1	2.1
486	-67.19032	18.26699	0.2	0.7	1.1	2.0
487	-67.19140	18.27531	0.3	0.7	1.2	2.2
488	-67.19349	18.28307	0.3	0.7	1.2	2.2
489	-67.19757	18.28879	0.3	0.7	1.1	2.1
490	-67.20667	18.29143	0.3	0.6	1.0	1.9
491	-67.22018	18.29461	0.3	0.6	0.9	1.8
492	-67.23427	18.29740	0.2	0.5	0.8	1.4
493	-67.24228	18.30849	0.3	0.6	0.9	1.6
494	-67.25028	18.32043	0.3	0.6	0.9	1.6
495	-67.25308	18.32739	0.3	0.6	0.9	1.7

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF PUERTO RICO (continued)						
Caribbean Sea (continued)						
496	-67.25724	18.33814	0.3	0.6	1.0	1.9
497	-67.26981	18.35292	0.2	0.6	0.9	1.6
498	-67.27156	18.36682	0.2	0.6	1.0	1.9
499	-67.26096	18.37239	0.3	0.6	1.0	1.9
500	-67.24878	18.37532	0.3	0.6	1.0	1.9
501	-67.23697	18.37896	0.3	0.6	1.0	2.0
502	-67.22628	18.38166	0.3	0.7	1.0	2.0
503	-67.21469	18.38576	0.3	0.7	1.1	2.1
504	-67.20602	18.39055	0.3	0.7	1.1	2.1
505	-67.19827	18.39363	0.3	0.7	1.1	2.1
506	-67.19140	18.39980	0.3	0.7	1.1	2.2
507	-67.18489	18.40467	0.3	0.6	1.1	2.1
508	-67.17587	18.40883	0.3	0.7	1.1	2.2
509	-67.16745	18.41289	0.3	0.7	1.2	2.3
510	-67.15929	18.41906	0.3	0.7	1.2	2.4
511	-67.15785	18.43083	0.3	0.7	1.2	2.4
512	-67.16228	18.44812	0.3	0.7	1.2	2.3
513	-67.17014	18.46342	0.3	0.7	1.1	2.2
514	-67.16959	18.48221	0.2	0.6	1.2	2.3
ISLAND OF VIEQUES						
Vieques Passage						
515	-65.57823	18.11401	0.3	0.7	0.9	1.3
516	-65.57967	18.12124	0.3	0.7	0.9	1.4
516b	-65.57606	18.12178	0.3	0.7	0.9	1.4
516c	-65.57186	18.12174	0.6	1.2	1.6	2.4
516d	-65.56793	18.12221	0.6	1.4	1.8	2.8
516e	-65.56166	18.12208	0.8	1.8	2.2	3.4
517	-65.55250	18.12177	0.9	2.0	2.5	3.8
518	-65.52624	18.12907	0.9	1.9	2.4	3.5
519	-65.50991	18.13581	0.9	1.9	2.4	3.4
520	-65.49297	18.13859	1.0	2.0	2.4	3.5
Vieques Sound						
521	-65.47073	18.14533	0.9	1.9	2.4	3.5
522	-65.45038	18.14817	0.9	1.9	2.4	3.5
523	-65.44593	18.15333	0.9	1.8	2.2	3.3
524	-65.44120	18.15872	0.8	1.7	2.1	3.2

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF VIEQUES (continued)						
Viequez Sound (continued)						
525	-65.43213	18.16099	0.8	1.7	2.1	3.2
526	-65.40832	18.16311	0.8	1.6	2.0	3.1
527	-65.38892	18.16337	0.7	1.6	2.0	3.0
528	-65.37563	18.16016	0.8	1.6	2.0	3.1
529	-65.36041	18.15662	0.8	1.6	2.0	3.1
530	-65.34906	18.15399	0.7	1.5	1.9	2.9
531	-65.33114	18.14927	0.7	1.5	1.9	3.0
532	-65.31839	18.14801	0.7	1.4	1.9	2.9
533	-65.30417	18.14369	0.7	1.5	1.9	2.9
534	-65.28914	18.14986	0.5	1.1	1.5	2.4
535	-65.27507	18.13724	0.5	1.0	1.3	2.0
536	-65.26610	18.13437	0.4	0.8	1.0	1.4
Caribbean Sea						
537	-65.28475	18.13036	0.4	0.8	1.0	1.6
538	-65.29544	18.12616	0.3	0.8	1.0	1.6
539	-65.30042	18.13319	0.4	0.8	1.1	1.6
540	-65.30724	18.13301	0.4	0.9	1.2	1.7
541	-65.31125	18.12433	0.3	0.8	1.0	1.6
542	-65.30259	18.12872	0.4	0.8	1.1	1.6
543	-65.32335	18.12436	0.4	0.8	1.1	1.6
544	-65.33245	18.12393	0.4	0.9	1.2	1.7
545	-65.33540	18.11645	0.4	0.8	1.1	1.6
546	-65.34426	18.11061	0.3	0.8	1.0	1.5
547	-65.35444	18.11389	0.4	0.8	1.0	1.6
548	-65.34328	18.11908	0.4	0.8	1.0	1.7
549	-65.35386	18.12360	0.4	0.8	1.1	1.6
550	-65.36277	18.12781	0.4	1.0	1.3	2.0
551	-65.37160	18.12317	0.4	1.1	1.4	2.2
552	-65.37209	18.11790	0.4	1.0	1.4	2.1
553	-65.37531	18.11258	0.4	1.0	1.4	2.1
554	-65.38492	18.11074	0.3	0.8	1.0	1.5
555	-65.39618	18.10858	0.4	0.9	1.1	1.6
556	-65.40805	18.11146	0.4	1.0	1.3	2.1
557	-65.40858	18.10575	0.4	0.9	1.2	1.7
558	-65.36021	18.11835	0.4	0.9	1.1	1.7
559	-65.41624	18.10566	0.4	1.0	1.3	2.0
560	-65.41731	18.10050	0.4	0.9	1.2	1.9
561	-65.42932	18.10845	0.4	1.2	1.6	2.5
562	-65.42466	18.10365	0.4	1.1	1.4	2.2

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF VIEQUES (continued)						
Caribbean Sea (continued)						
563	-65.42262	18.09486	0.3	0.8	1.0	1.5
564	-65.43654	18.09059	0.3	0.8	1.0	1.5
565	-65.44346	18.10285	0.4	1.1	1.4	2.2
566	-65.44920	18.10221	0.4	1.2	1.6	2.7
567	-65.44389	18.08954	0.3	0.9	1.1	1.7
568	-65.45006	18.08928	0.3	0.8	1.0	1.5
569	-65.45564	18.08580	0.3	0.8	1.0	1.5
570	-65.45623	18.09309	0.3	0.8	1.0	1.5
571	-65.46163	18.09554	0.3	0.8	1.1	1.6
572	-65.46666	18.09237	0.4	0.9	1.2	1.8
573	-65.47007	18.09210	0.4	0.8	1.0	1.5
574	-65.46115	18.08974	0.3	0.8	1.1	1.6
575	-65.47605	18.09402	0.4	0.8	1.1	1.6
576	-65.49619	18.09210	0.4	0.9	1.2	1.8
577	-65.51470	18.08609	0.4	0.9	1.1	1.8
578	-65.52986	18.07983	0.3	0.8	1.0	1.5
579	-65.51754	18.08973	0.1	1.0	2.1	4.1
580	-65.55331	18.08295	0.3	0.8	1.0	1.6
581	-65.56753	18.08849	0.3	0.8	1.0	1.4
582	-65.57462	18.09847	0.3	0.7	0.9	1.3
ISLAND OF CULEBRA						
Caribbean Sea						
583	-65.31624	18.33030	0.6	1.2	1.4	1.9
584	-65.31046	18.33964	0.5	1.0	1.2	1.6
585	-65.29996	18.33304	0.5	1.1	1.3	1.8
586	-65.29144	18.33724	0.5	1.0	1.2	1.6
587	-65.28424	18.33208	0.5	1.1	1.3	1.8
588	-65.27306	18.33232	0.5	1.0	1.2	1.8
589	-65.26174	18.32620	0.5	1.0	1.2	1.8
590	-65.25439	18.34313	0.5	1.0	1.2	1.6
591	-65.24785	18.31562	0.5	1.0	1.2	1.7
Ensanada Honda						
599	-65.28206	18.30478	0.5	1.1	1.4	2.3
600	-65.28956	18.30691	0.5	1.1	1.5	2.4
601	-65.30046	18.30700	0.6	1.3	1.8	2.7
602	-65.29264	18.30263	0.5	1.2	1.5	2.5

*Coordinates in NAD83 Datum

TABLE 6 - SUMMARY OF COASTAL STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION*			ELEVATION (meters MSL)			
	LONGITUDE	LATITUDE	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ISLAND OF CULEBRA (continued)						
Ensanada Honda (continued)						
603	-65.28533	18.29481	0.5	1.1	1.5	2.4
608	-65.28824	18.30337	0.5	1.1	1.5	2.4
609	-65.28071	18.29623	0.5	1.1	1.4	2.3
Vieques Sound						
592	-65.22363	18.31609	0.5	1.0	1.3	1.9
593	-65.24302	18.30240	0.4	0.9	1.1	1.8
594	-65.25535	18.30451	0.5	1.0	1.3	2.1
595	-65.25512	18.29583	0.5	1.0	1.3	2.1
596	-65.25969	18.28955	0.5	0.9	1.2	1.8
597	-65.26683	18.29550	0.5	1.0	1.2	2.0
598	-65.27608	18.29481	0.5	1.1	1.3	2.2
604	-65.27933	18.28960	0.5	1.1	1.4	2.3
605	-65.28048	18.28316	0.5	1.0	1.3	1.9
606	-65.28773	18.27585	0.5	1.0	1.2	1.8
607	-65.29258	18.28390	0.5	1.0	1.2	1.8
610	-65.29811	18.29217	0.5	1.0	1.2	1.7
611	-65.30406	18.29938	0.4	0.9	1.2	1.7
612	-65.31194	18.30200	0.4	0.9	1.2	1.7
613	-65.31851	18.31237	0.4	0.9	1.1	1.7
614	-65.33888	18.30540	0.4	0.9	1.1	1.6
615	-65.32759	18.32153	0.4	0.9	1.0	1.6
616	-65.33355	18.32993	0.4	0.7	0.9	1.3
617	-65.34341	18.34540	0.3	0.7	0.9	1.3
618	-65.34147	18.35243	0.4	0.7	0.9	1.2
619	-65.33581	18.34997	0.4	0.9	1.1	1.4
620	-65.32845	18.33946	0.5	1.1	1.3	1.9

*Coordinates in NAD83 Datum

To determine beach erosion during hurricanes along the coastline of Puerto Rico Commonwealth erosion assessments were made. Sandy beaches characterized by dunes, were analyzed to determine the Primary Frontal Dune (PFD) using standard FEMA methodology (FEMA, 2003). This methodology assumes that the primary factor controlling the basic type of erosion is the dune cross sectional area above the 1-percent annual chance stillwater elevation (including wave setup). If this area is less than 50.2 square meters, the dune is assumed to be removed from the seaward face to the inland limit. If the dune cross sectional area is greater than 50.2 square meters, the dune is assumed to retreat, leaving a remnant.

A non-standard erosion methodology was also applied to determine beach erosion in sandy beaches characterized by a veneer of sand overlaying rocky ledges. Through examination of pre- and post-storm photographs, it has been determined that a portion of this sand veneer (0.3-1 meter) is removed by wave action to expose the rocky ledge beneath. This assumption was verified by review of available literature such as, Hubbard (1991), conversations with specialists in the field (Dr. Dennis Hubbard, November, 4, 2002), and site investigation (August, 2002).

Nearshore wave-induced processes, such as wave setup and wave runup, constitute a greater part of the combined wave envelope that storm surge due to the islands' high cliffs and location exposed to ocean waves. For this particular environment, the Direct Integrated Method (FEMA, 2004) was used to determine wave setup along the coastline.

Offshore coral reefs surround Puerto Rico, inducing a localized variation in wave setup values. A modified wave setup approach was applied in those locations where reefs extend above the breaking depth of the incident wave height. The criterion applied was based upon the methodology outlined by Gourlay (1996).

Wave height calculation used in this study follows the methodology described in the FEMA (2003), Appendix D, of the Guidelines and Specifications for Flood Hazard Mapping Partners for using the WHAFIS model.

RUNUP 2.0 was used to predict wave runup value on natural shore then adjusted to follow the FEMA (2005) "Procedure Memorandum No. 37" that recommends the use of the 2% wave runup for determining base flood elevations. For steep cliffs and in areas dominated by coral reefs, wave runup was determined using the Technical Advisory Committee for Water Retaining Structures (TAW) method (van der Meer, 2002). For wave run-up at the crest of a slope that transitions to a plateau or downslope, run-up values were determined using the "Methodology for wave run-up on a hypothetical slope" as described in the FEMA (2003), Appendix D, of the Guidelines and Specifications for Flood Hazard Mapping Partners.

Figure 3, "Transect Location Map," illustrates the location of the transects. Along each transect, wave envelopes were computed considering the combined effects of changes in ground elevation, vegetation and physical features. Between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and engineering judgment to determine the aerial extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo major changes. The transect data for the three islands are presented in Table 7, "Transect Descriptions," which describes the location of each transect. In addition, Table 7, provides the 1-percent annual chance stillwater, wave setup and maximum wave crest elevations for each transect along the island coastline. In Table 8, "Transect Data," the flood hazard zone and base flood elevations for each transect flooding source is provided, along with the 1-percent annual chance stillwater elevation for the respective flooding source.

TABLE 7 - TRANSECT DESCRIPTIONS

		ELEVATION (meter MSL)		
TRANSECT	LOCATION	1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR1	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.6 kilometers northwest of intersection of Borinquen Avenue and Calle Este, located in Aguadilla, at N 18.489197°, W 67.162013°	1.1	1.2	3.6
PR2	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 430 meters northwest of intersection of Cliff Road and North East Road, located in Aguadilla, at N 18.508003°, W 67.134469°	1.1	1.2	3.7
PR3	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.4 kilometers northeast of intersection of Carretera 110 and Cliff Road, located in Aguadilla, at N 18.512487°, W 67.116675°	1.2	1.4	3.9
PR4	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.3 kilometers north of intersection of Carretera 110 and Carretera 4466, located in Isabela, at N 18.515347°, W 67.099308°	1.2	1.2	3.7

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR5	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.1 kilometers northeast of intersection of Sector Las Marias and Carretera 466, located in Isabela, at N 18.513207°, W 67.065715°	1.2	1.2	3.7
PR6	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.3 kilometers northwest of intersection of Avenue Manuela Lamela Abreu and Carretera Jobos, located in Isabela, at N 18.511788°, W 67.034616°	1.2	1.3	3.9
PR7	On the Atlantic Ocean coastline, on the northwest side of the island, approximately 1.1 kilometers north of intersection of Calle Naranjo and Carretera 473, located in Isabela, at N 18.511049°, W 67.020486°	1.2	1.3	4.0
PR8	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.3 kilometers northeast of intersection of Jardiness Mem and Carretera 113, located in Isabela, at N 18.497147°, W 66.987818°	1.3	1.3	4.0
PR9	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.4 kilometers northwest of intersection of Callejon Otero and Carretera 113, located in Isabela, at N 18.492969°, W 66.980991°	1.3	1.2	3.8
PR10	On the Atlantic Ocean coastline, on the north side of the island, approximately 870 meters northeast of intersection of Carretera 2 and Carretera 113, located in Isabela, at N 18.489443°, W 66.958226°	1.2	1.2	3.8
PR11	On the Atlantic Ocean coastline, on the north side of the island, approximately 770 meters northeast of intersection of Carretera 4484 and Calle Soto, located in Quebradillas, at N 18.486424°, W 66.922711°	1.3	1.5	4.3
PR12	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.3 kilometers west of intersection of Carretera 485 and Cestanllas of Hembville Calle, located in Camuy, at N 18.487961°, W 66.887045°	1.2	1.2	3.8

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR13	On the Atlantic Ocean coastline, on the north side of the island, approximately 630 meters northeast of intersection of Carretera 485 and Cestanllas of Hembville Calle, located in Camuy, at N 18.490291°, W 66.868895°	1.2	1.5	4.1
PR14	On the Atlantic Ocean coastline, on the north side of the island, approximately 890 meters northeast of intersection of Calle 4491 and Avenue Pablo J Aguilar, located in Hatillo, at N 18.490851°, W 66.820267°	1.2	1.5	4.1
PR15	On the Atlantic Ocean coastline, on the north side of the island, approximately 500 meters northeast of intersection of Calle B and Carretera 4491, located in Hatillo, at N 18.492396°, W 66.788382°	1.2	1.4	4.0
PR16	On the Atlantic Ocean coastline, on the north side of the island, approximately 380 meters northeast of intersection of Calle Dorothy Bourke and Calle Mirama, located in Arecibo, at N 18.474266°, W 66.737264°	1.2	1.3	3.8
PR17	On the Atlantic Ocean coastline, on the north side of the island, approximately 710 meters northeast of intersection of Calle Irizary and Avenida Rotario, located in Arecibo, at N 18.474943°, W 66.719651°	1.2	1.1	4.5[2]
PR18	On the Atlantic Ocean coastline, on the north side of the island, approximately 330 meters northwest of intersection of Carretera 681 and Carretera 655, located in Arecibo, at N 18.478906°, W 66.700216°	1.1	1.3	3.6
PR19	On the Atlantic Ocean coastline, on the north side of the island, approximately 500 meters northeast of intersection of Carretera 681 and Carretera 655, located in Arecibo, at N 18.48151°, W 66.695551°	1.2	1.3	3.8
PR20	On the Atlantic Ocean coastline, on the north side of the island, approximately 300 meters west of intersection of Carretera 681 and Calle 17, located in Arecibo, at N 18.485206°, W 66.678696°	1.0	1.2	3.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR21	On the Atlantic Ocean coastline, on the north side of the island, approximately 880 meters northeast of intersection of Carretera 681 and Calle Playera, located in Arecibo, at N 18.487491°, W 66.665127°	1.1	1.3	3.7
PR22	On the Atlantic Ocean coastline, on the north side of the island, approximately 700 meters northwest of intersection of Carretera 681 and Calle Los Bajas, located in Arecibo, at N 18.492462°, W 66.631876°	1.0	1.4	3.7
PR23	On the Atlantic Ocean coastline, on the north side of the island, approximately 480 meters southwest of intersection of Carretera 681 and Avenue C, located in Barceloneta, at N 18.484354°, W 66.575525°	1.2	0.8	3.1
PR24	On the Atlantic Ocean coastline, on the north side of the island, approximately 60 meters northeast of intersection of Carretera 681 and Carretera 684, located in Barceloneta, at N 18.417717°, W 66.554979°	1.0	1.3	3.5
PR25	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.1 kilometers north of intersection of Avenida Plazuela & Avenue Boca, located in Barceloneta, at N 18.481216°, W 66.534044°	1.1	1.2	3.5
PR26	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.4 kilometers northwest of intersection of Carretera 685 and Carretera 6684, located in Manati, at N 18.477087°, W 66.511068°	1.1	1.3	3.6
PR27	On the Atlantic Ocean coastline, on the north side of the island, approximately 1 kilometer northwest of intersection of Carretera 685 and Carretera 648, located in Manati, at N 18.474201°, W 66.486832°	1.0	1.7	10.1[2]
PR28	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.5 kilometers northeast of intersection of Carretera 685 and Carretera 686, located in Manati, at N 18.46906°, W 66.45735°	1.1	1.2	3.7

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR29	On the Atlantic Ocean coastline, on the north side of the island, approximately 920 meters northeast of intersection of Carretera 687 and Avenida Sol, located in Vega Baja, at N 18.487575°, W 66.43105°	0.9	1.3	3.3
PR30	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.0 kilometer northwest of intersection of Avenida Jupiter and Avenida Sol, located in Vega Baja, at N 18.489936°, W 66.400193°	1.0	1.3	3.4
PR31	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.1 kilometers northeast of intersection of Avenue Los Xlaranjios and Avenida Sol, located in Vega Baja, at N 18.485392°, W 66.383182°	1.0	1.2	3.5
PR32	On the Atlantic Ocean coastline, on the north side of the island, approximately 400 meters northwest of intersection of Carretera 690 and Ruta 6690, located in Vega Alta, at N 18.480829°, W 66.342411°	1.0	1.2	3.4
PR33	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.6 kilometers northwest of intersection of Carretera 693 and Avenue higuillar, located in Dorado, at N 18.474976°, W 66.302754°	1.0	0.8	3.7[2]
PR34	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.6 kilometers northeast of intersection of Carretera 693 and Avenue higuillar, located in Dorado, at N 18.478622°, W 66.272851°	1.2	1.2	3.6
PR35	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.0 kilometers northeast of intersection of Carretera 693 and Carretera 696, located in Dorado, at N 18.475674°, W 66.25759°	1.0	2.0	4.6
PR36	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.2 kilometers northwest of intersection of Calle Aleli and Calle Aetria, located in Dorado, at N 18.467613°, W 66.228363°	1.1	1.1	3.72

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

		ELEVATION (meter MSL)		
TRANSECT	LOCATION	1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR37	On the Atlantic Ocean coastline, on the north side of the island, approximately 900 meters northwest of intersection of Carretera 868 and Carretera 165, located in Dorado, at N 18.46617°, W 66.196222°	1.2	1.0	3.4
PR38	On the Atlantic Ocean coastline, on the north side of the island, approximately 800 meters southeast of intersection of Carretera 868 and Carretera 165, located in Toa Baja, at N 18.458282°, W 66.182937°	1.5	0.6	3.6[2]
PR39	On the Atlantic Ocean coastline, on the north side of the island, approximately 700 meters northwest of intersection of Carretera 7196 and Bulevar de Levittown, located in Toa Baja, at N 18.451096°, W 66.168016°	1.4	0.4	2.8
PR40	On the Atlantic Ocean coastline, on the north side of the island, approximately 140 meters northeast of intersection of Carretera 870 and Carretera 165, located in Palo Seco, at N 18.455042°, W 66.152325°	1.3	0.9	4.3[2]
PR41	On the Atlantic Ocean coastline, on the north side of the island, approximately 190 meters northeast of intersection of Carretera 870 and Calle 3, located in Toa Baja, at N 18.464093°, W 66.141425°	1.2	1.6	4.2
PR42	On the Atlantic Ocean coastline, on the north side of the island, approximately 650 meters northeast of intersection of Carretera 888 and Calle Laguna, located in Catano, at N 18.455561°, W 66.134389°	1.5	1.0	3.8
PR43	On the Atlantic Ocean coastline, on the north side of the island, approximately330 meters northwest of intersection of Calle Caparra and Calle San Lorenzo, located in Catano, at N 18.441727°, W 66.121003°	1.5	1.1	4.0
PR44	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.5 kilometers northwest of intersection of Express de Diego and Calle Matadero, located in San Juan, at N 18.431427°, W 66.101322°	1.6	0.3	3.5[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR45	On the Atlantic Ocean coastline, on the north side of the island, approximately 810 meters southwest of intersection of Expreso Luis Munoz Rivera and Carratera 2, located in San Juan, at N 18.440028°, W 66.086084°	1.4	0.3	1.7
PR46	On the Atlantic Ocean coastline, on the north side of the island, approximately 410 meters northwest of intersection of Expreso Luis Munoz Rivera and Carratera 2, located in San Juan, at N 18.444093°, W 66.082772°	1.4	0.3	1.7
PR47	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.1 kilometers northwest of intersection of Calle Lindbergh and Bulevar Saint Thomas, located in San Juan, at N 18.458669°, W 66.105787°	1.1	0.3	2.9[2]
PR48	On the Atlantic Ocean coastline, on the north side of the island, approximately 440 meters southwest of intersection of Calle San Andres and Avenida Fernandez Juncos, located in San Juan, at N 18.463073°, W 66.105727°	1.0	0.3	2.6[2]
PR49	On the Atlantic Ocean coastline, on the north side of the island, approximately 290 meters southwest of intersection of Calle Sol and Calle San Jose, located in San Juan, at N 18.464899°, W 66.119640°	1.0	1.0	4.6[2]
PR50	On the Atlantic Ocean coastline, on the north side of the island, approximately 610 meters northwest of intersection of Calle del Morro and Bulevar Norzagaray, located in San Juan, at N 18.471766°, W 66.125072°	1.0	1.6	6.22
PR51	On the Atlantic Ocean coastline, on the north side of the island, approximately 310 meters northeast of intersection of Calle San Agustin and Anenida Munoz Rivera, located in San Juan, at N 18.467133°, W 66.090427°	0.9	2.0	4.5
PR52	On the Atlantic Ocean coastline, on the north side of the island, approximately 360 meters northwest of intersection of Avenida Dr Asford and Calle Aguadilla, located in San Juan, at N 18.46039°, W 66.078433°	1.1	0.9	3.12

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR53	On the Atlantic Ocean coastline, on the north side of the island, approximately 480 meters northwest of intersection of Avenida Wilson and Calle Cervantes, located in San Juan, at N 18.456994°, W 66.06954°	1.1	1.0	3.2
PR54	On the Atlantic Ocean coastline, on the north side of the island, approximately 500 meters northeast of intersection of Calle Loíza and Calle Santa Cecilia, located in San Juan, at N 18.454375°, W 66.051658°	1.1	1.1	3.5
PR55	On the Atlantic Ocean coastline, on the north side of the island, approximately 240 meters southeast of intersection of Carretera 37 and Calle Neptuno, located in Carolina, at N 18.447108°, W 66.033128°	1.4	1.1	4.3[2]
PR56	On the Atlantic Ocean coastline, on the north side of the island, approximately 580 meters northeast of intersection of Carretera 37 and Calle Central, located in Carolina, at N 18.444613°, W 66.019565°	1.3	1.2	3.9
PR57	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.6 kilometers north of intersection of Carretera 26 and Calle Heriberto, located in Carolina, at N 18.446215°, W 66.002987°	1.3	0.9	3.2
PR58	On the Atlantic Ocean coastline, on the north side of the island, approximately 3.2 kilometers northwest of intersection of Calle Jaen and Calle Anndalucia, located in Loíza, at N 18.459865°, W 65.992638°	0.9	0.9	2.7
PR59	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.6 kilometers northwest of intersection of Calle Jaen and Calle Anndalucia, located in Loíza, at N 18.459815°, W 65.97921°	0.9	1.4	3.4
PR60	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.3 kilometers northeast of intersection of Calle Jaen and Calle Anndalucia, located in Loíza, at N 18.45265°, W 65.962969°	1.0	1.0	3.0

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR61	On the Atlantic Ocean coastline, on the north side of the island, approximately 4.2 kilometers northeast of intersection of Calle 219 and Avenida Campo Rico, located in Loíza, at N 18.445186°, W 65.926336°	1.1	1.0	3.2
PR62	On the Atlantic Ocean coastline, on the north side of the island, approximately 3.4 kilometers northwest of intersection of Carretera 187 and Calle Espiritu, located in Loíza, at N 18.446966°, W 65.908173°	1.0	1.1	3.3
PR63	On the Atlantic Ocean coastline, on the north side of the island, approximately 530 meters northeast of intersection of Carretera 187 and Calle Los Millionarios, located in Loíza, at N 18.436334°, W 65.869458°	1.3	1.1	3.7
PR64	On the Atlantic Ocean coastline, on the north side of the island, approximately 250 meters northeast of intersection of Calle Elias and Calle Santiago, located in Loíza, at N 18.430262°, W 65.833388°	1.2	1.1	3.6
PR65	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.2 kilometers southeast of intersection of Calle 6 and Calle 187, located in Río Grande, at N 18.419088°, W 65.821064°	1.4	1.1	4.0
PR66	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.3 kilometers northwest of intersection of Calle 7 and Avenida B, located in Río Grande, at N 18.409761°, W 65.808172°	1.6	1.2	4.3
PR67	On the Atlantic Ocean coastline, on the north side of the island, approximately 2.7 kilometers northeast of intersection of Calle 512 and Calle 516, located in Río Grande, at N 18.410348°, W 65.780069°	1.5	1.0	3.8

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR68	On the Atlantic Ocean coastline, on the north side of the island, approximately 750 meters northeast of intersection of Las Colinas and Avenue Luquillo, located in Río Grande, at N 18.395461°, W 65.761338°	1.5	0.8	3.5
PR69	On the Atlantic Ocean coastline, on the north side of the island, approximately 780 meters northeast of intersection of Carretera 3 and Calle 6, located in Luquillo, at N 18.383887°, W 65.748284°	1.5	1.0	3.9
PR70	On the Atlantic Ocean coastline, on the north side of the island, approximately 250 meters northwest of intersection of Carretera 193 and Camino Balneario, located in Luquillo, at N 18.382717°, W 65.732524°	1.4	0.8	3.5
PR71	On the Atlantic Ocean coastline, on the north side of the island, approximately 100 meters northeast of intersection of Calle Luquillo Beach Boulevard and Calle Ocean Drive, located in Luquillo, at N 18.383866°, W 65.720662°	1.4	0.8	3.4
PR72	On the Atlantic Ocean coastline, on the north side of the island, approximately 1.2 kilometers southeast of intersection of Calle Fernandez Garcia and Calle Efrain Velez Vega, located in Luquillo, at N 18.370115°, W 65.704157°	1.4	1.1	3.9
PR73	On the Atlantic Ocean coastline, on the northeast side of the island, approximately 2.1 kilometers northwest of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.375986°, W 65.646788°	1.2	2.0	4.9
PR74	On the Atlantic Ocean coastline, on the northeast side of the island, approximately 1.3 kilometers northeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.369387°, W 65.63732°	1.7	1.1	4.3
PR75	On the Atlantic Ocean coastline, on the northeast side of the island, approximately 3.0 kilometers northeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.381807°, W 65.626443°	1.1	2.0	4.8

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR76	On the Atlantic Ocean coastline, on the northeast side of the island, approximately 3.9 kilometers northeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.385066°, W 65.617141°	1.1	1.3	3.6
PR77	On the Vieques Sound coastline, on the northeast side of the island, approximately 3.1 kilometers northeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.375036°, W 65.617264°	1.4	2.1	5.3
PR78	On the Vieques Sound coastline, on the northeast side of the island, approximately 1.9 kilometers northeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.365267°, W 65.624929°	1.7	1.4	4.9
PR79	On the Vieques Sound coastline, on the northeast side of the island, approximately 1.4 kilometers southeast of intersection of Avenida el Conquistador and Carretera Cabezas, located in Fajardo, at N 18.353268°, W 65.62826°	1.9	1.3	4.9
PR80	On the Vieques Sound coastline, on the northeast side of the island, approximately 810 meters northeast of intersection of Calle A and Carretera Cabezas, located in Fajardo, at N 18.346204°, W 65.63622°	2.1	1.1	5.0
PR81	On the Vieques Sound coastline, on the northeast side of the island, approximately 1.1 kilometers northeast of intersection of Calle A and Carretera Cabezas, located in Fajardo, at N 18.343081°, W 65.630939°	2.1	1.3	5.1
PR82	On the Vieques Sound coastline, on the east side of the island, approximately 550 meters southeast of intersection of Calle Cometa and Calle Via, located in Fajardo, at N 18.330158°, W 65.6269°	2.1	1.3	5.2
PR83	On the Vieques Sound coastline, on the east side of the island, approximately 1.2 kilometers southeast of intersection of Calle Cometa and Calle Via, located in Fajardo, at N 18.322113°, W 65.627374°	2.2	1.3	5.3

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR84	On the Vieques Sound coastline, on the east side of the island, approximately 1.2 kilometers southeast of intersection of Calle 16 and Calle 17, located in Fajardo, at N 18.298959°, W 65.626493°	2.3	1.3	5.5
PR85	On the Vieques Sound coastline, on the east side of the island, approximately 840 meters northeast of intersection of Carretera 982 and Carretera 3, located in Fajardo, at N 18.288510°, W 65.631681°	2.6	1.2	5.8
PR86	On the Vieques Sound coastline, on the east side of the island, approximately 560 meters southeast of intersection of Carretera 982 and Carretera 3, located in Fajardo, at N 18.282021°, W 65.633934°	2.7	1.1	5.8
PR87	On the Vieques Sound coastline, on the east side of the island, approximately 900 meters northeast of intersection of Carretera 979 and Calle Casals, located in Ceiba, at N 18.276161°, W 65.628664°	2.6	1.1	5.6
PR88	On the Vieques Sound coastline, on the east side of the island, approximately 1.2 kilometers southeast of intersection of Boxer Drive and Tarawa Drive, located in Ceiba, at N 18.260319°, W 65.628292°	2.9	0.9	5.9
PR89	On the Vieques Sound coastline, on the east side of the island, approximately 2.0 kilometers northeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.254811°, W 65.617114°	2.7	1.1	5.8
PR90	On the Vieques Sound coastline, on the east side of the island, approximately 3.1 kilometers northeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.258726°, W 65.606464°	2.4	1.1	5.4
PR91	On the Vieques Sound coastline, on the east side of the island, approximately 3.0 kilometers east of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.242781°, W 65.602769°	2.2	1.1	5.2

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR92	On the Vieques Sound coastline, on the east side of the island, approximately 4.7 kilometers southeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.228594°, W 65.589642°	1.8	1.4	6.1[2]
PR93	On the Vieques Passage coastline, on the east side of the island, approximately 3.2 kilometers southeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.226885°, W 65.605774°	1.8	1.5	5.2
PR94	On the Vieques Passage coastline, on the east side of the island, approximately 3.8 kilometers southeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.217988°, W 65.606396°	1.9	1.1	4.7
PR95	On the Vieques Passage coastline, on the east side of the island, approximately 2.2 kilometers southeast of intersection of Forrestal Drive and Tarawa Drive, located in Ceiba, at N 18.228103°, W 65.617166°	1.8	1.5	5.2
PR96	On the Vieques Passage coastline, on the east side of the island, approximately 1.5 kilometers northeast of intersection of Franklin D Roosevelt Drive and Saratoga Drive, located in Ceiba, at N 18.214372°, W 65.632742°	2.1	1.2	5.1
PR97	On the Vieques Passage coastline, on the east side of the island, approximately 320 meters southeast of intersection of Franklin D Roosevelt Drive and Cowpens Drive, located in Ceiba, at N 18.200469°, W 65.633201°	1.5	1.1	4.0
PR98	On the Vieques Passage coastline, on the east side of the island, approximately 450 meters southwest of intersection of Ranger Road and Yorktown Circle, located in Ceiba, at N 18.199279°, W 65.645123°	1.6	1.0	4.1

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR99	On the Vieques Passage coastline, on the east side of the island, approximately 2.1 kilometers southeast of intersection of Bennington Road and Langley Drive, located in Naguabo, at N 18.207264°, W 65.663273°	2.1	1.0	4.8
PR100	On the Vieques Passage coastline, on the east side of the island, approximately 2.9 kilometers southeast of intersection of Carretera 3 and Carretera 974, located in Naguabo, at N 18.199965°, W 65.676609°	2.1	1.0	4.8
PR101	On the Vieques Passage coastline, on the east side of the island, approximately 2.5 kilometers southeast of intersection of Carretera 53 and Carretera 973, located in Naguabo, at N 18.197893°, W 65.686163°	2.4	0.9	5.0
PR102	On the Vieques Passage coastline, on the east side of the island, approximately 4.1 kilometers southeast of intersection of Carretera 3 and Carretera 31, located in Naguabo, at N 18.177918°, W 65.693639°	1.6	1.0	9.8[2]
PR103	On the Vieques Passage coastline, on the east side of the island, approximately 3.3 kilometers southeast of intersection of Carretera 3 and Carretera 31, located in Naguabo, at N 18.184112°, W 65.6976°	1.7	1.0	4.1
PR104	On the Vieques Passage coastline, on the east side of the island, approximately 3.3 kilometers southwest of intersection of Carretera 3 and Carretera 31, located in Naguabo, at N 18.184366°, W 65.707572°	1.9	1.0	4.3
PR105	On the Vieques Passage coastline, on the east side of the island, approximately 3.2 kilometers southeast of intersection of Carretera 971 and Carretera 31, located in Naguabo, at N 18.189208°, W 65.713143°	2.0	1.1	4.7
PR106	On the Vieques Passage coastline, on the east side of the island, approximately 2.8 kilometers southeast of intersection of Carretera 971 and Carretera 31, located in Naguabo, at N 18.189252°, W 65.722492°	2.2	1.0	4.8

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR107	On the Vieques Passage coastline, on the east side of the island, approximately 3.4 kilometers southeast of intersection of Calle Borges and Calle Quinones, located in Naguabo, at N 18.178808°, W 65.735916°	2.4	1.1	5.3
PR108	On the Vieques Passage coastline, on the east side of the island, approximately 240 meters southeast of intersection of Calle Dr Vidal and Calle Aduana, located in Humacao, at N 18.164361°, W 65.742800°	2.0	1.0	4.7
PR109	On the Vieques Passage coastline, on the east side of the island, approximately 360 meters southwest of intersection of Calle Dr Vidal and Calle 33, located in Humacao, at N 18.153325°, W 65.762379°	2.3	0.9	4.9
PR110	On the Vieques Passage coastline, on the east side of the island, approximately 1.5 kilometers southwest of intersection of Calle Dr Vidal and Carretera 925, located in Humacao, at N 18.141882°, W 65.769093°	2.2	1.0	4.8
PR111	On the Caribbean Sea coastline, on the east side of the island, approximately 1.8 kilometers east of intersection of Carretera 923 and Calle 5 Calle La Via, located in Humacao, at N 18.126781°, W 65.778787°	2.2	1.0	4.8
PR112	On the Caribbean Sea coastline, on the east side of the island, approximately 520 meters southeast of intersection of Carretera 923 and Camino Los Pescadores, located in Humacao, at N 18.113069°, W 65.778675°	1.7	1.1	4.3
PR113	On the Caribbean Sea coastline, on the east side of the island, approximately 1.9 kilometers northeast of intersection of Palmas Drives and Nursery Road, located in Humacao, at N 18.099067°, W 65.789274°	1.8	0.8	4.0
PR114	On the Caribbean Sea coastline, on the east side of the island, approximately 370 meters southeast of intersection of Beach Village and Montesol Drive, located in Humacao, at N 18.087084°, W 65.795012°	1.4	1.0	3.8

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR115	On the Caribbean Sea coastline, on the east side of the island, approximately 700 meters northeast of intersection of Harbor View Street and Palmas Drives, located in Humacao, at N 18.077427°, W 65.795554°	1.5	1.2	4.1
PR116	On the Caribbean Sea coastline, on the east side of the island, approximately 270 meters northeast of intersection of Shell Castle Club and Shell Caster Road, located in Humacao, at N 18.072643°, W 65.796289°	1.4	1.2	6.5[2]
PR117	On the Caribbean Sea coastline, on the east side of the island, approximately 1.2 kilometers south of intersection of Palmas Drives and Shell Caster Road, located in Yabucoa, at N 18.060847°, W 65.801284°	1.2	1.2	4.6[2]
PR118	On the Caribbean Sea coastline, on the east side of the island, approximately 2.0 kilometers southwest of intersection of Palmas Drives and Shell Caster Road, located in Yabucoa, at N 18.062513°, W 65.819515°	1.5	1.0	4.0[2]
PR119	On the Caribbean Sea coastline, on the east side of the island, approximately 2.6 kilometers northeast of intersection of Cart 901 and Calle 4, located in Yabucoa, at N 18.053871°, W 65.828983°	1.5	1.3	4.3
PR120	On the Caribbean Sea coastline, on the east side of the island, approximately 1.7 kilometers northeast of intersection of Cart 901 and Calle 4, located in Yabucoa, at N 18.052362°, W 65.838292°	1.5	1.5	4.7
PR121	On the Caribbean Sea coastline, on the east side of the island, approximately 1.4 kilometers east of intersection of Cart 901 and Calle 12, located in Yabucoa, at N 18.041111°, W 65.833821°	1.5	1.4	4.3
PR122	On the Caribbean Sea coastline, on the east side of the island, approximately 943 meters northeast of intersection of Carretera 901 and Cart 901, located in Yabucoa, at N 18.024260°, W 65.832880°	1.3	1.2	4.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR123	On the Caribbean Sea coastline, on the east side of the island, approximately 1.2 kilometers southeast of intersection of Carretera 901 and Cart 901, located in Yabucoa, at N 18.013948°, W 65.834987°	1.2	1.2	3.7
PR124	On the Caribbean Sea coastline, on the east side of the island, approximately 786 meters southwest of intersection of Carretera 901 and Cart 901, located in Yabucoa, at N 18.016042°, W 65.843917°	1.3	0.9	4.3[2]
PR125	On the Caribbean Sea coastline, on the southeast side of the island, approximately 1.2 kilometers east of intersection of Carretera 901 and Carretera 7760, located in Maunabo, at N 18.001275°, W 65.876043°	1.3	0.9	3.4
PR126	On the Caribbean Sea coastline, on the southeast side of the island, approximately 1.3 kilometers southwest of intersection of Carretera 901 and Carretera 7760, located in Maunabo, at N 17.991216°, W 65.888872°	1.3	1.2	3.9
PR127	On the Caribbean Sea coastline, on the southeast side of the island, approximately 1.9 kilometers south of intersection of Carretera 3 and Avenue Kennedy, located in Maunabo, at N 17.989915°, W 65.897202°	1.3	0.8	3.2
PR128	On the Caribbean Sea coastline, on the south side of the island, approximately 3.2 kilometers southwest of intersection of Carretera 7761 and Carr 759, located in Patillas, at N 17.976478°, W 65.916211°	1.3	1.4	4.6[2]
PR129	On the Caribbean Sea coastline, on the south side of the island, approximately 2.5 kilometers northeast of intersection of Calle Vista Mar and Carr 3, located in Patillas, at N 17.975836°, W 65.934413°	1.3	1.2	3.8
PR130	On the Caribbean Sea coastline, on the south side of the island, approximately 1.9 kilometers east of intersection of Calle Vista Mar and Carr 3, located in Patillas, at N 17.972101°, W 65.938868°	1.3	1.4	4.1

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

		ELEVATION (meter MSL)		
TRANSECT	LOCATION	1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR131	On the Caribbean Sea coastline, on the south side of the island, approximately 805 meters east of intersection of Calle Vista Mar and Carr 3, located in Patillas, at N 17.971747°, W 65.949622°	1.3	1.8	4.7
PR132	On the Caribbean Sea coastline, on the south side of the island, approximately 528 meters west of intersection of Calle Vista Mar and Carr 3, located in Patillas, at N 17.972889°, W 65.961963°	1.3	1.1	3.7
PR133	On the Caribbean Sea coastline, on the south side of the island, approximately 911 meters southeast of intersection of Carretera 758 and Carr 3, located in Patillas, at N 17.973549°, W 65.965339°	1.3	1.1	3.7
PR134	On the Caribbean Sea coastline, on the south side of the island, approximately 1.2 kilometers southwest of intersection of Carretera 758 and Carr 3, located in Patillas, at N 17.967756°, W 65.977241°	1.3	1.9	4.9
PR135	On the Caribbean Sea coastline, on the south side of the island, approximately 537 meters southwest of intersection of Carr 3 and Calle 1, located in Patillas, at N 17.975591°, W 65.990119°	1.5	1.1	3.9
PR136	On the Caribbean Sea coastline, on the south side of the island, approximately 1.1 kilometers southeast of intersection of Carretera 3 and Carr 3, located in Patillas, at N 17.977661°, W 66.021423°	1.4	1.0	3.7
PR137	On the Caribbean Sea coastline, on the south side of the island, approximately 1.4 kilometers south of intersection of Carretera 3 and Carr 3, located in Arroyo, at N 17.968780°, W 66.031491°	1.3	1.2	3.9
PR138	On the Caribbean Sea coastline, on the south side of the island, approximately 1.5 kilometers east of intersection of Camino Vecinal and Calle Cangrejos, located in Arroyo, at N 17.959777°, W 66.041986°	1.3	1.6	4.4
PR139	On the Caribbean Sea coastline, on the south side of the island, approximately 128 meters southwest of intersection of Camino Vecinal and Calle Cangrejos, located in Arroyo, at N 17.959070°, W 66.057034°	1.4	1.0	3.8

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR140	On the Caribbean Sea coastline, on the south side of the island, approximately 154 meters west of intersection of Calle Sol and Calle Cintron, located in Arroyo, at N 17.963648°, W 66.066158°	1.5	1.0	3.8
PR141	On the Caribbean Sea coastline, on the south side of the island, approximately 1.0 kilometers west of intersection of Calle 1 and Calle 4, located in Guayama, at N 17.965587°, W 66.075403°	1.5	1.1	4.0
PR142	On the Caribbean Sea coastline, on the south side of the island, approximately 904 meters southwest of intersection of C Ostra and Carretera 748, located in Guayama, at N 17.961706°, W 66.092204°	1.4	1.0	3.7
PR143	On the Caribbean Sea coastline, on the south side of the island, approximately 1.5 kilometers south of intersection of Calle Central and Carretera 744, located in Guayama, at N 17.948921°, W 66.113947°	1.3	1.1	3.6
PR144	On the Caribbean Sea coastline, on the south side of the island, approximately 2.6 kilometers southeast of intersection of Carretera 7710 and Carretera 3, located in Guayama, at N 17.940704°, W 66.141618°	1.2	0.9	3.3
PR145	On the Caribbean Sea coastline, on the south side of the island, approximately 2.1 kilometers south of intersection of Carretera 7710 and Carretera 3, located in Guayama, at N 17.937812°, W 66.157183°	1.2	1.6	4.3
PR146	On the Caribbean Sea coastline, on the south side of the island, approximately 2.0 kilometers southwest of intersection of Carretera 707 and Calle Geraneo, located in Guayama, at N 17.936948°, W 66.175323°	1.3	1.1	3.7
PR147	On the Caribbean Sea coastline, on the south side of the island, approximately 2.5 kilometers southwest of intersection of Carretera 707 and Calle B, located in Guayama, at N 17.937030°, W 66.194392°	1.1	1.1	3.4

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR148	On the Caribbean Sea coastline, on the south side of the island, approximately 646 meters southwest of intersection of C Carocol and Calle Cofresi, located in Salinas, at N 17.947796°, W 66.231069°	1.5	1.0	3.9
PR149	On the Caribbean Sea coastline, on the south side of the island, approximately 552 meters southeast of intersection of Camino el Indio and Calle Principal, located in Salinas, at N 17.939347°, W 66.260422°	1.2	0.6	2.8
PR150	On the Caribbean Sea coastline, on the south side of the island, approximately 564 meters northwest of intersection of Camino el Indio and Calle Principal, located in Salinas, at N 17.945739°, W 66.267850°	1.4	1.0	3.7
PR151	On the Caribbean Sea coastline, on the south side of the island, approximately 418 meters east of intersection of C Colirrubia and Calle Colirrubia, located in Salinas, at N 17.962625°, W 66.292745°	1.6	1.0	4.0
PR152	On the Caribbean Sea coastline, on the south side of the island, approximately 676 meters west of intersection of C Colirrubia and Calle Colirrubia, located in Salinas, at N 17.963648°, W 66.302969°	1.4	1.0	3.6
PR153	On the Caribbean Sea coastline, on the south side of the island, approximately 420 meters southwest of intersection of Calle Clauel and Calle Magnolia, located in Salinas, at N 17.978374°, W 66.320737°	1.5	0.9	3.7[2]
PR154	On the Caribbean Sea coastline, on the south side of the island, approximately 2.3 kilometers east of intersection of Calle 1 and Calle A, located in Santa Isabel, at N 17.972709°, W 66.344544°	1.3	1.0	3.5
PR155	On the Caribbean Sea coastline, on the south side of the island, approximately 780 meters northeast of intersection of Calle 3 and Calle D, located in Santa Isabel, at N 17.968198°, W 66.362941°	1.4	1.0	3.6
PR156	On the Caribbean Sea coastline, on the south side of the island, approximately 633 meters south of intersection of Calle 5 and Calle B, located in Santa Isabel, at N 17.955873°, W 66.373419°	1.3	0.9	3.4

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR157	On the Caribbean Sea coastline, on the south side of the island, approximately 1.7 kilometers southwest of intersection of Calle 5 and Calle B, located in Santa Isabel, at N 17.946894°, W 66.376817°	1.1	0.8	3.0
PR158	On the Caribbean Sea coastline, on the south side of the island, approximately 750 meters southeast of intersection of Calle 3 and Carretera 538, located in Santa Isabel, at N 17.948482°, W 66.401773°	1.2	0.9	3.2
PR159	On the Caribbean Sea coastline, on the south side of the island, approximately 401 meters west of intersection of Calle 3 and Carretera 538, located in Santa Isabel, at N 17.954155°, W 66.409457°	1.3	0.7	3.1
PR160	On the Caribbean Sea coastline, on the south side of the island, approximately 1.9 kilometers southwest of intersection of Calle del Río and Carretera 1, located in Santa Isabel, at N 17.961812°, W 66.430178°	1.4	1.0	3.5
PR161	On the Caribbean Sea coastline, on the south side of the island, approximately 124 meters southwest of intersection of Carretera 537 and Camino Vecinal, located in Santa Isabel, at N 17.978155°, W 66.443804°	1.7	0.9	4.0
PR162	On the Caribbean Sea coastline, on the south side of the island, approximately 754 meters northwest of intersection of Carretera 537 and Camino Vecinal, located in Santa Isabel, at N 17.981237°, W 66.450232°	1.6	0.9	3.9
PR163	On the Caribbean Sea coastline, on the south side of the island, approximately 628 meters southeast of intersection of Carretera 535 and Carretera 1, located in Juana Diaz, at N 17.990722°, W 66.464438°	1.7	0.9	3.9
PR164	On the Caribbean Sea coastline, on the south side of the island, approximately 81 meters southwest of intersection of Calle 26 and Calle 7, located in Juana Diaz, at N 17.990402°, W 66.491768°	1.5	0.9	3.8

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR165	On the Caribbean Sea coastline, on the south side of the island, approximately 1.2 kilometers southwest of intersection of Carretera 572 and Calle 2, located in Juana Diaz, at N 17.983092°, W 66.517959°	1.3	0.9	3.4
PR166	On the Caribbean Sea coastline, on the south side of the island, approximately 3.0 kilometers southwest of intersection of Carretera 510 and Carretera 1, located in Ponce, at N 17.974306°, W 66.543709°	1.1	1.1	3.4
PR167	On the Caribbean Sea coastline, on the south side of the island, approximately 3.1 kilometers southeast of intersection of Calle la Gran and Apta Luis A Ferre, located in Ponce, at N 17.962237°, W 66.577721°	0.9	1.2	3.1
PR168	On the Caribbean Sea coastline, on the south side of the island, approximately 2.3 kilometers southeast of intersection of Calle la Gran and Apta Luis A Ferre, located in Ponce, at N 17.966454°, W 66.585837°	1.0	1.1	3.3
PR169	On the Caribbean Sea coastline, on the south side of the island, approximately 1.0 kilometers southeast of intersection of Calle Suan and Avenida Caribe, located in Ponce, at N 17.969437°, W 66.601405°	0.9	1.2	3.3
PR170	On the Caribbean Sea coastline, on the south side of the island, approximately 1.5 kilometers southwest of intersection of Calle Suan and Avenida Caribe, located in Ponce, at N 17.966975°, W 66.616186°	1.0	1.3	3.4
PR171	On the Caribbean Sea coastline, on the south side of the island, approximately 190 meters southwest of intersection of Avenue Padre Noel and Calle Calamar, located in Ponce, at N 17.980870°, W 66.623129°	1.1	1.0	3.3
PR172	On the Caribbean Sea coastline, on the south side of the island, approximately 1.1 kilometers southwest of intersection of Avenue Los Meros and Avenue 65 Infanteria, located in Ponce, at N 17.981385°, W 66.638882°	1.0	1.1	3.1

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR173	On the Caribbean Sea coastline, on the south side of the island, approximately 916 meters southeast of intersection of Calle Dr Pila and Carretera 591, located in Ponce, at N 17.977176°, W 66.654057°	0.8	1.2	3.1
PR174	On the Caribbean Sea coastline, on the south side of the island, approximately 1.4 kilometers southwest of intersection of Camino Club de Tiros and Carretera 2, located in Ponce, at N 17.968749°, W 66.666718°	0.7	1.2	3.0
PR175	On the Caribbean Sea coastline, on the south side of the island, approximately 2.0 kilometers southwest of intersection of Camino Club de Tiros and Carretera 2, located in Ponce, at N 17.973120°, W 66.679352°	1.0	0.7	3.5[2]
PR176	On the Caribbean Sea coastline, on the south side of the island, approximately 501 meters west of intersection of Calle 2 and calle 3, located in Penuelas, at N 17.982704°, W 66.710619°	0.9	1.3	3.4
PR177	On the Caribbean Sea coastline, on the south side of the island, approximately 870 meters west of intersection of Calle 3 and Calle 4, located in Penuelas, at N 17.990154°, W 66.721512°	0.9	1.6	3.9
PR178	On the Caribbean Sea coastline, on the south side of the island, approximately 2.7 kilometers south of intersection of Carretera 337 and Carretera 127, located in Penuelas, at N 17.982227°, W 66.736882°	0.9	1.4	3.6
PR179	On the Caribbean Sea coastline, on the south side of the island, approximately 2.0 kilometers southwest of intersection of Carretera 337 and Carretera 127, located in Penuelas, at N 17.999622°, W 66.754454°	1.0	0.3	3.7[2]
PR180	On the Caribbean Sea coastline, on the south side of the island, approximately 589 meters south of intersection of Carretera 3336 and Carretera 127, located in Guayanilla, at N 18.005347°, W 66.771586°	1.0	1.1	3.3

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR181	On the Caribbean Sea coastline, on the south side of the island, approximately 1.9 kilometers south of intersection of Carretera 335 and Carretera 582, located in Guayanilla, at N 17.992927°, W 66.790491°	0.9	1.2	3.2
PR182	On the Caribbean Sea coastline, on the south side of the island, approximately 3.4 kilometers southeast of intersection of Carretera 335 and Calle Jose Garcia, located in Guayanilla, at N 17.971876°, W 66.789480°	0.7	2.0	4.1
PR183	On the Caribbean Sea coastline, on the south side of the island, approximately 3.1 kilometers south of intersection of Carretera 335 and Calle Jose Garcia, located in Guayanilla, at N 17.965360°, W 66.808921°	0.8	1.1	2.9
PR184	On the Caribbean Sea coastline, on the south side of the island, approximately 5.6 kilometers southwest of intersection of Carretera 335 and Calle Jose Garcia, located in Guayanilla, at N 17.949983°, W 66.840285°	0.7	1.1	2.7
PR185	On the Caribbean Sea coastline, on the south side of the island, approximately 4.1 kilometers southeast of intersection of Calle 3 and Calle 4, located in Yauco, at N 17.955450°, W 66.858175°	0.8	1.0	2.7
PR186	On the Caribbean Sea coastline, on the south side of the island, approximately 3.6 kilometers southeast of intersection of Calle 3 and Calle 4, located in Guanica, at N 17.950309°, W 66.869676°	0.8	1.5	3.5
PR187	On the Caribbean Sea coastline, on the south side of the island, approximately 2.9 kilometers southeast of intersection of Calle 3 and Calle 4, located in Guanica, at N 17.952467°, W 66.879655°	0.9	1.5	3.7
PR188	On the Caribbean Sea coastline, on the south side of the island, approximately 73 meters southeast of intersection of Calle 25 de Julia and Calle simon Mejias, located in Guanica, at N 17.964716°, W 66.907676°	0.9	1.2	3.2

[1]Includes wave setup

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR189	On the Caribbean Sea coastline, on the south side of the island, approximately 347 meters east of intersection of Carretera 3116R and Calle 2, located in Guanica, at N 17.969124°, W 66.928703°	1.1	0.2	2.1
PR190	On the Caribbean Sea coastline, on the south side of the island, approximately 2.5 kilometers southeast of intersection of Carretera 325 and Calle Las Brujas, located in Guanica, at N 17.945428°, W 66.917740°	0.8	1.3	3.2
PR191	On the Caribbean Sea coastline, on the south side of the island, approximately 2.1 kilometers south of intersection of Carretera 325 and Calle Las Brujas, located in Guanica, at N 17.941620°, W 66.931863°	0.9	1.2	3.3
PR192	On the Caribbean Sea coastline, on the south side of the island, approximately 3.8 kilometers southeast of intersection of Carretera 325 and Calle Marqueyes, located in Guanica, at N 17.927396°, W 66.923802°	0.5	1.3	2.9
PR193	On the Caribbean Sea coastline, on the south side of the island, approximately 3.0 kilometers south of intersection of Carretera 325 and Calle Marqueyes, located in Guanica, at N 17.932319°, W 66.936391°	0.7	0.7	2.5[2]
PR194	On the Caribbean Sea coastline, on the south side of the island, approximately 3.0 kilometers southwest of intersection of Carretera 325 and Calle Marqueyes, located in Guanica, at N 17.937940°, W 66.955253°	0.9	1.1	3.0
PR195	On the Caribbean Sea coastline, on the south side of the island, approximately 3.4 kilometers southwest of intersection of Carretera 325 and Calle Marqueyes, located in Guanica, at N 17.946059°, W 66.966250°	0.9	1.3	3.5
PR196	On the Caribbean Sea coastline, on the south side of the island, approximately 1.7 kilometers southwest of intersection of Carretera 234 and C la Montalua, located in Lajas, at N 17.954736°, W 66.982141°	1.0	1.3	3.6

[1]Includes wave setup [2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR197	On the Caribbean Sea coastline, on the south side of the island, approximately 518 meters southwest of intersection of Carretera 323 and Calle Aroma, located in Lajas, at N 17.972780°, W 66.993931°	1.2	0.7	3.0
PR198	On the Caribbean Sea coastline, on the south side of the island, approximately 2.1 kilometers southeast of intersection of Carretera 324 and Carretera 304, located in Lajas, at N 17.972081°, W 67.025122°	1.0	1.1	3.2
PR199	On the Caribbean Sea coastline, on the south side of the island, approximately 1.3 kilometers southwest of intersection of Carretera 324 and Carretera 304, located in Lajas, at N 17.973407°, W 67.049428°	1.0	1.0	3.1
PR200	On the Caribbean Sea coastline, on the south side of the island, approximately 3.2 kilometers south of intersection of Carretera 303 and Carr 302, located in Lajas, at N 17.950946°, W 67.129841°	0.9	1.0	2.9
PR201	On the Caribbean Sea coastline, on the southwest side of the island, approximately 2.2 kilometers southeast of intersection of Carretera 3301 and Camino Hernandez, located in Cabo Rojo, at N 17.963084°, W 67.182057°	1.1	1.2	3.5
PR202	On the Caribbean Sea coastline, on the southwest side of the island, approximately 4.0 kilometers southwest of intersection of Calle Union and Calle Julio Camacho, located in Cabo Rojo, at N 17.932991°, W 67.192383°	0.6	1.4	3.1
PR203	On the Caribbean Sea coastline, on the southwest side of the island, approximately 3.1 kilometers southwest of intersection of Carretera 3301 and Camino Hernandez, located in Cabo Rojo, at N 17.951509°, W 67.196495°	1.1	1.0	3.4
PR204	On the Caribbean Sea coastline, on the southwest side of the island, approximately 2.9 kilometers southwest of intersection of Carretera 3301 and Camino Hernandez, located in Cabo Rojo, at N 17.961538°, W 67.214265°	0.9	1.0	2.8

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR205	On the Caribbean Sea coastline, on the southwest side of the island, approximately 2.1 kilometers west of intersection of Carretera 3301 and Camino Hernandez, located in Cabo Rojo, at N 17.979081°, W 67.213499°	1.1	1.0	3.2
PR206	On the Caribbean Sea coastline, on the west side of the island, approximately 3.0 kilometers southwest of intersection of Carretera 301 and Calle 10, located in Cabo Rojo, at N 18.009378°, W 67.176610°	1.9	1.2	4.7
PR207	On the Caribbean Sea coastline, on the west side of the island, approximately 386 meters southwest of intersection of CCC Juan Silvestry and Calle Fermin Morales, located in Cabo Rojo, at N 18.024964°, W 67.174073°	1.8	1.3	4.9
PR208	On the Caribbean Sea coastline, on the west side of the island, approximately 1.2 kilometers southwest of intersection of Carretera 307 and Calle A, located in Cabo Rojo, at N 18.032238°, W 67.194633°	1.5	1.0	3.8[2]
PR209	On the Caribbean Sea coastline, on the west side of the island, approximately 2.7 kilometers west of intersection of Carretera 307 and Calle A, located in Cabo Rojo, at N 18.035311°, W 67.209107°	1.3	1.1	4.5[2]
PR210	On the Caribbean Sea coastline, on the west side of the island, approximately 1.9 kilometers southwest of intersection of Camino del Cerro and Callejon Enrique Garcia, located in Cabo Rojo, at N 18.048794°, W 67.198595°	1.4	1.2	4.0
PR211	On the Caribbean Sea coastline, on the west side of the island, approximately 1.4 kilometers northwest of intersection of Camino la Mela and Calle Juan Silvestry Franqui, located in Cabo Rojo, at N 18.064341°, W 67.197433°	1.4	1.2	4.0
PR212	On the Caribbean Sea coastline, on the west side of the island, approximately 630 meters south of intersection of Calle 12 and Calle 20, located in Cabo Rojo, at N 18.076355°, W 67.190291°	1.6	1.1	4.1

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR213	On the Caribbean Sea coastline, on the west side of the island, approximately 880 meters northwest of intersection of Calle 12 and Calle 20, located in Cabo Rojo, at N 18.083756°, W 67.198212°	1.4	1.0	3.7
PR214	On the Caribbean Sea coastline, on the west side of the island, approximately 453 meters north of intersection of Carretera 102 and Carretera 308, located in Cabo Rojo, at N 18.108224°, W 67.182199°	1.6	0.9	3.9
PR215	On the Caribbean Sea coastline, on the west side of the island, approximately 950 meters southwest of intersection of Carretera 102 and Camino de Pian Bonito, located in Cabo Rojo, at N 18.139748°, W 67.180752°	1.6	1.0	4.2[2]
PR216	On the Caribbean Sea coastline, on the west side of the island, approximately 320 meters northwest of intersection of Carretera 102 and Camino de Pian Bonito, located in Cabo Rojo, at N 18.150050°, W 67.176881°	1.7	0.9	4.0
PR217	On the Caribbean Sea coastline, on the west side of the island, approximately 1.0 kilometers southwest of intersection of Carretera 102 and Calle Miguel M Munoz, located in Cabo Rojo, at N 18.167916°, W 67.182607°	1.4	1.1	3.8
PR218	On the Caribbean Sea coastline, on the west side of the island, approximately 180 meters northwest of intersection of Calle G Pales Matos and Calle Jose P Morales, located in Mayaguez, at N 18.176903°, W 67.173181°	1.5	1.0	3.8
PR219	On the Caribbean Sea coastline, on the west side of the island, approximately 106 meters west of intersection of Avenida Yaguez and Bulevar Guanajibo, located in Mayaguez, at N 18.189594°, W 67.160078°	1.6	1.0	4.6[2]
PR220	On the Caribbean Sea coastline, on the west side of the island, approximately 181 meters southwest of intersection of Avenida Gonzalez Clemente and Calle McKinley, located in Mayaguez, at N 18.205661°, W 67.153320°	1.6	1.0	4.1

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR221	On the Caribbean Sea coastline, on the west side of the island, approximately 724 meters south of intersection of Carr 341 and Calle Diego Colon, located in Mayaguez, at N 18.222268°, W 67.169272°	1.2	1.3	3.9
PR222	On the Caribbean Sea coastline, on the west side of the island, approximately 110 meters northwest of intersection of Carr 341 and Calle Matildo Caban, located in Mayaguez, at N 18.238619°, W 67.173506°	1.2	1.0	3.4
PR223	On the Caribbean Sea coastline, on the west side of the island, approximately 1.1 kilometers southeast of intersection of Calle Los Robles and Calle Las Aevcenas, located in Mayaguez, at N 18.252962°, W 67.178638°	1.1	1.0	3.3
PR224	On the Caribbean Sea coastline, on the west side of the island, approximately 815 meters northwest of intersection of Calle Los Robles and Calle Las Aevcenas, located in Mayaguez, at N 18.267116°, W 67.188352°	1.1	1.0	3.2
PR225	On the Caribbean Sea coastline, on the west side of the island, approximately 275 meters west of intersection of Calle de Las Flores and Calle Orguidea, located in Añasco, at N 18.284783°, W 67.191739°	1.2	1.0	3.4
PR226	On the Caribbean Sea coastline, on the west side of the island, approximately 694 meters southwest of intersection of Carr 402 and Ent la Tosca, located in Añasco, at N 18.293457°, W 67.206958°	1.0	1.1	3.1
PR227	On the Caribbean Sea coastline, on the west side of the island, approximately 860 meters west of intersection of Carretera 429 and Rincon 117, located in Rincon, at N 18.299013°, W 67.233362°	0.8	1.2	4.7[2]
PR228	On the Caribbean Sea coastline, on the west side of the island, approximately 156 meters southwest of intersection of Calle 8 and Calle 11, located in Rincon, at N 18.322086°, W 67.248076°	0.9	1.2	3.3

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR229	On the Caribbean Sea coastline, on the west side of the island, approximately 350 meters northwest of intersection of Calle Munoz Rivera and Calle Nueva Final, located in Rincon, at N 18.338793°, W 67.254849°	1.0	1.4	3.7
PR230	On the Caribbean Sea coastline, on the west side of the island, approximately 1.2 kilometers northwest of intersection of Csn B and Carr Vista Linda, located in Rincon, at N 18.366014°, W 67.269773°	0.9	1.3	3.5
PR231	On the Caribbean Sea coastline, on the west side of the island, approximately 1.6 kilometers south of intersection of Camino Carretas and Sector Cuchillo Pina, located in Rincon, at N 18.373111°, W 67.247921°	1.0	1.4	3.7
PR232	On the Caribbean Sea coastline, on the west side of the island, approximately 1.4 kilometers west of intersection of Carretera 115 and Carretera 414, located in Aguada, at N 18.379168°, W 67.225001°	1.0	1.2	3.4
PR233	On the Caribbean Sea coastline, on the west side of the island, approximately 332 meters northwest of intersection of Carretera 115 and Carretera 414, located in Aguada, at N 18.383618°, W 67.214294°	1.1	1.6	4.2[2]
PR234	On the Caribbean Sea coastline, on the west side of the island, approximately 398 meters west of intersection of Calle Brisas del Mar and Calle 2, located in Aguada, at N 18.391729°, W 67.196750°	1.1	1.3	3.6
PR235	On the Caribbean Sea coastline, on the west side of the island, approximately 1.9 kilometers northwest of intersection of Carretera 439 and Carretera 441, located in Aguada, at N 18.402628°, W 67.183530°	1.1	1.2	3.5
PR236	On the Caribbean Sea coastline, on the west side of the island, approximately 1.6 kilometers north of intersection of Carretera 439 and Carretera 441, located in Aguada, at N 18.410768°, W 67.166624°	1.2	1.2	3.7

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
PR237	On the Caribbean Sea coastline, on the northwest side of the island, approximately 357 meters west of intersection of Carretera 111 and Calle Lorencita Ramirez de Are, located in Aguadilla, at N 18.417836°, W 67.157447°	1.2	1.2	4.3[2]
PR238	On the Caribbean Sea coastline, on the northwest side of the island, approximately 37 meters northwest of intersection of Calle Jose de Jesus Esteves and Calle Catalanes, located in Aguadilla, at N 18.430663°, W 67.155628°	1.2	1.3	4.0[2]
PR239	On the Caribbean Sea coastline, on the northwest side of the island, approximately 900 meters west of intersection of Calle Oliver and Camino el Mango, located in Aguadilla, at N 18.463402°, W 67.168027°	1.1	1.5	4.0
C1	On the Atlantic Ocean coastline, on the north side of the Culebra Island, approximately 1.9 kilometers northwest of intersection of Calle 1 and Carretera 251, located in Culebra Island, at N 18.328215°, W 65.315784°	1.4	0.8	5.4[2]
C2	On the Atlantic Ocean coastline, on the north side of the Culebra Island, approximately 4.0 kilometers northeast of intersection of Calle Luis Munoz Marin and Carretera 250, located in Culebra Island, at N 18.331027°, W 65.273775°	1.2	1.7	14.4[2]
C3	On the Ensenada Honda coastline, on the south side of the Culebra Island, approximately 4.0 kilometers southeast of intersection of Calle Luis Munoz Marin and Carretera 250, located in Culebra Island, at N 18.297202°, W 65.266173°	1.2	1.0	8.8[2]
C4	On the Ensenada Honda coastline, on the south side of the Culebra Island, approximately 118 meters south of intersection of Calle Luis Munoz Marin and Carretera 250, located in Culebra Island, at N 18.306986°, W 65.302215°	1.6	1.2	5.2[2]
C5	On the Vieques Sound coastline, on the south side of the Culebra Island, approximately 1.8 kilometers southeast of intersection of Calle Luis Munoz Marin and Carretera 250, located in Culebra Island, at N 18.292989°, W 65.296675°	1.2	1.3	5.2[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
C6	On the Vieques Sound coastline, on the south side of the Culebra Island, approximately 3.3 kilometers northwest of intersection of Calle 1 and Carretera 251, located in Culebra Island, at N 18.330411°, W 65.331688°	0.9	1.5	4.0[2]
V1	On the Vieques Passage coastline, on the west side of Vieques Island, approximately 9.2 kilometers northwest of intersection of Carretera 201 and Carretera 996, at N 18.113473°, W 65.575727°	0.9	1.0	3.0
V2	On the Vieques Passage coastline, on the west side of Vieques Island, approximately 4.8 kilometers northwest of intersection of Carretera 201 and Carretera 996, at N 18.126905°, W 65.52569°	2.4	1.0	5.3
V3	On the Vieques Passage coastline, on the north side of Vieques Island, approximately 3.7 kilometers southwest of intersection of Carretera 200 and Carretera 201, at N 18.135764°, W 65.492112°	2.4	0.9	6.2[2]
V4	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 630 meters northeast of intersection of Carretera 200 and Carretera 12, at N 18.145946°, W 65.448921°	2.4	0.8	5.1[2]
V5	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 240 meters southwest of intersection of Calle Morropo and Calle Richardson, at N 18.150433°, W 65.443407°	2.2	1.1	5.0
V6	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 1.1 kilometers northeast of intersection of Carretera 200 and Calle Richardson, at N 18.158173°, W 65.432384°	2.1	1.6	5.7
V7	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 2.3 kilometers northwest of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.160536°, W 65.388916°	2.0	1.5	5.3
V8	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 740 meters northeast of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.153629°, W 65.361223°	2.0	0.9	4.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
V9	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 5.3 kilometers southeast of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.145819°, W 65.318614°	1.8	1.0	5.8[2]
V10	On the Vieques Sound coastline, on the north side of Vieques Island, approximately 9.8 kilometers southeast of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.136247°, W 65.277312°	1.3	1.4	4.1
V11	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 6.6 kilometers southeast of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.13412°, W 65.308774°	1.2	0.8	4.2[2]
V12	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 5.6 kilometers southeast of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.125836°, W 65.324402°	1.1	1.1	3.4
V13	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 3.1 kilometers southwest of intersection of Carretera 200 and Camino Puerto Diablo, at N 18.12497°, W 65.372013°	1.4	0.7	3.3
V14	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 2.4 kilometers southeast of intersection of Carretera 997 and Carretera Destino-Esperanza, at N 18.107111°, W 65.417484°	1.3	1.2	3.8
V15	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 820 meters southeast of intersection of Carretera 997 and Carretera 996, at N 18.096922°, W 65.461626°	1.1	1.1	3.4
V16	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 750 meters southwest of intersection of Carretera 997 and Carretera 996, at N 18.095575°, W 65.475731°	1.1	1.1	3.3

[1]Includes wave setup
[2]Wave runup elevation

TABLE 7 - TRANSECT DESCRIPTIONS - continued

TRANSECT	LOCATION	ELEVATION (meter MSL) 1-PERCENT ANNUAL CHANCE STILLWATER	WAVE SETUP	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
V17	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 3.1 kilometers southwest of intersection of Carretera 201 and Carretera 996, at N 18.088017°, W 65.516135°	1.1	1.0	3.2
V18	On the Caribbean Sea coastline, on the north side of Vieques Island, approximately 6.9 kilometers southwest of intersection of Carretera 201 and Carretera 996, at N 18.084875°, W 65.553264°	1.0	1.5	3.8

TABLE 8 - TRANSECT DATA

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 1				
Atlantic Ocean	PR1	0.2	0.6	2.3[1]	2.3	VE	3.0-3.7
						AE	2.7-3.0
		0.2	0.6	1.1	2.3	AE	2.4[2]
Atlantic Ocean	PR2	0.3	0.7	2.4[1]	2.3	VE	3.0-3.7
						AE	3.0
		0.3	0.7	1.1	2.3	AE	2.7[2]
Atlantic Ocean	PR3	0.3	0.7	2.6[1]	2.3	VE	3.4-4.0
						AE	2.4-3.4
Atlantic Ocean	PR4	0.3	0.7	2.4[1]	2.4	VE	3.0-3.7
						AE	3.0
		0.3	0.7	1.2	2.4	AE	2.7[2]
Atlantic Ocean	PR5	0.3	0.7	2.4[1]	2.4	VE	3.0-3.7
						AE	2.4-3.0
Atlantic Ocean	PR6	0.3	0.7	2.5[1]	2.4	VE	3.0-4.0
						AE	2.4-3.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL)				ZONE	BASE FLOOD ELEVATION (meter MSL)
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT		
			Puerto Rico Region 1 - continued				
Atlantic Ocean	PR7	0.3	0.7	2.6[1]	2.4	VE	3.7-4.0
						AE	2.4-3.0
		0.3	0.7	1.2	2.4	VE	3.4[2]
						AE	3.4[2]
Atlantic Ocean	PR8	0.3	0.7	2.6[1]	2.5	VE	4.0
		0.3	0.7	1.3	2.5	VE	3.7[2]
						AE	3.7[2]
Atlantic Ocean	PR9	0.3	0.7	2.5[1]	2.5	VE	3.0-4.0
						AE	3.0
		0.3	0.7	1.3	2.5	AE	2.7[2]
Atlantic Ocean	PR10	0.3	0.7	2.5[1]	2.5	VE	3.0-3.7
				1.2		AE	3.0[2]
Atlantic Ocean	PR11	0.3	0.7	1.3	2.4	VE	4.6[2]
						AE	4.6[2]
Atlantic Ocean	PR12	0.3	0.7	2.5[1]	2.5	VE	3.7
		0.3	0.7	1.3	2.5	VE	3.4[2]
						AE	3.4[2]
Atlantic Ocean	PR13	0.3	0.7	2.7[1]	2.4	VE	3.4-4.0
						AE	2.7-3.4
Atlantic Ocean	PR14	0.3	0.7	2.7[1]	2.3	VE	3.4-4.3
						AE	2.7-3.4
Atlantic Ocean	PR15	0.3	0.7	2.6[1]	2.3	VE	3.4-4.0
						AE	3.4
		0.3	0.7	1.2	2.3	AE	3.0[2]
Atlantic Ocean	PR16	0.3	0.7	2.5[1]	2.3	VE	3.4-4.0
		0.3	0.7	1.2	2.3	VE	3.0[2]
						AE	3.0[2]
Atlantic Ocean	PR17	0.3	0.7	1.2	2.3	VE	4.6[2]
						AE	4.6[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
		Puerto Rico Region 1 - continued					
Atlantic Ocean	PR18	0.3	0.7	2.4[1]	2.1	VE	3.0-3.7
						AE	2.4-3.0
Atlantic Ocean	PR19	0.3	0.7	2.5[1]	2.2	VE	3.4-3.7
		0.3	0.7	1.2	2.2	VE	3.0[2]
						AE	3.0[2]
Atlantic Ocean	PR20	0.3	0.7	2.2[1]	2.0	VE	2.7-3.4
						AE	2.7
		0.3	0.7	1.0	2.0	AE	2.4[2]
Atlantic Ocean	PR21	0.3	0.7	2.4[1]	2.1	VE	3.0-3.7
						AE	2.4-3.0
Atlantic Ocean	PR22	0.3	0.6	2.4[1]	1.9	VE	3.4-3.7
		0.3	0.6	1.0	1.9	VE	3.0[2]
						AE	3.0[2]
Atlantic Ocean	PR23	0.4	0.8	2.0[1]	2.2	VE	3.0
		0.4	0.8	1.2	2.2	VE	2.7[2]
						AE	2.7[2]
Atlantic Ocean	PR24	0.3	0.7	2.3[1]	1.9	VE	3.0-3.4
		0.3	0.7	1.0	1.9	AE	2.7[2]
Atlantic Ocean	PR25	0.3	0.7	2.3[1]	2.0	VE	2.7-3.4
						AE	2.1-2.7
Atlantic Ocean	PR26	0.3	0.7	2.4[1]	2.1	VE	3.0-3.7
						AE	2.7-3.0
		0.3	0.7	1.1	2.1	AE	2.4[2]
Atlantic Ocean	PR27	0.3	0.7	1.0	1.9	VE	10.1[2]
						AE	10.1[2]
Atlantic Ocean	PR28	0.4	0.8	2.4[1]	2.1	VE	3.0-3.7
						AE	2.4-3.0
Atlantic Ocean	PR29	0.3	0.7	2.2[1]	1.6	VE	3.4
		0.3	0.7	0.9	1.6	AE	3.4[2]
Atlantic Ocean	PR30	0.3	0.7	2.2[1]	1.6	VE	3.4
		0.3	0.7	1.0	1.6	VE	3.0[2]
						AE	3.0[2]
						AO	Depth 0.6

[1]Includes wave setup [2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
Puerto Rico Region 1 - continued							
Atlantic Ocean	PR31	0.4	0.8	2.3[1]	1.9	VE	3.0-3.4
						AE	2.1-3.0
Atlantic Ocean	PR32	0.4	0.8	2.2[1]	1.7	VE	3.0-3.4
		0.4	0.8	1.0	1.7	VE	2.7[2]
						AE	2.7[2]
Atlantic Ocean	PR33	0.4	0.8	1.0	1.6	VE	3.7[2]
						AE	3.7[2]
Atlantic Ocean	PR34	0.3	0.7	2.4[1]	1.4	VE	3.0-3.7
						AE	2.4-3.0
Atlantic Ocean	PR35	0.3	0.7	3.0[1]	1.7	VE	3.7-4.6
						AE	3.0-3.7
Atlantic Ocean	PR36	0.4	0.8	1.1	1.8	VE	3.7[2]
						AE	3.7[2]
Atlantic Ocean	PR37	0.4	1.0	2.2[1]	2.0	VE	2.7-3.4
						AE	2.1-2.7
Atlantic Ocean	PR38	0.5	1.1	1.5	2.7	VE	3.7[2]
						AE	3.7[2]
Atlantic Ocean	PR39	0.5	1.1	1.8[1]	2.4	VE	2.4-2.7
		0.5	1.1	1.4	2.4	AE	1.8-2.4
Atlantic Ocean	PR40	0.5	1.0	1.3	2.0	VE	4.3[2]
						AE	4.3[2]
		0.5	1.1	1.5	2.5	AE	1.5
Atlantic Ocean	PR41	0.4	0.9	2.8[1]	1.6	VE	3.4-4.3
						AE	3.0-3.7
Atlantic Ocean	PR42	0.5	1.1	2.5[1]	2.4	VE	3.0-3.7
						AE	2.4-3.4
		0.5	1.1	1.5	2.4	AE	1.5
Atlantic Ocean	PR43	0.6	1.2	2.6[1]	2.4	VE	3.4-4.0
						AE	2.7-3.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Region 1 - continued			
Atlantic Ocean	PR44	0.6	1.3	1.6	2.4	VE	3.4[2]
						AO	Depth 0.3
		0.6	1.3	1.8[1]	2.4	AE	1.8
Atlantic Ocean	PR45	0.5	1.1	1.7[1]	2.1	VE	2.4
						AE	1.5-2.4
Atlantic Ocean	PR46	0.5	1.1	1.7[1]	2.1	VE	2.4
						AE	1.8-2.4
Atlantic Ocean	PR47	0.4	0.9	1.1	1.6	VE	2.7[2]
						AE	2.7[2]
Atlantic Ocean	PR48	0.4	0.8	1.0	1.5	VE	2.4[2]
						AE	2.4[2]
Atlantic Ocean	PR49	0.4	0.8	1.0	1.5	VE	4.6[2]
						AE	4.6[2]
Atlantic Ocean	PR50	0.3	0.7	1.0	1.5	VE	6.4[2]
						AE	6.4[2]
Atlantic Ocean	PR51	0.3	0.7	2.9[1]	1.2	VE	3.7-4.6
						AE	3.0-3.7
		0.4	0.9	2.1[1]	2.1	AE	2.1
		0.4	0.9	1.5[1]	2.1	AE	1.5
Atlantic Ocean	PR52	0.4	0.8	1.1	1.7	VE	3.0[2]
						AE	3.0[2]
		0.5	1.0	2.1[1]	2.0	AE	2.1
Atlantic Ocean	PR53	0.4	0.9	2.1[1]	1.8	VE	2.7-3.0
		0.4	0.9	1.1	1.8	AE	2.4[2]
		0.4	0.9	2.1[1]	1.8	AE	2.1
		0.5	1.0	2.1[1]	2.0	AE	2.1
Atlantic Ocean	PR54	0.4	0.9	2.3[1]	1.7	VE	3.0-3.4
						AE	2.4-3.0
		0.5	1.1	1.5	2.0	AE	1.5
		0.5	1.0	1.2	1.8	AE	1.2
Atlantic Ocean	PR55	0.5	1.1	1.4	2.4	VE	4.3[2]
						AE	1.5-1.8
						AO	Depth 0.6

[1]Includes wave setup [2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
Puerto Rico Region 1 - continued							
Atlantic Ocean	PR56	0.5	1.1	2.6[1]	2.0	VE	3.0-4.0
		0.5	1.1	1.3	2.0	AE	2.7[2]
						AE	1.5-1.8
Puerto Rico Region 2							
Atlantic Ocean	PR57	0.5	1.0	2.1[1]	1.8	VE	2.7-3.4
						AE	2.7
		0.5	1.0	1.3	1.8	AE	2.4[2]
Atlantic Ocean	PR58	0.3	0.7	1.8[1]	1.3	VE	2.4-2.7
						AE	1.8-2.4
		0.3	0.7	0.9	1.3	AE	2.1[2]
						AE	0.9
						AO	Depth 0.6
		0.4	0.8	1.3[1]	1.4	AE	1.2-1.5
Atlantic Ocean	PR59	0.3	0.7	2.2[1]	1.3	VE	3.4
		0.3	0.7	0.9	1.3	VE	3.0[2]
						AE	3.0[2]
Atlantic Ocean	PR60	0.4	0.8	2.0[1]	1.4	VE	2.7-3.0
						AE	2.1-2.7
		0.4	1.0	1.3[1]	1.8	AE	1.2-1.5
		0.4	0.9	1.0	1.6	AE	0.9
Atlantic Ocean	PR61	0.4	0.9	2.1[1]	1.7	VE	3.0
		0.4	0.9	1.1	1.7	VE	2.7[2]
						AE	2.7[2]
Atlantic Ocean	PR62	0.4	0.9	2.1[1]	1.5	VE	2.7-3.4
						AE	2.1-2.7
		0.4	0.9	1.3[1]	1.6	AE	1.2-1.5
		0.4	0.9	1.0	1.5	AE	0.9
Atlantic Ocean	PR63	0.5	1.1	2.4[1]	1.9	VE	3.0-3.7
						AE	2.4-3.0
		0.5	1.1	1.3	1.9	AE	1.2-1.8

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
		Puerto Rico Region 2 - continued					
Atlantic Ocean	PR64	0.5	1.0	2.4[1]	1.7	VE	3.0-3.7
						AE	2.4-3.0
		0.5	1.0	1.2	1.7	AE	1.2-1.5
Atlantic Ocean	PR65	0.6	1.2	2.6[1]	2.2	VE	3.4-4.0
						AE	2.7-3.4
		0.6	1.2	2.1[1]	2.2	AE	2.1-2.4
		0.6	1.2	1.8[1]	2.2	AE	1.8
		0.6	1.2	1.5[1]	2.2	AE	1.5
		0.5	1.1	1.2[1]	2.0	AE	1.2
Atlantic Ocean	PR66	0.6	1.3	2.8[1]	2.2	VE	3.4-4.3
						AE	2.7-3.4
		0.7	1.4	1.9[1]	2.7	AE	1.8-2.1
		0.6	1.3	1.6	2.2	AE	1.5
Atlantic Ocean	PR67	0.6	1.3	2.5[1]	2.2	VE	3.0-4.0
						AE	2.4-3.0
Atlantic Ocean	PR68	0.6	1.2	2.3[1]	2.2	VE	3.0-3.4
						AE	2.1-2.7
		0.6	1.2	1.5	2.2	AE	1.5
Atlantic Ocean	PR69	0.6	1.3	2.6[1]	2.2	VE	3.4-4.0
						AE	2.4-3.4
Atlantic Ocean	PR70	0.6	1.2	2.3[1]	2.0	VE	3.0-3.4
						AE	2.1-3.0
		0.6	1.2	1.4	2.0	AE	1.5
Atlantic Ocean	PR71	0.5	1.1	2.2[1]	2.1	VE	2.7-3.4
						AE	2.4-2.7
		0.5	1.1	1.4	2.1	AE	1.2-1.5
						AO	Depth 0.3
Atlantic Ocean	PR72	0.6	1.2	2.6[1]	2.0	VE	3.0-4.0
						AE	2.4-3.0
		0.6	1.2	1.4	2.0	AE	3.0[2]
Atlantic Ocean	PR73	0.5	1.0	3.2[1]	1.5	VE	4.0-4.9
						AE	3.0-4.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 2 - continued				
Atlantic Ocean	PR74	0.7	1.4	2.8[1]	2.3	VE	3.4-4.3
						AE	2.7-3.4
Atlantic Ocean	PR75	0.5	1.0	3.1[1]	1.5	VE	3.7-4.9
						AE	3.0-3.7
Atlantic Ocean	PR76	0.4	0.9	2.3[1]	1.5	VE	3.0-3.7
						AE	2.4-3.0
		0.4	0.9	1.1	1.5	AO	Depth 0.3
Vieques Sound	PR77	0.5	1.1	3.5[1]	2.1	VE	4.0-5.2
						AE	3.0-4.0
Vieques Sound	PR78	0.6	1.4	3.2[1]	2.9	VE	3.7-4.9
						AE	3.0-3.7
Vieques Sound	PR79	0.6	1.5	3.2[1]	3.0	VE	4.9
		0.6	1.5	1.9	3.0	VE	4.9[2]
						AE	4.9[2]
Vieques Sound	PR80	0.7	1.7	3.3[1]	3.4	VE	4.0-5.2
						AE	3.4-4.0
Vieques Sound	PR81	0.7	1.6	3.3[1]	3.2	VE	4.6-5.2
		0.7	1.6	2.0	3.2	VE	4.3[2]
						AE	4.3[2]
Vieques Sound	PR82	0.7	1.6	3.4[1]	3.4	VE	4.0-5.2
						AE	3.4-4.0
Vieques Sound	PR83	0.7	1.7	3.5[1]	3.5	VE	4.0-5.2
						AE	3.4-4.0
Vieques Sound	PR84	0.8	1.7	3.6[1]	3.6	VE	5.5
		0.8	1.7	2.3	3.6	VE	5.2[2]
						AE	5.2[2]
Vieques Sound	PR85	0.9	2.0	3.8[1]	4.1	VE	4.3-5.8
						AE	3.7-4.3
Vieques Sound	PR86	0.9	2.0	3.8[1]	4.2	VE	4.3-5.8
						AE	3.7-4.3

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 2 - continued				
Vieques Sound	PR87	0.9	2.0	3.7[1]	4.2	VE	4.3-5.5
						AE	3.7-4.3
Vieques Sound	PR88	1.0	2.2	3.8[1]	4.6	VE	4.6-5.8
						AE	4.0-4.6
		1.0	2.2	2.9[1]	4.6	AE	2.7
Vieques Sound	PR89	1.0	2.2	3.8[1]	4.4	VE	4.3-5.8
						AE	4.0-4.6
		0.7	1.8	3.5[1]	4.1	AE	3.4
Vieques Sound	PR90	0.8	1.8	3.5[1]	3.9	VE	4.3-5.5
		0.8	1.8	2.4	3.9	AE	4.0[2]
Vieques Sound	PR91	0.6	1.6	3.4[1]	3.9	VE	4.0-5.2
						AE	3.4-4.0
Vieques Sound	PR92	0.5	1.3	1.8	3.2	VE	6.1[2]
						AE	6.1[2]
			Puerto Rico Region 3				
Vieques Passage	PR93	0.5	1.3	3.4[1]	3.4	VE	4.0-5.2
						AE	3.4-4.0
Vieques Passage	PR94	0.6	1.4	3.1[1]	3.6	VE	3.7-4.6
						AE	3.0-3.7
Vieques Passage	PR95	0.5	1.3	3.4[1]	3.4	VE	4.0-5.2
						AE	3.4-4.0
Vieques Passage	PR96	0.6	1.5	3.3[1]	3.9	VE	4.0-5.2
						AE	3.4-4.0
		0.5	1.4	1.9	3.7	AE	1.8-2.1
Vieques Passage	PR97	0.4	1.0	2.6[1]	2.5	VE	3.7-4.0
		0.4	1.0	1.4	2.5	VE	3.4[2]
						AE	3.4[2]
Vieques Passage	PR98	0.4	1.1	1.6	2.9	VE	4.0[2]
						AE	4.0[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Region 3 - continued			
Vieques Passage	PR99	0.5	1.4	3.1[1]	3.9	VE	3.7-4.9
						AE	3.0-3.7
		0.5	1.4	2.7[1]	3.9	AE	2.7
		0.5	1.4	2.3[1]	3.9	AE	2.4
		0.5	1.4	2.1	3.9	AE	2.1
Vieques Passage	PR100	0.5	1.4	3.1[1]	3.8	VE	3.7-4.9
						AE	3.0-3.7
Vieques Passage	PR101	0.6	1.6	3.3[1]	4.4	VE	4.0-5.2
						AE	3.4-4.0
		0.6	1.6	3.0[1]	4.4	AE	3.0
		0.6	1.6	2.7[1]	4.4	AE	2.7
		0.6	1.6	2.4	4.4	AE	2.4
Vieques Passage	PR102	0.4	1.1	1.6	2.8	VE	9.8[2]
						AE	9.8[2]
Vieques Passage	PR103	0.4	1.1	2.7[1]	3.0	VE	3.4-4.0
						AE	2.7-3.4
		0.4	1.1	1.7	3.0	AE	1.8
Vieques Passage	PR104	0.5	1.2	2.8[1]	3.3	VE	3.4-4.3
						AE	2.7-3.4
Vieques Passage	PR105	0.5	1.4	3.1[1]	3.6	VE	3.7-4.9
						AE	3.0-3.7
Vieques Passage	PR106	0.5	1.5	3.2[1]	4.0	VE	3.7-4.9
						AE	3.7
		0.5	1.5	2.2	4.0	AE	3.4[2]
Vieques Passage	PR107	0.6	1.5	3.4[1]	4.4	VE	4.0-5.2
						AE	3.4-4.0
		0.6	1.5	3.0[1]	4.4	VE	3.0
						AE	3.0
		0.6	1.5	2.7[1]	4.4	AE	2.7
		0.6	1.5	2.4	4.4	AE	2.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Region 3 - continued			
Vieques Passage	PR108	0.4	1.3	3.0[1]	3.6	VE	3.7-4.6
						AE	3.0-3.7
		0.5	1.5	2.6[1]	4.3	AE	2.7
		0.5	1.5	2.3[1]	4.3	AE	2.4
		0.4	1.4	2.0	3.8	AE	2.1
Vieques Passage	PR109	0.5	1.4	3.2[1]	4.3	VE	4.0-4.9
						AE	3.0-4.0
		0.5	1.4	2.7[1]	4.3	AE	2.7
		0.5	1.4	2.4[1]	4.3	AE	2.4
		0.5	1.4	2.3	4.3	AE	2.1
Vieques Passage	PR110	0.5	1.4	3.1[1]	4.2	VE	4.6-4.9
		0.5	1.4	2.2	4.2	VE	4.3[2]
						AE	4.3[2]
		0.5	1.4	2.7[1]	4.2	AE	2.7
		0.5	1.4	2.4[1]	4.2	AE	2.4
		0.5	1.4	2.2	4.2	AE	2.1
Caribbean Sea	PR111	0.5	1.4	3.2[1]	4.3	VE	3.7-4.9
						AE	3.0-3.7
Caribbean Sea	PR112	0.4	1.0	2.8[1]	3.2	VE	3.7-4.3
		0.4	1.0	1.7	3.2	VE	3.4[2]
						AE	3.4[2]
Caribbean Sea	PR113	0.5	1.1	2.6[1]	3.6	VE	3.4-4.0
						AE	2.7-3.4
Caribbean Sea	PR114	0.4	0.9	2.5[1]	2.8	VE	3.4-3.7
		0.4	0.9	1.5	2.8	VE	3.0[2]
						AE	3.0[2]
						AE	1.5
Caribbean Sea	PR115	0.4	0.9	2.7[1]	3.0	VE	3.4-4.3
						AE	2.7-3.4
Caribbean Sea	PR116	0.4	0.9	1.4	2.6	VE	6.4[2]
						AE	6.4[2]
Caribbean Sea	PR117	0.3	0.8	1.2	2.2	VE	4.6[2]
						AE	4.6[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
		Puerto Rico Region 3 - continued					
Caribbean Sea	PR118	0.4	0.9	1.5	2.9	VE	4.0[2]
						AE	4.0[2]
Caribbean Sea	PR119	0.4	0.9	2.8[1]	2.8	VE	3.4-4.3
						AE	2.7-3.4
Caribbean Sea	PR120	0.4	1.0	3.1[1]	2.9	VE	3.7-4.6
						AE	3.0-3.7
Caribbean Sea	PR121	0.4	0.9	3.1[1]	2.9	VE	3.4-4.3
						AE	2.7-3.4
Caribbean Sea	PR122	0.4	0.8	2.6[1]	2.5	VE	3.4-4.0
						AE	3.4
		0.4	0.8	1.4	2.5	AE	3.0[2]
Caribbean Sea	PR123	0.3	0.8	2.4[1]	2.2	VE	3.4-3.7
		0.3	0.8	1.2	2.2	VE	3.0[2]
						AE	3.0[2]
Caribbean Sea	PR124	0.3	0.8	1.3	2.3	VE	4.3[2]
						AE	4.3[2]
Caribbean Sea	PR125	0.4	0.8	1.4	2.6	VE	3.4[2]
						AE	3.4[2]
Caribbean Sea	PR126	0.3	0.8	2.5[1]	2.5	VE	3.7-4.0
		0.3	0.8	1.3	2.5	VE	3.4[2]
						AE	3.4[2]
Caribbean Sea	PR127	0.3	0.8	1.3	2.4	VE	3.4[2]
		0.3	0.8	2.1[1]	2.4	AE	2.1-2.7
Caribbean Sea	PR128	0.3	0.8	1.3	2.4	VE	4.6[2]
						AE	4.6[2]
Caribbean Sea	PR129	0.3	0.8	2.5[1]	2.4	VE	3.0-4.0
						AE	3.0
		0.3	0.8	1.3	2.4	AE	2.7[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
Puerto Rico Region 3 - continued							
Caribbean Sea	PR130	0.3	0.8	2.7[1]	2.4	VE	3.4-4.0
						AE	3.4
		0.3	0.8	1.3	2.4	AE	3.0[2]
Caribbean Sea	PR131	0.3	0.8	3.1[1]	2.4	VE	3.7-4.6
						AE	3.0-3.7
Caribbean Sea	PR132	0.3	0.8	2.4[1]	2.5	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR133	0.3	0.8	2.4[1]	2.5	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR134	0.3	0.8	3.2[1]	2.5	VE	4.0-4.9
						AE	3.0-4.0
Caribbean Sea	PR135	0.4	0.9	2.5[1]	2.8	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR136	0.4	0.9	2.4[1]	2.6	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR137	0.4	0.9	2.6[1]	2.5	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR138	0.3	0.8	2.9[1]	2.4	VE	3.4-4.3
						AE	3.0-3.7
Caribbean Sea	PR139	0.3	0.8	2.4[1]	2.7	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR140	0.4	0.9	2.5[1]	2.8	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR141	0.4	0.9	2.6[1]	2.8	VE	3.4-4.0
						AE	2.4-3.4
Caribbean Sea	PR142	0.4	0.9	2.4[1]	2.6	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR143	0.3	0.8	2.4[1]	2.5	VE	3.0-3.7
						AE	2.4-3.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Region 4			
Caribbean Sea	PR144	0.3	0.8	2.1[1]	2.2	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR145	0.3	0.7	2.8[1]	2.3	VE	3.4-4.3
						AE	2.7-3.4
Caribbean Sea	PR146	0.5	1.4	3.1[1]	3.7	VE	3.7-4.3
						AE	3.0-3.7
		0.5	1.4	3.0[1]	3.6	VE	3.7-4.0
						AE	3.0-3.7
		0.4	0.8	2.4[1]	2.2	VE	3.0-3.7
						AE	2.7-3.0
		0.4	1.2	2.6[1]	2.2	VE	3.0-3.4
						AE	3.0-3.4
		0.5	1.2	2.7[1]	3.2	AE	2.7
Caribbean Sea	PR147	0.4	1.3	2.9[1]	3.5	VE	3.7-4.3
						AE	3.0-3.7
		0.4	1.2	2.8[1]	3.3	VE	3.4-4.0
						AE	3.4
		0.4	0.8	2.2[1]	2.1	VE	2.7-3.4
						AE	2.1-2.7
		0.4	1.1	2.7[1]	3.2	AE	2.7-3.0
		0.4	0.8	2.4[1]	2.1	AE	2.4
		0.4	1.3	1.9	3.5	AE	1.8
Caribbean Sea	PR148	0.4	1.0	2.5[1]	2.8	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR149	0.3	0.8	1.8[1]	2.2	VE	2.4-2.7
						AE	1.8-2.4
		0.3	0.8	2.0[1]	2.2	VE	2.4-2.7
						AE	1.8-2.4
Caribbean Sea	PR150	0.4	0.9	2.4[1]	2.5	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR151	0.4	1.1	2.6[1]	3.1	VE	3.4-4.0
						AE	2.7-3.4
Caribbean Sea	PR152	0.4	1.0	2.3[1]	2.6	VE	3.0-3.7
						AE	2.4-3.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 4 – continued				
Caribbean Sea	PR153	0.4	1.0	1.5	2.7	VE	3.7[2]
		0.4	1.0	2.3[1]	2.7	AE	2.4
		0.4	1.0	1.5	2.7	AO	Depth 0.6
Caribbean Sea	PR154	0.4	1.0	2.2[1]	2.2	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR155	0.5	1.1	2.4[1]	2.2	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR156	0.5	1.0	2.2[1]	2.0	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR157	0.4	0.9	2.0[1]	1.6	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR158	0.3	0.8	2.1[1]	2.2	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR159	0.3	0.9	1.3	2.4	VE	3.0[2]
		0.3	0.9	2.0[1]	2.4	AE	2.1
		0.3	0.9	1.3	2.4	AO	Depth 0.6
Caribbean Sea	PR160	0.3	0.9	2.3[1]	2.5	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR161	0.4	1.1	2.6[1]	3.1	VE	3.4-4.0
						AE	2.4-3.0
Caribbean Sea	PR162	0.4	1.1	2.5[1]	2.9	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR163	0.4	1.2	2.6[1]	3.1	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR164	0.4	1.0	2.5[1]	2.7	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR165	0.4	0.9	2.2[1]	2.2	VE	2.7-3.4
						AE	2.1-2.7

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
		Puerto Rico Region 4 – continued					
Caribbean Sea	PR166	0.3	0.8	2.2[1]	1.9	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR167	0.3	0.6	0.9	1.5	VE	3.0[2]
		0.3	0.7	2.2[1]	1.8	AE	2.1-2.7
		0.3	0.6	2.0[1]	1.5	AE	2.1
		0.3	0.6	0.9	1.5	AO	Depth 0.6
Caribbean Sea	PR168	0.3	0.7	2.1[1]	1.8	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR169	0.3	0.7	2.1[1]	1.6	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR170	0.3	0.7	2.2[1]	1.8	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR171	0.3	0.8	2.1[1]	2.0	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR172	0.3	0.7	2.0[1]	1.7	VE	2.7-3.0
						AE	2.1-2.7
		0.3	0.7	1.0	1.7	AE	0.9
Caribbean Sea	PR173	0.4	0.7	2.0[1]	1.5	VE	2.7-3.0
						AE	2.1-2.7
		0.4	0.7	0.9	1.5	VE	2.4[2]
Caribbean Sea	PR174	0.3	0.6	2.0[1]	1.1	VE	2.7-3.0
						AE	1.8-2.7
Caribbean Sea	PR175	0.3	0.7	1.0	1.8	VE	3.4[2]
						AE	3.4[2]
Caribbean Sea	PR176	0.3	0.7	2.2[1]	1.6	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR177	0.3	0.7	2.6[1]	1.6	VE	3.4-4.0
						AE	2.4-3.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
Puerto Rico Region 4 – continued							
Caribbean Sea	PR178	0.4	0.7	2.3[1]	1.4	VE	3.0-4.0
						AE	2.4-3.0
Caribbean Sea	PR179	0.3	0.8	1.1	1.9	VE	3.7[2]
						AE	3.7[2]
Caribbean Sea	PR180	0.4	0.8	2.1[1]	1.7	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR181	0.4	0.8	2.1[1]	1.2	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR182	0.3	0.5	2.7[1]	1.1	VE	3.4-4.3
						AE	2.7-3.4
Caribbean Sea	PR183	0.3	0.6	1.9[1]	1.1	VE	2.4-3.0
						AE	1.8-2.4
Caribbean Sea	PR184	0.2	0.5	1.8[1]	1.0	VE	2.4-2.7
						AE	2.4
		0.2	0.5	0.7	1.0	AE	2.1[2]
Caribbean Sea	PR185	0.3	0.6	1.8[1]	1.1	VE	2.4-2.7
						AE	1.8-2.4
Caribbean Sea	PR186	0.3	0.6	2.3[1]	1.6	VE	3.0-3.4
						AE	2.1-3.0
Caribbean Sea	PR187	0.3	0.7	2.4[1]	1.6	VE	3.0-3.7
						AE	2.4-3.0
		0.3	0.7	0.9	1.6	AO	Depth 0.6
Caribbean Sea	PR188	0.4	0.7	2.1[1]	1.4	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR189	0.4	0.9	1.2[1]	1.4	VE	1.8-2.1
						AE	1.8
		0.4	0.9	1.1	1.4	AE	1.5[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 4 – continued				
Caribbean Sea	PR190	0.3	0.6	2.1[1]	1.0	VE	2.7-3.4
						AE	2.7
		0.3	0.6	0.8	1.0	AE	2.4[2]
Caribbean Sea	PR191	0.4	0.8	2.1[1]	1.4	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR192	0.2	0.4	1.9[1]	0.8	VE	2.4-2.7
						AE	1.8-2.4
Caribbean Sea	PR193	0.2	0.5	0.7	1.0	VE	2.4[2]
						AE	2.4[2]
Caribbean Sea	PR194	0.3	0.6	1.9[1]	1.4	VE	2.4-3.0
						AE	1.8-2.4
Caribbean Sea	PR195	0.3	0.7	2.2[1]	1.6	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR196	0.3	0.7	2.3[1]	1.8	VE	3.0
						AE	2.4-3.0
Caribbean Sea	PR197	0.3	0.9	2.0[1]	2.2	VE	2.7-3.0
						AE	1.8-2.7
Caribbean Sea	PR198	0.3	0.8	2.1[1]	1.7	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR199	0.3	0.8	2.0[1]	1.6	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR200	0.3	0.7	1.9[1]	1.4	VE	2.4-3.0
						AE	1.8-2.4
Caribbean Sea	PR201	0.4	1.0	2.3[1]	1.5	VE	3.0-3.7
						AE	2.4-3.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 4 – continued				
Caribbean Sea	PR202	0.2	0.5	2.0[1]	1.0	VE	2.7-3.0
						AE	2.7
		0.2	0.5	0.6	1.0	AE	2.4[2]
Caribbean Sea	PR203	0.4	0.9	2.2[1]	1.7	VE	2.7-3.4
						AE	2.1-2.7
			Puerto Rico Region 5				
Caribbean Sea	PR204	0.2	0.6	1.8[1]	1.5	VE	2.4-2.7
						AE	1.8-2.4
		0.2	0.6	0.9	1.5	AE	0.9
Caribbean Sea	PR205	0.3	0.7	2.1[1]	2.0	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR206	0.5	1.3	3.1[1]	3.3	VE	3.7-4.6
						AE	3.0-3.7
Caribbean Sea	PR207	0.5	1.3	3.2[1]	3.5	VE	4.0-4.9
						AE	3.0-4.0
Caribbean Sea	PR208	0.4	1.0	2.4[1]	2.7	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR209	0.3	0.9	1.3	2.3	VE	4.6[2]
						AE	4.6[2]
Caribbean Sea	PR210	0.4	1.0	2.6[1]	2.6	VE	3.4-4.0
						AE	3.0-3.4
		0.4	1.0	1.4	2.6	AE	2.7[2]
						AE	1.5
Caribbean Sea	PR211	0.4	0.9	2.6[1]	2.7	VE	3.4-4.0
						AE	2.7-3.4
		0.4	0.9	1.4	2.7	AE	1.5
Caribbean Sea	PR212	0.4	1.1	2.7[1]	3.1	VE	3.4-4.0
						AE	2.7-3.4
Caribbean Sea	PR213	0.3	0.8	2.4[1]	2.7	VE	3.0-3.7
						AE	2.4-3.0

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Region 5 - continued			
Caribbean Sea	PR214	0.4	1.1	2.5[1]	3.0	VE	3.0-4.0
						AE	2.4-3.0
		0.4	1.1	1.6	3.0	AE	1.5
Caribbean Sea	PR215	0.4	1.1	1.7	3.2	VE	4.3[2]
						AE	1.5-1.8
						AO	Depth 0.3
Caribbean Sea	PR216	0.4	1.0	2.6[1]	3.3	VE	3.4-4.0
						AE	2.4-3.4
Caribbean Sea	PR217	0.3	0.8	2.5[1]	2.7	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR218	0.4	1.0	2.5[1]	2.9	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR219	0.5	1.1	1.6	3.1	VE	4.6[2]
						AE	2.1
						AO	Depth 0.6
Caribbean Sea	PR220	0.4	1.0	2.7[1]	3.2	VE	3.4-4.0
						AE	2.7-3.4
		0.4	1.0	1.7	3.2	AE	1.5-1.8
Caribbean Sea	PR221	0.3	0.8	2.5[1]	2.5	VE	4.0
		0.3	0.8	1.2	2.5	AE	4.0[2]
Caribbean Sea	PR222	0.3	0.7	2.2[1]	2.3	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR223	0.3	0.7	2.1[1]	2.2	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR224	0.2	0.7	2.1[1]	2.0	VE	2.7-3.0
						AE	2.1-2.7
Caribbean Sea	PR225	0.3	0.7	2.2[1]	2.2	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR226	0.3	0.6	2.0[1]	1.9	VE	2.7-3.0
						AE	2.4-2.7
		0.3	0.6	1.0	1.9	AE	2.1[2]

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Region 5 - continued				
Caribbean Sea	PR227	0.2	0.5	0.8	1.4	VE	4.6[2]
						AE	3.0
						AO	Depth 0.9
Caribbean Sea	PR228	0.3	0.6	2.1[1]	1.6	VE	2.7-3.4
		0.3	0.6	0.9	1.6	AE	2.7[2]
Caribbean Sea	PR229	0.3	0.6	1.0	1.9	VE	3.7[2]
						AE	3.7[2]
Caribbean Sea	PR230	0.2	0.6	2.3[1]	1.9	VE	3.0-3.4
						AE	2.7-3.0
		0.2	0.6	1.0	1.9	AE	2.4[2]
Caribbean Sea	PR231	0.3	0.6	2.4[1]	1.9	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR232	0.3	0.7	2.2[1]	2.0	VE	2.7-3.4
						AE	2.1-2.7
Caribbean Sea	PR233	0.3	0.7	1.1	2.1	VE	4.3[2]
						AO	Depth 0.3
Caribbean Sea	PR234	0.3	0.7	2.3[1]	2.1	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR235	0.3	0.6	2.3[1]	2.1	VE	3.0-3.7
						AE	2.7-3.0
		0.3	0.6	1.1	2.1	AE	2.4[2]
Caribbean Sea	PR236	0.3	0.7	2.4[1]	2.3	VE	3.0-3.7
						AE	2.4-3.0
Caribbean Sea	PR237	0.3	0.7	1.2	2.4	VE	4.3[2]
						AE	4.3[2]
						AO	Depth 0.6
Caribbean Sea	PR238	0.3	0.7	1.2	2.4	VE	4.0[2]
						AE	4.0[2]
Caribbean Sea	PR239	0.3	0.7	2.6[1]	2.2	VE	3.4-4.0
						AE	2.7-3.4

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
				Puerto Rico Islands			
Atlantic Ocean	C1	0.6	1.2	1.4	1.9	VE	5.5[2]
						AE	5.5[2]
Atlantic Ocean	C2	0.5	1.0	1.2	1.8	VE	14.3[2]
						AE	14.3[2]
Ensenada Honda	C3	0.5	1.0	1.2	2.0	VE	8.8[2]
						AE	8.8[2]
Ensenada Honda	C4	0.6	1.3	1.8	2.7	VE	5.2[2]
						AE	5.2[2]
Vieques Sound	C5	0.5	1.0	1.2	1.7	VE	5.2[2]
						AE	5.2[2]
Vieques Sound	C6	0.4	0.7	0.9	1.3	VE	4.0[2]
						AE	4.0[2]
Vieques Passage	V1	0.8	1.8	3.4[1]	3.4	AE	3.4-3.7
		0.7	1.4	3.1[1]	2.8	AE	3.0
		0.3	0.7	1.9[1]	1.3	VE	2.7-3.0
						AE	1.8-2.7
		0.6	1.2	2.8[1]	2.4	AE	2.7
		0.6	1.2	2.4[1]	2.4	AE	2.4
Vieques Passage	V2	0.9	1.9	3.4[1]	3.5	VE	4.9-5.2
		0.9	1.9	2.4	3.5	VE	4.6[2]
						AE	4.6[2]
Vieques Passage	V3	1.0	2.0	2.4	3.5	VE	6.1[2]
						AE	6.1[2]
Vieques Sound	V4	0.9	1.9	2.4	3.5	VE	5.2[2]
						AE	5.2[2]
Vieques Sound	V5	0.9	1.8	3.3[1]	3.3	VE	4.0-4.9
						AE	3.4-4.0
Vieques Sound	V6	0.8	1.7	3.7[1]	3.2	VE	4.3-5.8
						AE	3.7-4.3

[1]Includes wave setup
[2]Wave runup elevation

TABLE 8 - TRANSECT DATA - continued

FLOODING SOURCE	TRANSECT	STILLWATER ELEVATION (meter MSL) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	ZONE	BASE FLOOD ELEVATION (meter MSL)
			Puerto Rico Islands - continued				
Vieques Sound	V7	0.7	1.6	3.4[1]	3.0	VE	4.3-5.2
		0.7	1.6	2.0	3.0	VE	4.0[2]
						AE	4.0[2]
Vieques Sound	V8	0.8	1.6	2.9[1]	3.1	VE	4.3
		0.8	1.6	2.0	3.1	VE	4.0[2]
						AE	2.1
						AO	Depth 0.9
Vieques Sound	V9	0.7	1.4	1.9	2.9	VE	5.8[2]
						AE	5.8[2]
Vieques Sound	V10	0.5	1.0	2.7[1]	2.0	VE	3.4-4.0
						AE	2.7-3.4
Caribbean Sea	V11	0.4	0.9	1.2	1.7	VE	4.3[2]
						AE	4.3[2]
Caribbean Sea	V12	0.4	0.8	2.2[1]	1.6	VE	3.4
		0.4	0.8	1.1	1.6	VE	3.0[2]
						AE	3.0[2]

[1]Includes wave setup
[2]Wave runup elevation

Users of the FIRM should also be aware that coastal flood elevations are provided in the Summary of Stillwater Elevations table in this report. If the elevation on the FIRM is higher than the elevation shown in this table, a wave height, wave runup, and/or wave setup component likely exists, in which case, the higher elevation should be used for construction and/or floodplain management purposes.

As defined in the July 1989 Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping, the coastal high hazard area (Zone VE) is the area where wave action and/or high velocity water can cause structural damage (Guidelines and Specifications for Wave Elevation Determination and V-Zone Mapping, Federal Emergency Management Agency [FEMA], 1989). It is designated on the FIRM as the most landward of the following three points:

1) The point where the 0.9 meter or greater wave height could occur;
2) The point where the eroded ground profile is 0.9 meter or more below the maximum runup elevation; and
3) The primary frontal dune as defined in the NFIP regulations.

These three points are used to locate the inland limit of the coastal high hazard area to ensure that adequate insurance rates apply and appropriate construction standards are imposed, should local agencies permit building in this area.

3.4 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. All flood elevations shown in this FIS report and on the FIRM are referenced to MSL. Structure and ground elevations in the community must, therefore, be referenced to MSL.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual chance floodplains; and 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the community. For the streams studied in detail, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. For both the June 2, 1999, and April 19, 2005 FIS, the boundaries were interpolated between cross sections using topographic maps (Continental Aerial Surveys, 1979; Continental Aerial Surveys, November 21, 1978; Topographic Maps: Río Mameyes Basin, Río Fajardo Basin, Río Daguao Basin, Río Jacaguas Basin, Puerto Rico, Continental Aerial Surveys, November 1978; Aerial Photographs, Río Guayanilla, Puerto Rico, Kucera and Associates, 1976; USACE, 1979; DOI, 1957, etc.; Aerial Photography for Lajas and Majada Basins, Cardan Mapping Systems Corporation, May 3, 1981; Mark Hurd Aerial Survey, 1978; Aerial Photographs, Río Cibuco Basin, Puerto Rico, Kucera and Associates, May 1976; Kucera and Associates, 1977; DOC, 1983, etc.; Methodology for Calculating

Wave Action Effects Associated with Storm Surges, National Academy of Sciences; Southern Resources Mapping Corporation, 1987-1989; DOI, 1970; Topographic Maps, Martin Peña Navigation Channel, USACE, 1985; Aerial Photographs, Río Culebrinas Basin, Puerto Rico, Continental Aerial Surveys, November 1978; Topographic Maps, Río Grande de Añasco Basin, Río Grande de Manatí Basin, Río Anton Ruíz Basin, Puerto Rico, Continental Aerial Surveys, November 1978; Topographic Maps, Río Humacao Basin, Continental Aerial Surveys, November 15, 1978; USACE 1980; Topographic Maps, Río Tallaboa Basin, USACE, June 1, 1977; Topographic Maps, Cardan Mapping Systems, May 3, 1981).

Shallow flooding boundaries on Río Melania were determined from historical data. These boundaries coincide closely with the 1970 flood and were delineated using topographic maps (HA-446, DOI, 1971; 7.5-Minute Series, Topographic Maps, DOI, 1957, etc.). Further adjustments were made based on field reconnaissance of historic flooding and engineering judgment.

The 1- and 0.2-percent annual chance tidal floodplain boundaries were delineated using topographic maps at a scale of 1:20,000 with contour intervals of 1 and 5 meters and aerial photographs (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.; Topographic Maps, USACE, June 1, 1977).

For the 1999 revision, coastal floodplain boundaries were delineated using topographic maps at a scale of 1:20,000 with a contour interval of 5 meters and aerial photographs (Topographic Maps, Continental Aerial Surveys, Inc., 1979; 7.5-Minute Series, Topographic Maps, DOI, 1957, etc.). The floodplain boundaries for the Río Matilde, Río Cañas, Río Pastillo, and Quebrada del Agua were interpolated between cross sections using topographic maps at a scale of 1:20,000 with contour intervals of 10, 5, and 1 meters (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.).

For the flooding sources studied by approximate methods, the 1-percent annual chance floodplains were delineated using the previously printed FIRM for the Commonwealth of Puerto Rico, topographic maps at scales of 1:5,000 and 1:20,000 with contour intervals of 1, 5, and 10 meters, USGS Flood-Prone Area Maps, and SCS flood-prone area maps (Flood Insurance Rate Map, Commonwealth of Puerto Rico, FEMA, 1996; Continental Aerial Surveys, Inc., 1979; USACE, 1979; Aerial Photographs, Río Culebrinas Basin, Puerto Rico, Continental Aerial Surveys, Inc., November 1978; Topographic Maps, Río Grande de Añasco Basin, Río Grande de Manatí Basin, Río Anton Ruíz Basin, Puerto Rico, Continental Aerial Surveys, November 1978; Topographic Maps, Río Humacao Basin, Continental Aerial Surveys, Inc., November 15, 1978; Topographic Maps, Río Grande de Manatí Basin, USACE, 1980; Topographic Maps, Río Tallaboa Basin, USACE, June 1, 1977; Aerial Photographs, Río Guayanilla, Kucera and Associates, Incorporated, 1976; 7.5-Minute Series, Topographic Maps, DOI, 1957, etc.; Aerial Photographs, Río Cibuco Basin, Kucera and Associates, Incorporated, 1976; Southern Resources Mapping

Corporation, 1987-1989; Flood-Prone Area Maps, DOI, Geological Survey, 1973, etc.; Map of Flood-Prone Areas DOI, Geological Survey, 1966, etc.; Soil Conservation Service, 1974).

Floodplain boundaries determined by approximate methods for Río Majada between approximately 1.7 and 2.1 kilometers upstream its mouth were delineated using Hydrologic Investigation Atlas HA-447 (HA-447, DOI, 1971). Upstream of this historic data for Río Majada and for Río Lapa and Río Jajome approximate floodplain boundaries determined by approximate methods were delineated using topographic maps (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.).

For the 2005 revision, the floodplain boundaries for Río de Bayamón, Río Coamo, Río de La Plata, Río Guamaní and Río Nigua were interpolated between cross sections using topographic maps at a scale of 1:20,000 with contour intervals of 10, 5 and 1 meter (7.5-Minute Series, Topographic Maps, DOI, 1957, etc.).

For the coastal portion of this revision, the transect profiles were obtained using bathymetric and topographic data from various sources. Bathymetric data consisted of NOAA surveys dating between 1962 and 2001. USACE hydrographic LiDAR data were used for the near shore, although a large gap existed along the south coast of Puerto Rico. Any remaining gaps between the NOAA hydrographic survey data and USACE hydrographic LiDAR were filled using NOAA navigational chart soundings. The topographic data sources included USACE topographic LiDAR data dated 2003, aerial photogrammetric topographic data sources dated 1996-1998 (where gaps in the USACE LiDAR dataset existed), and USGS National Elevation Dataset (west half of Vieques Island), dating to the 1970s and 1980s. All bathymetric and topographic data were brought to the MSL datum.

USACE topographic LiDAR was collected by 3001, Inc., for the USACE in 2004 as part of an effort to develop digital orthophoto imagery for administration of the U.S. Department of Agriculture GIS Orthophotography update program. These data cover nearly the entire island of Puerto Rico at 15 meter postings. It was processed to bare earth and referenced to the ellipsoid, with a vertical accuracy of 30 cm RMSE.

For the this revision, floodplain boundaries for detailed analysis of the Quebrada Cambute, Río Bairoa, Río Caiguitas, Río Loíza, Río Turabo and Río Valenciano streams were developed based on contours derived from bare earth mass LiDAR points and photogrammetry as collected in 2004 by Sanborn. Floodplain boundaries for detailed analysis of the Quebrada Mabu, Quebrada Mariana, Quebrada Mariana Tributary, Río Fajardo, Río Guayanes, Río Humacao, Río Sabana, Quebrada Honda, Río Culebrinas, Río Culebrinas Unnamed Tributary, Río Grande de Añasco, Río Guanajibo, and Río Guatemala streams were developed based on contours derived from bare earth mass LiDAR points and photogrammetry as collected in 2005 by Sanborn. The mass point data were collected at 1 meter intervals with a vertical accuracy of 15 cm RMSE, producing 0.5 meter contour intervals. The data were supplemented with field surveys conducted by RLDA in 2004 and 2005.

Floodplain boundaries for detailed analysis of the Quebrada Honda, Río Matilde, Río Pastillo, Río Cañas, Río Guayo, Río Jacaguas at Villalba and Río Jacaguas streams were developed based on contours derived from bare earth mass LiDAR points and photogrammetry as collected in 2006 by Sanborn. The data were supplemented with field surveys conducted by Bench Mark Surveys in 2006.

All data were tied into NAD83 horizontal datum and PRVD02 vertical datum which was then projected in UTM Zone 19 units.

For the floodplain boundaries for Río Grande de Manati were developed based on Triangulated Irregular Network (TIN) points derived from the bare earth mass LiDAR points as collected in 2004 by 3001, Inc. These data were supplemented with field surveys conducted by RLDA in 2006. The data were adjusted to msl datum for consistency.

Floodplain boundaries for Quebrada La Mina and Quebrada La Mina Tributary were developed based on Triangulated Irregular Network (TIN) points derived from the bare earth mass LiDAR points as collected in 2004 by 3001, Inc.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the flooding sources studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 0.3 meter, provided that hazardous velocities are not produced.

No floodways were computed for Bayamón Express Channel, Caño Tiburones, Canal Puerto Nuevo, Río Camuy, Río Caricaboa, Río Cruces, Río Grande, Río Grande de Jayuya, Río Hondo Local Channel, Río Hondo, Río de la Plata Overflow, Río Morovis, Río Piedras, Río Yauco, Río Zamas, Quebrada Berrenchin Tributary No. 1, Quebrada Branderi, Quebrada Cepero, Quebrada Guaracanal, Quebrada del Agua, Quebrada Dona Ana, Quebrada Josefina, Quebrada Margarita, and Quebrada Santa Catalina. Portions of floodway were not computed for Río Grande de Arecibo, Río de la Plata (at Comerio), Río de la Plata (at Cayey), Río de la Plata Tributary No. 1, Río Guavate, Río Mayaguez Quebrada Santo Domingo, Río de Aibonito Tributary No. 1, and Río Guadiana. A more detailed explanation follows.

Very little encroachment was performed in the Río Camuy Basin to keep the surcharge less than 0.3 meter. Because of the wide floodplain in this area, the flow is two dimensional. Any encroachments not only reduce the conveyance, but also restrict the flow into any storage areas. Any significant encroachments created surcharges on the order of 1 or 2 meters. By encroaching small amounts on the eastern end of the basin, the surcharges were held within the allowable limits. This encroachment, however small, did not allow floodwaters to flow into that end, altering the direction of flow. The discharges into the remaining elements increased, thus increasing the water velocity. These altered flow patterns created a small decrease of the flood elevations in some areas of the basin. The situation of increased velocities, accompanied by decreased water-surface elevations, is similar to that of water running through a constriction in a bridge or some other obstacle and causing a decrease in the elevations just before a hydraulic jump or entering the supercritical regime. No floodway data has been presented for Río Camuy.

With the present state-of-the-art techniques, the 0.3-meter encroachment criterion is extremely difficult to maintain as a limit when methods other than steady flow standard-step backwater (HEC-2) are employed (USACE, Hydrologic Engineering Center, 1984). The Lower Río Grande de Arecibo Basin was analyzed using a gradually varied unsteady flow mathematical model. The lower Río Cibuco Basin and the Río Matilde Basin were analyzed using a two-dimensional hydraulic mathematical model (DOC, 1972). Neither of these models has a specific option to calculate a floodway, as does the HEC-2 computer program. The floodway must be selected by some other means and analyzed for compliance with the specified criteria. However, once results are determined and the floodway elevations can be compared, any changes to locations where the criterion is not met will affect the entire study system to the extent that the criterion may not be met at some other location where it previously was satisfied.

The floodways for the Río Grande de Arecibo, the Río Cañas, and the Río Pastillo were analyzed on the basis of redistribution of conveyance and volume from each side of the floodplain. A floodway for that portion of the Río Grande de Arecibo from river kilometer 11.2 to Dos Bocas Dam was not computed due to the inapplicability of the floodway concept within this area. This area of the river is in a narrow, gorge-like valley with steep sides. All floodway fringe areas would be adjacent to the steep side and would be of no practical use. Therefore, the 1-percent annual chance floodplain boundary should be considered the floodway boundary.

A floodway was not computed for Quebrada del Agua. Similarly, a floodway fringe area on the east side of Río Grande de Arecibo below river kilometer 3.0 was not computed. During the 1-percent annual chance flood, this portion of the floodplain is subject to flooding from sources outside the Río Grande de Arecibo Basin. This source is the Caño Tiburones, which is a large irrigation and drainage canal extending along the coastal area between the communities of Arecibo and Barceloneta, a distance of approximately 12.5 kilometers. The only physical identification that exists separating the floodplain limits for Caño Tiburones and the Río Grande de Arecibo is a dike that runs southward from the vicinity of the mouth of Caño Tiburones and parallels PR Highway 2 for approximately 10.9 kilometers. Flooding west of this dike was assumed to be primarily from the Río Grande de Arecibo.

The floodways for Caño Madre Vieja and the lower basin of Río Culebrinas, west of PR Highway 2 were computed on the basis of both volume and conveyance reduction from selected areas at the outer edge of the floodplain. The selected areas were primarily those areas where development exists.

Flood volume and conveyance reduction were accomplished by modifying the original two-dimensional hydraulic model to reflect the encroachments (Wang, 1978). The original and modified hydraulic models were then compared for compliance with 0.30 meter differential criteria. No floodway data have been presented for Caño Madre Vieja and the lower basin of Río Culebrinas.

The floodway for the Río Grande de Loíza Reach 1, north of PR Highway 3, was computed on the basis of both volume and conveyance reduction from selected areas at the outer edge of the floodplain. The selected areas were primarily those areas where development exists. Flood volume and conveyance reduction were accomplished by modifying the original two-dimensional hydraulic model to reflect the encroachments (Modified Version of the Receiving Water Quantity Block of the SWMM Model, USACE, Hydrologic Engineering Center). The original and modified hydraulic models were then compared for compliance with the 0.3-meter differential criteria.

The floodways for the Río Grande de Loíza Reach 1, south of PR Highway 3, were computed on the basis of equal conveyance reduction from each side of the floodplain.

On Río Mameyes from Cross Section P to the upstream limit of detailed study, flow is at critical depth. Therefore, the 1-percent annual chance floodplain boundaries were adopted as the floodway, excluding ineffective flow areas. Because the portion of Río Mameyes downstream of Cross Section C is affected by coastal rather than riverine flooding, no floodway was designated for this area.

Floodways for Río de la Plata (at Comerio), Río de la Plata (at Cayey), Río de la Plata Tributary No. 1, Río Guavate, Quebrada Santo Domingo, Río de Aibonito Tributary No. 1, Río Guadiana in the Río de la Plata Basin were computed using the USGS computer program J635 (Step-Backwater and Floodway Analysis Computer Program J635, Users Manual, DOI, May 1977).

No information is presented in Table 9 for cross sections where the channel velocity is so high that the 1-percent annual chance flood is at or near critical depth or where the 1-percent annual chance flood is confined to the channel. In these cases, the floodway is coincident with the -percent annual chance boundary, excluding areas of non-effective flow; no encroachment, and therefore, no increase in base flood elevations is allowed. This occurs for the following cross sections:

Río de la Plata (at Comerio), cross sections X through AW;

Río de la Plata (at Cayey), cross sections BD through BG, BK, BL, BP, BQ, and BS through BV;

Río de la Plata Tributary No. 1, cross sections C through H and L through Q;

Río Guavate, cross sections C, D, and H;

Quebrada Santo Domingo, cross sections A through M;

Río de Aibonito Tributary No. 1, cross sections A through E and G through T; and

Río Guadiana, cross sections A through AB.

Determination of a floodway for Río de la Plata Overflow was not within the scope of this countywide FIS; therefore, none is presented.

Floodways were not computed for the Río Grande de Jayuya, the Río Zamas, and the Río Caricaboa in the Upper Río Grande de Arecibo Basin because the 1-percent annual chance floodplains are also inundated by the 50-year flood, and also because the channel has steep banks and any encroachment would produce excessive velocities and hazardous conditions. Therefore, the 1-percent annual chance floodplain boundaries are considered to be the floodway boundary.

A floodway was not computed for Caño Tiburones because the flooding is mostly storage and not subject to conveyance.

Floodways were not computed for Río Morovis, the Bayamón Express Channel, and the Río Hondo Local Channel because the 1-percent annual chance flood discharge is contained within the channel banks.

Representatives of the Commonwealth of Puerto Rico, the USACE, and FEMA decided that floodways would not be determined for Río Hondo and Quebrada Santa Catalina. Areas adjacent to those streams are almost completely developed and the development has already encroached into the floodplain. However, if a large flood should occur and destroys structures located adjacent to those streams, it is advisable that additional studies be conducted on Río Hondo and/or Quebrada Santa Catalina to determine a floodway and floodway fringe.

Floodways were not calculated for Canal Puerto Nuevo, Río Piedras, Quebrada Margarita, Quebrada Dona Ana, Quebrada Josefina, Quebrada Guaracanal, and Quebrada Cepero.

Due to the scope of the December 15, 1990, revision for the Río Espíritu Santo Basin, no floodway was calculated for the Río Grande.

A floodway was not computed for Río Yaguez at Mayaguez downstream of PR Highway 2 because the 1-percent annual chance floodwaters spread out in all directions through streets, passages between houses, and buildings and fences. These obstructions offer great resistance to the floodwaters creating high velocities. Encroachment on floodplains that have been developed to this extent will create even more hazardous conditions. The floodway for Río Yaguez at Mayaguez upstream of PR Highway 2 was computed on the basis of equal-conveyance reduction from each side of the floodplain.

Floodways were not computed for the Río Yauco Basin because the floodplains downstream from the Pueblo of Yauco are planted with sugar cane and have roughness coefficients (Manning's "n") that can be as high as 0.35. Encroachment on floodplains under this condition will result in an increase of channel velocity to a hazardous level. Floodways in the upper reaches of all three streams were not determined, because supercritical flows and/or very high velocities will occur under existing conditions. Encroachment on the stream channel will aggravate the situation, resulting in even more hazardous conditions. Therefore, the 1-percent annual chance floodplain boundary shown for the Río Yauco, Quebrada Berrenchin (except for the downstream section), and Quebrada Berrenchin Tributary No. 1 is also considered the floodway boundary.

For all other streams studied, the floodways were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 9). The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and the 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

A portion of the floodway for Canal Puerto Nuevo, Quebrada Aguas Clara, Quebrada Ceiba, Río Antón Ruiz, Río Blanco, Río Fajardo, Río Grande de Añasco, Río Guamani, Río Guayanilla, Río Humacao, Río Inabon, Río Jacaguas, Río Loco, Río Macana, Río Mameyes, Río Matilde, Río Nigua, Río Nigua (at Arroyo), Río Sabana, Río Santiago, and Río Tallaboa is administrative and was decided upon by the study contractors and FEMA.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 9 for certain downstream cross sections of Unnamed Stream, Caño Guayabo, Quebrada de las Mulas, Quebrada Mabu, Quebrada Mariana, Caño de Martin Pena, Río Espíritu Santo, Río de la Plata Tributary No. 1, Quebrada Aguas Claras Tributary, Quebrada Pileto, Quebrada Mendoza, and Concepción Channel are lower than the regulatory flood elevations in that area, which must take into account the 1-percent annual chance flooding due to backwater from other sources.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 9, "Floodway Data." To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 0.3 meter at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 5.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Arecibo								
B	0.4	1,402	910	1.5	2.7	2.7	2.7	0.0
C	0.8	2,225	2,230	0.6	3.6	3.6	3.6	0.0
D	2.1	3,414	7,525	0.5	5.2	5.2	5.2	0.0
E	2.9	3,383	7,050	0.6	6.6	6.6	6.6	0.0
F	3.4	3,871	7,710	0.4	7.1	7.1	7.4	0.3
G	4.2	3,109	7,155	0.6	7.8	7.8	8.1	0.3
H	5.1	1,859	5,295	0.9	9.1	9.1	9.4	0.3
I	6.5	1,402	7,245	0.6	11.5	11.5	11.8	0.3
J	6.9	1,372	4,180	1.1	12.8	12.8	13.1	0.3
K	7.4	1,493	5,390	0.9	14.1	14.1	14.5	0.3
L	8.9	2,286	7,710	0.6	15.5	15.5	15.7	0.2
M	9.9	2,103	5,015	0.9	16.6	16.6	16.6	0.1
N	10.7	1,707	5,945	0.8	17.7	17.7	17.7	0.0
O	11.2	671	2,975	1.6	18.6	18.6	18.6	0.0
P	11.9	701	3,500	1.3	20.6	20.6	20.6	0.0
Q	12.6	914	3,380	1.4	22.3	22.3	22.3	0.0
R	13.4	823	4,090	1.2	23.8	23.8	23.8	0.0
S	13.9	823	3,605	1.3	24.7	24.7	24.7	0.0
T	14.9	884	4,200	1.2	26.6	26.6	26.6	0.0
U	16.5	1,158	4,645	1.1	29.6	29.6	29.6	0.0

[1]Kilometers above confluence with Atlantic Ocean

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GRANDE DE ARECIBO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Cibuco								
A	1.1[1]	3,450	1,890	0.8	4.2	4.2	4.4	0.2
B	1.9[1]	3,950	2,640	0.6	4.2	4.2	4.4	0.2
C	3.4[1]	3,960	3,970	0.4	4.2	4.2	4.4	0.2
D	4.7[1]	2,770	465	3.2	5.4	5.4	5.4	0.0
E	6.8[1]	2,570	6,264	0.4	7.6	7.6	7.9	0.3
F	7.9[1]	550	2,261	0.7	11.4	11.4	11.7	0.3
G	8.7[1]	490	2,512	0.4	12.3	12.3	12.6	0.3
H	9.4[1]	390	2,225	0.4	12.9	12.9	13.2	0.3
I	9.9[1]	390	1,762	0.5	13.5	13.5	13.8	0.3
J	11.9[1]	400	1,680	0.6	15.6	15.6	15.9	0.3
K	12.2[1]	550	2,395	0.4	16.1	16.1	16.4	0.3
L	13.5[1]	1,000	3,020	0.3	16.5	16.5	16.8	0.3
M	16.0[1]	470	1,260	0.8	18.2	18.2	18.5	0.3
N	16.6[1]	360	1,642	0.6	19.7	19.7	20.0	0.3
O	17.5[1]	180	949	1.0	21.6	21.6	21.9	0.3
Rio Indio								
A	0.9[2]	440	2,200	0.3	12.1	12.1	12.4	0.3
B	2.0[2]	300	902	0.7	12.8	12.8	13.1	0.3
C	3.2[2]	260	1,058	0.6	15.1	15.1	15.4	0.3
D	3.9[2]	170	669	0.9	17.2	17.2	17.5	0.3
E	4.4[2]	220	1,216	0.5	17.8	17.8	18.1	0.3

[1]Kilometers above confluence with Atlantic Ocean
[2]Kilometers above confluence with Río Cibuco

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CIBUCO – RIO INDIO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Honda (Rio Cibuco Basin)								
A	2,878	108	101	2.3	17.0	15.6[2]	15.8	0.2
B	3,018	122	175	1.3	17.7	17.7	17.9	0.2
C	3,156	72	124	1.9	18.5	18.5	18.7	0.2
D	3,272	83	176	1.3	20.3	20.3	20.5	0.2
E	3,334	115	328	0.7	20.9	20.9	21.0	0.1
F	3,515	107	260	0.9	21.1	21.1	21.3	0.2
G	3,833	58	163	1.4	24.0	24.0	24.3	0.3
H	4,108	55	90	2.6	25.3	25.3	25.5	0.2
I	4,153	136	219	1.1	26.5	26.5	26.7	0.2
J	4,326	105	186	1.2	27.5	27.5	27.7	0.2
K	4,527	119	152	1.5	28.7	28.7	28.7	0.0
L	4,576	123	123	1.4	29.1	29.1	29.1	0.0
M	4,890	55	120	1.4	31.6	31.6	31.9	0.3
N	5,361	30	57	3.0	35.4	35.4	35.7	0.3
O	5,849	98	98	1.7	39.9	39.9	40.1	0.2
P	5,937	84	114	1.5	41.1	41.1	41.3	0.2
Q	6,103	31	60	2.8	42.8	42.8	42.8	0.0
R	6,378	23	87	2.0	44.9	44.9	45.0	0.1
S	6,492	80	262	0.3	47.8	47.8	48.0	0.2
T	7,008	37	141	0.5	47.9	47.9	48.1	0.2
U	7,552	21	40	1.9	49.8	49.8	49.8	0.0
V	7,863	22	47	1.6	55.6	55.6	55.6	0.0
W	8,140	10	22	3.4	59.1	59.1	59.1	0.0
X	8,287	8	14	2.1	62.9	62.9	62.9	0.0
Y	8,545	22	13	2.2	69.9	69.9	69.9	0.0
Z	8,767	15	19	1.5	74.2	74.2	74.2	0.0

[1]Meters above confluence with Rio Cibuco

[2]Elevation computed without consideration of backwater effects from Rio Cibuco

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA HONDA (RIO CIBUCO BASIN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio de Los Negros								
A	1.7[1]	50	181	2.1	75.8	75.8	76.1	0.3
B	1.9[1]	100	351	1.1	76.7	76.7	77.0	0.3
C	2.0[1]	160	530	0.7	76.9	76.9	77.2	0.3
D	2.1[1]	30	123	3.1	77.0	77.0	77.3	0.3
E	2.3[1]	40	175	2.2	77.9	77.9	78.2	0.3
F	2.4[1]	50	170	2.2	77.9	77.9	78.2	0.3
G	2.4[1]	60	234	1.6	78.5	78.5	78.7	0.2
H	2.6[1]	130	399	0.6	78.9	78.9	79.2	0.3
I	2.7[1]	20	81	2.3	79.7	79.7	80.0	0.3
J	2.8[1]	30	77	2.5	80.3	80.3	80.6	0.3
K	3.0[1]	15	73	2.6	82.8	82.8	82.8	0.0
L	3.2[1]	15	36	5.4	85.2	85.2	85.3	0.1
Rio de Bayamón								
A	6,793[2]	127	688	3.1	11.0	11.0	11.0	0.0
B	8,002[2]	138	541	3.3	12.2	12.2	12.2	0.0
C	8,547[2]	195	562	4.6	13.1	13.1	13.1	0.0
D	8,884[2]	215	636	4.5	14.4	14.4	14.4	0.0
E	9,609[2]	126	587	2.9	15.7	15.7	15.8	0.0
F	10,641[2]	137	478	3.1	17.7	17.7	17.9	0.2
G	11,737[2]	173	676	3.1	20.4	20.4	20.7	0.3
H	12,748[2]	212	750	2.0	22.5	22.5	22.8	0.3
I	13,689[2]	174	638	2.3	23.9	23.9	24.0	0.1
J	14,810[2]	113	365	4.1	28.4	28.4	28.5	0.0
K	16,146[2]	57	265	5.6	35.7	35.7	35.9	0.2
L	16,329[2]	74	473	4.9	40.4	40.4	40.4	0.0

[1]Kilometers above mouth

[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE LOS NEGROS – RIO DE BAYAMON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio de Bayamón (continued)								
M	17,402[1]	85	312	5.9	41.8	41.8	42.0	0.2
N	18,459[1]	39	190	7.4	47.3	47.3	47.3	0.0
O	19,452[1]	82	295	6.1	52.7	52.7	52.7	0.0
P	20,294[1]	117	560	3.6	56.9	56.9	56.9	0.0
Q	21,263[1]	69	340	3.7	66.9	66.9	66.9	0.0
R	22,559[1]	29	147	7.3	94.1	94.1	94.2	0.1
S	23,658[1]	63	144	6.9	114.3	114.3	114.3	0.0
T	24,730[1]	27	142	7.3	144.3	144.3	144.4	0.1
U	25,340[1]	29	141	7.2	160.4	160.4	160.4	0.0
V	26,478[1]	27	142	7.3	180.2	180.2	180.2	0.0
W	27,005[1]	25	101	6.3	188.7	188.7	188.7	0.0
X	27,999[1]	92	488	2.0	207.6	207.6	207.8	0.2
Y	28,909[1]	28	106	6.4	217.9	217.9	217.9	0.0
Z	30,281[1]	35	109	6.2	243.3	243.3	243.3	0.0
AA	30,767[1]	23	102	6.8	250.6	250.6	250.6	0.1
Rio Guaynabo								
A	0.1[2]	160	929	2.2	17.1	17.1	17.1	0.0
B	0.3[2]	129	643	1.2	17.7	17.7	17.7	0.0
C	0.5[2]	71	360	2.2	17.7	17.7	17.8	0.1
D	0.9[2]	70	317	2.5	18.3	18.3	18.4	0.1
E	2.6[2]	48	254	3.1	21.3	21.3	21.5	0.2
F	3.6[2]	120	450	1.8	23.3	23.3	23.5	0.2

[1]Meters above mouth
[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE BAYAMON – RIO GUAYNABO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Bayamón (continued)								
M	17,402[1]	85	312	5.9	41.8	41.8	42.0	0.2
N	18,459[1]	39	190	7.4	47.3	47.3	47.3	0.0
O	19,452[1]	82	295	6.1	52.7	52.7	52.7	0.0
P	20,294[1]	117	560	3.6	56.9	56.9	56.9	0.0
Q	21,263[1]	69	340	3.7	66.9	66.9	66.9	0.0
R	22,559[1]	29	147	7.3	94.1	94.1	94.2	0.1
S	23,658[1]	63	144	6.9	114.3	114.3	114.3	0.0
T	24,730[1]	27	142	7.3	144.3	144.3	144.4	0.1
U	25,340[1]	29	141	7.2	160.4	160.4	160.4	0.0
V	26,478[1]	27	142	7.3	180.2	180.2	180.2	0.0
W	27,005[1]	25	101	6.3	188.7	188.7	188.7	0.0
X	27,999[1]	92	488	2.0	207.6	207.6	207.8	0.2
Y	28,909[1]	28	106	6.4	217.9	217.9	217.9	0.0
Z	30,281[1]	35	109	6.2	243.3	243.3	243.3	0.0
AA	30,767[1]	23	102	6.8	250.6	250.6	250.6	0.1
Rio Guaynabo								
A	0.1[2]	160	929	2.2	17.1	17.1	17.1	0.0
B	0.3[2]	129	643	1.2	17.7	17.7	17.7	0.0
C	0.5[2]	71	360	2.2	17.7	17.7	17.8	0.1
D	0.9[2]	70	317	2.5	18.3	18.3	18.4	0.1
E	2.6[2]	48	254	3.1	21.3	21.3	21.5	0.2
F	3.6[2]	120	450	1.8	23.3	23.3	23.5	0.2

[1]Meters above mouth
[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO BAYAMON – RIO GUAYNABO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guaynabo (continued)								
G	4.2[1]	63	311	2.6	24.1	24.1	24.2	0.1
H	4.7[1]	80	228	3.5	25.6	25.6	25.8	0.2
I	5.2[1]	49	212	3.8	27.7	27.7	27.9	0.2
J	5.6[1]	66	315	1.9	29.1	29.1	29.2	0.1
Quebrada Juan Mendez								
A	330[2]	599	1,600	0.8	2.7	2.7	3.0	0.3
B	486[2]	672	1,738	0.7	2.8	2.8	3.0	0.3
C	759[2]	539	1,428	0.6	3.0	3.0	3.1	0.2
D	783[2]	546	1,169	0.7	3.0	3.0	3.2	0.2
E	1,007[2]	406	607	1.4	3.3	3.3	3.4	0.1
F	1,047[2]	547	225	2.2	3.4	3.4	3.5	0.1
G	1,201[2]	397	805	1.0	4.0	4.0	4.2	0.1
H	1,245[2]	459	551	1.4	4.1	4.1	4.2	0.1
I	1,677[2]	112	480	1.4	5.5	5.5	5.6	0.1
J	1,704[2]	227	765	0.3	8.0	8.0	8.3	0.3
K	2,019[2]	130	164	1.2	8.4	8.4	8.4	0.0
L	2,169[2]	73	188	1.1	10.3	10.3	10.5	0.2
M	2,399[1]	95	195	1.0	11.0	11.0	11.2	0.2
N	2,440[1]	94	219	0.9	11.6	11.6	11.8	0.2
O	2,659[1]	170	245	0.8	12.5	12.5	12.8	0.3
P	2,705[1]	225	386	0.5	13.4	13.4	13.5	0.1
Q	2,849[1]	160	423	0.5	13.5	13.5	13.7	0.2
R	3,039[1]	45	102	1.9	13.7	13.7	13.8	0.2
S	3,114[1]	115	262	0.8	15.1	15.1	15.4	0.3
T	3,224[1]	87	223	0.9	15.8	15.8	16.0	0.2

[1]Kilometers above mouth

[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYNABO – QUEBRADA JUAN MENDEZ

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Juan Mendez (continued)								
U	3,434[1]	116	322	0.6	18.2	18.2	18.3	0.1
V	3,473[1]	144	437	0.5	19.1	19.1	19.2	0.1
W	3,658[1]	108	332	0.6	19.6	19.6	19.7	0.1
X	3,697[1]	121	426	0.5	20.6	20.6	20.6	0.1
Y	3,908[1]	53	148	1.0	20.7	20.7	20.8	0.1
Z	3,981[1]	57	203	0.7	22.0	22.0	22.0	0.1
AA	4,025[1]	58	162	0.9	22.5	22.5	22.6	0.1
AB	4,109[1]	57	111	1.3	22.6	22.6	22.6	0.1
AC	4,199[1]	88	51	2.3	24.8	24.8	24.8	0.0
AD	4,249[1]	87	51	2.3	26.9	26.9	26.9	0.0
AE	4,394[1]	72	47	2.6	28.4	28.4	28.4	0.0
AF	4,489[1]	111	54	2.2	30.6	30.6	30.6	0.0
AG	4,739[1]	84	290	0.5	31.0	31.0	31.0	0.0
AH	4,771[1]	88	319	0.4	31.2	31.2	31.2	0.0
Cano de Martin Peña								
A	1,106[2]	120.0	240	0.2	2.0	0.73	1.0	0.3
B	1,373[2]	106.7	240	0.2	2.0	0.76	1.1	0.3
C	2,257[2]	106.7	241	0.2	2.0	0.76	1.1	0.3

[1]Meters above mouth
[2]Meters above downstream side of Avenida John F. Kennedy

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA JUAN MENDEZ – CAÑO DE MARTIN PENA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Culebrinas (downstream reach)								
A	3,856	1,220.5	6,194.6	0.3	8.7	8.7	8.8	0.1
B	4,169	1,216.5	5,571.5	0.3	8.7	8.7	8.8	0.1
C	4,898	1,169.8	4,567.7	0.5	8.7	8.7	8.9	0.2
D	5,517	1,387.9	4,367.4	0.4	8.7	8.7	8.9	0.2
E	6,815	1,479.0	2,934.7	0.5	8.9	8.9	9.1	0.2
F	7,246	1,537.1	2,682.6	0.7	9.0	9.0	9.2	0.2
G	8,375	809.4	1,309.2	1.1	10.0	10.0	10.1	0.1
H	8,857	273.7	545.9	2.9	10.9	10.9	11.1	0.2
I	9,419	378.6	1,133.5	1.1	12.3	12.3	12.6	0.3
J	9,668	286.0	878.2	1.4	12.5	12.5	12.8	0.3
K	9,903	267.6	795.8	1.8	12.8	12.8	13.2	0.4
L	10,338	322.6	1,076.2	2.4	14.1	14.1	14.3	0.2
M	10,617	307.9	1,163.9	1.7	14.7	14.7	14.9	0.2
N	11,545	326.0	1,325.0	1.2	15.8	15.8	16.0	0.2
O	12,158	248.0	660.7	2.9	16.4	16.4	16.6	0.2
P	12,197	231.7	1,103.8	1.6	18.3	18.3	18.5	0.2
Q	12,761	398.8	2,334.9	0.4	18.5	18.5	18.7	0.2
R	13,022	388.6	2,018.6	0.6	18.5	18.5	18.7	0.2
S	13,174	228.9	1,305.9	0.9	18.5	18.5	18.7	0.2
T	13,392	179.2	1,011.8	1.4	18.6	18.6	18.8	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CULEBRINAS (DOWNSTREAM REACH)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Culebrinas (at San Sebastian)								
U	0	158.4	787.8	1.5	57.3	57.3	57.3	0.0
V	370	178.0	1,128.8	0.8	57.4	57.4	57.5	0.1
W	594	188.4	1,147.4	0.4	57.4	57.4	57.6	0.2
X	1,105	231.3	1,074.9	0.3	57.5	57.5	57.6	0.1
Y	1,136	215.8	990.7	0.4	57.5	57.5	57.6	0.1
Z	1,284	189.4	857.5	0.5	57.5	57.5	57.6	0.1
AA	1,557	242.7	844.3	0.4	57.5	57.5	57.7	0.2
AB	1,937	197.2	522.9	0.7	57.5	57.5	57.7	0.2
AC	2,125	171.0	376.2	1.2	57.7	57.7	57.9	0.2
AD	2,342	104.8	301.0	1.8	58.2	58.2	58.3	0.1
AE	2,399	47.4	165.1	3.2	58.3	58.3	58.4	0.1
AF	2,436	85.7	294.3	1.9	60.1	60.1	60.3	0.2
AG	2,594	62.4	267.6	2.1	60.4	60.4	60.5	0.1
AH	2,990	97.3	448.7	1.7	61.6	61.6	61.7	0.1
AI	3,141	97.1	456.3	1.5	61.9	61.9	61.9	0.0
AJ	3,491	210.8	402.7	1.2	62.3	62.3	62.4	0.1
AK	3,582	244.2	416.9	1.0	62.3	62.3	62.5	0.2
AL	3,638	290.9	755.3	0.4	62.5	62.5	62.8	0.3
AM	3,741	272.7	594.6	0.5	62.5	62.5	62.8	0.3
AN	3,899	238.4	413.3	0.9	62.5	62.5	62.8	0.3
AO	4,151	68.4	221.4	2.0	64.5	64.5	64.5	0.0
AP	4,196	66.8	216.8	1.7	64.9	64.9	65.0	0.1
AQ	4,273	56.1	201.1	2.0	65.1	65.1	65.2	0.1
AR	4,399	46.3	243.8	1.8	65.4	65.4	65.7	0.3
AS	4,802	31.6	148.0	3.0	67.0	67.0	67.2	0.2
AT	4,900	44.1	192.1	2.4	67.8	67.8	68.0	0.2

[1]Meters above Limit of Detailed Study*
*Limit of Detailed Study is approximately 1,120 meters downstream of Calle Jose Torres Pino

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CULEBRINAS (AT SAN SEBASTIAN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Culebrinas (at San Sebastian) (continued)								
AU	5,219[1]	111.6	391.2	1.2	68.7	68.7	69.0	0.3
AV	5,330[1]	73.1	254.0	2.2	69.0	69.0	69.3	0.3
Rio Culebrinas (At San Sebastian) Tributary								
A	333[2]	19.1	52.9	1.7	60.8	60.8	60.9	0.1
B	383[2]	26.0	70.6	1.1	61.6	61.6	61.6	0.0
C	446[2]	57.7	129.0	0.5	61.8	61.8	62.0	0.2
D	654[2]	25.2	69.5	1.0	61.9	61.9	62.1	0.2
E	819[2]	21.6	47.2	1.7	62.6	62.6	62.8	0.2
F	980[2]	25.1	64.5	1.2	63.6	63.6	63.8	0.2
G	1,112[2]	25.7	68.8	1.1	64.1	64.1	64.3	0.2
Rio Guatemala								
A	629[2]	229.0	351.8	1.1	54.4	54.4	54.7	0.3
B	1,015[2]	179.3	347.6	1.3	55.5	55.5	55.8	0.3
C	1,496[2]	104.5	214.0	1.6	57.6	57.6	57.8	0.2
D	1,615[2]	195.6	338.2	1.3	58.9	58.9	59.2	0.3
E	1,873[2]	334.7	419.4	1.1	59.2	59.2	59.5	0.3
F	1,937[2]	119.6	190.8	2.6	59.4	59.4	59.5	0.1
G	1,992[2]	34.6	126.5	2.9	59.7	59.7	59.9	0.2
H	2,158[2]	54.2	204.0	1.9	60.8	60.8	61.0	0.2
I	2,449[2]	31.5	132.2	2.7	62.2	62.2	62.4	0.2
J	2,802[2]	38.3	189.7	1.9	64.7	64.7	64.9	0.2
K	3,112[2]	47.5	185.2	1.9	66.1	66.1	66.3	0.2
L	3,407[2]	20.1	93.1	3.8	68.1	68.1	68.3	0.2
M	3,622[2]	22.3	84.8	4.2	71.4	71.4	71.5	0.1

[1]Meters above Limit of Detailed Study*
*Limit of Detailed Study is approximately 1,120 meters downstream of Calle Jose Torres Pino
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CULEBRINAS (AT SAN SEBASTIAN) – RIO CULEBRINAS (AT SAN SEBASTIAN) TRIBUTARY – RIO GUATEMALA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayabo								
A	110	247	434	0.8	2.7	2.7	3.0	0.3
B	305	350	613	0.6	2.8	2.8	3.1	0.3
C	525	445	500	0.7	3.0	3.0	3.3	0.3
Rio Culebra								
D	860	271	593	0.5	3.3	3.3	3.6	0.3
E	1,035	280	477	0.6	3.4	3.4	3.7	0.3
F	1,310	343	398	0.7	3.6	3.6	3.9	0.3
G	1,475	136	138	1.9	4.7	4.7	4.9	0.2
H	1,635	133	126	2.1	6.3	6.3	6.5	0.2
I	1,791	120	311	0.9	7.1	7.1	7.3	0.2
J	1,891	151	363	0.7	7.1	7.1	7.4	0.3
K	2,169	199	303	0.9	7.3	7.3	7.6	0.3
L	2,224	169	266	1.0	7.4	7.4	7.7	0.3
M	2,314	141	173	1.6	7.5	7.5	7.7	0.2
N	2,404	130	178	1.5	7.8	7.8	8.1	0.3
O	2,519	149	172	1.6	8.6	8.6	8.8	0.2

[1]Meters above confluence with Bahia de Aguadilla (Atlantic Ocean)

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYABO – RIO CULEBRA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Culebra (continued)								
P	2,577[1]	264	565	0.5	9.5	9.5	9.8	0.3
Q	2,652[1]	246	451	0.4	9.5	9.5	9.8	0.3
R	2,832[1]	233	279	0.7	9.5	9.5	9.8	0.3
S	3,012[1]	148	101	2.0	9.9	9.9	10.0	0.1
T	3,219[1]	158	313	0.6	10.5	10.5	10.8	0.3
Cano Guayabo								
A	380[2]	24	46	1.3	7.3	6.7[4]	7.0	0.3
B	435[2]	29	52	1.2	7.4	6.8[4]	7.1	0.3
C	525[2]	29	54	1.1	7.5	6.9[4]	7.1	0.2
D	615[2]	31	56	1.1	7.8	7.0[4]	7.2	0.2
E	730[2]	39	57	1.1	8.6	7.2[4]	7.4	0.2
F	787[2]	40	95	0.6	9.5	7.7[4]	7.8	0.1
G	968[2]	40	85	0.6	9.5	7.7[4]	7.8	0.1
H	1,180[2]	40	103	0.5	9.5	7.8[4]	8.0	0.2
I	1,507[2]	19	48	0.7	9.5	7.8[4]	8.1	0.3
Unnamed Stream								
A	102[3]	40	103	0.5	9.5	7.8[4]	8.0	0.2
B	327[3]	9	8	2.2	9.5	7.7[4]	7.9	0.2
C	510[3]	33	18	0.6	10.1	10.1	10.1	0.0

[1]Meters above confluence with Bahia de Aguadilla (Atlantic Ocean)
[2]Meters above confluence with Rio Culebra
[3]Meters above confluence with Cano Guayabo
[4]Elevation computed without consideration of backwater effects from Rio Culebra

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CULEBRA – CANO GUAYABO – UNNAMED STREAM

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Espiritu Santo								
B	0.8[1]	723.8	1,816	0.8	2.4	2.4	2.7	0.3
C	1.5[1]	1,366.2	3,547	0.4	2.7	2.7	3.0	0.3
D	1.8[1]	1,339.0	3,578	0.4	2.8	2.8	3.1	0.3
E	2.1[1]	1,100.3	2,807	0.5	3.0	3.0	3.3	0.3
F	2.8[1]	741.8	2,286	0.6	3.5	3.5	3.8	0.3
G	3.4[1]	1,239.3	4,042	0.3	3.9	3.9	4.2	0.3
H	3.7[1]	1,013.4	3,254	0.4	4.1	4.1	4.4	0.3
I	3.9[1]	627.1	2,105	0.7	4.3	4.3	4.6	0.3
J	4.2[1]	344.5	697	2.1	5.0	5.0	5.2	0.2
K	4.6[1]	187.5	751	2.0	6.9	6.9	7.0	0.1
Rio Mameyes								
C	1,015[2]	520	1,377	1.1	3.5	3.5	3.8	0.3
D	1,540[2]	568	1,315	1.1	4.6	4.6	4.9	0.3
E	1,800[2]	405	1,205	1.2	5.3	5.3	5.5	0.3
F	1,965[2]	254	668	2.2	5.8	5.8	6.0	0.2
G	2,215[2]	269	652	2.2	7.5	7.5	7.7	0.2
H	2,270[2]	448	775	1.9	8.2	8.2	8.3	0.1
I	2,311[2]	521	348	4.2	8.4	8.4	8.4	0.0
J	2,341[2]	523	1,314	1.1	9.4	9.4	9.4	0.0
K	2,505[2]	349	976	1.5	9.6	9.6	9.6	0.0
L	2,782[2]	290	691	2.1	10.3	10.3	10.5	0.2
M	3,010[2]	354	937	1.6	11.7	11.7	11.9	0.2
N	3,237[2]	482	808	1.8	12.4	12.4	12.6	0.3
O	3,745[2]	278	571	2.3	15.3	15.3	15.3	0.0
P	3,838[2]	160	374	3.1	17.1	17.1	17.1	0.0
Q	4,096[2]	168	601	1.9	18.8	18.8	19.0	0.3

[1]Kilometers above mouth
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO ESPIRITU SANTO – RIO MAMEYES

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Mameyes (continued)								
R	4,246	166	532	2.2	19.2	19.2	19.4	0.2
S	4,391	380	523	1.9	20.4	20.4	20.4	0.0
T	4,555	333	559	1.7	21.8	21.8	21.8	0.0
U	4,914	268	439	2.2	24.9	24.9	24.9	0.0
V	5,091	100	258	3.8	27.6	27.6	27.6	0.0
Rio Fajardo								
A	1,551	565.7	752.4	1.2	2.2	2.2	2.4	0.2
B	2,055	522.1	729.1	1.1	2.9	2.9	3.0	0.1
C	2,668	336.9	466.9	1.6	3.9	3.9	4.2	0.3
D	2,966	464.3	688.3	1.7	4.9	4.9	5.1	0.2
E	3,327	420.2	529.6	1.9	5.5	5.5	5.8	0.3
F	3,742	398.1	547.1	1.2	6.7	6.7	6.9	0.2
G	3,912	300.3	714.9	1.0	7.6	7.6	7.7	0.1
H	4,380	418.4	668.2	1.0	8.1	8.1	8.2	0.1
I	4,506	618.0	1,143.8	0.5	10.1	10.1	10.1	0.0
J	5,009	279.6	447.1	1.8	10.1	10.1	10.3	0.2
K	5,539	765.2	960.9	1.5	12.0	12.0	12.1	0.1
L	6,565	300.0	369.8	3.2	14.7	14.7	14.9	0.2
M	6,932	247.6	465.3	2.0	17.1	17.1	17.4	0.3
N	7,416	110.1	481.3	1.7	18.3	18.3	18.6	0.3
O	7,985	157.3	507.0	1.5	19.5	19.5	19.6	0.1
P	8,269	96.8	321.3	2.3	20.3	20.3	20.4	0.1
Q	8,981	120.2	391.0	1.9	23.8	23.8	24.0	0.2
R	9,764	132.1	329.3	3.4	27.0	27.0	27.2	0.2
S	10,843	166.7	253.7	2.9	35.6	35.6	35.6	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO MAMEYES – RIO FAJARDO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Fajardo (continued)								
T	11,245	166.7	253.7	2.9	39.6	39.6	39.6	0.0
U	11,637	58.5	164.4	4.5	43.3	43.3	44.7	0.4
V	11,843	53.5	210.8	3.0	45.3	45.3	45.4	0.1
W	12,283	84.8	310.5	2.0	48.9	48.9	49.0	0.1
X	12,809	93.6	216.2	3.5	53.5	53.5	53.6	0.3
Y	13,197	224.0	347.0	1.8	56.2	56.2	56.5	0.3
Z	13,793	119.5	185.7	4.2	60.7	60.7	60.9	0.2
Rio Sabana								
A	875	589.3	812.2	1.0	2.7	2.7	2.9	0.2
B	1,058	495.8	564.9	1.4	2.9	2.9	3.1	0.2
C	1,210	58.1	131.3	2.9	3.7	3.7	3.9	0.2
D	1,427	142.2	375.9	1.3	4.5	4.5	4.6	0.1
E	1,709	125.5	187.0	2.8	4.8	4.8	5.1	0.3
F	2,121	309.7	410.2	1.4	7.4	7.4	7.7	0.3
G	2,455	148.9	240.2	2.2	8.7	8.7	9.0	0.3
H	2,993	44.3	162.4	2.2	12.5	12.5	12.5	0.0
I	3,290	40.1	157.8	2.2	13.9	13.9	14.2	0.3
J	3,639	184.1	446.7	1.2	15.0	15.0	15.2	0.2
K	3,978	241.1	399.9	1.6	15.5	15.5	15.8	0.3
L	4,203	192.5	177.8	3.3	16.4	16.4	16.7	0.3
M	4,251	195.0	275.6	2.1	17.3	17.3	17.6	0.3
N	4,416	40.7	102.2	3.1	17.8	17.8	18.0	0.2
O	4,698	50.9	116.9	2.6	20.1	20.1	20.3	0.2
P	4,921	33.1	87.3	3.5	22.3	22.3	22.4	0.1
Q	5,275	56.9	135.4	2.3	26.5	26.5	26.7	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO FAJARDO – RIO SABANA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Blanco								
A	2,135	2,415	6,840	0.3	3.7	3.7	4.0	0.3
B	2,775	2,280	6,280	0.3	4.3	4.3	4.5	0.2
C	2,809	2,287	6,432	0.3	4.4	4.4	4.6	0.2
D	3,885	610	2,060	0.5	5.5	5.5	5.6	0.2
E	4,755	1,010	3,330	0.3	5.9	5.9	6.2	0.3
F	5,080	960	2,860	0.4	6.0	6.0	6.3	0.3
G	5,289	757	2,047	0.5	6.6	6.6	6.7	0.2
H	5,404	806	1,965	0.6	6.7	6.7	6.9	0.2
I	5,749	770	1,809	0.6	7.0	7.0	7.2	0.2
J	5,904	742	1,532	0.7	7.2	7.2	7.4	0.2
K	5,944	785	1,706	0.7	7.4	7.4	7.6	0.2
L	6,285	645	1,644	0.7	7.9	7.9	8.1	0.2
M	6,935	574	1,413	0.7	8.6	8.6	8.8	0.2
Rio Santiago								
A[2]	585							
B[2]	953							
C[2]	978							
D	1,194	1,406	2,947	0.2	4.7	4.7	5.0	0.3
E	1,486	848	1,230	0.5	5.4	5.4	5.6	0.2
F	1,654	576	1,392	0.4	6.1	6.1	6.4	0.3
G	1,934	792	1,709	0.3	6.8	6.8	7.1	0.3
H	2,109	104	216	1.1	7.2	7.2	7.5	0.3
I	2,197	30	56	4.3	8.8	8.8	8.8	0.0
J	2,231	30	78	3.1	9.5	9.5	9.5	0.0
K	2,400	145	374	0.6	10.3	10.3	10.4	0.1
L	2,680	98	90	2.7	10.9	10.9	10.9	0.0

[1]Meters above mouth
[2]Shared With Rio Blanco – See Rio Blanco for Floodway and Base Flood Water-Surface Elevation Data

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO BLANCO – RIO SANTIAGO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Santiago (continued)								
M	2,796	90	101	2.4	13.1	13.1	13.1	0.0
N	2,844	90	110	2.2	13.9	13.9	13.9	0.0
O	3,105	137	295	0.8	14.5	14.5	14.7	0.2
P	3,220	76	113	2.1	14.7	14.7	14.9	0.2
Q	3,282	76	98	2.4	15.5	15.5	15.5	0.0
R	3,335	76	137	1.6	16.1	16.1	16.1	0.0
S	3,380	102	152	1.6	16.3	16.3	16.4	0.0
T	3,519	105	123	1.2	20.2	20.2	20.3	0.1
U	3,560	120	253	0.4	21.5	21.5	21.6	0.1
V	3,640	160	514	0.3	21.7	21.7	21.8	0.1
W	3,740	177	313	0.8	21.8	21.8	21.9	0.1
X	3,895	292	209	2.2	22.7	22.7	22.7	0.0
Y	4,010	188	202	1.9	24.3	24.3	24.3	0.0
Z	4,430	251	396	1.1	26.4	26.4	26.4	0.0
Rio Santiago Lateral Branch								
A[2]	0							
B[2]	179							
C[2]	436							
D	750	470	703	0.30	7.3	7.3	7.6	0.3
E	980	495	541	0.40	8.0	8.0	8.2	0.2
F	1,010	495	668	0.30	8.3	8.3	8.5	0.2
G	1,210	454[3]	420	0.50	9.4	9.4	9.6	0.3
H	1,354	566	743	0.30	10.7	10.7	11.0	0.3
I	1,430	533	565	0.40	11.7	11.7	12.0	0.3

[1]Meters above mouth
[2]Shared With Rio Santiago – See Rio Santiago for Floodway and Base Flood Water-Surface Elevation Data
[3]Width including island

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO SANTIAGO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Santiago Lateral Branch (continued)								
J	1,445[1]	535	573	0.4	12.1	12.1	12.4	0.3
K	1,583[1]	440	596	0.4	13.7	13.7	13.9	0.2
L	1,656[1]	374	422	0.5	14.9	14.9	15.1	0.2
M	1,830[1]	358	294	0.8	17.5	17.5	17.7	0.2
N	1,850[1]	360	563	0.4	18.4	18.4	18.6	0.2
O	1,930[1]	302	763	0.3	18.6	18.6	18.8	0.2
P	2,030[1]	260	612	0.4	18.9	18.9	19.1	0.2
Q	2,050[1]	260	620	0.3	19.1	19.1	19.3	0.2
R	2,150[1]	150	300	0.7	20.0	20.0	20.1	0.1
S	2,230[1]	208	440	0.5	21.1	21.1	21.3	0.2
T[2]								
U[2]								
Rio Yaguez (at Mayaguez)								
A	1.205[3]	335	1,046	0.7	7.2	7.2	7.5	0.3
B	1.275[3]	244	721	1.1	7.2	7.2	7.5	0.3
C	1.506[3]	221	457	1.7	7.5	7.5	7.7	0.2
D	1.688[3]	244	634	1.2	9.4	9.4	9.4	0.0
E	1.724[3]	274	798	1.0	9.5	9.5	9.5	0.0
F	1.776[3]	219	707	1.1	9.5	9.5	9.5	0.0
G	1.940[3]	244	796	1.0	9.7	9.7	9.7	0.0
H	2.255[3]	244	599	1.3	10.2	10.2	10.2	0.0
I	2.262[3]	271	745	1.0	10.2	10.2	10.5	0.3
J	2.287[3]	240	655	1.2	10.2	10.2	10.5	0.3

[1]Meters above confluence with Rio Santiago
[2]Shared With Rio Santiago – See Rio Santiago for Floodway and Base Flood Water-Surface Elevation Data
[3]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO SANTIAGO LATERAL BRANCH – RIO YAGUEZ (AT MAYAGUEZ)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Yaguez (at Mayaguez) (continued)								
K	2.538[1]	229	318	2.4	10.9	10.9	10.9	0.0
L	2.542[1]	232	690	1.1	11.8	11.8	12.0	0.2
M	2.752[1]	299	437	1.8	12.3	12.3	12.3	0.0
N	2.768[1]	299	685	1.1	12.8	12.8	12.8	0.1
O	3.003[1]	198	525	1.5	13.3	13.3	13.3	0.0
P	3.144[1]	203	498	1.6	13.7	13.7	13.8	0.1
Q	3.342[1]	123	413	1.9	14.6	14.6	14.6	0.0
R	3.449[1]	91	383	2.0	15.4	15.4	15.4	0.0
S	3.586[1]	42	161	4.8	15.4	15.4	15.4	0.0
T	3.789[1]	153[3]	245	3.2	16.9	16.9	16.9	0.0
Rio Grande de Anasco								
A	676[2]	3,234.9	7,405.1	1.2	2.9	2.9	3.2	0.3
B	1,729[2]	4,031.7	8,197.9	0.9	3.3	3.3	3.5	0.2
C	2,831[2]	4,276.3[3]	6,903.5	0.8	3.7	3.7	3.9	0.2
D	3,503[2]	3,054.2[3]	4,597.1	1.0	4.6	4.6	4.7	0.1
E	4,900[2]	2,559.6	6,269.8	2.1	6.9	6.9	7.1	0.2
F	6,782[2]	2,129.7[3]	5,328.6	2.5	8.6	8.6	8.7	0.1
G	8,251[2]	2,487.8	6,735.9	2.0	9.0	9.0	9.0	0.0
H	9,513[2]	2,160.7	5,663.4	1.4	9.9	9.9	10.0	0.1
I	11,343[2]	1,820.9	4,413.9	1.6	10.4	10.4	10.6	0.2
J	12,375[2]	1,141.9	2,633.4	4.3	11.4	11.4	11.4	0.0
K	12,956[2]	572.1	2,609.0	1.1	12.8	12.8	12.8	0.0

[1]Kilometers above mouth
[2]Meters above mouth
[3]Width includes island

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO YAGUEZ (AT MAYAGUEZ) – RIO GRANDE DE ANASCO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Anasco (continued)								
L	13,564	490.3	1,886.0	1.8	13.3	13.3	13.3	0.0
M	14,375	454.8	1,689.2	2.0	13.9	13.9	14.0	0.1
N	15,145	387.0	1,279.1	3.0	14.4	14.4	14.7	0.3
O	15,852	450.1	1,868.2	1.9	15.9	15.9	16.2	0.3
P	16,307	355.6	1,394.8	2.8	17.1	17.1	17.3	0.2
Q	16,667	319.9	1,166.4	3.8	17.8	17.8	18.0	0.2
R	16,934	536.9	2,745.6	1.2	18.6	18.6	18.8	0.2
S	17,245	352.4	1,373.9	3.1	18.5	18.5	18.8	0.3
T	17,585	307.5	1,436.2	2.3	19.4	19.4	19.5	0.1
U	18,255	299.0	1,668.3	2.0	20.0	20.0	20.1	0.1

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GRANDE DE ANASCO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Manati								
A	23,799[1]	357	2,341	2.8	23.1	23.1	23.1	0.0
B	25,718[1]	161	1,249	4.9	26.8	26.8	27.1	0.3
C	25,828[1]	332	2,094	2.9	28.3	28.3	28.5	0.2
D	27,800[1]	166	2,087	2.9	31.5	31.5	31.7	0.2
E	27,932[1]	144	1,589	3.8	31.1	31.1	31.3	0.2
F	29,915[1]	202	1,523	4.0	36.6	36.6	36.7	0.1
G	29,965[1]	204	1,939	3.2	37.6	37.6	37.7	0.1
H	31,445[1]	181	1,583	3.9	40.1	40.1	40.2	0.1
I	31,724[1]	279	3,035	2.0	41.1	41.1	41.2	0.1
J	32,236[1]	504	2,762	2.2	41.2	41.2	41.2	0.0
K	33,154[1]	188	1,695	3.5	43.9	43.9	44.1	0.2
L	33,200[1]	218	1,664	3.6	45.0	45.0	45.1	0.1
M	34,116[1]	195	1,641	3.4	47.9	47.9	48.1	0.2
N	34,156[1]	197	1,614	3.4	48.9	48.9	49.0	0.1
Rio Orocovis								
A	10.725[2]	40	134.8	2.5	485.4	485.4	485.4	0.0
B	10.830[2]	55	160.1	2.1	486.6	486.6	486.6	0.0
C	10.880[2]	60	142.1	2.4	487.3	487.3	487.3	0.0
D	10.925[2]	40	128.5	2.7	487.8	487.8	487.8	0.0
E	11.025[2]	30	112.5	3.0	489.3	489.3	489.3	0.0
F	11.200[2]	40	119.1	2.9	492.0	492.0	492.0	0.0
G	11.355[2]	120	173.3	2.0	494.4	494.4	494.4	0.0
H	11.390[2]	130	65.2	3.8	494.9	494.9	494.9	0.0
I	11.470[2]	80[3]	193.7	1.8	496.5	496.5	496.5	0.0

[1]Meters above Mouth
[2]Kilometers above mouth
[3]Width does not include island

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GRANDE DE MANATI – RIO OROCOVIS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Orocovis (continued)								
J	11.610	120	80.0	3.2	499.7	499.7	499.7	0.0
K	11.635	75	134.1	1.8	500.3	500.3	500.3	0.0
L	11.775	70	171.0	1.4	502.3	502.3	502.3	0.0
M	11.850	90	176.3	1.4	502.7	502.7	502.7	0.0
N	11.940	60	113.3	2.2	503.4	503.4	503.4	0.0
O	12.075	40	80.3	3.1	505.8	505.8	505.8	0.0
P	12.300	40	193.3	1.0	511.6	511.6	511.6	0.0
Q	12.325	40	68.7	2.8	512.8	512.8	512.8	0.0
R	12.480	30	105.0	1.8	515.8	515.8	515.8	0.0
Rio de la Plata (at Toa Baja)								
B	0.752	2,570	9,345	0.6	4.6	4.6	4.7	0.1
C	1.149	2,710	9,043	0.6	4.7	4.7	4.9	0.2
D	1.736	2,460	9,324	0.6	4.9	4.7	4.9	0.2
E	2.007	2,201	8,288	0.6	5.0	5.0	5.2	0.2
F	2.247	1,888	5,765	0.9	5.2	5.2	5.4	0.2
G	2.335	2,141	6,119	0.8	5.6	5.6	5.6	0.0
H	2.898	2,263	7,722	0.7	6.2	6.2	6.3	0.1
I	3.420	2,446	8,831	0.6	6.5	6.5	6.6	0.2
J	4.482	1,619	7,229	0.7	7.2	7.2	7.5	0.2
K	5.587	2,050	7,654	0.7	7.9	7.9	8.1	0.2
L	7.317	1,316	4,867	1.1	9.1	9.1	9.3	0.2
M	9.711	753	2,370	2.2	10.4	10.4	10.5	0.1
N	10.746	458	2,558	2.0	12.3	12.3	12.6	0.3
O	11.627	300	1,143	4.5	12.5	12.5	12.5	0.0

[1]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO OROCOVIS – RIO DE LA PLATA (AT TOA BAJA)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio de la Plata (at Toa Alta) (continued)								
P	12.435	400	2,760	1.9	17.0	17.0	17.3	0.3
Q	12.681	408	2,551	2.0	17.3	17.3	17.5	0.2
R	13.390	394	3,238	1.5	18.8	18.8	19.0	0.2
S	14.790	284	1,978	2.5	19.2	19.2	19.4	0.3
T	15.796	178	1,937	2.5	20.4	20.4	20.5	0.1
U	16.337	179	1,908	2.5	22.0	22.0	22.3	0.2
V	17.542	360	2,604	1.9	20.9	20.9	21.1	0.2
W	17.732	265	3,431	1.4	20.4	20.4	20.6	0.2
Rio de la Plata (At Comerio)								
Z-AW[2]								
AX	48.456	129	955	4.5	202.1	202.1	202.3	0.2
AY	48.792	88	693	6.0	202.6	202.6	202.9	0.3
AZ	49.177	95	793	5.1	204.2	204.2	204.5	0.3
Rio de la Plata (At Cayey)								
BA-BD[2]								
BE	89.950	213	1,115	1.2	370.8	370.8	371.1	0.3
BF	90.150	213	1,123	1.0	370.9	370.9	371.2	0.3
BG	90.410	213	1,728	0.6	370.9	370.9	371.2	0.3
BH-BI[2]								
BJ	91.090	213	598	1.9	371.8	371.8	372.1	0.3
BK	91.558	213	364	2.4	372.6	372.6	372.9	0.3
BL	92.620	213	462	1.9	375.8	375.8	376.0	0.2

[1] Kilometers above Mouth
[2] Data not available

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE LA PLATA (AT TOA BAJA) – RIO DE LA PLATA (AT COMERO) – RIO DE LA PLATA (AT CAYEY)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio de la Plata (At Cayey) (continued)								
BM-BN[3]								
BO	93.280	183	319	2.74	378.7	378.7	378.7	0.0
BP-BS[3]								
Rio de la Plata Tributary No. 1								
BE[2]	0.160	213	1,115	1.24	370.8	370.8	371.1	0.3
A	0.410	30	60	2.16	370.9	367.1[4]	367.1	0.0
B	0.730	30	61	1.76	370.9	368.9[4]	368.9	0.0
C-H[3]								
I	1.600	61	78	1.37	373.9	373.9	374.2	0.3
J	1.894	61	53	2.03	375.4	375.4	375.5	0.1
K	2.120	61	77	1.39	377.0	377.0	377.2	0.2
L-Q[3]								
Rio Guavate								
BJ[2]	0.200	213	598	1.88	371.8	371.8	372.1	0.3
A	0.920	91	187	1.30	373.4	373.4	373.7	0.3
B	1.160	91	126	2.00	373.9	373.9	374.2	0.3
C[3]								
D[3]								
E	1.780	91	125	2.00	377.8	377.8	377.8	0.0
F	2.019	91	157	1.60	378.6	378.6	378.6	0.0
G	2.190	91	140	1.80	379.0	379.0	379.1	0.1
H[3]								
I	2.680	91	99	2.50	382.2	382.2	382.3	0.1

[1]Kilometers above Mouth
[2]Shared with Río de la Plata At Cayey
[3]Data not available
[4]Elevation computed without consideration of influence from Río de la Plata At Cayey

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE LA PLATA (AT CAYEY) – RIO DE LA PLATA TRIBUTARY NO. 1 – RIO GUAVATE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio de Aibonito Tributary No. 1								
A*								
B*								
C*								
D*								
E	0.324[1]	27	90	1.7	594.8	594.8	594.9	0.1
F	0.361[1]	29	90	1.7	594.8	594.9	595.0	0.1
G-T*								
Rio Grande de Loíza Reach 1								
A	14,235[2]	223	2,104	3.9	13.0	13.0	13.3	0.3
B	14,903[2]	590	5,852	1.5	14.2	14.2	14.4	0.2
C	16,386[2]	299	2,759	2.9	14.3	14.3	14.6	0.3
D	16,699[2]	237	2,738	2.9	15.3	15.3	15.5	0.2
E	17,057[2]	193	2,588	3.1	15.4	15.4	15.8	0.4
F	17,420[2]	199	2657	3.0	15.6	15.6	15.8	0.2
G	17,719[2]	195	2468	3.2	15.6	15.6	15.9	0.3
H	18,371[2]	222	2652	3.0	16.4	16.4	16.8	0.4
I	18,750[2]	196	2739	2.9	17.1	17.1	17.4	0.3
J	19,315[2]	114	1702	4.6	17.2	17.2	17.5	0.3
K	19,571[2]	165	2415	3.3	18.1	18.1	18.3	0.2
L	19,968[2]	219	2822	2.8	18.6	18.6	18.9	0.3
M	20,301[2]	349	4244	1.9	19.1	19.1	19.4	0.3
N	20,594[2]	190	2716	3.0	19.1	19.1	19.3	0.2
O	21,724[2]	269	2741	2.8	20.1	20.1	20.4	0.3
P	21,861[2]	78	1381	5.6	20.1	20.1	20.4	0.3
Q	21,953[2]	120	1926	4.0	21.0	21.0	21.3	0.3

[1]Kilometers above mouth
[2]Meters above mouth

*No data available

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE AIBONITO TRIBUTARY NO. 1 –RIO GRANDE DE LOÍZA REACH 1

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Loíza Reach 1 (continued)								
R	22,365[1]	110	1,865	4.2	21.6	21.6	21.9	0.3
S	22,683[1]	130	2,086	3.7	22.1	22.1	22.3	0.2
T	22,897[1]	109	1,772	4.4	22.2	22.2	22.3	0.1
U	23,110[1]	155	2,023	3.8	22.3	22.3	22.6	0.3
V	23,439[1]	153	2,103	3.7	23.2	23.2	23.5	0.3
W	23,870[1]	115	1,777	4.4	23.4	23.4	23.6	0.2
X	24,724[1]	114	1,790	4.3	24.0	24.0	24.2	0.2
Y	25,089[1]	131	1,826	4.2	24.4	24.4	24.7	0.3
Z	25,597[1]	100	1,530	5.1	25.1	25.1	25.3	0.2
AA	25,923[1]	95	1,417	5.5	25.2	25.2	25.4	0.2
AB	26,280[1]	171	2,479	3.1	27.6	27.6	27.9	0.3
AC	26,464[1]	143	1,829	4.2	27.6	27.6	27.8	0.2
AD	26,982[1]	121	1,483	5.2	28.1	28.1	28.4	0.3
Rio Grande de Loíza Reach 2								
A	5,304[2]	233	1,630	2.0	58.1	58.1	58.3	0.3
B	5,928[2]	270	2,224	1.6	59.0	59.0	59.3	0.3
C	8,830[2]	168	1,068	1.9	63.7	63.7	63.9	0.2
D	9,081[2]	186	980	2.2	64.5	64.5	64.7	0.2
E	10,739[2]	71	689	2.9	69.6	69.6	69.8	0.3
F	11,291[2]	247	1,445	1.6	70.9	70.9	71.3	0.3
G	12,667[2]	152	1,138	1.7	74.0	74.0	74.4	0.3
H	13,974[2]	130	727	2.6	75.9	75.9	76.0	0.2
I	14,754[2]	142	1,010	1.8	79.6	79.6	79.7	0.1
J	15,528[2]	92	661	2.9	81.1	81.1	81.4	0.3

[1]Meters above mouth
[2]Meters above Limit of Detailed Study**
**Limit of Detailed Study is approximately 3,640 meters downstream of Puerto Rico Highway 30

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DE AIBONITO TRIBUTARY NO. 1 – RIO GRANDE DE LOÍZA REACH 1 – RIO GRANDE DE LOÍZA REACH 2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Loíza Reach 2 (continued)								
K	16,804[1]	92	852	2.01	85.2	85.2	85.5	0.3
L	16,818[1]	92	886	1.93	85.5	85.5	85.9	0.3
M	17,205[1]	140	876	1.95	87.2	87.2	87.5	0.2
N	17,502[1]	149	1,125	1.54	88.2	88.2	88.5	0.3
O	18,429[1]	84	589	2.42	91.1	91.1	91.3	0.2
P	18,864[1]	170	1,047	1.21	93.3	93.3	93.5	0.2
Q	19,063[1]	78	569	2.36	93.6	93.6	93.9	0.2
R	19,270[1]	117	774	1.73	95.0	95.0	95.2	0.2
Rio Canovanas								
A	4.43[2]	128	690	1.92	14.8	14.8	15.0	0.1
B	5.64[2]	197	610	2.40	15.2	15.2	15.5	0.3
C	6.89[2]	207	340	4.68	17.1	17.1	17.1	0.0
D	7.18[2]	86	290	3.39	18.2	18.2	18.4	0.2
E	7.99[2]	322	678	1.70	20.4	20.4	20.5	0.1
F	8.49[2]	82	274	5.18	22.0	22.0	22.0	0.0
G	8.88[2]	64	234	5.07	23.3	23.3	23.4	0.1
H	9.28[2]	90	397	2.49	25.2	25.2	25.3	0.1
I	9.66[2]	68	279	3.52	25.4	25.4	25.6	0.2
J	11.34[2]	134	229	3.29	34.5	34.5	34.5	0.0
K	11.78[2]	173	225	3.35	37.7	37.7	37.7	0.0
L	12.32[2]	77	178	4.24	40.9	40.9	40.9	0.0
M	12.96[2]	215	393	1.92	46.6	46.6	46.8	0.2
N	12.99[2]	101	206	3.66	47.1	47.1	47.1	0.0
O	13.16[2]	127	235	3.20	48.9	48.9	48.9	0.0
P	13.87[2]	49	184	4.11	54.2	54.2	54.2	0.0
Q	14.28[2]	69	163	4.63	59.2	59.2	59.2	0.0

[1]Meters above Limit of Detailed Study**

**Limit of Detailed Study is approximately 3,640 meters downstream of Puerto Rico Highway 30

[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GRANDE DE LOÍZA REACH 2 – RIO CANOVANAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Canovanillas								
A	1.38[1]	253	767	1.0	9.7	9.7	10.0	0.3
B	1.54[1]	228	849	0.9	9.8	9.8	10.1	0.3
C	2.29[1]	117	250	3.0	9.9	9.9	10.2	0.3
D	2.72[1]	107	453	1.7	11.3	11.3	11.4	0.1
Rio Gurabo Reach 1								
A	341[2]	96	616	5.8	51.7	46.8[3]	46.9	0.1
B	2,027[2]	1,188	8,321	0.5	52.0	50.3[3]	50.4	0.1
C	2,432[2]	916	6,383	0.6	52.0	50.3[3]	50.4	0.1
D	3,203[2]	895	6,475	0.6	52.0	50.4[3]	50.5	0.1
E	3,642[2]	1,092	8,057	0.6	52.0	50.8[3]	51.0	0.2
F	5,110[2]	1,055	6,513	0.6	52.0	50.9[3]	51.1	0.2
G	5,349[2]	547	4,379	0.8	52.5	52.5	52.6	0.1
H	7,178[2]	543	3,054	1.3	52.9	52.9	53.0	0.1
I	7,298[2]	595	3,985	0.9	53.2	53.2	53.4	0.2
J	8,137[2]	506	3,423	1.0	53.4	53.4	53.6	0.2
K	8,547[2]	858	5,004	0.7	53.6	53.6	53.8	0.2
L	9,576[2]	478	3,046	1.2	53.8	53.8	54.0	0.2
M	10,239[2]	346	1,408	2.4	54.3	54.3	54.5	0.2
N	11,401[2]	166	850	3.5	55.1	55.1	55.2	0.1
O	11,715[2]	306	1,798	1.6	56.5	56.5	56.7	0.2
P	12,687[2]	602	2,034	1.5	56.9	56.9	57.2	0.3

[1]Kilometers above mouth
[2]Meters above confluence with Rio Grande De Loíza Reach 2
[3]Elevation computed without consideration of backwater effects from Rio Grande De Loíza Reach 2

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CANOVANILLAS – RIO GURABO REACH 1

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Gurabo Reach 1 (continued)								
Q	13,680[1]	252	1,182	2.4	57.8	57.8	58.0	0.2
R	13,937[1]	514	2,920	1.0	60.4	60.4	60.6	0.2
S	14,427[1]	865	4,106	0.7	60.5	60.5	60.7	0.2
T	15,711[1]	338	799	1.6	60.6	60.6	60.8	0.2
U	16,646[1]	340	603	2.2	62.3	62.3	62.3	0.0
V	17,548[1]	61	329	3.8	65.8	65.8	65.8	0.0
W	17,677[1]	348	1,158	1.1	67.4	67.4	67.5	0.1
X	18,163[1]	136	548	2.3	67.7	67.7	67.7	0.0
Y	18,458[1]	218	814	1.6	68.4	68.4	68.4	0.0
Z	19,348[1]	122	414	3.0	71.6	71.6	71.7	0.1
Rio Gurabo Reach 2								
AA	23,050[2]	223	820	1.8	81.4	81.4	81.7	0.3
AB	23,460[2]	333	712	2.0	82.5	82.5	82.8	0.3
AC	23,850[2]	245	1,011	1.5	83.7	83.7	83.8	0.1
AD	24,170[2]	192	789	1.9	84.2	84.2	84.3	0.1
AE	24,560[2]	275	782	1.5	84.9	84.9	85.1	0.2
AF	24,810[2]	171	464	2.4	85.6	85.6	85.8	0.2
AG	25,000[2]	44	92	5.2	86.8	86.8	86.8	0.0
AH	25,270[2]	115	333	1.5	89.2	89.2	89.2	0.0

[1]Meters above confluence with Rio Grande De Loíza Reach 2
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GURABO REACH 1 – RIO GURABO REACH 2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Valenciano								
A	2,032[1]	87	559	2.4	63.2	63.2	63.4	0.2
B	2,062[1]	83	604	2.2	63.9	63.9	64.1	0.2
C	2,416[1]	135	777	1.7	64.8	64.8	65.0	0.2
D	3,165[1]	72	458	2.9	66.7	66.7	66.9	0.2
Rio Bairoa								
A	2,862[2]	130	314	3.7	53.3	53.3	53.7	0.4
B	2,952[2]	57	145	5.7	54.7	54.7	54.7	0.0
C	2,962[2]	58	206	4.0	55.6	55.6	55.7	0.2
D	3,226[2]	337	826	1.7	56.9	56.9	57.0	0.1
E	4,004[2]	409	501	2.9	58.2	58.2	58.5	0.3
F	4,316[2]	28	126	3.1	60.6	60.6	60.8	0.1
G	4,330[2]	28	162	2.4	62.0	62.0	62.1	0.0
H	4,813[2]	85	218	2.2	63.5	63.5	63.8	0.3
I	4,833[2]	27	76	5.4	65.0	65.0	65.1	0.0
J	6,286[2]	99	219	4.5	73.5	73.5	73.8	0.3
K	6,435[2]	118	300	2.9	74.8	74.8	74.8	0.0
L	7,558[2]	137	207	5.4	78.8	78.8	79.1	0.3
M	7,812[2]	75	176	4.1	80.9	80.9	81.2	0.3
N	8,674[2]	95	141	5.8	84.6	84.6	84.8	0.3
O	12,790[2]	22	50	3.0	217.4	217.4	217.5	0.2
P	13,130[2]	23	89	1.7	237.0	237.0	237.0	0.0
Q	13,410[2]	16	33	4.5	237.8	237.8	237.8	0.0
R	13,630[2]	19	50	3.1	242.3	242.3	242.3	0.0
S	13,760[2]	45	54	1.5.	243.9	243.9	243.9	0.0

[1]Meters above confluence with Rio Gurabo
[2]Meters above confluence with Rio Grande De Loíza Reach 2

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO VALENCIANO – RIO BAIROA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Cambute								
A	90[1]	13	31	4.1	9.9	7.0[5]	7.1	0.1
B	116[1]	25	77	1.6	9.9	8.0[5]	8.0	0.0
C	200[1]	10	30	4.1	9.9	8.2[5]	8.2	0.0
D	471[1]	15	44	2.9	10.4	10.4	10.6	0.2
Quebrada Muertos								
A	0.10[2]	15	35	2.0	220.7	220.7	221.0	0.3
B	0.68[2]	12	30	2.4	229.1	229.1	229.1	0.0
C	1.42[2]	16	22	1.5	244.0	244.0	244.0	0.0
Quebrada Algarrobo								
A	151[3]	19	86	5.1	78.0	77.6[6]	77.8	0.2
Rio Caguitas								
A	2,926[4]	157	613	2.1	54.1	54.1	54.2	0.1
B	3,296[4]	120	329	4.7	54.4	54.4	54.6	0.2
C	3,937[4]	152	377	4.9	57.1	57.1	57.1	0.0
D	4,430[4]	46	225	4.2	59.2	59.2	59.3	0.1
E	4,455[4]	46	258	3.6	60.0	60.0	60.1	0.1
F	4,555[4]	39	195	6.6	60.0	60.0	60.1	0.1
G	4,627[4]	57	282	3.7	61.3	61.3	61.4	0.1
H	4,721[4]	57	335	2.8	62.4	62.4	62.5	0.1
I	5,062[4]	52	234	6.2	63.0	63.0	63.3	0.3
J	6,675[4]	120	340	4.2	69.3	69.3	69.6	0.3
K	6,887[4]	65	390	2.4	72.3	72.3	72.7	0.4
L	7,966[4]	176	550	3.3	73.6	73.6	73.7	0.1
M	8,952[4]	89	187	5.4	75.8	75.8	75.9	0.1
N	9,253[4]	105	327	3.9	78.1	78.1	78.3	0.2

[1]Meters above confluence with Rio Canovanillas
[2]Kilometers above mouth
[3]Meters above mouth
[4]Meters above confluence with Rio Grande De Loíza Reach 2
[5]Elevation computed without consideration of backwater effects from Rio Canovanillas
[6]Elevation computed without consideration of backwater effects from Rio Caguitas

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA CAMBUTE – QUEBRADA MUERTOS – QUEBRADA ALGARROBO – RIO CAGUITAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Turabo								
A	1,846[1]	73	419	3.7	62.0	62.0	62.2	0.2
B	1,861[1]	259	625	2.5	62.7	62.7	62.8	0.1
C	2,275[1]	49	257	6.0	62.8	62.8	63.1	0.3
D	2,456[1]	270	748	2.1	65.3	65.3	65.3	0.0
E	2,952[1]	74	261	5.9	65.4	65.4	65.5	0.1
F	3,438[1]	268	1,167	1.4	69.1	69.1	69.2	0.1
G	6,174[1]	209	675	2.1	82.6	82.6	82.8	0.1
H	6,370[1]	473	1,292	1.5	84.7	84.7	84.8	0.1
I	7,115[1]	334	397	3.3	86.3	86.3	86.4	0.1
J	8,005[1]	72	376	3.5	93.2	93.2	93.5	0.3
K	8,349[1]	70	217	4.7	93.6	93.6	93.9	0.3
L	8,400[1]	69	235	4.3	96.5	96.5	96.5	0.0
M	8,534[1]	61	213	4.8	96.5	96.5	96.5	0.0
N	8,805[1]	57	267	3.8	98.0	98.0	98.0	0.0
O	8,853[1]	64	190	5.5	100.6	100.6	100.6	0.0
P	9,064[1]	62	266	3.8	103.0	103.0	103.0	0.0
Q	9,306[1]	57	244	4.2	103.3	103.3	103.5	0.2
Rio Herrera								
A	5.48[2]	379	316	1.0	4.9	4.9	4.9	0.0
B	5.91[2]	262	193	1.7	6.3	6.3	6.4	0.1
C	6.20[2]	105	138	2.3	7.5	7.5	7.7	0.3
D	6.41[2]	39	84	3.8	8.8	8.8	8.8	0.0
E	6.44[2]	144	321	1.0	10.6	10.6	10.6	0.0
F	6.47[2]	172	308	1.0	10.7	10.7	10.7	0.0
G	6.94[2]	44	159	2.0	11.0	11.0	11.3	0.3
H	7.57[2]	81	111	2.9	13.8	13.8	13.8	0.0

[1]Meters above confluence with Rio Grande De Loíza Reach 2
[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO TURABO – RIO HERRERA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Caguitas Tributary 1								
A	0.19	71	105	0.9	61.7	61.7	62.0	0.3
B	0.34	41	46	1.5	62.0	62.0	62.2	0.2
C	0.37	16	25	2.8	62.4	62.4	62.5	0.1
D	0.40	13	19	3.7	62.4	62.4	62.5	0.1
E	0.57	58	34	2.1	63.8	63.8	63.8	0.0
F	0.89	25	33	2.1	65.4	65.4	65.4	0.0
G	1.12	27	31	2.3	67.8	67.8	67.8	0.0
H	1.37	17	56	1.3	72.5	72.5	72.5	0.0
I	1.62	16	31	2.3	73.9	73.9	73.9	0.0
J	1.70	15	27	2.6	74.6	74.6	74.6	0.0
K	1.96	19	45	1.6	78.4	78.4	78.4	0.0
L	2.40	39	28	2.5	82.2	82.2	82.2	0.0
M	2.57	13	27	2.6	84.3	84.3	84.3	0.0
N	2.93	17	46	1.6	87.3	87.3	87.3	0.1
O	3.47	16	20	3.5	93.5	93.5	93.5	0.0
P	3.73	15	41	1.7	96.8	96.8	97.1	0.2
Rio Caguitas Tributary 2								
A	0.09	7	8	3.1	62.5	62.5	62.5	0.0
B	0.15	7	10	2.4	64.6	64.6	64.6	0.0
C	0.16	6	9	2.7	64.7	64.7	64.8	0.1
D	0.27	28	27	0.9	65.5	65.5	65.6	0.1
E	0.60	7	8	3.1	67.7	67.7	67.8	0.1
F	0.88	6	8	3.1	71.2	71.2	71.3	0.1
G	1.04	11	11	2.2	74.1	74.1	74.3	0.2
H	1.24	11	8	2.8	76.0	76.0	76.0	0.0

[1]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CAGUITAS TRIBUTARY 1 – RIO CAGUITAS TRIBUTARY 2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Cañaboncito								
A	81[1]	34	49	3.4	73.0	73.0	73.2	0.2
B	175[1]	38	69	3.7	74.1	74.1	74.4	0.3
Rio Anton Ruiz								
A	1,935[2]	3,683	10,008	0.1	3.0	3.0	3.3	0.3
B	2,745[2]	3,772	11,335	0.1	3.1	3.1	3.4	0.3
C	3,225[2]	3,426	9,674	0.1	3.1	3.1	3.4	0.3
D	4,795[2]	2,095	6,554	0.1	3.3	3.3	3.5	0.3
E	5,117[2]	1,189	3,001	0.2	3.3	3.3	3.6	0.3
F	5,755[2]	549	1,286	0.5	4.2	4.2	4.4	0.2
G	6,614[2]	621	1,593	0.4	5.6	5.6	5.9	0.3
H	6,418[2]	822	1,776	0.3	6.7	6.7	7.0	0.3
I	6,646[2]	951	2,044	0.3	7.5	7.5	7.7	0.2
J	7,023[2]	972	1,496	0.4	8.4	8.4	8.6	0.2
K	7,355[2]	1,087	1,504	0.4	10.0	10.0	10.2	0.2
L	7,672[2]	965	1,125	0.3	11.1	11.1	11.4	0.3
M	7,965[2]	237	260	1.2	13.4	13.4	13.6	0.1
N	8,250[2]	163	382	0.8	16.5	16.5	16.8	0.3
O	9,180[2]	211	336	0.9	19.3	19.3	19.6	0.2
P	9,610[2]	176	163	1.8	21.4	21.4	21.5	0.2
Q	9,930[2]	79	175	1.7	23.8	23.8	24.1	0.3
R	10,182[2]	142	210	1.4	25.4	25.4	25.6	0.2
S	10,372[2]	148	269	1.1	26.2	26.2	26.4	0.2

[1]Meters above confluence with Rio Caguitas
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CAÑABONCITO – RIO ANTON RUIZ

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Mambiche								
A	155	30	66	1.8	28.0	28.0	28.0	0.0
B	460	37	89	1.3	31.4	31.4	31.4	0.0
C	668	109	113	0.9	31.9	31.9	32.1	0.2
D	786	101	59	1.7	33.5	33.5	33.5	0.0
E	1,070	80	93	1.1	36.5	36.5	36.7	0.2
F	1,280	29	42	2.3	38.4	38.4	38.5	0.1
G	1,523	46	44	1.7	41.5	41.5	41.5	0.0
H	1,771	206	528	0.1	48.3	48.3	48.3	0.0
Quebrada de las Mulas								
A	835	568	603	0.3	3.2	2.6[2]	2.9	0.3
B	1,055	462	548	0.3	3.7	3.7	3.9	0.2
C	1,322	225	333	0.5	5.3	5.3	5.6	0.2
D	1,662	385	528	0.3	7.3	7.3	7.4	0.1
E	2,028	164	148	0.9	9.6	9.6	9.8	0.2
F	2,235	242	311	0.4	11.3	11.3	11.6	0.3
G	2,466	224	135	1.0	13.2	13.2	13.2	0.0
H	2,690	156	243	0.4	16.4	16.4	16.4	0.0
I	3,175	50	56	1.7	17.6	17.6	17.6	0.0
J	3,441	85	73	1.3	20.2	20.2	20.2	0.0
K	3,581	60	70	1.0	21.2	21.2	21.2	0.0
L	3,713	42	44	1.6	21.9	21.9	21.9	0.0
M	4,116	78	71	1.0	24.1	24.1	24.1	0.0
N	4,236	26	26	2.7	25.4	25.4	25.4	0.0
O	4,493	62	64	1.1	28.3	28.3	28.3	0.0
P	4,685	60	52	1.0	29.4	29.4	29.4	0.0

[1]Meters above mouth
[2]Elevation computed without consideration of backwater effects from Rio Anton Ruiz

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA MAMBICHE – QUEBRADA DE LAS MULAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada de las Mulas (continued)								
Q	4,839	34	20	2.4	32.4	32.4	32.4	0.0
R	4,946	18	23	2.2	34.7	34.7	34.7	0.0
S	5,144	23	27	1.0	36.3	36.3	36.3	0.0
T	5,273	11	10	2.9	38.7	38.7	38.7	0.0
U	5,441	9	10	2.9	44.7	44.7	44.7	0.0
Rio Daguao								
A	3,690	335	534	0.6	5.7	5.7	6.0	0.3
B	3,800	288	234	1.3	6.6	6.6	6.7	0.2
C	3,852	219	341	0.9	8.1	8.1	8.3	0.1
D	3,926	175	542	0.6	9.4	9.4	9.4	0.0
E	4,070	213	394	0.8	9.5	9.5	9.5	0.0
F	4,455	130	206	1.5	10.5	10.5	10.8	0.2
G	4,750	40	117	2.7	13.0	13.0	13.3	0.3
H	4,956	200	358	0.9	15.6	15.6	15.7	0.2
I	5,059	199	313	1.0	16.7	16.7	16.9	0.2
J	5,399	58	92	2.8	17.3	17.3	17.4	0.1
K	5,614	38	79	3.2	19.1	19.1	19.1	0.0
L	5,949	186	274	0.9	24.0	24.0	24.0	0.0
M	6,080	105	114	2.3	24.2	24.2	24.2	0.0
N	6,430	54	92	2.8	27.7	27.7	27.7	0.0
O	6,800	88	107	2.4	33.6	33.6	33.6	0.0
P	7,190	75	95	2.7	37.1	37.1	37.1	0.0
Q	7,520	68	100	2.6	41.0	41.0	41.0	0.0
R	7,855	98	176	1.5	46.2	46.2	46.2	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA DE LAS MULAS – RIO DAGUAO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Daguao (continued)								
S	8,279	66	66	2.4	49.3	49.3	49.3	0.0
T	8,387	51	57	2.8	50.6	50.6	50.6	0.0
U	8,641	108	92	1.8	52.6	52.6	52.6	0.0
V	8,901	65	69	2.3	55.5	55.5	55.5	0.0
W	9,311	70	82	2.0	60.8	60.8	60.8	0.0
X	9,596	81	77	2.1	64.0	64.0	64.0	0.0
Quebrada Ceiba								
A	690	485	1,140	0.2	3.1	3.1	3.4	0.3
B	985	385	363	0.7	3.8	3.8	3.9	0.1
C	1,055	410	998	0.3	5.4	5.4	5.5	0.0
D	1,280	151	298	0.9	5.8	5.8	5.9	0.0
E	1,350	50	88	3.0	5.9	5.9	6.0	0.1
F	1,555	107	206	1.3	7.9	7.9	7.9	0.0
G	1,827	60	123	1.9	10.1	10.1	10.1	0.0
H	2,005	30	67	3.4	10.1	10.1	10.1	0.0
I	2,357	30	54	4.2	13.4	13.4	13.4	0.0
J	2,620	40	59	3.9	15.7	15.7	15.7	0.0
K	3,082	58	73	2.6	23.9	23.9	23.9	0.0
L	3,364	58	61	3.1	28.2	28.2	28.4	0.1
M	3,629	53	58	3.2	33.7	33.7	33.7	0.0
N	3,887	28	55	3.4	39.0	39.0	39.0	0.0
O	4,157	32	46	4.1	44.5	44.5	44.5	0.1
P	4,413	55	80	2.4	49.7	49.7	49.7	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO DAGUAO – QUEBRADA CEIBA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Ceiba (continued)								
Q	4,744	25	45	2.2	55.0	55.0	55.0	0.0
R	4,933	30	30	3.3	59.3	59.3	59.3	0.0
S	5,262	18	38	0.5	66.8	66.8	66.8	0.0
T	5,475	11	17	1.1	72.4	72.4	72.4	0.0
U	5,646	11	7	2.6	77.3	77.3	77.3	0.0
V	5,866	13	8	2.3	85.5	85.5	85.5	0.0
Quebrada Aguas Claras								
A	432	350	907	0.2	3.9	3.9	4.2	0.3
B	656	194	205	1.0	4.7	4.7	4.9	0.2
C	996	209	454	0.3	8.1	8.1	8.3	0.1
D	1,332	105	78	1.9	10.2	10.2	10.2	0.0
E	1,571	85	104	1.4	13.6	13.6	13.8	0.3
F	1,804	72	82	1.8	16.1	16.1	16.3	0.3
G	2,049	31	50	3.0	19.4	19.4	19.5	0.1
H	2,269	68	125	1.2	21.6	21.6	21.6	0.0
I	2,612	111	117	0.8	23.7	23.7	23.9	0.2
J	2,841	75	165	0.6	27.8	27.8	28.1	0.3
K	3,008	45	133	0.7	29.7	29.7	29.7	0.0
L	3,158	29	33	2.8	31.5	31.5	31.5	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA CEIBA – QUEBRADA AGUAS CLARAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebradas Aguas Claras Tributary								
A	110[1]	107	80	0.9	8.9	8.6[2]	8.8	0.2
B	140[1]	12	18	4.0	8.9	8.7[2]	8.7	0.0
C	177[1]	28	40	1.8	10.6	10.6	10.7	0.1
D	448[1]	10	19	3.8	13.4	13.4	13.5	0.1
E	687[1]	27	36	2.0	15.7	15.7	16.0	0.3
F	957[1]	21	51	1.2	20.2	20.2	20.2	0.0
G	1,141[1]	25	32	1.9	21.6	21.6	21.6	0.1
H	1,391[1]	27	33	1.9	25.3	25.3	25.4	0.1
I	1,651[1]	22	24	2.6	30.4	30.4	30.4	0.0
J	1,924[1]	24	21	0.9	34.9	34.9	35.0	0.1
K	2,158[1]	24	10	1.9	41.4	41.4	41.4	0.0
L	2,417[1]	51	22	0.8	49.3	49.3	49.3	0.0
Rio Humacao								
A	920[2]	510.0	1,050.8	2.0	4.4	4.4	4.6	0.2
B	1,592[2]	348.2	662.9	3.1	5.8	5.8	5.9	0.1
C	2,157[2]	350.0	838.3	2.1	7.7	7.7	8.0	0.3
D	2,601[2]	99.7	464.5	3.6	8.3	8.3	8.6	0.3
E	2,700[2]	102.3	473.0	3.6	8.9	8.9	9.0	0.1
F	3,097[2]	96.5	447.8	3.8	9.0	9.0	9.1	0.1
G	3,475[2]	191.2	601.2	2.7	11.3	11.3	11.4	0.1
H	3,590[2]	216.0	614.8	2.5	12.0	12.0	12.1	0.1
I	3,799[2]	258.1	568.0	2.7	12.2	12.2	12.5	0.3
J	4,436[2]	364.6	943.9	1.9	13.7	13.7	14.0	0.3
K	5,082[2]	67.2	339.8	4.2	15.3	15.3	15.4	0.1

[1]Meters above confluence with Quebrada Aguas Claras
[2]Meters above mouth
[3]Elevation computed without consideration of backwater effects from Quebrada Aguas Claras

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA AGUAS CLARAS TRIBUTARY – RIO HUMACAO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Humacao (continued)								
L	5,717	109.5	476.7	2.8	18.1	18.1	18.1	0.0
M	6,107	103.3	375.9	2.7	20.0	20.0	20.2	0.2
N	6,297	134.0	530.9	1.9	21.0	21.0	21.3	0.3
O	6,588	335.0	1,473.6	0.8	21.6	21.6	21.9	0.3
P	7,025	79.4	360.5	2.5	22.4	22.4	22.6	0.2
Q	7,481	65.5	332.4	2.6	23.7	23.7	24.0	0.3
R	7,692	52.3	257.8	3.3	24.3	24.3	24.6	0.3
S	7,820	53.0	303.2	2.8	25.4	25.4	25.7	0.3
T	7,956	62.0	356.8	2.4	26.6	26.6	26.8	0.2
U	8,428	116.1	599.5	1.4	28.1	28.1	28.4	0.3
V	8,738	112.4	377.3	2.2	29.1	29.1	29.3	0.2
W	8,872	72.9	342.1	2.5	29.7	29.7	30.0	0.3
X	8,998	52.8	285.4	3.0	30.7	30.7	30.9	0.2
Y	9,303	84.0	395.1	2.1	32.8	32.8	33.0	0.2
Z	9,690	68.0	314.2	2.7	34.3	34.3	34.6	0.3
AA	10,087	46.0	213.9	3.5	36.8	36.8	37.0	0.2
AB	10,564	32.5	173.6	4.3	43.0	43.0	43.1	0.1
AC	10,818	32.0	184.5	4.1	47.2	47.2	47.4	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO HUMACAO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Mabu								
A	418	188.0	359.6	0.8	15.9	15.9	16.2	0.3
B	679	153.2	300.8	0.6	16.1	16.1	16.4	0.3
C	942	137.6	139.6	1.3	16.4	16.4	16.7	0.3
D	1,274	152.6	130.0	1.2	17.5	17.5	17.7	0.3
E	1,436	104.1	122.2	1.8	18.5	18.5	18.8	0.3
F	1,738	221.0	297.7	1.0	20.3	20.3	20.6	0.3
G	1,917	160.0	117.5	3.3	20.6	20.6	20.9	0.3
H	2,066	137.4	161.9	1.5	21.4	21.4	21.7	0.3
I	2,196	195.0	83.3	2.4	22.0	22.0	22.1	0.1
J	2,279	218.8	135.7	2.5	22.4	22.4	22.6	0.2
K	2,368	150.7	76.2	3.6	22.6	22.6	22.9	0.3
L	2,500	117.3	64.7	3.3	24.0	24.0	24.2	0.2
M	2,567	104.6	66.5	3.3	24.6	24.6	24.9	0.3
N	2,634	46.1	58.3	3.9	26.1	26.1	26.2	0.1
O	2,701	20.6	44.6	3.4	26.6	26.6	26.9	0.3
P	2,868	27.1	53.5	2.4	28.6	28.6	28.8	0.2
Q	3,031	8.3	18.6	4.9	30.4	30.4	30.4	0.0
R	3,190	16.0	20.4	4.4	34.5	34.5	34.5	0.0
S	3,216	27.7	30.0	3.4	35.6	35.6	35.6	0.0
T	3,306	35.3	26.2	2.7	36.7	36.7	36.7	0.0
U	3,472	18.1	18.2	3.1	38.5	38.5	38.6	0.2
V	3,572	32.7	22.8	2.7	40.8	40.8	40.9	0.0
W	3,652	17.1	22.6	2.6	43.3	43.3	43.3	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA MABU

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Mariana								
A	154	91.3	367.6	1.5	19.1	19.1	19.4	0.3
B	590	38.6	147.7	3.8	20.4	20.4	20.5	0.1
C	669	66.7	212.7	2.6	21.3	21.3	21.5	0.1
D	734	51.3	277.7	1.9	22.5	22.5	22.6	0.1
E	863	71.3	365.4	1.5	22.7	22.7	23.0	0.3
F	1,248	103.2	427.3	1.0	23.4	23.4	23.7	0.3
G	1,775	27.3	130.3	2.8	24.6	24.6	24.9	0.2
H	2,272	30.9	100.0	3.2	28.2	28.2	28.4	0.2
I	2,575	19.6	63.5	6.1	36.2	36.2	36.2	0.1
J	2,906	62.6	229.2	1.8	39.9	39.9	40.2	0.3
K	3,155	15.7	91.8	3.4	40.8	40.8	41.0	0.3
L	3,721	35.6	73.9	4.8	51.8	51.8	51.8	0.0
M	3,906	24.5	90.1	3.8	56.4	56.4	56.6	0.2
N	4,102	29.8	75.2	5.6	75.2	75.2	75.5	0.2
Quebrada Mariana Tributary								
A	106	31.6	89.7	1.3	20.6	20.6	20.7	0.1
B	250	19.3	55.6	2.1	22.1	22.1	22.2	0.1
C	564	45.6	137.9	0.8	23.3	23.3	23.4	0.1
D	1,141	14.9	36.2	3.2	25.3	25.3	25.4	0.1
E	1,362	25.6	74.4	1.6	27.8	27.8	28.1	0.3
F	1,756	25.5	68.9	1.7	30.2	30.2	30.3	0.1
G	1,817	12.5	36.4	3.1	30.6	30.6	30.7	0.1
H	1,829	27.2	110.5	1.0	31.7	31.7	32.0	0.3
I	1,931	16.4	54.4	2.1	32.2	32.2	32.4	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA MARIANA – QUEBRADA MARIANA TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guanajibo								
A	760	2,296.3	7,661.6	1.6	4.4	4.4	4.6	0.2
B	1,267	1,842.2	6,353.8	1.6	5.0	5.0	5.2	0.2
C	1,871	1,695.6	6,173.4	1.4	5.7	5.7	6.0	0.3
D	2,704	1,279.4	4,754.0	2.4	7.2	7.2	7.5	0.3
E	3,019	1,178.7	4,848.8	2.0	7.7	7.7	8.0	0.3
F	3,681	1,389.0	6,128.2	1.6	8.3	8.3	8.6	0.3
G	4,106	1,184.2	5,589.9	1.6	8.8	8.8	9.1	0.3
H	4,550	928.3	4,456.3	1.9	9.5	9.5	9.7	0.2
I	5,181	661.8	3,636.1	2.6	10.7	10.7	11.0	0.3
J	5,906	361.0	2,636.9	3.6	12.7	12.7	13.0	0.3
K	6,080	436.3	3,238.1	2.1	14.0	14.0	14.1	0.1
L	6,324	642.0	5,379.2	1.1	14.1	14.1	14.3	0.2
M	6,515	748.0	6,206.9	1.1	14.3	14.3	14.6	0.3
N	7,000	960.8	7,901.0	0.6	14.3	14.3	14.6	0.3
O	7,361	1,086.2	9,031.5	0.5	14.3	14.3	14.6	0.3
P	8,147	1,240.0	9,675.0	0.4	14.4	14.4	14.7	0.3
Q	8,846	1,476.4	9,937.1	0.3	14.4	14.4	14.7	0.3
R	9,362	1,901.6	10,701.2	0.2	14.4	14.4	14.7	0.3
S	10,876	2,003.0	8,874.5	0.3	14.5	14.5	14.8	0.3
T	11,763	2,049.7	8,616.3	0.3	14.5	14.5	14.8	0.3
U	11,961	2,209.0[2]	9,047.6	0.2	14.5	14.5	14.9	0.4
V	12,551	2,600.9[2]	8,219.1	0.3	14.6	14.6	14.9	0.3
W	13,227	2,632.6	6,868.8	0.6	14.7	14.7	15.0	0.3
X	13,694	2,701.2	5,180.2	0.6	15.3	15.3	15.5	0.2
Y	14,516	2,623.4	4,388.7	1.2	16.9	16.9	17.0	0.1
Z	15,063	2,348.6	3,798.8	1.7	18.1	18.1	18.2	0.1

[1]Meters above mouth
[2]Combined with Rio Viejo

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUANAJIBO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guanajibo (continued)								
AA	15,607	2,351.2	2,519.1	1.1	19.5	19.5	19.8	0.3
AB	16,572	1,767.2	2,718.0	0.9	21.2	21.2	21.3	0.1
AC	17,133	1,505.4	2,290.4	0.8	21.9	21.9	22.0	0.1
AD	18,412	1,777.0	2,960.2	0.7	23.4	23.4	23.5	0.1
AE	19,893	1,447.1	1,468.4	1.4	24.8	24.8	24.8	0.0
AF	20,375	1,203.9	1,417.2	1.8	26.0	26.0	26.1	0.1
AG	20,863	786.9	783.2	2.7	28.2	28.2	28.3	0.1
AH	21,090	1,144.6	1,561.7	1.3	30.2	30.2	30.4	0.2
AI	21,729	779.7	1,285.4	1.0	31.0	31.0	31.2	0.2
AJ	22,323	783.5	1,092.4	1.7	32.0	32.0	32.2	0.2
AK	23,065	542.6	1,062.3	1.2	33.5	33.5	33.5	0.0
AL	23,207	542.0	966.0	1.7	33.7	33.7	33.8	0.1
AM	24,166	432.4	994.5	2.2	35.4	35.4	35.5	0.1
AN	24,638	430.2	1,106.2	1.6	36.6	36.6	36.6	0.0
AO	24,816	510.0	684.7	3.9	37.0	37.0	37.0	0.0
AP	25,365	389.3	942.0	1.5	39.6	39.6	39.9	0.3
AQ	25,789	494.4	1,002.9	1.7	40.5	40.5	40.7	0.2
AR	26,109	548.3	1,163.1	1.7	41.3	41.3	41.4	0.1
AS	26,300	542.0	1,013.3	1.9	42.5	42.5	42.6	0.1
AT	26,712	226.0	947.6	1.7	44.7	44.7	44.8	0.1
AU	27,030	86.7	377.5	4.5	45.0	45.0	45.3	0.3
AV	27,286	316.0	1,402.0	1.1	48.3	48.3	48.4	0.1
AW	27,589	267.4	1,135.4	2.0	48.5	48.5	48.6	0.1
AX	28,410	307.3	1,606.4	1.0	49.8	49.8	50.0	0.2
AY	29,158	206.3	1,079.2	1.6	52.7	52.7	52.9	0.2
AZ	30,150	190.1	698.6	2.1	55.4	55.4	55.6	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUANAJIBO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guanajibo (continued)								
BA	30,595	251.0	659.7	1.7	57.5	57.5	57.7	0.2
BB	30,973	362.4	949.2	1.2	58.5	58.5	58.8	0.3
BC	31,220	292.5	652.5	1.9	59.4	59.4	59.5	0.1
BD	32,344	91.4	366.6	2.7	63.1	63.1	63.2	0.1
BE	32,940	114.2	455.3	2.2	66.4	66.4	66.6	0.2
BF	33,538	188.9	709.0	1.5	68.5	68.5	68.8	0.3
BG	34,043	92.3	337.3	2.5	70.9	70.9	70.9	0.0
BH	34,595	139.2	431.8	2.2	74.7	74.7	74.8	0.1
BI	35,049	135.1	324.5	3.2	77.4	77.4	77.7	0.3
BJ	35,846	73.9	349.4	2.4	82.8	82.8	83.0	0.2
BK	36,540	87.8	381.4	2.3	87.4	87.4	87.6	0.2
BL	36,930	141.6	377.6	2.7	89.4	89.4	89.5	0.1
BM	37,377	55.4	209.9	2.6	93.0	93.0	93.0	0.0
BN	37,739	72.1	239.9	2.3	95.6	95.6	95.8	0.2
BO	38,077	120.8	282.6	2.3	98.9	98.9	99.0	0.1
BP	38,577	115.3	249.3	2.1	102.8	102.8	102.9	0.1
BQ	39,082	73.9	224.4	2.3	107.3	107.3	107.3	0.0
BR	39,647	92.3	221.9	2.5	113.0	113.0	113.1	0.1

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUANAJIBO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Honda (Rio Guanajibo Basin)								
A	173	65.5	116.8	3.6	89.5	89.5	89.6	0.1
B	689	125.1	211.4	2.7	92.6	92.6	92.8	0.2
C	944	80.7	145.2	2.2	94.1	94.1	94.4	0.3
D	1,358	71.1	129.9	2.5	97.2	97.2	97.4	0.2
E	1,631	80.7	133.2	1.7	98.8	98.8	99.1	0.3
F	1,996	42.2	74.8	2.3	101.9	101.9	102.0	0.1
G	2,236	85.5	114.4	1.8	104.0	104.0	104.3	0.3
H	2,259	50.3	66.6	1.7	104.1	104.1	104.4	0.3
I	2,296	41.4	57.9	1.8	104.5	104.5	104.6	0.1
J	2,353	41.1	40.6	2.8	104.8	104.8	104.9	0.1
K	2,398	27.9	48.0	1.5	105.4	105.4	105.4	0.0
L	2,442	26.9	37.7	1.9	106.1	106.1	106.2	0.1

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA HONDA (RIO GUANAJIBO BASIN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Mendoza								
A	2.40[1]	470	467	0.5	13.8	9.0[3]	9.0	0.0
B	3.30[1]	368	397	0.5	13.8	10.7[3]	10.9	0.2
C	3.63[1]	368	329	0.6	13.8	12.5[3]	12.5	0.0
D	4.26[1]	248	263	0.7	15.3	15.3	15.6	0.3
E	4.51[1]	50	73	2.5	16.8	16.8	16.8	0.0
F	4.67[1]	25	82	2.3	17.6	17.6	17.8	0.2
G	4.82[1]	8	25	7.5	17.8	17.8	17.8	0.0
H	4.90[1]	8	29	6.4	19.1	19.1	19.1	0.0
Quebrada Las Tunas								
I	4.95[1]	8	27	5.9	19.1	19.1	19.1	0.0
J	5.15[1]	8	25	6.4	19.7	19.7	19.7	0.0
K	5.27[1]	11	28	5.6	19.7	19.7	19.7	0.0
L	5.78[1]	61	120	1.3	23.1	23.1	23.3	0.2
M	6.23[1]	28	54	2.9	24.9	24.9	25.0	0.1
Concepcion Channel								
A	0.00[2]	3	9	3.8	19.1	18.5[4]	18.5	0.0
B	0.15[2]	12	31	1.1	19.8	19.8	19.8	0.0
C	0.34[2]	12	25	1.3	20.0	20.0	20.0	0.0
D	0.56[2]	22	53	0.6	20.1	20.1	20.3	0.2
E	0.76[2]	81	136	0.2	20.1	20.1	20.4	0.3

[1]Kilometers above confluence with Rio Guanajibo profile base line
[2]Kilometers above confluence with Quebrada Mendoza Profile Baseline
[3]Elevation computed without consideration of backwater effects from Rio Guanajibo
[4]Elevation computed without consideration of backwater effects from Quebrada Mendoza

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA MENDOZA – QUEBRADA LAS TUNAS – CONCEPCION CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Pileta								
A	1.26[1]	117	100	0.4	13.8	11.2[3]	11.4	0.2
B	1.87[1]	67	40	0.6	13.8	13.6[3]	13.6	0.0
C	2.01[1]	14	13	1.9	14.2	14.2	14.2	0.0
D	2.24[1]	98	93	0.3	15.5	15.5	15.5	0.0
E	2.29[1]	35	30	0.8	15.5	15.5	15.5	0.0
F	2.37[1]	59	20	1.2	16.2	16.2	16.2	0.0
G	2.68[1]	26	31	0.8	18.5	18.5	18.7	0.2
Rio Loco								
A	2.85[2]	404	845	0.8	6.5	6.5	6.5	0.0
B	6.14[2]	506	799	0.8	13.8	13.8	13.9	0.1
C	6.68[2]	310	444	1.4	17.2	17.2	17.2	0.0
D	7.35[2]	490	829	0.6	19.8	19.8	19.9	0.1
E	8.19[2]	562	515	1.0	24.0	24.0	24.3	0.3
F	9.48[2]	200	264	1.9	30.4	30.4	30.4	0.0
G	9.75[2]	96	301	1.7	31.5	31.5	31.6	0.1
H	9.90[2]	250	623	0.8	31.8	31.8	31.9	0.1
I	11.68[2]	160	384	1.4	39.4	39.4	39.6	0.2
J	12.27[2]	110	327	1.3	42.4	42.4	42.5	0.1
K	13.12[2]	80	263	1.6	46.6	46.6	46.6	0.0
L	13.78[2]	30	66	4.7	52.7	52.7	52.7	0.0

[1]Kilometers above confluence with Quebrada Mendoza profile base line
[2]Kilometers above mouth
[3]Elevation computed without consideration of backwater effects from Rio Guanajibo

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA PILETA – RIO LOCO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada Berrenchin								
A	0.966[1]	25	35	1.9	30.3	30.3	30.3	0.0
B	1.030[1]	49	58	1.1	30.6	30.6	30.6	0.0
C	1.336[1]	120	153	1.0	30.7	30.7	30.8	0.1
D	1.576[1]	246	122	1.3	33.7	33.7	33.7	0.0
Rio Guayanilla								
A	1.93[2]	2,250	3,375	0.7	6.5	6.5	6.5	0.0
B	2.76[2]	1,690	3,042	0.8	10.2	10.2	10.3	0.1
C	3.53[2]	670	1,675	2.3	13.7	13.7	13.7	0.0
D	4.36[2]	420	672	1.5	16.5	16.5	16.6	0.1
E	5.09[2]	250	806	1.3	23.1	23.1	23.1	0.0
F	5.94[2]	180	270	1.8	26.5	26.5	26.5	0.1
Rio Macana								
A	0.34[2]	300	450	1.7	3.3	3.3	3.5	0.2
B	0.61[2]	300	570	1.7	4.8	4.8	4.9	0.1
C	0.96[2]	300	1,200	1.6	10.9	10.9	11.0	0.1

[1]Stream distance in kilometers above confluence with Rio Yauco

[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA BERRENCHIN – RIO GUAYANILLA – RIO MACANA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Tallaboa								
B	0.525	1,126	1,100	0.9	3.5	3.3	3.3	0.0
C	0.900	1,186[2]	800	1.1	4.2	4.2	4.3	0.1
D	1.450	1,170[2]	1,630	0.6	5.4	5.4	5.5	0.1
E	1.765	1,140	1,180	0.7	5.7	5.7	5.8	0.1
F	1.980	647[2]	947	1.0	7.2	7.2	7.2	0.0
G	2.195	650	853	1.1	9.2	9.2	9.3	0.1
H	2.460	480	784	1.2	9.9	9.9	10.1	0.2
I	2.715	426[2]	1,210	0.6	11.5	11.5	11.8	0.3
J	2.830	494	1,460	0.5	12.6	12.6	12.8	0.2
K	3.170	394	1,063	0.8	12.7	12.7	12.9	0.2
L	3.578	446	360	2.3	13.1	13.1	13.3	0.2
M	3.950	449	507	1.6	15.1	15.1	15.2	0.1
N	4.330	343	328	2.5	18.4	18.4	18.4	0.0
O	4.660	369	652	1.4	19.5	19.5	19.7	0.2
P	4.950	460	1,012	0.9	21.3	21.3	21.5	0.2
Q	5.080	400	553	1.6	22.2	22.2	22.3	0.1
R	5.270	355	651	1.4	23.0	23.0	23.2	0.2
S	5.567	241	339	2.7	24.7	24.7	24.7	0.0
T	5.775	185	245	3.7	26.1	26.1	26.1	0.0
U	5.967	285	434	2.1	28.1	28.1	28.1	0.0
V	6.170	306	359	2.5	29.5	29.5	29.6	0.1
W	6.510	397	528	1.7	31.6	31.6	31.7	0.1
X	6.800	152	275	3.3	33.6	33.6	33.6	0.0

[1]Kilometers above mouth
[2]Floodway width includes islands

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO TALLABOA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Tallaboa (continued)								
Y	6.934	230	421	2.1	34.8	34.8	35.1	0.3
Z	7.245	162	329	2.7	37.7	37.7	37.7	0.0
AA	7.500	110	286	2.4	40.0	40.0	40.2	0.2
AB	7.600	210	342	3.1	40.6	40.6	40.8	0.2
AC	7.832	195	277	2.2	41.8	41.8	41.9	0.1
AD	7.923	111	317	1.9	43.3	43.3	43.5	0.2
AE	8.135	94	183	3.4	43.9	43.9	44.1	0.2
AF	8.350	32	125	4.9	45.1	45.1	45.3	0.2
AG	8.480	48	164	3.7	46.6	46.6	46.8	0.2
AH	8.645	36	137	4.5	47.4	47.4	47.6	0.2
AI	8.800	45	184	3.3	48.7	48.7	49.0	0.3
AJ	8.985	91	285	2.1	51.3	51.3	51.6	0.3
AK	9.156	89	205	3.0	52.1	52.1	52.3	0.2
AL	9.330	59	134	4.5	53.6	53.6	53.6	0.0
AM	9.570	50	149	4.1	55.4	55.4	55.6	0.2
AN	9.700	46	136	4.5	57.3	57.3	57.3	0.0
AO	9.958	160	311	2.0	60.0	60.0	60.3	0.3
AP	10.175	71	157	3.9	61.7	61.7	61.7	0.0
AQ	10.480	37	118	5.2	64.8	64.8	64.8	0.0
AR	10.775	30	106	5.8	68.3	68.3	68.3	0.0

[1]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO TALLABOA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayanes (Rio Tallaboa Basin)								
A	0.170	83	149	4.0	42.4	42.4	42.4	0.0
B	0.300	98	131	4.5	43.4	43.4	43.4	0.0
C	0.408	112	148	4.0	45.1	45.1	45.1	0.0
D	0.500	93	87	3.8	46.8	46.8	46.8	0.0
E	0.658	54	194	6.0	48.8	48.8	48.8	0.0
F	0.762	98	224	2.5	52.2	52.2	52.2	0.0
G	0.857	150	77	7.4	53.1	53.1	53.1	0.0
H	0.953	144	171	3.3	54.1	54.1	54.1	0.0
I	1.070	68	90	6.3	54.7	54.7	54.7	0.0
J	1.163	90	168	3.4	56.9	56.9	56.9	0.0
K	1.330	50	72	7.9	60.1	60.1	60.1	0.0
L	1.370	50	57	9.9	60.1	60.1	60.1	0.0
M	1.412	44	65	8.7	60.9	60.9	60.9	0.0
N	1.474	46	112	5.1	63.8	63.8	64.1	0.3
O	1.622	80	129	4.2	65.9	65.9	65.9	0.0
P	1.732	52	84	6.5	66.8	66.8	66.8	0.0
Q	1.818	50	71	7.7	68.6	68.6	68.6	0.0
R	1.900	56	102	5.4	71.2	71.2	71.2	0.0
S	1.985	35	75	7.3	71.9	71.9	71.9	0.0
T	2.050	27	61	9.0	72.3	72.3	72.3	0.0
U	2.078	24	89	6.1	74.6	74.6	74.6	0.0
V	2.160	36	96	5.7	75.9	75.9	75.9	0.0
W	2.220	34	80	6.8	76.2	76.2	76.2	0.0
X	2.282	33	61	9.0	76.5	76.5	76.5	0.0

[1]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYANES (RIO TALLABOA BASIN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Matilde								
A	688[1]	913	1,256	0.4	2.4	2.4	2.7	0.3
B	1,093[1]	545	543	0.9	3.0	3.0	3.2	0.2
C	1,287[1]	263	290	1.7	4.5	4.5	4.5	0.0
D	1,366[1]	273	472	1.1	5.6	5.6	5.6	0.0
E	1,565[1]	403	527	1.0	5.9	5.9	6.0	0.1
F	1,742[1]	424	560	0.9	6.1	6.1	6.3	0.2
G	1,844[1]	26	112	4.5	6.6	6.6	6.8	0.2
H	2,232[1]	34	154	3.3	8.8	8.8	8.9	0.1
I	2,747[1]	23	109	4.4	10.4	10.4	10.6	0.2
Rio Canas								
A	123[2]	24	88	2.6	10.4	10.4	10.7	0.3
B	600[2]	17	55	4.1	12.0	12.0	12.1	0.1
C	782[2]	20	48	4.7	13.4	13.4	13.5	0.1
D	1,021[2]	24	77	2.9	15.6	15.6	15.7	0.1
E	1,083[2]	51	176	1.4	16.5	16.5	16.6	0.1
F	1,256[2]	21	51	4.9	16.9	16.9	16.9	0.0
G	1,636[2]	25	81	3.1	20.2	20.2	20.3	0.1
H	1,979[2]	18	49	5.1	22.3	22.3	22.3	0.0
I	2,300[2]	233	298	1.0	25.4	25.4	25.4	0.0
J	2,515[2]	177	180	1.7	27.3	27.3	27.5	0.2
K	2,843[2]	64	107	2.9	29.7	29.7	29.9	0.2
L	3,247[2]	43	98	3.2	32.0	32.0	32.3	0.3
M	3,578[2]	36	86	3.2	34.4	34.4	34.4	0.0
N	3,631[2]	22	59	4.3	34.7	34.7	34.7	0.0
O	3,852[2]	20	53	4.7	36.7	36.7	36.8	0.1

[1]Meters above mouth
[2]Meters above confluence with Rio Matilde

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO MATILDE – RIO CANAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Canas (continued)								
P	4,085[1]	34	70	4.2	39.2	39.2	39.3	0.1
Q	4,127[1]	12	46	3.7	40.3	40.3	40.3	0.0
Rio Pastillo								
A	119[2]	20	68	5.0	10.4	10.3[3]	10.6	0.3
B	575[2]	26	106	3.2	13.8	13.8	13.8	0.0
C	716[2]	26	68	5.0	14.0	14.0	14.0	0.0
D	1,059[2]	32	117	2.7	16.5	16.5	16.5	0.0
E	1,478[2]	24	63	4.9	17.8	17.8	17.8	0.0
F	1,611[2]	28	87	3.6	19.6	19.6	19.7	0.1
G	1,941[2]	26	72	4.3	21.6	21.6	21.7	0.1
H	2,381[2]	19	69	4.5	25.2	25.2	25.4	0.2
I	2,889[2]	30	108	2.9	28.3	28.3	28.4	0.1
J	3,150[2]	16	49	5.7	29.8	29.8	29.8	0.0
K	3,389[2]	26	97	2.9	32.4	32.4	32.5	0.1
L	3,875[2]	19	52	5.4	35.0	35.0	35.0	0.0
M	4,269[2]	19	73	3.8	38.9	38.9	39.0	0.1
N	4,634[2]	46	105	2.7	41.0	41.0	41.1	0.1
O	4,788[2]	28	91	3.1	42.0	42.0	42.3	0.3

[1]Meters above confluence with Rio Matilde
[2]Meters above confluence with Rio Canas
[3]Elevation computed without consideration of backwater effects from Rio Canas

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CANAS – RIO PASTILLO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Jacaguas								
A[2]	96	5,415	9,747	0.4	2.4	2.4	2.7	0.3
B[2]	855	5,297	8,869	0.5	2.6	2.6	2.9	0.3
C[2]	1,151	5,441	9,982	0.4	3.4	3.4	3.6	0.2
D[2]	1,813	5,318	7,072	0.6	3.9	3.9	4.1	0.2
E[2]	2,210	5,285	6,114	0.7	4.6	4.6	4.8	0.2
F[2]	2,495	5,229	5,753	0.7	5.2	5.2	5.4	0.2
G[2]	3,025	5,100	5,627	0.7	5.8	5.8	6.0	0.2
H[2]	3,343	4,970	5,689	0.7	6.7	6.7	6.9	0.2
I[2]	4,186	4,549	4,974	0.8	7.9	7.9	8.1	0.2
J[2]	4,477	4,253	4,651	0.9	8.5	8.5	8.7	0.2
K[2]	4,952	4,548	4,842	0.8	8.8	8.8	9.0	0.2
L[2]	5,527	4,299	8,276	0.5	11.7	11.7	12.0	0.3
M[2]	5,972	3,798	4,605	0.8	12.1	12.1	12.3	0.2
N	6,322	2,003	3,534	0.8	13.2	13.2	13.5	0.3
O	6,914	1,491	2,252	1.2	13.7	13.7	14.0	0.3
P	7,477	531	829	3.3	15.3	15.3	15.5	0.2
Q	8,022	542	1,233	2.2	16.8	16.8	17.1	0.3
R	8,551	578	780	3.5	18.2	18.2	18.4	0.2
S	9,293	637	1,373	1.8	20.7	20.7	20.9	0.2
T	10,035	647	1,016	2.5	22.6	22.6	22.9	0.3
U	10,649	664	1,673	1.5	24.6	24.6	24.8	0.2
V	11,090	634	1,198	2.1	25.2	25.2	25.3	0.1
W	11,444	458	843	2.9	26.0	26.0	26.1	0.1
X	11,607	450	1,342	1.8	27.7	27.7	27.9	0.2
Y	12,041	326	924	2.6	28.2	28.2	28.4	0.2
Z	12,245	271	1,132	2.1	30.4	30.4	30.7	0.3
AA	12,563	172	619	3.9	32.3	32.3	32.3	0.0

[1]Meters above mouth
[2]Cross section shared with Rio Inabon

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO JACAGUAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Jacaguas (continued)								
AB	13,021	252	1,169	2.1	35.9	35.9	35.9	0.0
AC	13,353	524	2,118	1.1	36.6	36.6	36.6	0.0
AD	13,916	519	3,218	0.8	40.7	40.7	41.0	0.3
AE	14,140	537	2,823	0.9	40.8	40.8	41.0	0.2
AF	14,776	228	965	2.5	41.4	41.4	41.7	0.3
AG	15,161	270	1,129	2.1	42.8	42.8	43.0	0.2
AH	15,591	482	1,840	1.3	43.3	43.3	43.5	0.2
AI	15,922	341	1,446	1.7	44.5	44.5	44.7	0.2
AJ	16,269	300	1,515	1.5	45.4	45.4	45.6	0.2
AK	16,730	265	1,074	2.1	46.5	46.5	46.8	0.3
AL	16,914	294	1,182	2.0	47.1	47.1	47.3	0.2
AM	17,139	366	1,265	1.8	48.0	48.0	48.2	0.2
AN	17,330	393	1,328	1.8	48.6	48.6	48.9	0.3
AO	17,926	169	722	3.2	51.1	51.1	51.4	0.3
AP	18,218	128	684	3.2	52.5	52.5	52.6	0.2
AQ	18,925	126	621	3.5	55.3	55.3	55.5	0.2
AR	19,398	337	1,342	1.6	58.3	58.3	58.5	0.3
AS	19,811	214	933	2.4	59.3	59.3	59.5	0.3
AT	20,322	122	632	3.5	62.2	62.2	62.4	0.2
AU	20,791	204	858	2.6	65.0	65.0	65.2	0.2
AV	21,379	159	773	2.9	68.2	68.2	68.4	0.2
AW	21,757	250	958	2.3	69.3	69.3	69.6	0.3
AX	21,796	252	903	2.4	69.5	69.5	69.8	0.3
AY	22,145	143	473	4.7	70.9	70.9	71.2	0.3
AZ	22,386	94	596	3.7	74.8	74.8	75.1	0.3
BA	22,499	85	548	4.0	76.5	76.5	76.6	0.1
BB	22,599	124	894	2.5	77.4	77.4	77.6	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO JACAGUAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Jacaguas (At Villalba)								
A	0	118	254	3.0	133.4	133.4	133.5	0.1
B	206	130	242	3.1	136.9	136.9	136.9	0.0
C	379	39	156	4.9	138.2	138.2	138.5	0.3
D	565	40	132	5.7	140.3	140.3	140.3	0.0
E	787	29	95	5.7	143.1	143.1	143.1	0.0
F	836	40	212	2.5	145.6	145.6	145.8	0.2
G	1,046	96	164	3.3	148.4	148.4	148.4	0.0
H	1,128	110	180	3.0	150.1	150.1	150.1	0.0
I	1,256	65	126	4.3	151.0	151.0	151.0	0.0
J	1,532	80	142	3.8	155.1	155.1	155.1	0.0
K	1,870	30	96	5.6	157.8	157.8	157.8	0.0
L	2,115	39	105	5.1	161.8	161.8	161.8	0.0
M	2,440	25	72	5.2	166.3	166.3	166.3	0.0
N	2,491	24	82	4.5	167.6	167.6	167.6	0.0
O	2,758	21	67	5.5	169.9	169.9	169.9	0.0
P	3,055	16	65	5.7	173.5	173.5	173.7	0.2
Q	3,426	28	72	5.1	179.7	179.7	179.7	0.0
R	3,699	22	73	5.0	183.2	183.2	183.5	0.3
S	4,042	19	65	5.7	188.1	188.1	188.1	0.0
T	4,487	19	64	5.8	196.0	196.0	196.0	0.0

[1]Meters above Limit of Detailed Study*
*Limit of Detailed Study is located approximately 712.8 meters downstream of confluence of Quebrada Achote

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO JACAGUAS (AT VILLALBA)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Inabon								
A[2]	1,201	5,415	9,747	0.4	2.4	2.4	2.7	0.3
B[2]	1,863	5,297	8,869	0.5	2.6	2.6	2.9	0.3
C[2]	3,070	5,441	9,982	0.4	3.4	3.4	3.6	0.2
D[2]	3,706	5,318	7,072	0.6	3.9	3.9	4.1	0.2
E[2]	3,964	5,285	6,114	0.7	4.6	4.6	4.8	0.2
F[2]	4,313	5,229	5,753	0.7	5.2	5.2	5.4	0.2
G[2]	4,505	5,100	5,627	0.7	5.8	5.8	6.0	0.2
H[2]	4,880	4,970	5,689	0.7	6.7	6.7	6.9	0.2
I[2]	5,524	4,549	4,974	0.8	7.9	7.9	8.1	0.2
J[2]	5,695	4,253	4,651	0.9	8.5	8.5	8.7	0.2
K[2]	5,759	4,548	4,842	0.8	8.8	8.8	9.0	0.2
L[2]	6,723	4,299	8,276	0.5	11.7	11.7	12.0	0.3
M[2]	6,980	3,798	4,605	0.8	12.1	12.1	12.3	0.2
N	7,430	780	1,393	0.8	15.0	15.0	15.2	0.2
O	7,830	622	962	1.1	16.4	16.4	16.7	0.3
P	8,266	785	1,290	0.8	18.7	18.7	18.9	0.2
Q	8,643	750	1,108	0.1	19.9	19.9	20.2	0.3
R	8,900	60	295	3.6	21.1	21.1	21.3	0.2
S	9,152	98	546	2.0	22.9	22.9	23.2	0.3
T	9,358	109	526	2.0	23.7	23.7	23.9	0.2
U	9,819	84	398	2.7	26.1	26.1	26.3	0.2
V	10,102	82	462	2.3	27.6	27.6	27.8	0.2
W	10,459	167	504	2.1	29.1	29.1	29.3	0.2
X	11,175	71	279	3.8	34.0	34.0	34.0	0.0
Y	11,397	68	318	3.4	36.2	36.2	36.5	0.3
Z	11,764	64	363	3.1	41.4	41.4	41.4	0.0
AA	11,880	82	324	3.3	42.8	42.8	42.8	0.0

[1]Meters above mouth
[2]Cross section shared with Rio Jacaguas

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO INABON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Inabon (continued)								
AB	11,968	72	385	3.4	43.7	43.7	43.7	0.0
AC	12,273	71	246	2.4	46.2	46.2	46.2	0.0
AD	12,568	56	155	3.5	48.7	48.7	48.7	0.0
AE	12,816	61	145	3.7	51.2	51.2	51.2	0.0
AF	13,075	29	135	4.0	54.4	54.4	54.7	0.3
AG	13,418	42	136	4.0	58.6	58.6	58.6	0.0
AH	13,719	50	157	3.3	63.4	63.4	63.5	0.1
AI	14,064	79	230	2.3	66.7	66.7	66.9	0.2
AJ	14,453	56	124	4.2	71.5	71.5	71.5	0.0
AK	14,745	62	193	2.7	76.4	76.4	76.6	0.2
AL	15,048	118	231	2.0	79.2	79.2	79.3	0.1
AM	15,325	41	135	3.4	81.8	81.8	81.9	0.1
AN	15,647	31	125	3.6	85.9	85.9	86.2	0.3
AO	15,814	35	140	3.2	87.8	87.8	88.0	0.2
AP	15,962	40	150	3.0	89.2	89.2	89.3	0.1
AQ	16,296	35	113	4.0	92.9	92.9	93.0	0.1
AR	16,548	36	131	3.5	96.4	96.4	96.5	0.1
AS	16,744	31	112	4.1	98.8	98.8	98.9	0.1
AT	16,976	32	111	4.1	102.2	102.2	102.3	0.1
AU	17,176	29	107	4.3	105.8	105.8	105.8	0.0
AV	17,426	47	141	3.2	110.4	110.4	110.5	0.1
AW	17,726	28	104	4.4	114.8	114.8	115.0	0.2
AX	17,946	26	124	3.7	118.0	118.0	118.1	0.1
AY	18,153	30	127	3.6	120.2	120.2	120.4	0.2
AZ	18,337	40	213	2.1	124.5	124.5	124.7	0.2
BA	18,587	34	149	3.1	131.0	131.0	131.1	0.1
BB	18,757	30	145	3.1	132.5	132.5	132.5	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO INABON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayo								
A	46	50	146	5.1	45.0	43.0[2]	43.2	0.2
B	475	82	192	3.9	47.6	47.6	47.6	0.0
C	749	105	269	2.8	50.1	50.1	50.4	0.3
D	1,011	59	169	4.4	52.4	52.4	52.5	0.1
E	1,402	40	131	5.7	56.4	56.4	56.4	0.0
F	1,854	34	129	5.8	61.1	61.1	61.2	0.1
G	1,992	38	145	5.1	63.3	63.3	63.4	0.1
H	2,135	57	181	4.1	64.8	64.8	64.9	0.1
I	2,357	169	229	3.2	67.7	67.7	67.7	0.0
J	2,656	153	210	3.1	69.8	69.8	70.1	0.3
K	3,001	172	208	3.1	75.3	75.3	75.5	0.2
L	3,076	203	288	2.3	76.4	76.4	76.7	0.3
M	3,402	152	185	3.5	78.9	78.9	78.9	0.0
N	3,721	40	152	4.3	81.2	81.2	81.3	0.1
O	4,065	143	208	3.1	87.3	87.3	87.3	0.0
P	4,184	87	172	3.8	89.2	89.2	89.3	0.1
Q	4,450	30	109	5.9	91.9	91.9	91.9	0.0
R	4,712	41	126	5.2	94.9	94.9	95.0	0.1
S	4,821	43	145	4.5	96.2	96.2	96.2	0.0
T	5,206	38	124	5.4	102.8	102.8	102.8	0.0
U	5,317	37	118	5.5	104.9	104.9	105.0	0.1
V	5,389	45	186	3.5	107.3	107.3	107.3	0.0
W	5,520	45	126	5.2	107.5	107.5	107.5	0.0
X	5,681	52	135	4.8	111.2	111.2	111.2	0.0
Y	5,832	38	130	5.0	112.7	112.7	112.7	0.0
Z	5,979	35	115	5.6	114.1	114.1	114.1	0.0

[1]Meters above confluence with Rio Inabon

[2]Elevation computed without consideration of backwater effects from Rio Inabon

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayo (continued)								
AA	6,130[1]	26	96	6.0	116.6	116.6	116.6	0.0
AB	6,312[1]	36	111	5.1	119.2	119.2	119.2	0.0
AC	6,517[1]	33	114	5.0	123.4	123.4	123.6	0.2
AD	6,784[1]	38	107	5.4	127.0	127.0	127.0	0.0
AE	6,999[1]	36	115	5.0	129.9	129.9	129.9	0.0
AF	7,254[1]	45	116	4.9	133.8	133.8	133.8	0.0
AG	7,609[1]	51	123	4.6	139.7	139.7	139.8	0.1
AH	7,848[1]	26	95	6.0	143.3	143.3	143.3	0.0
AI	8,202[1]	30	99	5.8	150.0	150.0	150.0	0.0
AJ	8,448[1]	33	104	5.5	154.0	154.0	154.0	0.0
AK	8,529[1]	38	116	4.9	156.1	156.1	156.2	0.1
Rio Coamo (at Velazquez)								
A	580[2]	2,875	3,948	0.5	3.6	3.6	3.7	0.1
B	960[2]	2,695	3,698	0.5	5.5	5.5	5.6	0.1
C	1,360[2]	2,480	3,225	0.5	7.1	7.1	7.2	0.1
D	2,050[2]	1,950	3,389	0.6	10.5	10.5	10.6	0.1
E	2,350[2]	1,566	4,325	0.6	13.3	13.3	13.5	0.2
F	2,705[2]	1,110	3,664	0.7	13.7	13.7	13.9	0.2
G	3,260[2]	783	2,570	0.5	15.9	15.9	16.0	0.1
H	3,621[2]	795	2,001	0.6	17.4	17.4	17.5	0.1

[1]Meters above confluence with Rio Inabon
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYO – RIO COAMO (AT VELAZQUEZ)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Coamo (at Paso Seco)								
J	5,780[1]	444	1,152	1.8	28.7	28.7	28.7	0.0
K	6,220[1]	169	728	2.8	30.0	30.0	30.0	0.0
L	6,520[1]	130	529	3.8	31.1	31.1	31.1	0.0
M	6,895[1]	96	393	5.2	32.8	32.8	32.8	0.0
N	7,020[1]	84	326	6.2	33.7	33.7	33.7	0.0
O	7,170[1]	190	513	4.0	37.6	37.6	37.6	0.0
P	7,445[1]	117	530	3.6	40.1	40.1	40.1	0.0
Rio Descalabrado								
A	2.667[2]	452	828	0.8	15.9	15.9	16.2	0.3
B	2.670[2]	423	959	0.7	15.9	15.9	16.2	0.3
C	2.680[2]	388	614	1.1	15.9	15.9	16.2	0.3
D	2.705[2]	347	570	1.2	16.4	16.4	16.7	0.3
E	2.840[2]	229	413	1.6	17.8	17.8	18.1	0.3
F	2.991[2]	179	414	1.6	19.0	19.0	19.2	0.2
G	3.185[2]	136	383	1.8	19.8	19.8	20.1	0.2
H	3.355[2]	57	196	3.4	20.4	20.4	20.4	0.0
I	3.480[2]	72	281	2.4	21.3	21.3	21.5	0.2
J	3.615[2]	62	250	2.7	21.9	21.9	22.1	0.2
K	3.720[2]	87	312	2.2	22.5	22.5	22.6	0.1
L	3.730[2]	91	265	2.5	22.5	22.5	22.5	0.0
M	3.745[2]	98	333	2.0	22.6	22.6	22.7	0.2
N	3.930[2]	166	466	1.4	23.1	23.1	23.2	0.1
O	4.105[2]	87	296	2.3	23.4	23.4	23.5	0.1
P	4.195[2]	117	358	1.9	23.8	23.8	23.9	0.0
Q	4.245[2]	151	422	1.6	24.2	24.2	24.2	0.0

[1]Meters above mouth
[2]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO COAMO (AT PASO SECO) – RIO DESCALABRADO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Nigua								
A	0.505	1,494	3,247	1.0	3.3	3.3	3.5	0.2
B	1.315	1,193	2,855	1.1	6.3	6.3	6.5	0.2
C	1.697	877	2,104	1.6	8.1	8.1	8.3	0.2
D	1.947	855	1,746	1.9	9.5	9.5	9.6	0.1
E	2.197	373	1,205	2.7	10.7	10.7	10.9	0.2
F	2.397	400	1,483	2.2	11.2	11.2	11.3	0.1
G	2.788	350	1,020	3.2	12.1	12.1	12.2	0.1
H	3.168	804	3,505	0.9	17.5	17.5	17.5	0.0
I	4.065	758	2,512	1.2	18.0	18.0	18.2	0.2
J	4.282	894	1,812	1.7	18.9	18.9	19.1	0.2
K	4.650	797	1,979	1.6	21.3	21.3	21.6	0.3
L	5.029	708	1,684	1.8	23.6	23.6	23.8	0.2
M	5.321	950	2,002	1.5	24.7	24.7	24.9	0.2
N	5.516	1,027	2,489	1.2	25.6	25.6	25.7	0.1
O	6.038	515	1,188	2.5	28.7	28.7	28.7	0.0
P	6.247	540	1,294	2.3	30.8	30.8	30.9	0.1
Q	6.940	534	951	3.1	34.5	34.5	34.5	0.0
R	7.159	647	1,500	2.0	37.1	37.1	37.2	0.1
S	7.478	621	1,491	2.0	39.2	39.2	39.2	0.0
T	8.035	430	1,077	2.7	44.7	44.7	44.7	0.0
U	8.355	440	1,143	2.6	47.5	47.5	47.6	0.1
V	8.566	345	917	3.2	49.5	49.5	49.6	0.1

[1]Kilometers above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO NIGUA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Grande de Patillas								
A	1,782[1]	729	3,142	0.5	12.7	12.7	13.0	0.3
B	2,048[1]	532	1,859	0.9	13.4	13.4	13.7	0.3
C	2,225[1]	601	2,031	0.8	14.2	14.2	14.5	0.3
D	2,383[1]	738	2,485	0.6	14.8	14.8	15.1	0.3
E	2,731[1]	293	753	2.1	16.8	16.8	17.0	0.2
F	3,030[1]	305	1,171	1.4	20.1	20.1	20.4	0.3
G	3,040[1]	305	984	1.6	20.1	20.1	20.4	0.3
H	3,377[1]	303	1,231	1.3	22.8	22.8	22.9	0.1
Quebrada Mamey								
A	3,138[2]	209	270	0.4	17.0	17.0	17.3	0.3
B	3,295[2]	179	155	0.8	18.3	18.3	18.6	0.3
C	3,365[2]	90	105	1.1	19.4	19.4	19.6	0.2
D	3,380[2]	91	125	0.9	20.1	20.1	20.1	0.0
E	3,435[2]	84	162	0.7	20.3	20.3	20.4	0.1
F	3,534[2]	115	105	0.8	20.8	20.8	21.0	0.3
G	3,550[2]	118	119	0.7	21.0	21.0	21.3	0.3
H	3,681[2]	77	109	0.7	22.1	22.1	22.4	0.3

[1]Meters above mouth
[2]Meters above mouth of Rio Chico

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GRANDE DE PATILLAS - QUEBRADA MAMEY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Nigua (at Arroyo)								
B	274	61	153	3.5	3.6	3.6	3.8	0.3
C	427	73	185	2.9	4.5	4.5	4.7	0.2
D	518	76	154	3.5	4.8	4.8	5.0	0.2
E	610	76	206	2.6	6.0	6.0	6.0	0.0
F	693	61	239	2.3	6.1	6.1	6.3	0.2
G	869	56	126	4.2	6.8	6.8	6.8	0.0
H	960	37	128	4.2	7.6	7.6	7.6	0.0
I	999	27	117	4.6	8.4	8.4	8.4	0.0
J	1,217	118	336	2.7	9.9	9.9	10.1	0.2
K	1,255	90	211	3.6	9.9	9.9	10.1	0.2
L	1,258	111	240	2.8	10.1	10.1	10.2	0.1
M	1,273	127	278	2.6	10.2	10.2	10.4	0.2
N	1,395	61	198	2.7	10.3	10.3	10.6	0.3
O	1,514	48	134	4.0	10.6	10.6	10.8	0.2
P	1,636	56	179	3.0	11.7	11.7	11.7	0.0
Q	1,758	51	143	3.7	12.0	12.0	12.0	0.0
R	1,865	43	128	4.2	12.6	12.6	12.6	0.0
S	1,971	31	96	5.6	13.5	13.5	13.5	0.0
T	2,017	38	137	3.9	14.8	14.8	14.8	0.0
U	2,063	37	130	4.1	14.9	14.9	14.9	0.0
V	2,093	27	122	4.4	15.1	15.1	15.1	0.0
W	2,110	28	125	4.3	15.3	15.3	15.3	0.0
X	2,171	30	131	4.1	15.9	15.9	15.9	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO NIGUA (AT ARROYO)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Nigua (at Arroyo) (continued)								
Y	2,220	30	135	4.0	16.1	16.1	16.1	0.0
Z	2,270	37	102	5.2	16.6	16.6	16.6	0.0
AA	2,319	70	128	4.2	18.6	18.6	18.6	0.0
AB	2,380	81	213	2.5	19.4	19.4	19.6	0.2
AC	2,627	64	761	3.3	20.4	20.4	20.6	0.2
AD	3,120	84	226	2.4	21.9	21.9	22.1	0.3
Rio Nigua (at Pitahaya)								
AE	3,440	126	168	3.2	25.6	25.6	25.7	0.0
AF	3,975	209	260	2.1	30.6	30.6	30.9	0.3
AG	4,360	200	225	3.5	35.2	35.2	35.5	0.3
AH	4,565	312	334	1.2	36.9	36.9	37.2	0.3
AI	5,060	151	254	1.5	43.5	43.5	43.7	0.2
AJ	5,310	151	231	1.7	46.8	46.8	46.8	0.0
AK	5,455	149	159	2.4	49.0	49.0	49.2	0.1
AL	5,590	55	96	4.1	51.0	51.0	51.0	0.0
AM	5,775	118	156	2.5	53.4	53.4	53.4	0.0
AN	5,915	42	85	4.6	54.6	54.6	54.6	0.0
AO	6,020	31	64	6.0	56.4	56.4	56.4	0.0
AP	6,188	133	192	2.0	59.9	59.9	59.9	0.0
AQ	6,225	116	164	2.4	60.3	60.3	60.3	0.0
AR	6,382	23	75	5.2	63.5	63.5	63.5	0.0

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO NIGUA (AT ARROYO) - RIO NIGUA (AT PITAHAYA)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guamani								
A	200	80	199	4.6	5.0	5.0	5.0	0.0
B	598	143	504	1.8	7.5	7.5	7.8	0.3
C	871	110	262	3.5	8.3	8.3	8.3	0.0
D	1,096	260	296	3.1	11.3	11.3	11.3	0.0
E	1,763	160	377	2.4	15.1	15.1	15.2	0.1
F	2,278	260	362	2.6	19.8	19.8	19.8	0.0
G	2,340	180	510	1.8	21.1	21.1	21.1	0.0
H	2,531	213	402	2.3	21.8	21.8	21.8	0.0
I	2,931	465	847	1.1	24.4	24.4	24.5	0.1
J	3,186	390	534	1.8	25.5	25.5	25.7	0.2
K	4,186	139	333	2.8	36.8	36.8	37.0	0.2
L	4,540	200	434	2.2	40.8	40.8	40.8	0.0
M	4,739	188	366	2.5	43.5	43.5	43.5	0.0
N	4,809	209	594	1.6	44.5	44.5	44.7	0.0
O	4,994	217	361	2.6	45.6	45.6	45.6	0.2
P	5,064	220	475	2.0	46.6	46.6	46.8	0.3
Q	5,277	258	442	2.1	49.3	49.3	49.5	0.2
R	5,657	156	327	2.6	55.1	55.1	55.1	0.0
S	6,067	121	225	3.8	59.0	59.0	59.1	0.1
T	6,537	307	423	2.0	66.0	66.0	66.1	0.1
U	6,822	265	826	1.0	67.6	67.6	67.8	0.2
V	7,044	352	370	2.3	71.0	71.0	71.3	0.3
W	7,244	152	317	2.7	75.6	75.6	75.7	0.1
X	7,404	167	415	2.0	77.4	77.4	77.6	0.2
Y	7,576	196	450	1.9	78.9	78.9	79.1	0.2
Z	7,906	101	237	3.6	86.2	86.2	86.3	0.1

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAMANI

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guamani								
AA	7,939	54	246	3.3	87.8	87.8	87.8	0.0
AB	8,158	132	261	3.1	89.3	89.3	89.3	0.0
AC	8,385	74	174	4.7	92.4	92.4	92.5	0.1
AD	8,492	62	167	4.9	94.0	94.0	94.0	0.0
AE	8,567	67	326	3.4	96.0	96.0	96.0	0.0
AF	8,738	158	1,232	0.7	97.1	97.1	97.2	0.1
AG	8,893	95	259	3.2	103.7	103.7	103.7	0.0
AH	9,031	65	202	4.1	105.4	105.4	105.4	0.0
AI	9,364	71	286	2.9	112.7	112.7	112.7	0.0
AJ	9,381	95	372	2.2	113.5	113.5	113.5	0.0
AK	9,553	42	118	4.9	114.0	114.0	114.0	0.0
AL	9,656	29	99	5.8	116.0	116.0	116.0	0.0
AM	9,676	73	255	2.3	118.7	118.7	118.7	0.0
AN	9,925	32	100	5.7	124.2	124.2	124.2	0.0
AO	10,166	51	108	5.3	128.8	128.8	128.8	0.0
AP	10,406	70	143	4.0	133.5	133.5	133.5	0.0
AQ	10,587	56	129	4.5	138.8	138.8	138.9	0.1
AR	10,715	41	110	5.2	141.9	141.9	141.9	0.0
AS	10,728	54	170	3.4	143.4	143.4	143.4	0.0
AT	10,952	44	104	5.5	146.6	146.6	146.6	0.0
AU	11,080	41	105	5.5	150.9	150.9	150.9	0.0
AV	11,166	44	125	4.6	152.3	152.3	152.3	0.0
AW	11,186	55	188	3.0	153.7	153.7	154.0	0.3
AX	11,229	47	109	5.3	154.4	154.4	154.4	0.0

[1]Meters above Mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAMANI

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Melania								
A	2,080[1]	183	234	0.9	7.2	7.2	7.5	0.3
B	2,250[1]	183	260	0.8	8.3	8.3	8.6	0.2
C	2,394[1]	183	119	1.8	9.1	9.1	9.1	0.0
D	2,575[1]	137	214	1.0	10.4	10.4	10.4	0.0
E	2,705[1]	113	164	1.3	10.9	10.9	10.9	0.0
F	2,820[1]	102	187	1.2	11.6	11.6	11.6	0.0
G	2,903[1]	107	128	1.7	12.0	12.0	12.1	0.1
H	3,020[1]	73	151	1.4	12.5	12.5	12.7	0.2
Rio Seco								
A	1,734[2]	116	264	2.0	16.0	16.0	16.3	0.3
B	1,956[2]	125	197	2.6	17.0	17.0	17.3	0.3
C	2,065[2]	119	207	2.5	18.1	18.1	18.1	0.0
D	2,200[2]	89	155	3.3	18.7	18.7	18.8	0.1
E	2,361[2]	101	194	2.6	19.9	19.9	19.9	0.0
F	2,530[2]	61	177	2.9	20.5	20.5	20.5	0.0
G	2,692[2]	80	233	2.2	21.4	21.4	21.4	0.0
H	2,799[2]	45	106	4.9	22.3	22.3	22.3	0.0
I	2,900[2]	107	162	3.2	24.3	24.3	24.3	0.0
J	3,017[2]	109	165	3.1	25.5	25.5	25.5	0.0

[1]Meters above mouth (along profile base line)
[2]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO MELANIA - RIO SECO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayanes								
A	941	829.0	2,632.6	0.6	4.7	4.7	4.8	0.1
B	1,631	1,159.0	3,627.5	0.5	4.9	4.9	5.0	0.1
C	2,026	1,166.0	3,634.4	0.6	5.0	5.0	5.1	0.1
D	2,489	1,380.0	4,217.5	0.5	5.0	5.0	5.3	0.3
E	2,818	1,600.0	3,424.5	0.6	5.1	5.1	5.4	0.3
F	2,889	1,611.0	3,151.5	0.9	5.1	5.1	5.4	0.3
G	3,083	1,500.1	2,928.6	1.0	5.3	5.3	5.5	0.2
H	3,311	1,600.0	3,136.2	0.9	5.4	5.4	5.7	0.3
I	3,811	1,619.5	1,713.3	1.3	5.6	5.6	5.8	0.2
J	4,190	1,815.0	2,272.4	0.8	6.6	6.6	6.6	0.0
K	4,578	2,011.3	2,130.8	1.0	7.2	7.2	7.2	0.0
L	5,058	1,827.8	1,360.0	2.2	8.3	8.3	8.4	0.1
M	5,568	2,260.3	2,454.5	1.0	8.9	8.9	9.2	0.3
N	5,927	2,049.3	2,514.6	1.1	9.2	9.2	9.4	0.2
O	6,272	1,914.1	2,225.7	1.2	9.5	9.5	9.7	0.2
P	6,814	1,940.0	1,267.8	4.1	10.6	10.6	10.6	0.0
Q	7,348	1,633.5	1,937.3	1.7	11.5	11.5	11.8	0.3
R	7,760	1,407.8	1,519.4	2.3	12.4	12.4	12.4	0.0
S	7,990	1,129.8	1,081.8	2.4	13.2	13.2	13.3	0.1
T	8,067	1,140.0	1,103.5	3.3	13.7	13.7	13.7	0.0
U	8,396	1,260.1	2,335.2	1.1	14.6	14.6	14.9	0.3
V	9,859	1,032.2	1,183.6	1.7	16.1	16.1	16.3	0.2
W	10,601	1,090.3	1,166.9	1.3	17.1	17.1	17.3	0.2
X	11,013	979.6	993.1	1.7	17.5	17.5	17.8	0.3
Y	11,692	944.2	1,343.8	1.0	18.3	18.3	18.6	0.3
Z	11,973	927.6	1,207.9	1.2	18.5	18.5	18.7	0.2

[1]Meters above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYANES (RIO GUAYANES BASIN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Guayanes (continued)								
AA	12,403[1]	907.3	1,343.2	0.8	19.5	19.5	19.8	0.3
AB	12,781[1]	651.6	683.6	2.0	19.9	19.9	20.1	0.2
AC	13,043[1]	588.2	834.4	1.3	20.4	20.4	20.7	0.3
AD	13,412[1]	698.2	636.4	1.3	20.8	20.8	21.1	0.3
AE	14,051[1]	547.2	649.8	2.0	22.7	22.7	22.9	0.2
AF	14,576[1]	514.9	914.3	1.0	23.4	23.4	23.7	0.3
AG	14,826[1]	410.7	707.9	0.9	23.6	23.6	23.9	0.3
AH	15,151[1]	150.7	211.2	3.7	24.0	24.0	24.2	0.2
AI	15,448[1]	204.3	425.4	1.5	25.7	25.7	26.0	0.3
AJ	15,791[1]	155.2	349.4	2.2	26.4	26.4	26.7	0.3
AK	16,010[1]	121.5	235.6	4.1	27.4	27.4	27.7	0.3
AL	16,330[1]	34.9	147.5	4.7	34.3	34.3	34.5	0.2
Rio Limones								
A	684[2]	282.0	433.4	2.2	17.0	17.0	17.2	0.2
B	1,885[2]	168.3	415.4	2.1	21.9	21.9	22.0	0.1
C	2,097[2]	231.6	463.4	1.8	22.4	22.4	22.5	0.1
D	2,163[2]	299.0	562.3	1.4	22.5	22.5	22.7	0.2
E	2,197[2]	307.0	475.6	1.7	22.5	22.5	22.8	0.3
F	2,328[2]	194.7	409.5	1.9	23.0	23.0	23.1	0.1
G	2,477[2]	133.9	519.7	1.0	23.3	23.3	23.3	0.0
H	2,663[2]	77.8	285.0	2.3	23.3	23.3	23.3	0.0
I	2,957[2]	114.9	374.3	1.0	24.1	24.1	24.3	0.2
J	3,265[2]	69.0	200.5	2.3	24.5	24.5	24.6	0.1
K	3,704[2]	85.9	296.9	1.0	25.6	25.6	25.7	0.1
L	3,913[2]	32.4	108.3	3.6	27.0	27.0	27.0	0.0
M	3,958[2]	61.2	242.7	1.6	28.5	28.5	28.5	0.0
N	4,016[2]	55.7	193.9	2.0	28.6	28.6	28.6	0.0
O	4,422[2]	32.4	85.0	4.6	31.1	31.1	31.2	0.1
P	4,539[2]	55.1	140.1	2.6	35.3	35.3	35.3	0.0
Q	4,611[2]	48.7	89.2	4.1	37.6	37.6	37.8	0.2

[1]Meters above mouth
[2]Meters above confluence with Rio Guayanes

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO GUAYANES (RIO GUAYANES BASIN) – RIO LIMONES

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Maunabo								
B	0.25[1]	707	2,156	0.5	3.5	3.5	3.8	0.3
C	1.00[1]	774	1,381	0.7	5.5	5.5	5.8	0.3
D	1.41[1]	640	1,220	0.8	6.6	6.6	6.8	0.2
E	2.13[1]	759	1,262	0.6	7.6	7.6	7.8	0.2
F	2.61[1]	670[3]	917	0.4	8.5	8.5	8.8	0.3
G	3.35[1]	774[3]	1,037	0.6	10.1	10.1	10.1	0.0
H	3.85[1]	646[3]	660	0.7	11.3	11.3	11.6	0.0
I	4.75[1]	320	759	0.7	14.1	14.1	14.1	0.3
J	5.02[1]	446	1,234	0.4	14.3	14.3	14.4	0.1
K	5.43[1]	158	468	1.1	16.1	16.1	16.1	0.0
L	5.88[1]	91	221	2.3	16.4	16.4	16.5	0.1
M	6.49[1]	268	313	1.4	19.9	19.9	19.9	0.0
N	7.26[1]	104	166	2.6	24.1	24.1	24.2	0.0
Quebrada Arenas								
A	1.15[2]	30	95.5	2.0	7.3	7.3	7.5	0.3
B	1.45[2]	30	63.1	3.0	10.9	10.9	10.9	0.0
C	1.63[2]	74	142.9	1.2	12.9	12.9	13.1	0.3
D	1.88[2]	60	118.3	1.3	15.0	15.0	15.1	0.2
E	2.29[2]	61	118.7	1.2	17.9	17.9	18.1	0.2
F	2.45[2]	36	54.6	4.7	18.6	18.6	18.6	0.0
G	2.61[2]	28	50.2	6.1	21.5	21.5	21.5	0.0

[1]Kilometers above confluence with Caribbean Sea
[2]Kilometers above confluence with Rio Maunabo
[3]Width including island

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO MAUNABO - QUEBRADA ARENAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Jacaboa								
B	0.25	130	284	1.6	4.4	4.4	4.7	0.2
C	0.64	130	296	1.5	7.6	7.6	7.9	0.3
D	0.86	122	266	1.6	10.3	10.3	10.3	0.0
E	1.48	183	373	1.1	14.8	14.8	14.9	0.1
F	2.02	183	382	1.0	17.8	17.8	18.0	0.2
G	2.27	122	229	1.7	20.6	20.6	20.6	0.0
H	2.52	122	264	1.1	23.4	23.4	23.4	0.0
I	2.82	76	144	1.8	26.5	26.5	26.7	0.3
J	3.10	76	147	1.7	31.0	31.0	31.1	0.1

[1]Kilometers above confluence with Caribbean Sea

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO JACABOA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE[1]	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rio Candelero								
A	849	139	461	1.0	4.0	4.0	4.0	0.0
B	1,794	88	161	2.2	6.1	6.1	6.1	0.0
C	2,050	63	125	2.8	7.7	7.7	7.7	0.0
D	2,666	92	166	2.1	10.9	10.9	10.9	0.0
E	3,023	90	168	2.1	12.3	12.3	12.3	0.0

[1]Meters confluence with Atlantic Ocean

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

RIO CANDELERO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (METERS MSL)			
CROSS SECTION	DISTANCE	WIDTH (METERS)	SECTION AREA (SQUARE METERS)	MEAN VELOCITY (METERS PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quebrada La Mina								
A	466[1]	101	99	2.0	9.3	9.3	9.4	0.1
B	728[1]	53	103	2.0	11.9	11.9	11.9	0.0
C	1,412[1]	35	89	2.3	16.6	16.6	16.8	0.2
D	1,639[1]	18	57	3.5	20.4	20.4	20.4	0.0
E	2,035[1]	38	109	1.9	25.5	25.5	25.7	0.2
F	2,452[1]	27	77	1.0	30.8	30.8	30.9	0.1
G	2,664[1]	14	35	2.2	33.8	33.8	34.0	0.2
H	3,099[1]	24	34	1.6	41.4	41.4	41.5	0.1
I	3,231[1]	18	26	2.3	44.8	44.8	44.8	0.0
J	3,524[1]	8	8	3.2	54.5	54.4	54.4	0.0
K	3,854[1]	13	10	2.5	71.2	71.2	71.2	0.0
L	4,054[1]	18	14	1.8	77.7	77.7	77.7	0.0
Quebrada La Mina Tributary								
A	130[2]	10	15	1.9	50.2	50.2	50.5	0.3
B	528[2]	8	9	3.3	67.2	67.2	67.2	0.0
C	754[2]	9	9	3.2	82.3	82.3	82.3	0.0

[1]Meters above mouth
[2]Meters above confluence with Quebrada La Mina

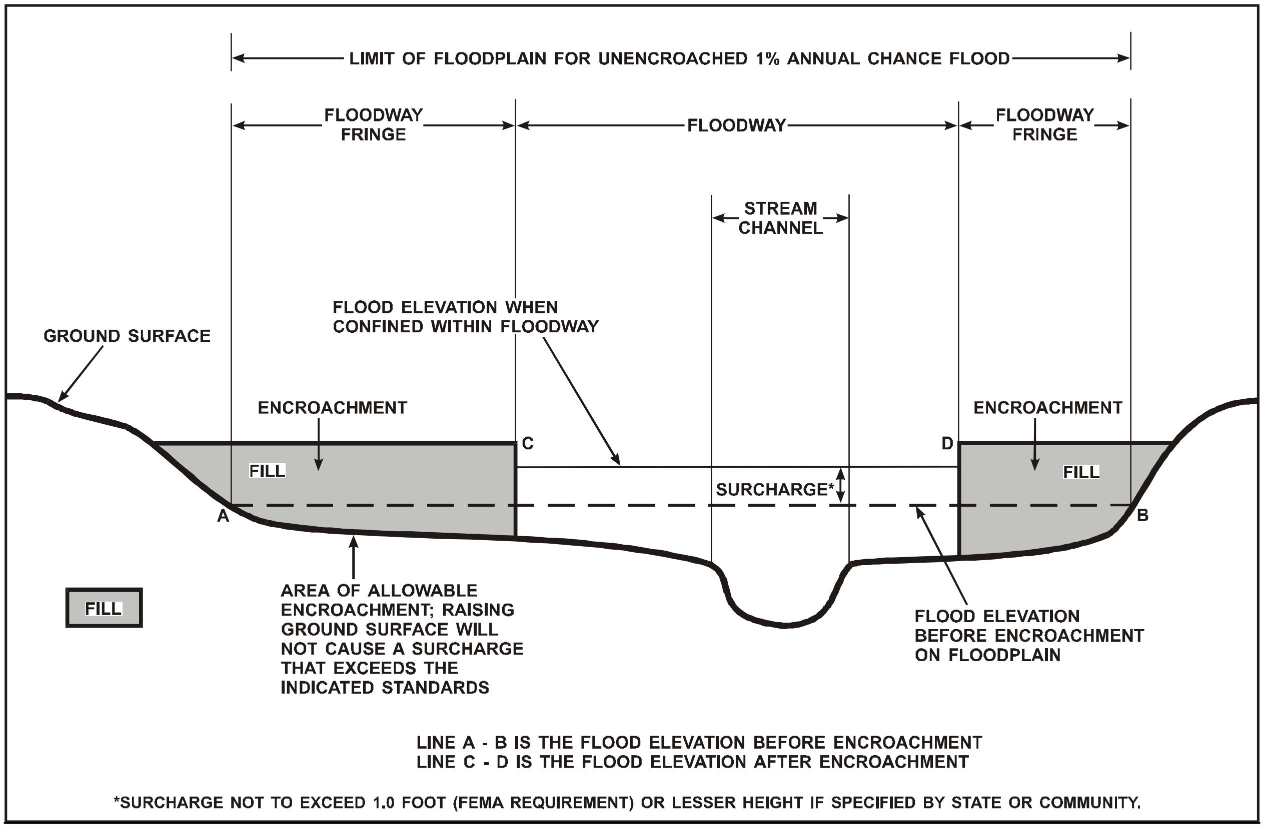
TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

FLOODWAY DATA

QUEBRADA LA MINA – QUEBRADA LA MINA TRIBUTARY



FLOODWAY SCHEMATIC Figure 5

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR

Area of special flood hazard formerly protected from the 1-percent annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent annual chance flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected base flood elevations to the tenth of a meter or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of the Commonwealth of Puerto Rico and its Municipalities. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepare for the Commonwealth of Puerto Rico and its Municipalities are presented in Table 10, "Community Map History."

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within the Commonwealth of Puerto Rico has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS reports, FIRMs, and/or FBFMs for the Commonwealth of Puerto Rico. This is a multi-volume FIS. Each volume may be revised separately, in which case it supersedes the previously printed volume. Users should refer to the Table of Contents in Volume 1 for the current date of each volume; volumes bearing these dates contain the most up-to-date flood hazard data.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Bayamón, Municipality of	August 1, 1978[1]	None[1]	August 1, 1978[1]	July 2, 1981[1] July 19, 1982[1] August 5, 1986[1] December 15, 1990[1] August 3, 1992[1] June 2, 1999[1] April 19, 2005[1]
Ponce, Municipality of	August 1, 1978[1]	None[1]	August 1, 1978[1]	July 19, 1982[1] August 3, 1992[1] June 2, 1999[1] April 19, 2005[1]
Puerto Rico, Commonwealth of	August 1, 1978	None	August 1, 1978	February 15, 1980 August 15, 1980 July 1, 1981 July 2, 1981 July 19, 1982 September 16, 1982 July 5, 1983 April 3, 1984 August 15, 1984 August 5, 1986 September 29, 1986 January 2, 1987 January 2, 1990 December 15, 1990 January 2, 1992 May 18, 1992 August 3, 1992 January 6, 1994 September 20, 1996 June 2, 1999 April 19, 2005

[1]This community did not have its own FIRM prior to this FIS. The land area for this community was previously shown on the FIRM for the Commonwealth of Puerto Rico, but was not identified as a separate NFIP community. Therefore, the dates for this community were taken from the FIRM for the Commonwealth of Puerto Rico.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

COMMUNITY MAP HISTORY

A hydrologic and hydraulic study was conducted on Río Camuy for an area upstream of PR Highway 2 (Hidalgo y Alejandro Consultants, 1980). Flows at the PR Highway 2 bridge were computed to be lower than those in this countywide FIS. Puerto Rican agencies (particularly the PR Highway Authority) were notified of the discrepancy in a meeting and subsequently indicated that they had no objections to the FIS results.

NOAA prepared a publication, entitled Storm-Tide Frequency Analysis for the Coast of Puerto Rico (DOC, 1975). The study provided stage-frequency relationships for the tidal waters of Puerto Rico. In September 1972, the USACE, Jacksonville District, completed Special Flood Hazard Information, Río Grande de Arecibo, Puerto Rico (Special Flood Hazard Information, Río Grande de Arecibo, Puerto Rico, USACE, 1972). The USGS completed a FIS for the Río Grande de Arecibo Basin (Upper Part) that was published in 1978 (Flood Insurance Study, Río Grande de Arecibo Basin, Puerto Rico (Upper Part), DOI, Geological Survey, 1978).

The USACE, Jacksonville District, completed a floodplain information report for Río Cibuco and Río Indio in June 1973 (Flood Plain Information, Río Cibuco and Río Indio, Vega Baja and Vega Alta, Puerto Rico, USACE, Jacksonville District, 1973). NOAA prepared a publication, entitled Storm Tide-Frequency Analysis for the Coast of Puerto Rico, in May 1975 (DOC, 1975).

The USACE, Jacksonville District completed a floodplain information report for the Río de Bayamón Basin in March 1965 (Flood Plain Information, Río de Bayamón, Puerto Rico, USACE, 1965). The USACE also completed a special flood hazard information report, dated April 1973, that presented residual flood hazards upstream of the Bayamón Express Channel and Río Hondo Local Channel (Special Flood Hazard Information Report, Bayamón and Hondo Rivers, Puerto Rico, USACE, Jacksonville District, 1973). This countywide FIS updates both reports to reflect 1979 conditions.

A preliminary report for flood control studies on Río de Bayamón was completed by Miguel A. Quinones y Asociados for the Commonwealth of Puerto Rico, dated April 1964 (Flood Control Studies, Bayamón River, San Juan Metropolitan Area, Commonwealth of Puerto Rico Planning Board, 1964). This report was the initial flood control planning report for the existing channelization.

In 1972, Flavio Acaron Consultants of San Juan, Puerto Rico, conducted a hydrologic study of the Río Piedras Basin (Río Piedras Basin Flood Control Study, Flavio Acaron Consultants, 1973). The firm used its analytic hydrologic model to simulate and evaluate various hypothetical alternatives available for flood control in the basin. The model consisted of a rainfall simulator component and an overland flow component. The discharges used in this study are lower than those determined for the Flavio Acaron study. The USACE attributed the discrepancy to differences in rainfall input data and the construction of PR Highway 52. The USACE found that their methodology using Technical Release No. 20 best matched the available historical data (DOA, 1965). Flavio Acaron performed a backwater analysis on Canal Puerto Nuevo/Río Piedras from the mouth to approximately 1.9 kilometers upstream of the confluence of Quebrada Buena

Vista, and on Quebrada Margarita from the mouth to approximately 0.5 kilometer upstream of Avenida Guaynabo. The extent of their study was less than this study. Since Flavio Acaron used larger discharges than this study, their computed water-surface elevations were also higher. Flavio Acaron plotted the 4-percent annual chance flood profile along Río Piedras and Quebrada Margarita and the 0.5-percent annual chance flood profile along Quebrada Margarita for the existing channel conditions in January 1973. Those profiles show elevations approximately 3 or 4 meters higher than the elevations computed in this study for all of Canal Puerto Nuevo/Río Piedras and for Quebrada Margarita downstream of the PR Highways 2 and 23 interchange. Upstream of this interchange on Quebrada Margarita, their computed elevations are approximately 1 meter higher than in this study.

The Flavio Acaron floodplain delineations are wider than those presented in this study. The difference is due to the larger flows used by Flavio Acaron. The report by Flavio Acaron is not clear on what recurrence interval they delineated; however, the largest interval they considered is 200 years. Their 0.5-percent annual chance discharges are larger than the 0.2-percent annual chance discharges used in this study.

The Flavio Acaron report was accepted by the Puerto Rico Department of Public Works. Subsequently, an Environmental Impact Statement was presented on the recommended plan; however, the drainage improvements plan has not been carried out due to lack of funding from Public Works or the U.S. Department of Housing and Urban Development.

The USACE has conducted a preliminary hydrologic and hydraulic investigation of portions of Río Piedras Basin (USACE, 1974). The results of this preliminary investigation, completed in 1982, were made available to the study contractor and were incorporated into this study as previously discussed. The boundaries presented for this study are in close agreement with those determined by the USACE.

The Puerto Rico Planning and Environmental Quality Boards have prepared the North Metropolitan Area-wide Waste Management Plan (Commonwealth of Puerto Rico, 1976-1977). This plan did not determine flood discharges or elevations for Río Piedras Basin. However, data provided in the plan were used by the study contractor in the hydrologic analysis for Quebrada Juan Mendez.

The USGS published a report on the June and October 1970 floods (DOI, Geological Survey, 1971). This report presented flood profiles for both the June and October events and flood boundaries for the June event for Canal Puerto Nuevo/Río Piedras. These elevations and boundaries were based on high-water marks recovered after each event. The results of the hydrologic analyses performed for this study were found to be in agreement with the historical data in the USGS report.

FISs have been prepared for the adjacent Río de Bayamón and Río Grande de Loíza Basins (Flood Insurance Study, Río de Bayamón Basin, Puerto Rico, FEMA, 1981; Flood Insurance Study, Río Grande de Loíza Basin, Puerto Rico, FEMA, 1981). Information presented in those studies is in general agreement with this study.

The USGS provided two reports that contained data useful to the study of the Espíritu Santo River Basin (U.S. DOI, Geological Survey, 1967-present; HA-533, U.S. DOI, 1975).

A Type 7 FIS entitled Storm Tide-Frequency Analysis for the Coast of Puerto Rico, was completed by NOAA in May 1975 (U.S. DOC, 1975). The study provided stage frequency relationships for the tidal waters of Puerto Rico.

In 1968, the USGS published Hydrologic Investigations Atlas HA-288, Floods in the Mayaguez Area of Puerto Rico in cooperation with the Commonwealth of Puerto Rico Department of Public Works (HA-288, Floods in the Mayaguez Area of Puerto Rico, DOI, 1968). The USGS prepared a Flood-Prone Area Map covering the Río Yaguez Basin using approximate methods (7.5-Minute Series Flood-Prone Area Map, DOI, 1964).

The USACE, Jacksonville District, completed a floodplain information report for Río Grande de Manatí in March 1967 (Flood Plain Information, Manatí River, Puerto Rico, USACE, Jacksonville District, March 1967).

The USGS has prepared an unpublished regional flood-frequency report for Puerto Rico (Regional Flood Frequency for Puerto Rico, DOI, 1977). This report was used to determine flood frequencies up to 100 years for all streams studied by detailed methods in the Río de la Plata Basin except Río de la Plata (at Toa Baja) and Río de la Plata (at Toa Alta).

The USACE, Jacksonville District, published a special flood hazard information report for Río Caguitas at Caguas and for the Río Grande de Loíza Basin, which covered the area downstream of PR Highway 3 (Special Flood Hazard Information, Caguitas River, Caguas, Puerto Rico, USACE, February 1974; Flood Hazard Information, Río Grande de Loíza, Puerto Rico, USACE, 1975).

NOAA prepared a publication entitled Storm-Tide Frequency Analysis for the Coast of Puerto Rico (DOC, 1975).

Two reports, Flood Plain Information, Humacao River, Puerto Rico by the USACE and Floods at Humacao, Puerto Rico by the USGS, provided information on historical flooding in the Río Humacao Basin (Flood Plain Information, Humacao River, Puerto Rico, USACE, August 1966; HA-265, DOI, 1967).

Private contractors have undertaken partial studies of Río Guanajibo Basin focusing on the determination of high-water levels in the location of proposed engineering projects (Remedial Measures for PR Highway 102, Within Lower Flood Plain of Guanajibo River, GDA Ingenieros Consultores, 1979; Reconnaissance Report-Guanajibo River at Sabana Grande, Puerto Rico, USACE, 1978; Preliminary Studies-Flood Protection and Drainage for the Urban Development-Mansiones de Guanajibo, Hadjitheodorou, Christos, 1973; Report of the Hydrologic and Hydraulic Study for the Extension of Carolina Street between San Jose and Villas del Oeste Development, J.A. Batlle and

Associates, 1980; Mapas de Zonas Susceptibles a Inundaciones – Junta de Planificación, Estado Libre Asociado de Puerto Rico, 1979).

In 1979, the Puerto Rico Planning Board adopted as the official plans Mapas de Zonas Susceptibles a Inundaciones, for the control of building and land development in flood-prone areas (Mapas de Zonas Susceptibles a Inundaciones – Junta de Planificación, Estado Libre Asociade de Puerto Rico, 1979).

The USGS has established some watermarks in the Río Guanajibo Basin corresponding to Tropical Storm Eloise, which had a recurrence interval of approximately 100 years (DOC, 1972).

A publication entitled Water Resources Data for Puerto Rico, Part I, Surface Water Records has been published annually since 1967 (DOI, 1967-present). The USGS published a map and report entitled Floods in Eastern Lajas Valley and the Lower Río Loco Basin, Southwestern Puerto Rico (HA-532, DOI, Geological Survey, 1974).

In 1971, the USGS published a hydrologic investigation atlas in cooperation with the Commonwealth of Puerto Rico, Department of Public Works (HA-414, DOI, 1971). This countywide FIS contains flood profiles and flood delineations of the September 3, 1928, flood for Río Yauco from its mouth upstream to approximately river kilometer 11. The 1928 flood was approximately a 20-year flood, and supports the results presented in this countywide FIS.

NOAA, National Weather Service, prepared a study for the FIA in 1975 (DOC, 1975).

In October 1967, the USACE completed a floodplain information report for Río Guayanilla (Flood Plain Information, Guayanilla River, Guayanilla, Puerto Rico, USACE, 1967).

The USACE, Jacksonville District, prepared a plan of study for an expanded floodplain information report for Río Tallaboa Basin in June 1977 (Expanded Flood Plain Information, Plan of Study, Tallaboa River Basin, Puerto Rico, USACE, 1977). That report is being combined with the Section 205 flood control study for Río Tallaboa Basin. The hydrologic and hydraulic results of the 1977 report were used in this countywide FIS and will also be used in the Section 205 flood control study.

A report entitled Water Resources of the Tallaboa Valley, Puerto Rico, dated 1972, and a preliminary map, Floods of September 1975 in the Tallaboa Valley, Puerto Rico, dated 1978 were provided by the USGS (Water Resources of the Tallaboa Valley, Puerto Rico, DOI, 1972; Floods of September 1975 in the Tallaboa Valley, Puerto Rico, DOI, 1978).

The USGS has prepared a regional flood-frequency report for Puerto Rico (DOI, 1979). This report was used to determine flood frequencies up to 100 years for all streams studied by detailed methods in the Santa Isabel-Juana Díaz Coamo area.

In 1971, the USGS published a hydrologic investigations atlas in cooperation with the Commonwealth of Puerto Rico, Department of Public Works (HA-448, DOI 1971). The report includes flood profiles and boundaries of the October 9, 1970, flood for the streams studied in this countywide FIS. The hydrologic investigations atlas was used to develop some of the approximate 1-percent annual chance boundaries for this countywide FIS.

Hydrologic Investigations Atlas HA-446 and Hydrologic Investigations Atlas HA-445 include areas within Río Grande de Patillas and Río Guamani Basin (HA-446, DOI, 1971; HA-445, DOI, 1971). The USACE prepared a report entitled, Ponce Regional Water Resources Management Study, which outlines several proposals for flood control projects on Río Guamani and Río Nigua (Ponce Regional Water Resources Management Study, USACE).

In 1971, the USGS published Hydrologic Investigations Atlas HA-445, Floods in Patillas-Maunabo Area, Puerto Rico (HA-445, DOI, 1971). The USACE, Jacksonville District, completed a floodplain information report for Río Maunabo in October 1970 (Flood Plain Information, Maunabo River, Vicinity of Maunabo, Puerto Rico, USACE, 1970).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 26 Federal Plaza, Room 1351, New York, New York 10278.

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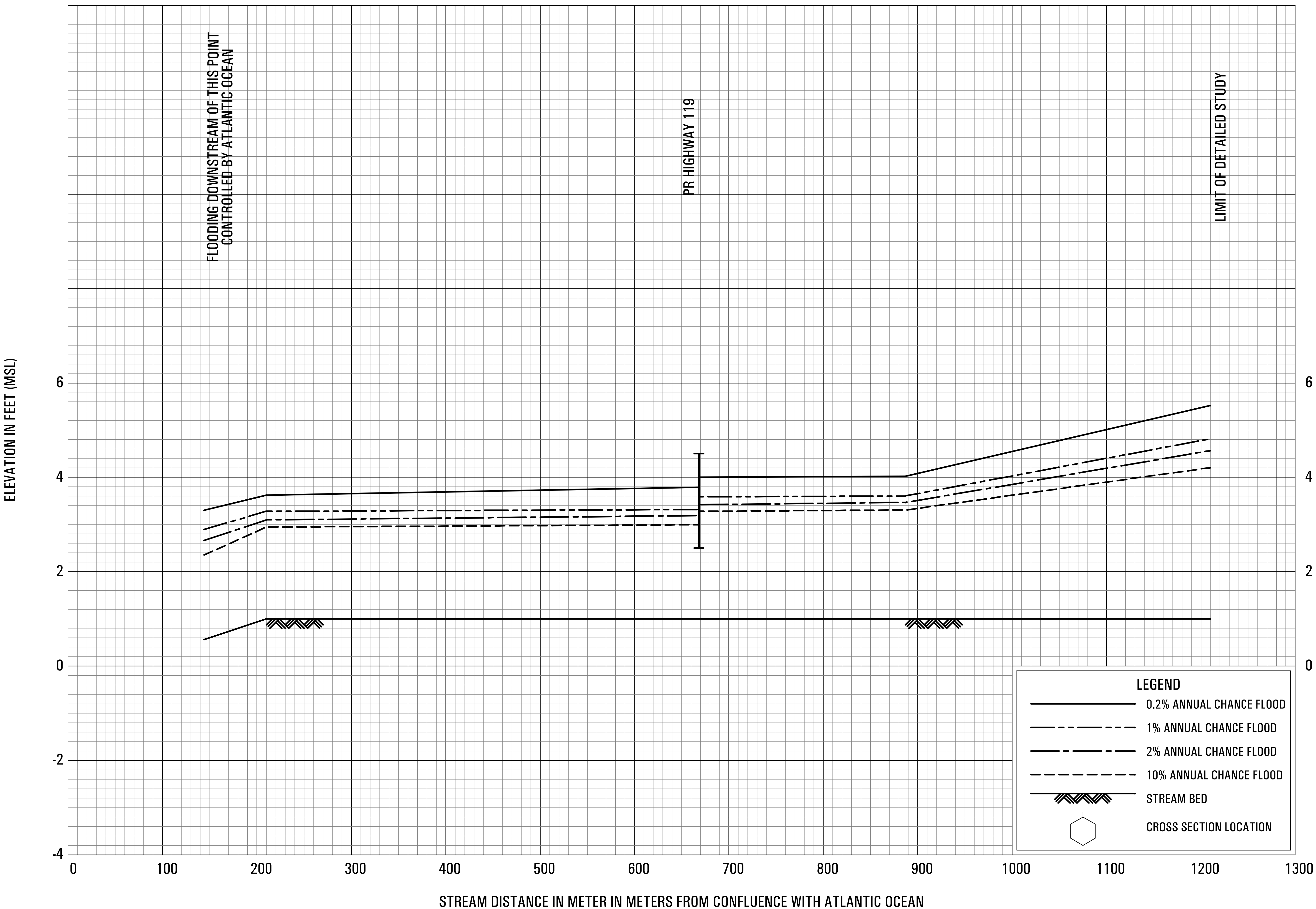

FLOOD PROFILES

RIO CAMUY

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

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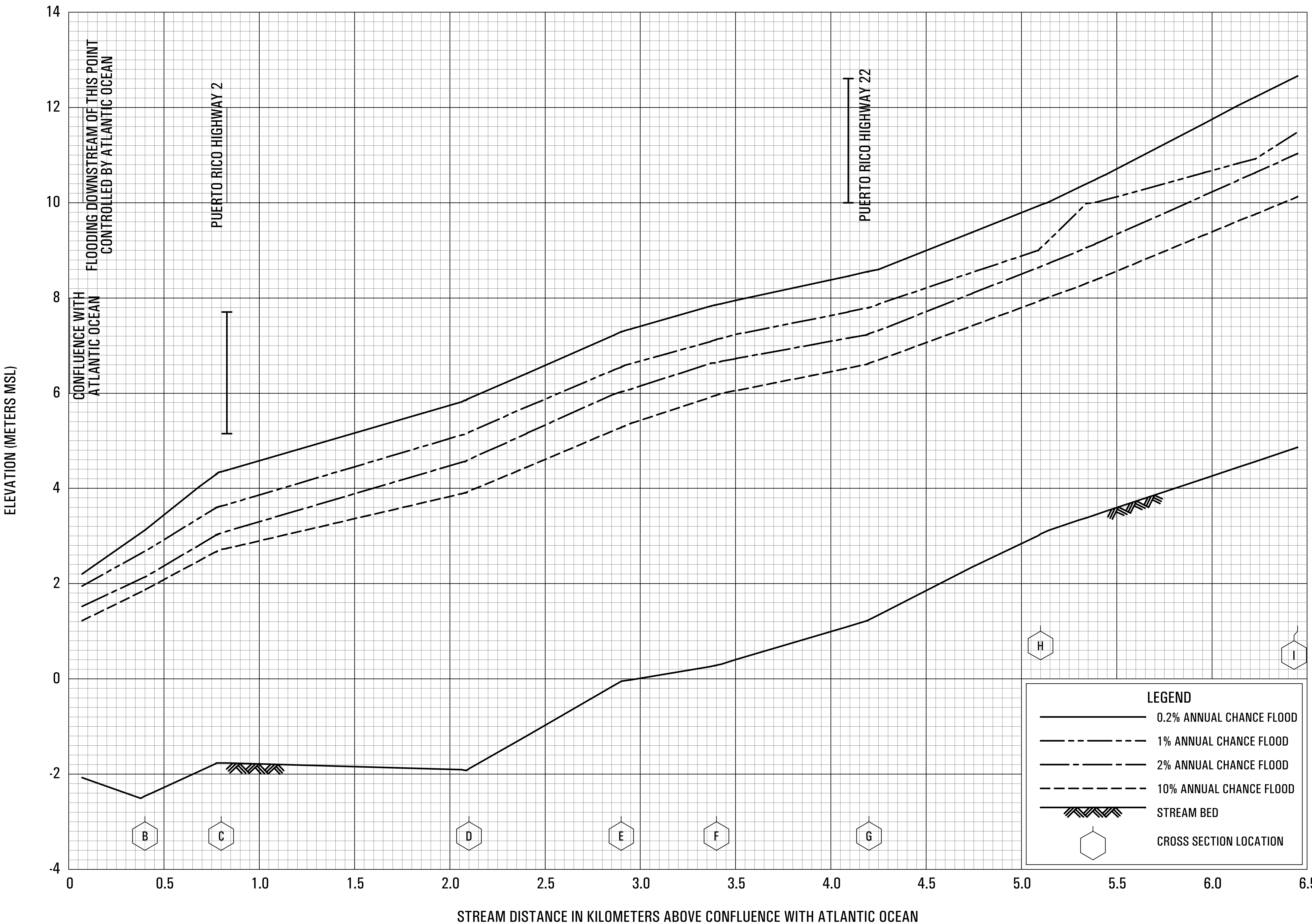

FLOOD PROFILES

RIO GRANDE DE ARECIBO

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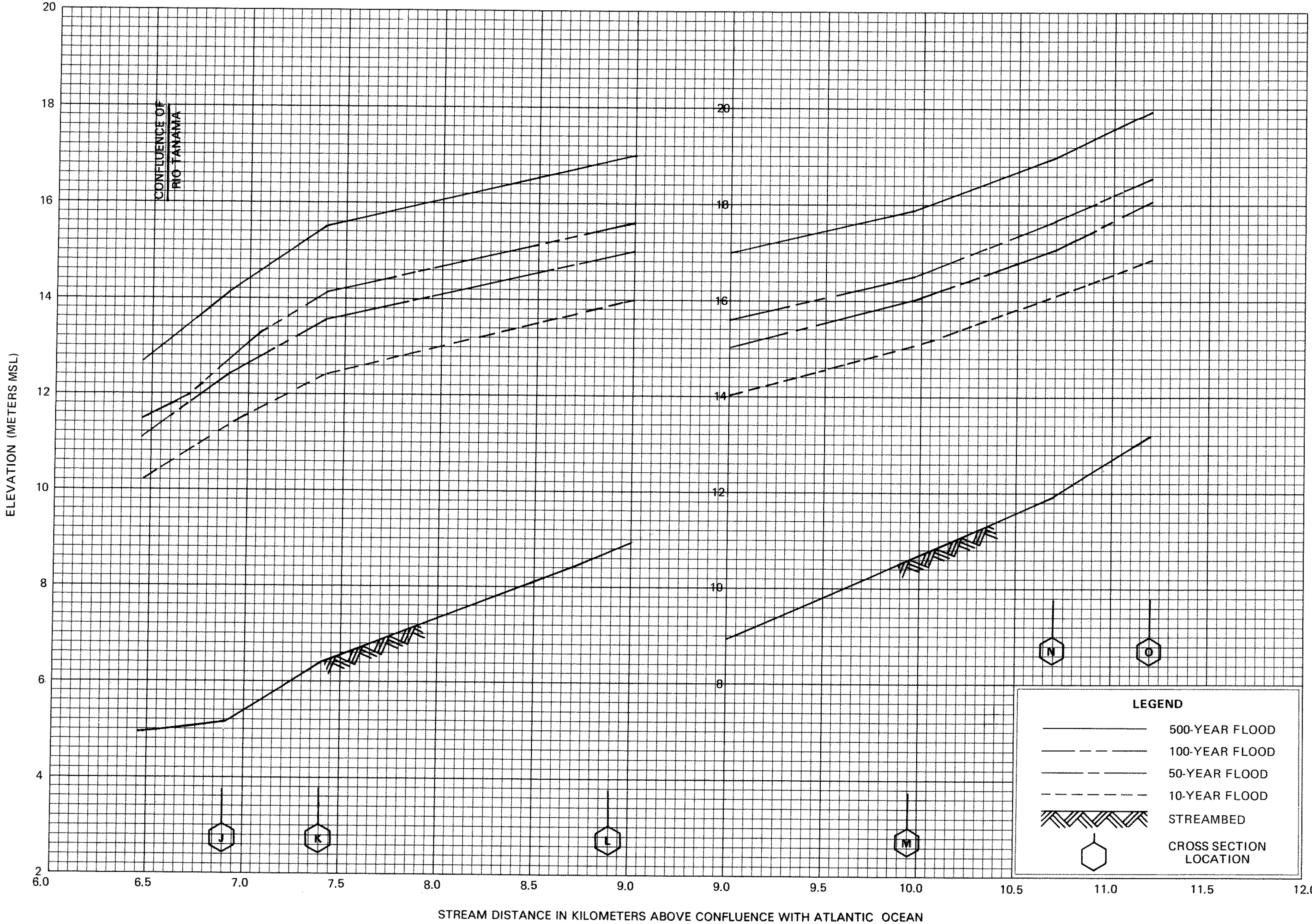

FLOOD PROFILES

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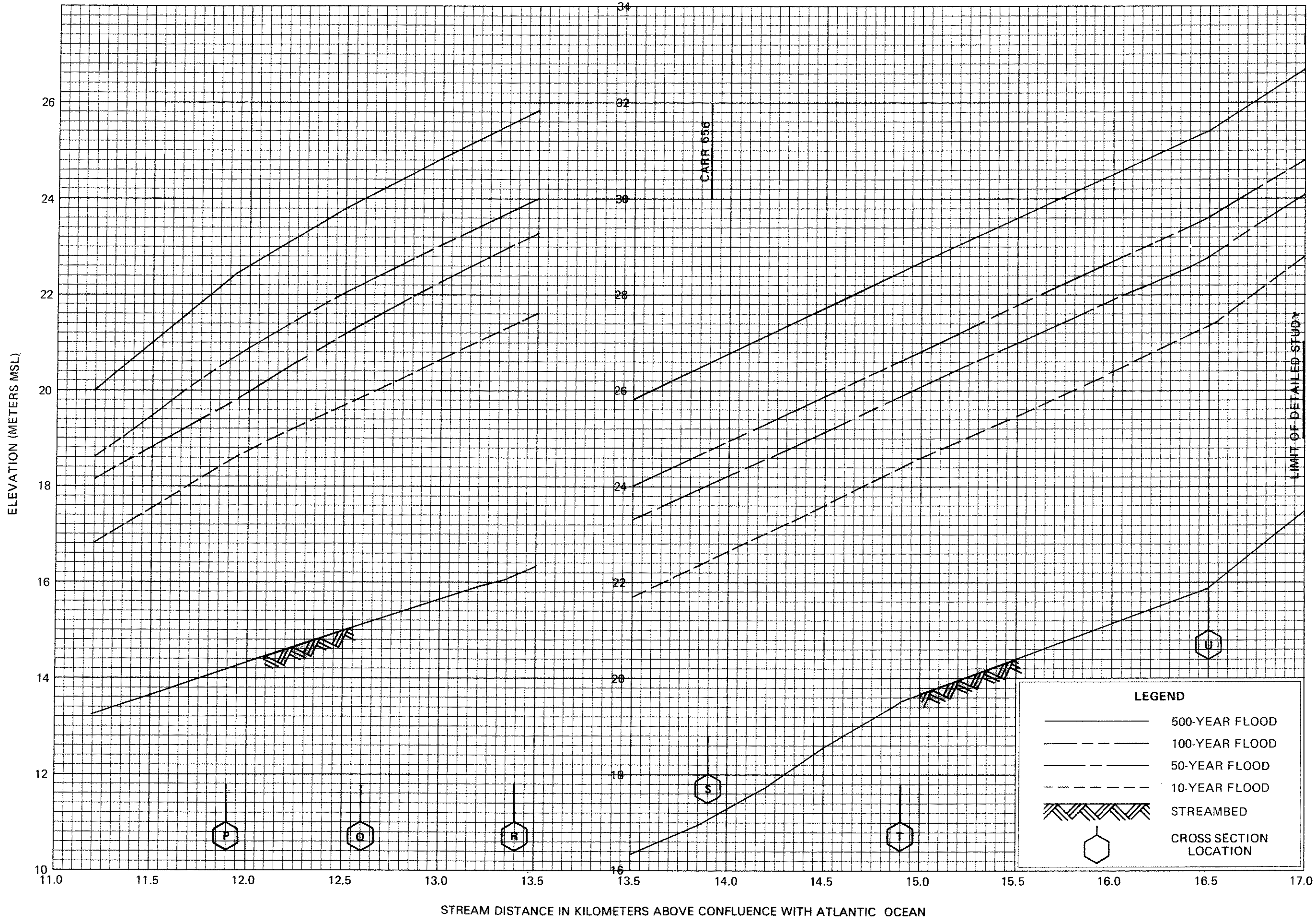

FLOOD PROFILES

RIO GRANDE DE ARECIBO

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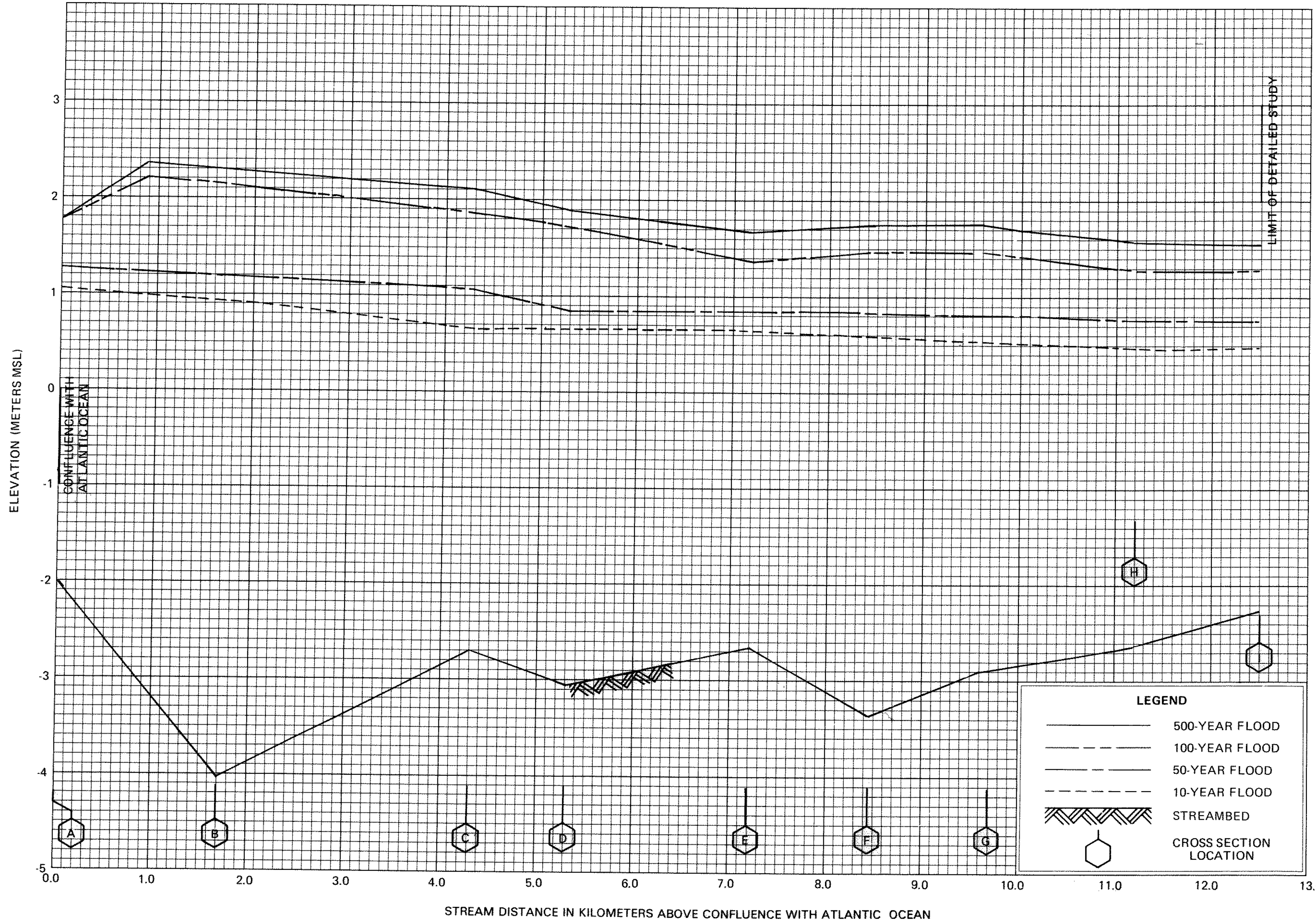

FLOOD PROFILES

CANO TIBURONES

FEDERAL EMERGENCY MANAGEMENT AGENCY

COMMONWEALTH OF PUERTO RICO AND MUNICIPALITIES

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