RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
SECTION 205
FINAL DETAILED PROJECT REPORT
AND ENVIRONMENTAL ASSESSMENT

APPENDIX E
ECONOMIC ANALYSIS

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

APPENDIX E
ECONOMIC ANALYSIS

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DETAILED PROJECT REPORT

APPENDIX E
ECONOMIC ANALYSIS

I. INTRODUCTION

A. General

The Río Culebrinas Detailed Project Report is being conducted under Section 205 of the Flood Control Act of 1948, as amended.

The study area is located southwest of the town of Aguadilla and at Espinar Ward, northeast of Aguada. This appendix describes the social and economic conditions pertaining to the detailed Río Culebrinas floodplain. A description of the estimated flood damage induced by the river for existing and future conditions, as well as the benefits to be derived from the implementation of alternative flood control plans for the area, are discussed.

B. Social and Economic Profile

The municipalities of Aguadilla and Aguada are included in the western region of Puerto Rico, as established by the Puerto Rico Planning Board. This region located in the most western part of Puerto Rico, includes the municipalities of Aguada, Aguadilla, Añasco, Cabo Rojo, Guánica, Hormigueros, Isabela, Lajas, Mayagüez, Moca, Rincón, Sabana Grande, and San Germán. Aguadilla is one of the three development centers of the region. It has a territorial extension of 94.8 square kilometers and a population density of 626 persons per square kilometer. Aguada, located south west of Aguadilla has a territorial area of 80.1 square kilometers and a population density of 448.3 persons per square kilometer. They are located about 130 kilometers from the San Juan Metropolitan Area.

The city of Aguadilla is one of the largest urbanized areas on this part of the island. The economic base of the municipality revolves around major manufacturing activities, trade, educational, and health services. The second most important airport in Puerto Rico is located at Aguadilla's former Ramey Air Force Base.

1. Population. The total population for the Municipalities of Aguadilla and Aguada grew from 86,173 inhabitants in 1980 to 95,246 in 1990 for an increase of 10.5 percent. According to US Census Bureau estimates for July 1998, the municipality of Aguadilla showed an increase of 12 percent for a total population of 66,404. Aguada also showed a change of 9.6 percent for a total population of 39,347. The Community

of Espinar, which is part of Aguada, had a total population of 1,382 in 1990 and estimated 1,600 inhabitants in 1998. The population of the two municipalities, according to the Puerto Rico Planning Board, is expected to grow to 106,200 in 2005. See Figure E-1.

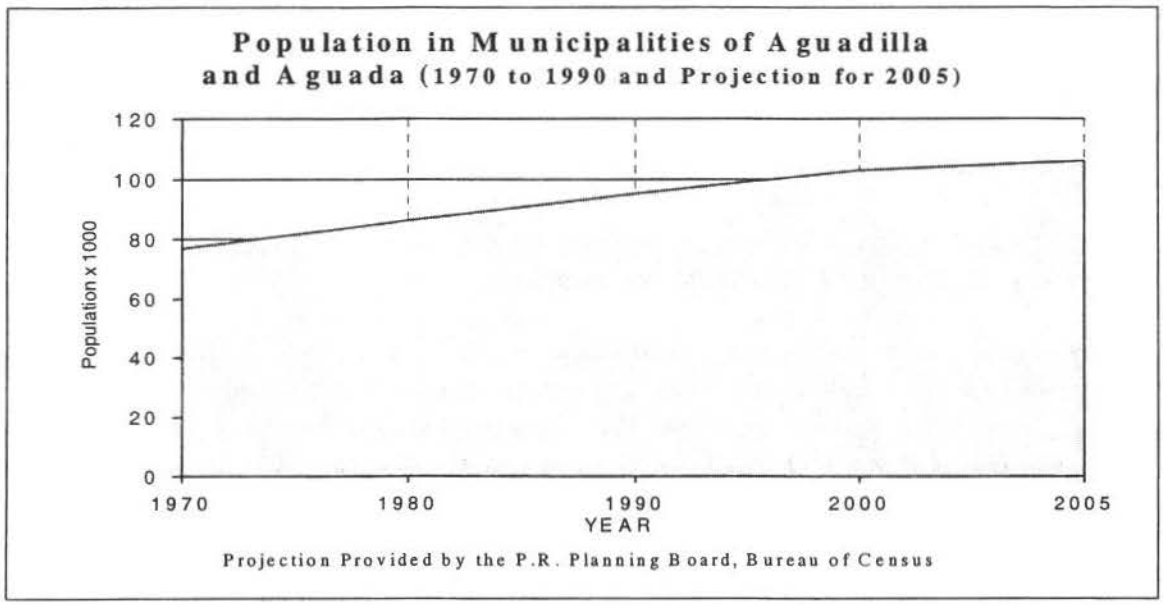


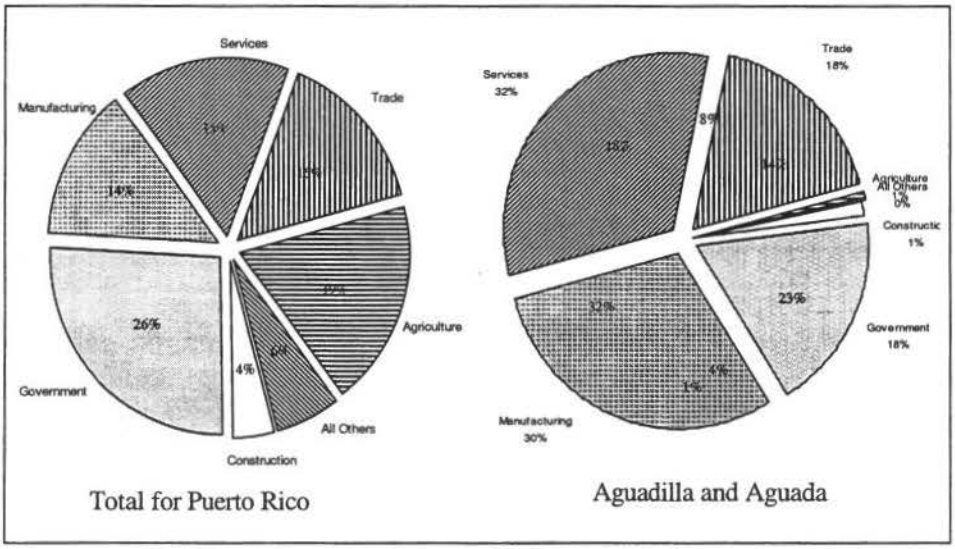
Figure E-1

2. Employment. Local economy was traditionally centered around agricultural pursuits mainly sugar cane in the coastal plain, and coffee, cash crops and cattle at higher ground. The sugar industry, as in the rest of the island has significantly declined. However, it is still cultivated throughout the study areas. The Central Coloso, the only sugar mill still operating in Puerto Rico, is located in the study area.

Today manufacturing, services and government sectors are the principal providers of employment. As of May 1999, the total labor force in Aguadilla and Aguada was about 24,360[1] persons. Of these, 85.3 percent or 20,779 were employed. The unemployment rate was estimated at 14.7 percent. Refer to Figure E-2 and Table E-1.

Employment by Sector

Percentage Distribution



Source: P.R. Department of Labor and Human Resources

Figure E-2

[1] This figure represents the total employment covered by the Employment Security Law. This law covers about 97 percent of the Puerto Rico labor force.

TABLE E-1

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
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Distribution of Employed People by Major Economic Sector
(Aguadilla and Aguada)
As of May 1999

Total Labor Force	24,360
Employed	20,779
Unemployed	3,581
Unemployed Rate	14.7
Distribution:	
Manufacturing	6,096
Non-Manufacturing	14,548
Construction	450
Transportation, Communications, etc.	1,218
Trade	3,620
Finance	485
Services	4,989
Government	3,756
Others	30
Agriculture and Related	135

3. Infrastructure. Public utilities for power and domestic sanitary and water supply provide the necessary services to the area. These include a wastewater treatment plant with 8-MGD capacity that serves the towns of Aguadilla and Aguada. An electric power transmission center located at Victoria Ward (Reach 3, Zone 5) has 112 MVA capacity with 2 incoming 115 KV transmission lines and five 38 KV subtransmission lines. Eight substations connected to the 38KV system distribute power to the 13.2 and 4.16 KV network.

A network of state roads and highways connect the town of Aguadilla and Aguada with the rest of the island. These recently improved transportation routes, adjoining the study area, contribute to support continuous economic development of the municipalities in the northwestern and western region of Puerto Rico.

The second most important airport of Puerto Rico is located at Aguadilla. The airport is rapidly becoming a major air cargo movement center. According to Ports Authority statistics air cargo between 1997 and 1998 increased from 36,770,100 to 55,800,600 pounds. This represents a 52 percent increase.

4. Tourism. Aguadilla is well known for its surfing beaches favored by local tourism and international wave riders. The most popular sites are Crashboat, Gas Chambers and Wilderness. This sector of the base economy is characterized by its

growth and development over the past years with sustained investments in the hotel rooms inventory. This expansion offers new and/or renovated accommodations, which in FY98 showed an increase of over 10 percent registration for the area.

C. Detailed Study Area

The detailed study area includes the southern portion of the town of Aguadilla including Higuey and Victoria wards, and Espinar Ward in the town of Aguada. The area is divided into three damage reaches for purpose of economic analysis, plan formulation, and evaluation. The total area encompasses approximately 942 structures and facilities of all land uses, major transportation routes, and parks. Most of the houses in the floodable area are medium-sized concrete structures. Families in this area belong to middle to low income groups. Elderly persons represent about 11 percent of the population residing in the study area. See Plate 1 at the end of this Economic Appendix for delineation of reaches.

II. FLOOD DAMAGE ANALYSIS

A. General

This section provides a description of damage reaches and zones, property subject to flooding, values of property, and depth-damage relationships used to calculate flood damage estimates. Potential flood damage without project and damage estimates for the alternative flood control plans under consideration are also included.

The inventory of property subject to flooding was conducted through field visits using flood profile maps for existing conditions developed as part of this study.

B. Damage Reaches and Zones

Reach 1, is located south of Caño Madre Vieja and from extends the coastline to the intersection of PR Highway 115 and PR Highway 447. This reach includes the community known as Espinar Ward of the municipality of Aguada.

Reaches 2 and 3 comprise the southern part of the town of Aguadilla and contain most of the commercial, public, and utilities affected by flooding. Refer to Table E-2 and Plate 1 for further details.

TABLE E-2

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Reaches and Zones for Economic Analysis

REACH	ZONES	DESCRIPTION OF SECTORS
1	1 to 7	South of Caño Madre Vieja, Espinar Ward of Aguada, mostly residential low-income community.
2	1	Residential Public Housing Community in Aguadilla.
3	1 to 5	Southern portion of the town of Aguadilla. Residential, Commercial, Public and Utilities land use.

Damage reach 1 was further subdivided into seven topographically similar zones to facilitate economic analysis. Reach 3 was subdivided into five zones for the same purpose.

C. Inventory of Property Subject to Flooding

For purposes of this analysis, property subject to flooding was grouped in six land use categories. These are: residential, commercial, public, nonprofit organization facilities, utilities, and highways and streets. The following paragraphs describe the property subject to flooding and land use categories.

1. Residential. Approximately 90 percent of all residential structures in the study area are subject to flooding by the 100-year flood. Table E-3 shows their distribution by nodes and flood frequency.

Most of the residential structures affected consist of reinforced concrete, one-family housing units. Average size of structures is about 80 square meters.

TABLE E-3

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Estimated Residential Structures affected by flooding
By Reach/Node and Flood Frequency

	Reach/Node													
Frequency	**1/1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**2/1**	**3/1**	**3/2**	**3/3**	**3/4**	**3/5**	**TOTAL**
2	0	48	0	0	0	0	0	6	3	0	0	0	10	**67**
5	0	48	8	0	0	0	0	31	11	144	0	0	10	**252**
10	0	48	15	0	0	0	0	31	25	160	0	23	10	**312**
25	0	48	23	6	5	1	0	31	33	160	0	74	10	**391**
50	36	48	91	6	8	2	14	31	55	160	70	93	10	**624**
100	36	48	152	6	11	3	20	31	55	160	78	93	10	**703**
SPF	36	48	152	6	18	6	95	31	55	160	87	93	10	**797**

2. Commercial. A total of 95 commercial establishments within the study area are affected by the 100-year flood event. The historical depth-damage relationships developed at the Jacksonville District, Antilles Office consider eight different categories of commercial activity. Businesses were grouped on the basis of the type of transaction performed, the merchandise or services offered, and the similarities in the display of contents. Seven of these categories are present in the Río Culebrinas study area. These are described as follows:

a. Commercial category 1. Professional services offices, general merchandise outlets, miscellaneous retail stores, auto parts stores, sporting goods stores, drug stores, electrical equipment stores, food stores, auto services outlets, and apparel and accessories stores.

b. Commercial category 2. Personal, professional and commercial services outlets.

c. Commercial category 3. Eating and drinking places, repair services outlets, and small building materials outlets.

d. Commercial category 4. Auto Dealers.

e. Commercial category 5. Hardware stores and building materials outlets.

f. Commercial category 6. Finance institutions and real estate offices.

g. Commercial category 7. Warehouses.

Table E-4 shows the estimated number of commercial establishments grouped by commercial category.

TABLE E-4

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
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Commercial Facilities affected by flooding
by category and flood frequency

Type of Business	Frequency (Years)						
	2	**5**	**10**	**25**	**50**	**100**	**SPF**
Commercial Category 1	4	6	10	14	34	38	38
Commercial Category 2					6	6	6
Commercial Category 3	3	4	9	15	34	34	34
Commercial Category 4				5	7	7	7
Commercial Category 5					9	9	9
Commercial Category 6							1
Commercial Category 7					1	1	1
TOTAL ALL CATEGORIES	**7**	**10**	**19**	**34**	**91**	**95**	**96**

3. Public. The public land use category comprises all facilities operated by the Commonwealth and municipal governments within the study area.

4. Nonprofit organizations. This category includes religious institution facilities and private educational facilities.

The number of public and nonprofit facilities affected by flooding is shown in Table E-5.

TABLE E-5

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Property Subject to Flooding
Public and Nonprofit Facilities

Category	Frequency (Years)						
	2	**5**	**10**	**25**	**50**	**100**	**SPF**
Public	1	1	2	13	22	22	24
Nonprofit	0	0	0	0	2	4	7
TOTAL	1	1	2	13	24	26	31

5. Utilities. This category includes 18 electric power substations and related utility facilities as well as electric power lines, improvements to the land including the water, telephone, sewage and, and utility meters within the detailed study area.

6. Streets. This category includes all sidewalks, roads, and streets. Measurements of these facilities were made utilizing flooded area maps developed for this study. Table E-6 shows the results of such measurements by node and flood frequency. The 100-year flood affects approximately 11.7 kilometers of roads and streets.

TABLE E-6

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Property Subject to Flooding
Kilometers of Streets and Highways

Reaches	Frequency (Years)					
	5	10	25	50	100	SPF
1	0.32	0.88	1.87	3.78	4.69	5.64
2	1.40	1.93	3.03	5.67	7.00	9.32
Total	1.72	2.81	4.90	9.45	11.69	14.96

D. Assessment of Property Values

1. General. Structure and content values were developed for each facility/structure under each land use category within the floodable area of the detailed study area. The structures values were based on construction cost estimates and comparable appraisal and sales data. Sources of information include construction cost estimates in the Ponce and Mayagüez area, the PR Appraisers Comparable Sales Data System Report, Municipal Property Registry Sales Data Bank and the PR Regulations and Administration Construction Cost Data System data. The physical condition of each structure was observed and values determined following accepted appraisers procedures. These values were adjusted downward to account for depreciation of structures resulting from obvious physical, functional or external obsolescent. Value of land was not included in the structure value assessment. Content values in the case of residential structures were established on the basis of data collected for similar developments for recently completed flood control studies while in the case of commercial facilities they were mostly established on the basis of interviews with businessmen.

2. Residential. For structure value, each house in the study area was visited and measured; its physical condition, including date of construction and first floor elevation determined. Then, a replacement value adjusted for depreciation was determined using construction cost data from sources mentioned above. The residential content values were assessed by comparative analysis with recently completed flood control feasibility studies in Puerto Rico and recent field investigations developed for the Economics Reevaluation of other projects. Comparative analysis was based on similar socio-economics conditions at each site. Experience in other studies performed has shown that content value do not vary significantly through Puerto Rico for similar type of developments and socioeconomic conditions. Table E-7 shows average structure and content values for residential developments by reach.

TABLE E-7

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Average Values of Property Subject to Flooding
Residential Land Use

Reach	Sector	Number of structures	Average values ($ 2003)	
			Structure	Contents
1	Espinar Ward	325	34,800	11,300
2	Aponte Public Housing	31	125,000	23,000
3	Aguadilla urban Area	441	46,200	17,100
	TOTAL DETAILED STUDY AREA	797	44,616	14,694

3. Commercial and other land uses. Structure values for commercial uses were established following same procedure as with the residential structures. Their content however were based on specific inspections and interviews with owners and managers of the facilities as well as on previous data developed for other projects.

Values for public, non-profit, and utilities facilities were determined utilizing comparable data from recent studies. Utility values were provided by the PR Aqueduct and Sewer Authority, PR Electric and Power Authority and the PR Telephone Company. Table E-8 shows structure and content value for commercial land uses, while Table E-9 shows corresponding values for other land uses.

TABLE E-8

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
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Estimated Value of Structures and Contents
Commercial Facilities

Land Use Category	Number of Structures	Total Values ($2003)	
		Structure	Contents
Commercial Category 1	38	2,282,388	2,403,796
Commercial Category 2	6	438,675	519,100
Commercial Category 3	34	1,054,755	567,721
Commercial Category 4	7	638,300	15,371,368
Commercial Category 5	9	1,316,000	7,477,000
Commercial Category 6	1	70,000	250,000
Commercial Category 7	1	39,375	50,000
Total Commercial Use	96	5,839,493	26,638,985

Table E-9

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Value of Structures and Contents
Public, Nonprofit and Utilities

	Number of Structures	**Total Values ($2003)**	
		Structure	**Contents**
Public	24	1,952,995	4,429,921
Nonprofit	7	498,750	67,302
Utilities	18	1,836,538	350,000
Total Public, Nonprofit and Utilities	**49**	**4,288,283**	**4,847,223**

4. Other property (external to main structure). This property refers to lawns, yards, parking areas, fences, automobiles, and other facilities outside the main structures. Values for these were obtained through field visits and were integrated with their corresponding land use.

E. Depth-Damage Relationships

Depth-damage relationships for the residential, commercial, and public land uses developed for the Río Puerto Nuevo Survey Report (Jacksonville District, 1984) were utilized to estimate flood damages for existing development. These damage curves were developed using historical data on flood damages throughout the island.

The depth-damage curves are developed on a percentage basis were generated for the residential, commercial, public schools and nonprofit organizations land uses. Available historical damage data for comparable areas throughout the island allowed the establishment of relationships between depth of water and percentage damage potential to structure and contents for the facilities mentioned. Such data were not available for some land uses and the depth-damage relationships were established on an absolute basis from information provided by representatives of these land uses. Below a description of the procedure followed in the development of the depth damage curves.

1. Residential. To determine the damage susceptibility of residential structures, the actual damages to 250 comparable structures throughout Puerto Rico during the floods of Eloise (1975) and other most recent hurricanes were analyzed. The data was obtained from the Damage Survey Reports (DSR) of the Federal Emergency Management Agency (FEMA). Restoration of damages was executed under the Minimum Repair Program of that agency. For each residential structure the cost of replacing or repairing the structural damages was divided by the total estimated value of the structure. A minimum-least-squares curve of the percentages of structural damages related to the depth of water was fitted to the data. The curve was used to determine structural damages to all residential structures within the flood plain. Most of the structural damages are to the following categories: electric system, plumbing system, windows, doors, air conditioning units, water heaters, kitchen cabinets, built-in stoves and ovens, bathroom fixtures, wall-to-wall carpeting, paint, and other furnishings. The foundations and the structures do not suffer significant damages because they are primarily built of reinforced concrete. These are affected mostly in areas near the riverbanks where velocities are significant. Due to lack of data, relationships between velocities and damage potential could not be developed and were not considered. To determine residential content damage susceptibility, actual damages to content in 30 residential structures in the Puerto Nuevo area during the 1977 flood were analyzed. These data were obtained from the Small Business Administration records on disaster loans to residents in the area and from records of flood insurance policy claims from the National Flood Insurance Program (NFIP). The value of contents damaged was divided by estimates of the total value of contents, and a minimum-least-square regression of percentage of content damages to depths of water was fitted to the data. This curve

was then used to determine damages from different flood stages to the contents of residences throughout the flood plain. Figure E-3 shows the curves. The historical depth of water was obtained from the U.S. Geological Survey records and residents of the area. These curves were updated in 1987 using actual flood damages to 98 housing structures from the 1985 floods along the Río Cibuco, Vega Baja, Puerto Rico.

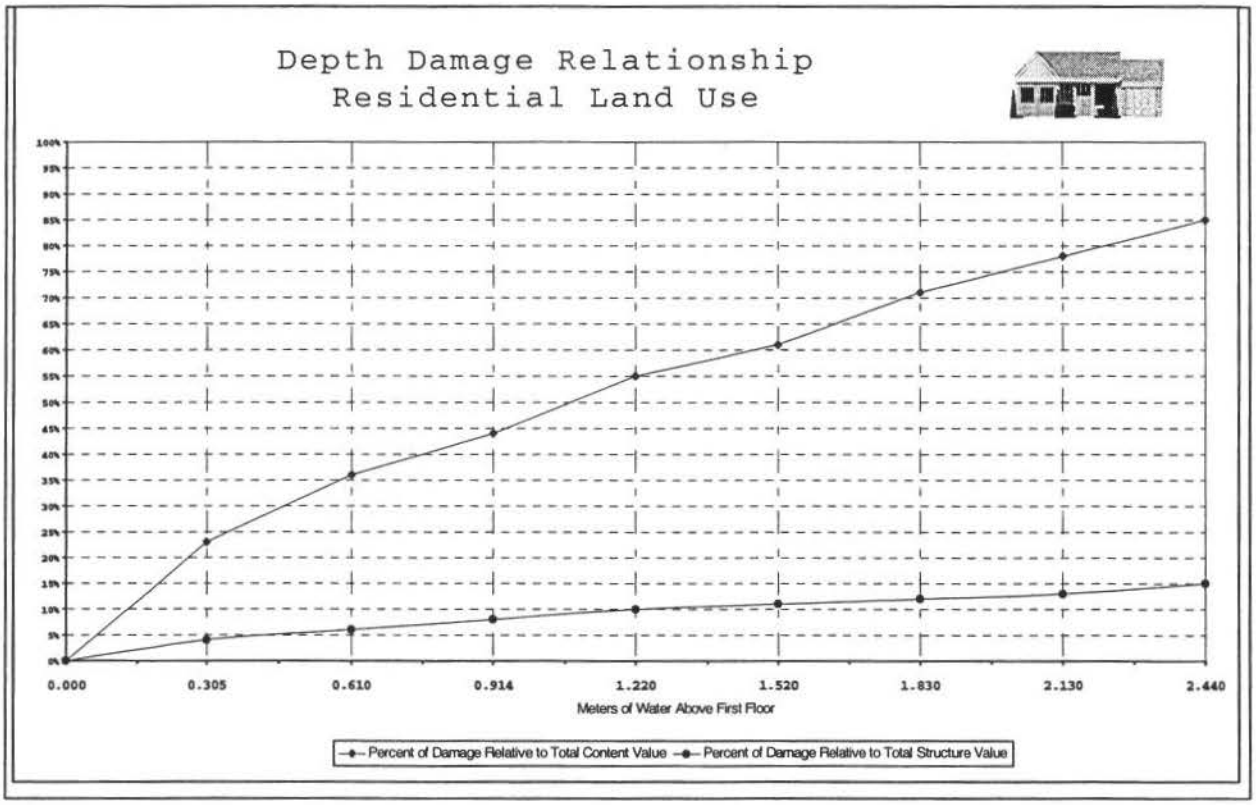


Figure E-3

2. Commercial establishments. Curves derived for the various categories of commercial establishments for the Río Puerto Nuevo area were developed during 1990 by a professional appraiser with considerable experience in investigating claims under the National Flood Insurance Program (NFIP).

Average damages in terms of a percentage were determined by the analysis of claims under the NFIP. Empirical data were used to develop damages for floodwaters of less than 1.22-meter depth. Percentage figures for damages occurring at depths over 1.22 meters were estimated by the appraiser on the basis of professional judgment. Although similar in nature, different types of businesses show different contents damage percentages since the merchandise is displayed differently. For commercial facilities, major structural damages consist of the electrical system, plumbing facilities, door, windows, air conditioning units, and other furnishings.

In some instances, a total loss at 1.22, 2.1, or 2.44 meters depth has been considered. In other cases, total loss occurs at a higher water elevation. The

average floor-to-ceiling height in an average commercial building is between 2.44 and 3 meters, while other types of businesses have higher ceilings and some property is stored or placed above 2.44 meters.

Figures E-4 to E-10 present the depth-damage percentage relationships for he various commercial categories found in the study area. As indicated previously, these are categories 1, 2, 3, 4, 5, 6, and 7.

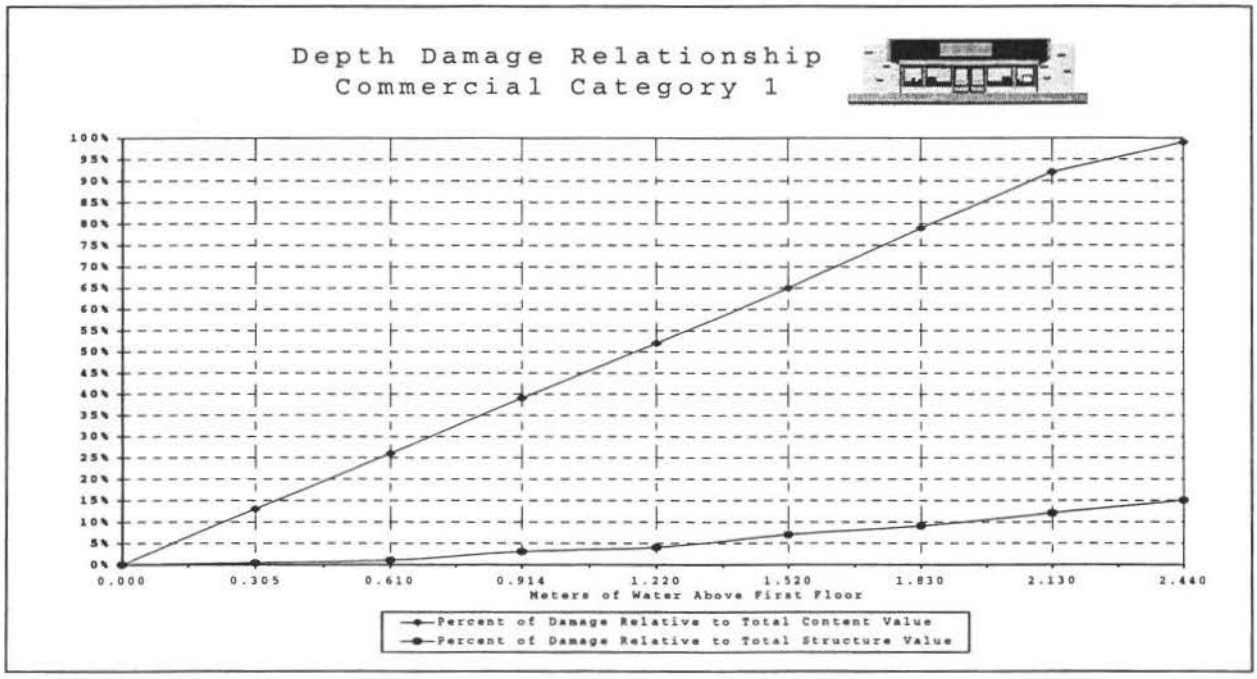


Figure E-4

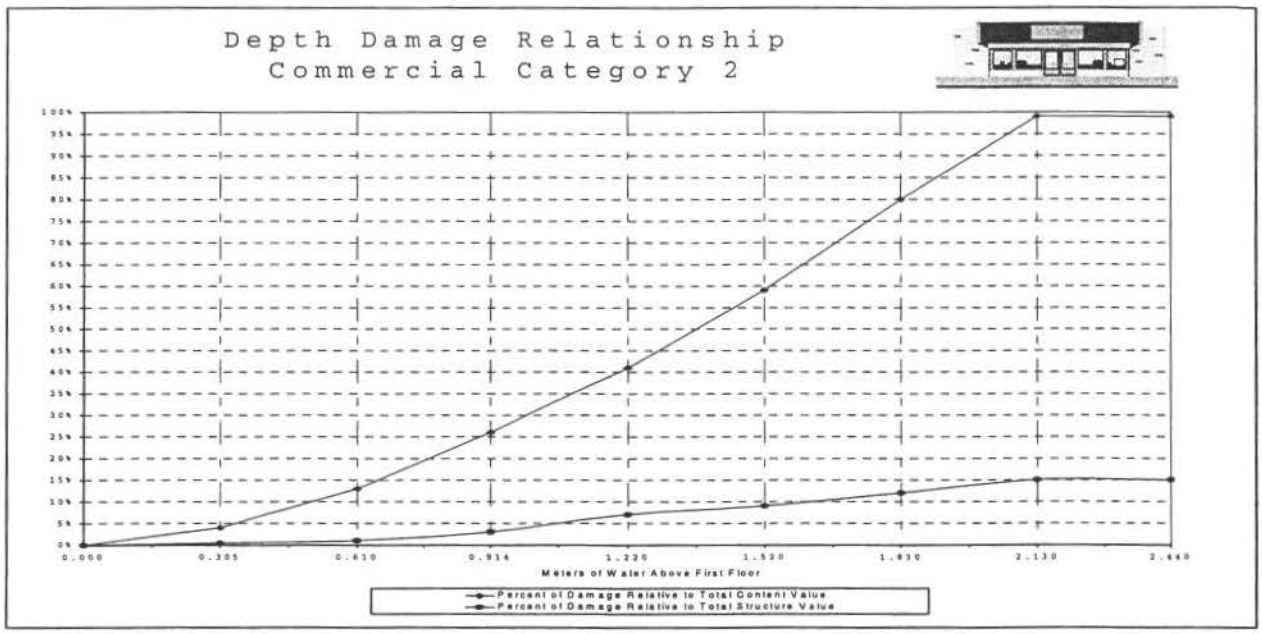

Depth Damage Relationship
Commercial Category 2
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0.000
0.305
0.610
0.914
1.220
1.530
1.830
2.130
2.440
Meters of Water Above First Floor
Percent of Damage Relative to Total Content Value
Percent of Damage Relative to Total Structure Value

Figure E-5

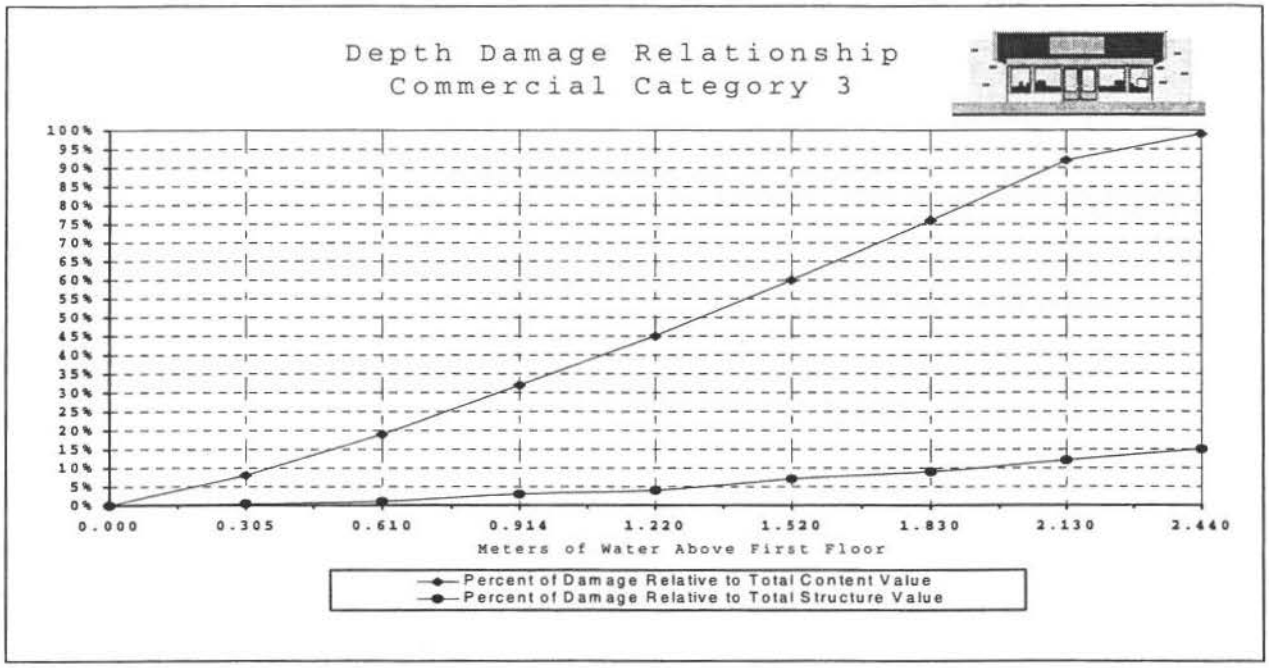


Figure E-6

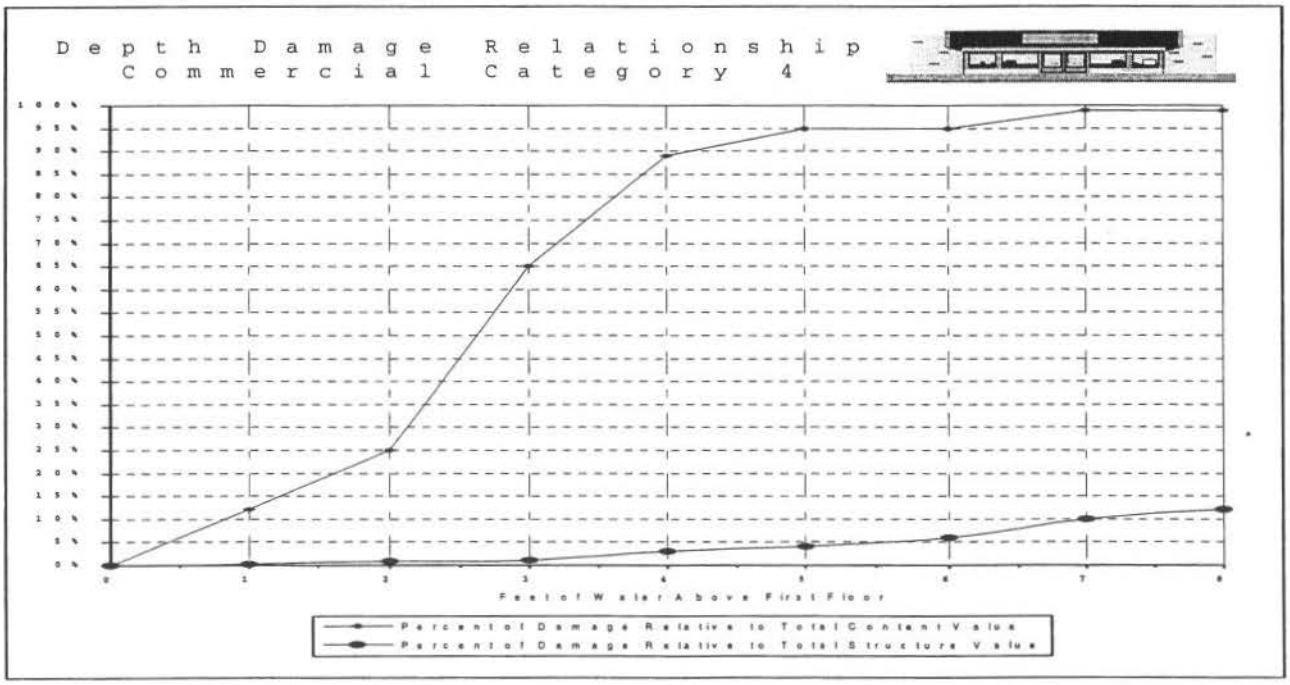


Figure E-7

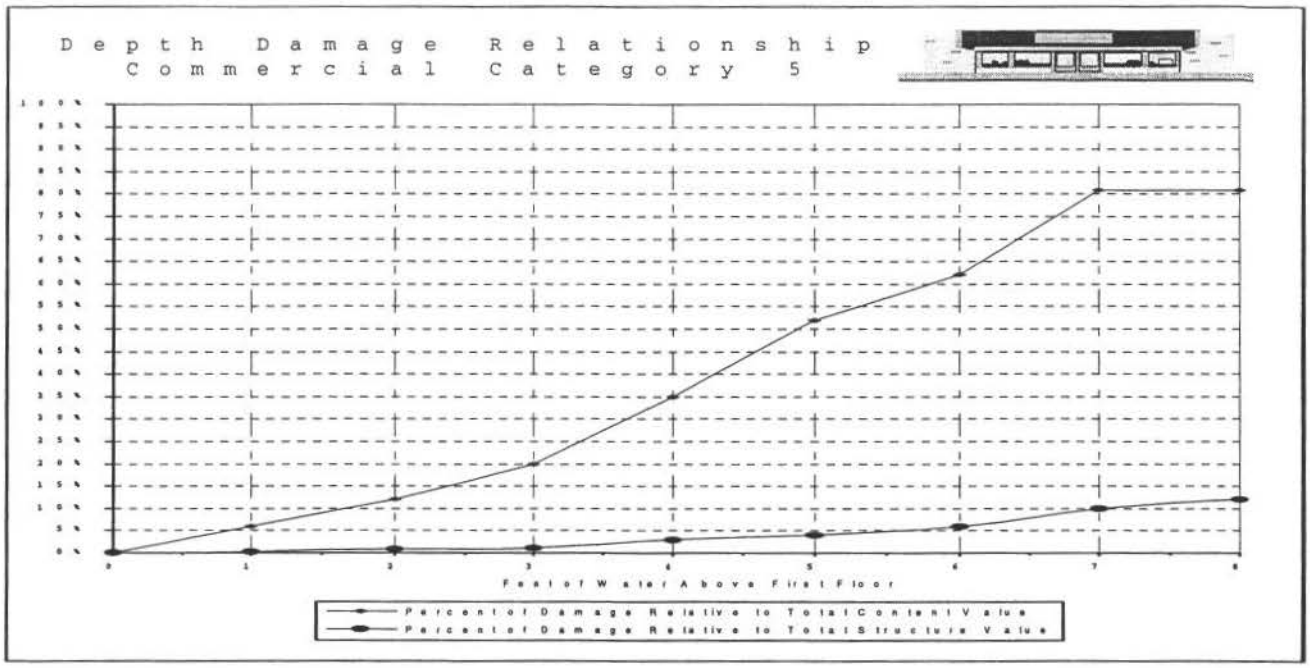


Figure E-8

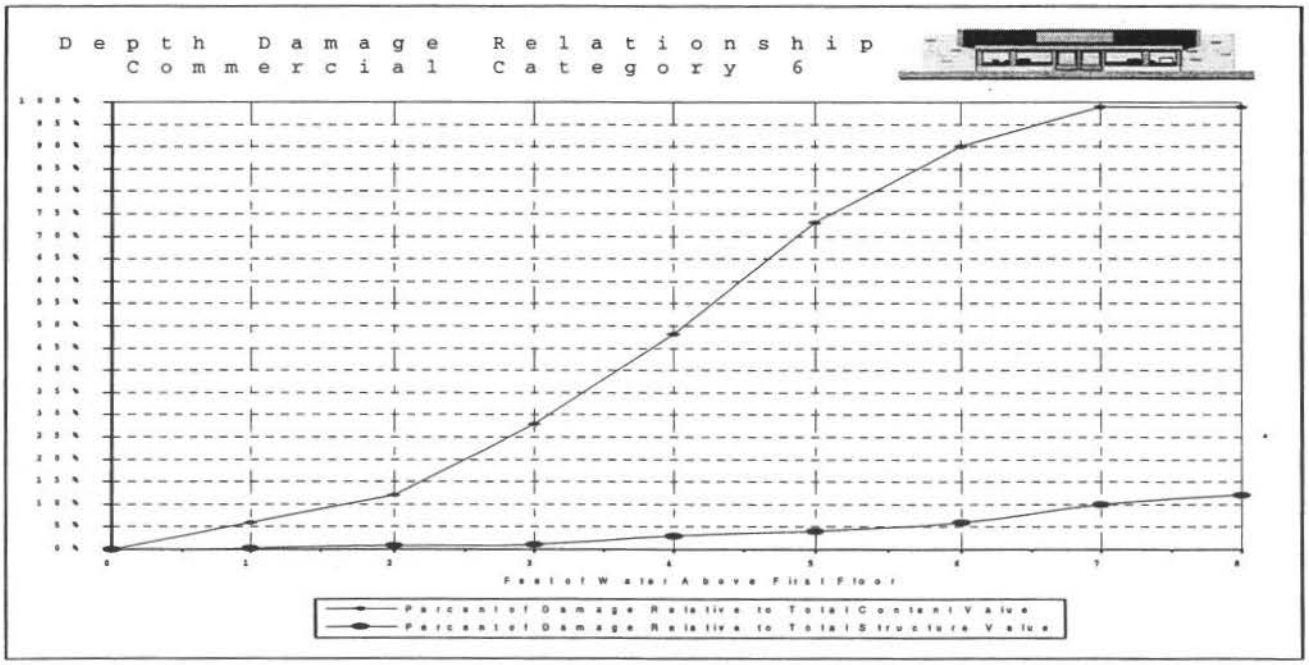


Figure E-9

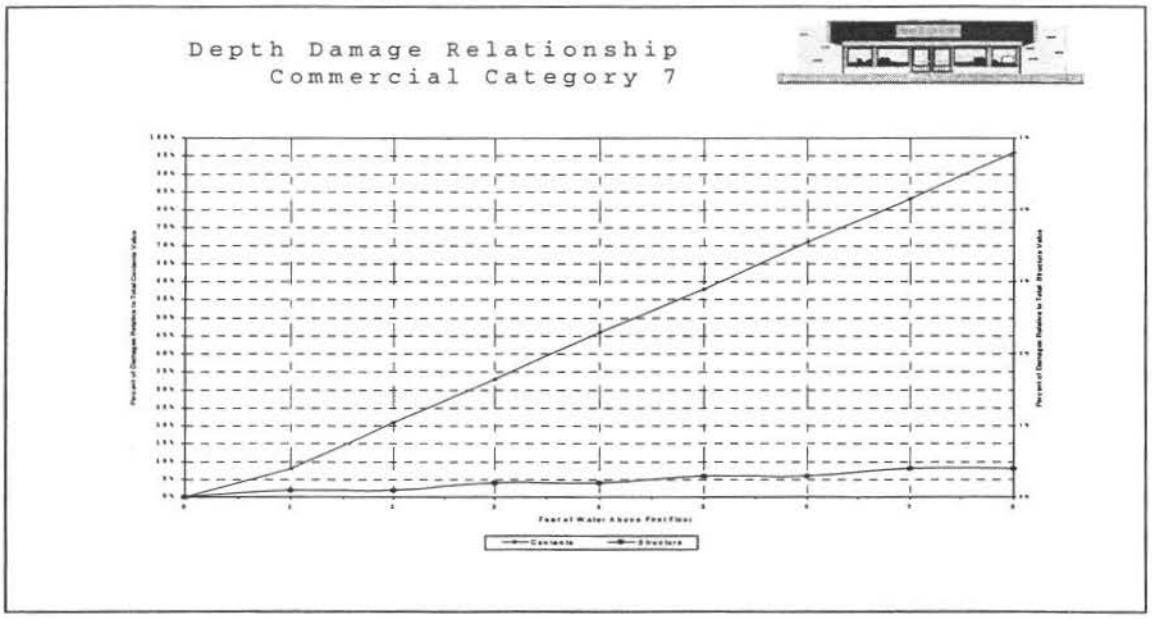


Figure E-10

3. Public buildings and offices. Damage estimates to structure and contents of public buildings and offices were established using the depth-damage relationship developed for elementary schools. For school buildings, data provided by the Superintendent of Schools, the school directors, the Public Buildings Authority, and the General Services Administration were used to develop basic depth-damage relationships. Figures E-11 and E-12 show damage curves for school facilities.

4. Utilities. Cleanup and cost of repair for water, sewage, electric, gas and telephone lines, meters, and cable TV external facilities were estimated at $2,000 per 4,000 square meters of developed land in the detailed study area. These figures are based on field observations and discussions with representatives from public agencies and private enterprises that administer the various utilities. The damage potential of specialized equipment at electric substations was assessed through discussions with electric utility engineers.

5. Roads and streets. Damage to roads and streets were estimated applying a percentage of the cost of repair per kilometer to the number of kilometers flooded for each flood frequency analyzed. Damage per kilometer was developed through discussions with officials of the San Juan Regional Office of the Department of Transportation and Public Works (DTPW). Analysis of current road construction and repair costs was obtained from variety of source. In accordance with DTPW, the total cost of repairing a badly damaged two-lane highway is $79,600 per kilometer. Damages to roads and streets during the flood events analyzed were estimated as a function of the water elevation above the surface of the pavement. A ceiling of 80 percent of the estimated maximum potential restoration cost was established in the evaluation of damages for the worst condition in this category of land use. Damages to

streets were estimated at 75 percent of the road damage per kilometer following the same procedure as indicated above.

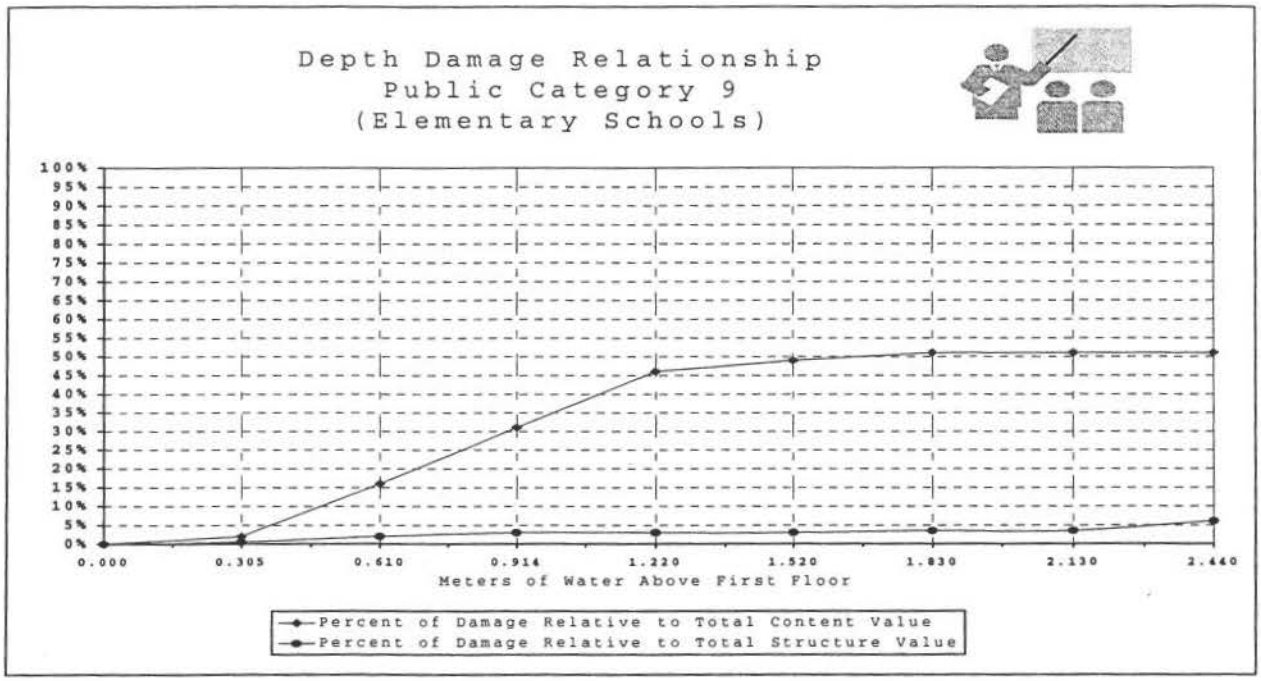


Figure E-11

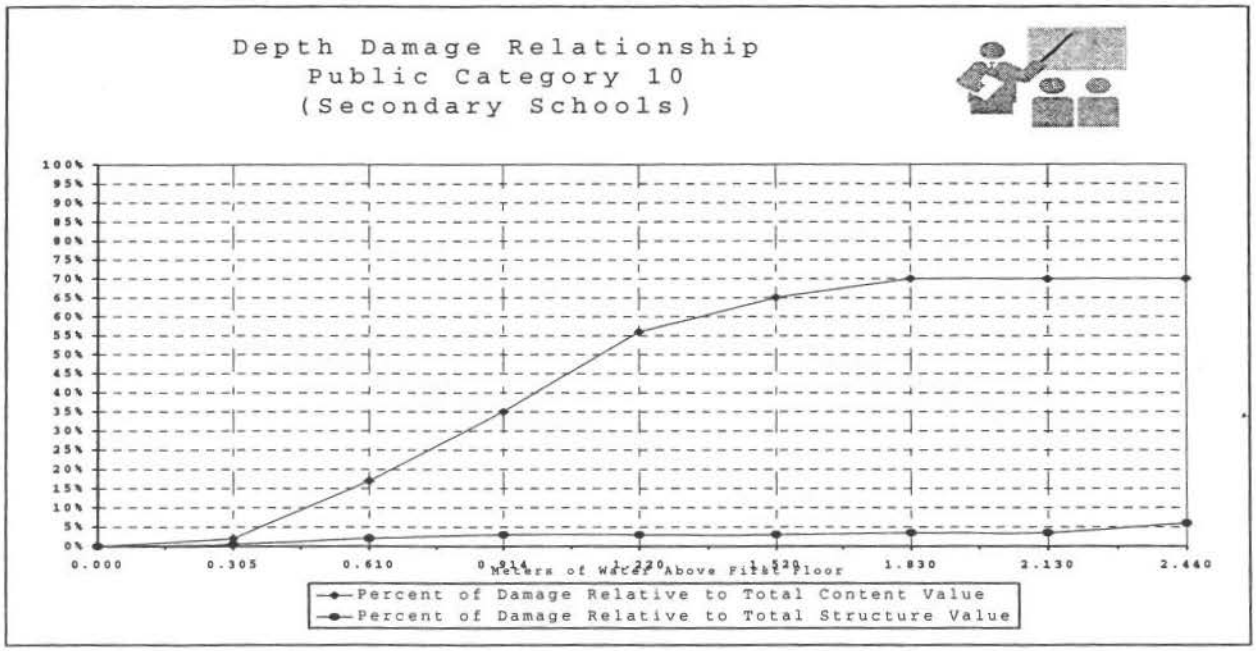


Figure E-12

6. Nonprofit organizations. Damage potential to the structures and contents of these facilities were developed using the depth-damage relationship for elementary schools. This is shown in Figure E-13.

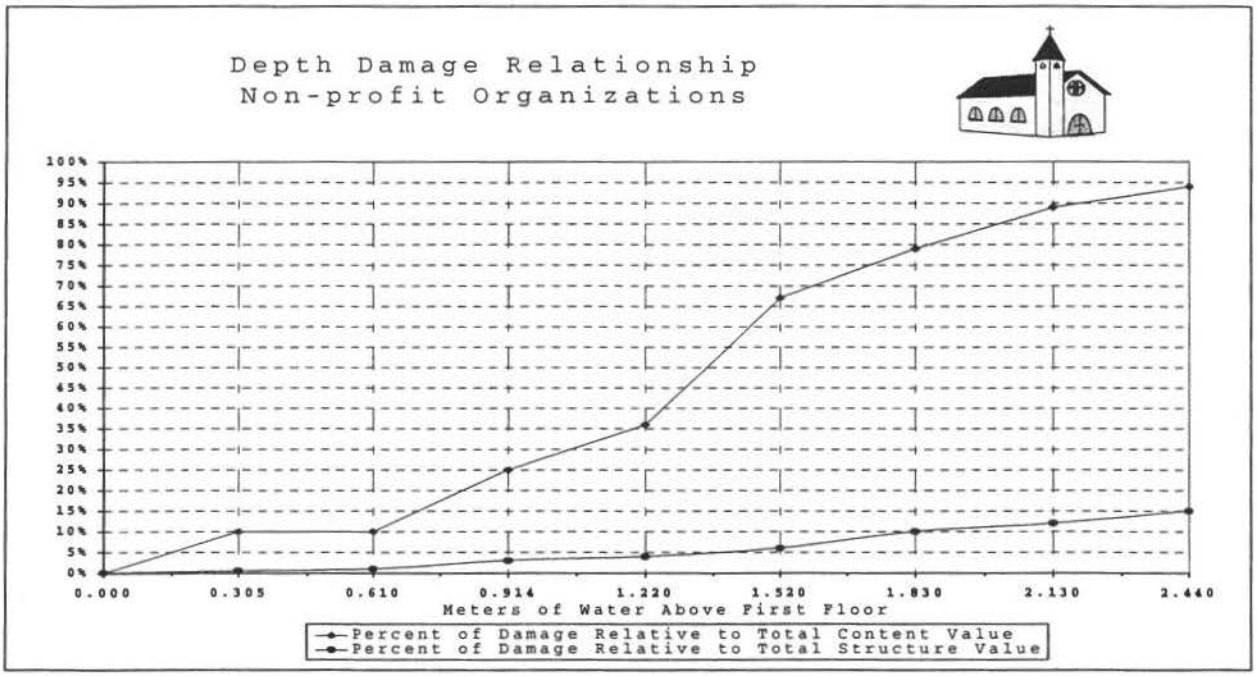


Figure E-13

F. Flood Damage

1. Historical floods. There is considerable descriptive information about the events that occurred in October 1985, April and May 1986, January 1992, September 1998 and most recent events, which took place during 1996-1998 (refer to Section V11.A.2 of Main Report). However, quantitative data on damage is very limited.

2. Potential damage. Flood damage according to flood frequency for residential, commercial, public, and nonprofit land uses were estimated utilizing a computer program developed at the Antilles Office. The program relates the depth-damage relationships previously considered to the value of structure and contents of different land uses subject to flooding given the first floor elevation of each structure. This provides information of potential damage for each flood frequency event.

To compare alternative plans average annual and cost and average annual equivalent damage are computed. This equivalent value represents a uniform distribution of annual values and is computed by discounting and amortizing each year's expected annual damage figure over the period of analysis, taking into account the time value of money associated with damage estimates. Expected annual damage and equivalent annual damage were computed utilizing the Expected Annual Flood Damage Computation Model developed by the Hydrologic Engineering Center, U.S.

Army Corps of Engineers. Potential damage were estimated at the beginning of the study using the 1999 price levels for structure and content values and were discounted at 6-7/8, the prevailing interest rate for the time of analysis for the first 50 years of the project life. During a recent field visit, it was noted that the original damage conditions for the entire study area have not experienced any significant change. Final analysis for the estimated damage assessment considers the FY 2003 price levels discounted at the 5 7/8 percent interest rate for the first 50 years of the project life.

a. Existing conditions. Table E-10 shows flood damage estimates for single events and land use categories under existing conditions. Total expected damages for the study area range from $531,000 for the 2-year event to over $12,000,000 for the 100-year flood.

TABLE E-10

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Flood Damages for Single Flood Events
Without Project Conditions
($1,000 of 2003)

Damage Category	Frequency (Years)						
	2	5	10	25	50	100	SPF
Residential	177	508	1,206	2,235	4,529	5,180	11,109
Commercial	94	105	238	349	4,294	4,318	15,759
Public	54	54	129	207	371	371	1,521
Nonprofit	0	0	0	0	3	12	43
Utilities	206	382	627	843	1,297	2,007	2,282
Streets and Highways	0	7	22	50	153	222	546
TOTAL PER LAND USE	**531**	**1,056**	**2,222**	**3,684**	**10,647**	**12,110**	**31,260**

3. Expected annual flood damage. Expected annual damage for existing conditions (2003) are shown on Table E-11. These expected damage, which total $1,157,600, were derived through a damage-frequency analysis. The damage frequency integration technique was used to transform flood event damage for each of the land use categories analyzed into expected average annual damage.

TABLE E-11

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Expected Annual Flood Damages Existing Conditions
(In $1,000 of 2003)

DAMAGES CATEGORY	ESPINAR	AGUADILLA	TOTAL
Residential	191.0	322.6	513.6
Commercial	2.0	274.3	276.3
Public	1.5	67.9	69.4
Non-profit	0.2	0.2	0.4
Utilities	20.9	265.5	286.4
Streets and Highways	3.5	8.0	11.5
TOTAL EXPECTED ANNUAL DAMAGES	**219.1**	**938.5**	**1,157.6**

Source: U.S. Army Corps of Engineers. Estimates developed applying Expected Annual Damages Model program Hydrologic Engineers Center. October 2003. Current discount rate: 5-7/8%

III. NATIONAL ECONOMIC DEVELOPMENT BENEFITS

A. General

This section describes the procedures utilized to estimate the various categories of national economic benefits analyzed for assessing flood control plans for the detailed study area. It also presents aggregate cost data of the plans considered. [2] Costs are discussed in detail in Appendix C, Design and Cost Estimates, while the flood control plans are described in detail in the Main Report.

B. Categories of Benefits Considered

1. Inundation reduction. Reduction of physical damages to property, experienced by occupants of the floodplain, is considered a contribution to income at the national level. The difference between expected physical annual damages expressed in monetary terms under with and without projects condition for each plan was taken as the contribution (the benefits) of that plan. Appropriate multiple frequency computations of hydrologic and hydraulic conditions and stage-damage relationships were used to estimate physical flood damages in the area.

Utilizing the depth/damage relationships previously discussed and flood stage data developed as discussed in Appendix A, Hydrology and Hydraulics, residual

[2] The total first cost for the recommended plan was updated to reflect cost growth from October 2001 to October 2003. Refers to Table C-1, Appendix C, MCACES report, October 2003.

damage estimates were developed for each land use category and level of protection. The plans are discussed in detail in the Main Report. Inundation reduction benefits for each of the candidate flood control plans are presented on Table E-12. Residual damages are also presented on Table E-12.

TABLE E-12

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Inundation Damages Reduction Benefits
by Plan and Land Use
($1,000 of 2003)

Land Use	SPF Levee		100 Year Levee		50 Year Levee	
	Damage Reduced	Residual Damage	Damage Reduced	Residual Damaged	Damage Reduced	Residual Damaged
Residential	513.6	0.0	461.6	52.0	408.3	105.3
Commercial	276.3	0.0	202.5	73.8	158.6	117.7
Public	69.4	0.0	62.3	7.1	58.5	10.9
Non-profit	0.4	0.0	0.2	0.2	0.04	0.3
Utilities	286.4	0.0	275.7	10.7	255.0	31.4
Streets & Highways	11.5	0.0	8.9	2.6	6.7	4.8
TOTALS	**1,157.6**	**0.0**	**1,011.2**	**146.4**	**887.1**	**270.5**

Source: U.S. Army Corps of Engineers. Estimates develop applying Expected Annual Damages Model program Hydrologic Engineers Center. October 2003. Current Discount rate: 5-7/8%

2. Employment benefits. The basis for considering this benefit is contained in ER 1105-2-100, which is quoted in part. "Benefits from use of otherwise unemployed or underemployed labor resources may be recognized as a project benefit if the area has substantial and persistent unemployment at the time the plan is submitted for authorization and for appropriations to begin construction. Substantial and persistent unemployment exists in an area when: The current rate of unemployment, as determined by the appropriate annual statistics for the most recent 12 consecutive months, is 6 percent or more and has averaged at least 6 percent for the qualifying time periods. The annual average rate of unemployment has been at least: (a) 50 percent above the national average for three of the preceding four calendar years, or (b) 75 percent above the national average for two of the preceding three calendar years, or (c) 100 percent above the national average for one of the preceding two calendar years." Consequently, this benefit was considered for the study area.

The NED benefit considered for employment benefits is limited to payments to unemployed and underemployed labor resources directly utilized in the construction and installation of the project and labor used for operations and maintenance.

The unemployment rate in Puerto Rico has been very high as compared to the national average. The average annual rate of unemployment for Puerto Rico was estimate in 12.3 percent for the year 2002. United States National unemployment rate (annual average) for the same period was estimate in 5.8 percent. The unemployment remains as one of the major socioeconomics problems in Puerto Rico.

For determining the portion of construction labor cost allocated to the unemployed, it was assumed that 20 percent of the total construction cost of the project would be used for the wages and salaries of the construction workers. This figure was arrived at on the basis of information provided by representatives of the local private construction industry contacted through telephone calls, data obtained from the Unemployment Insurance Bureau of the Puerto Rico Department of Labor and Human Resources and from the Rio Puerto Nuevo Flood Control Project currently being built under the supervision of the Corps of Engineers in the San Juan Metropolitan Area.

To determine the relative amount and classification of labor, an analysis of the construction schedule at the river stream was made. The percentage distribution for the various categories is as follows:

Skilled	-	77%
Unskilled	-	20%
Others	-	3%

These percentages were determined from actual data from the Río Antón Ruiz project in Humacao, Puerto Rico. This project consists of levees and channel diversion. It was assumed that labor would remain constant during the construction phase due to the nature of the project and the location of the project in the eastern region of the island.

Wages and salaries used to employ workers pull out from the unemployed pool for each category of workers were determined on the basis of an analysis of empirical data from the Río Antón Ruiz. Percentages determined are as follows:

Skilled	-	60%
Unskilled	-	37%
Others	-	3%

These benefits are included as part of the recommended plan and were amortized at FY 2003 interest rate of 5 7/8 percent. The annual benefits over the 50-year life span of the project results in annual equivalent employment benefits of $19,525.

3. Reduction in Flood Insurance Overhead. With a flood control project in place, occupants of the previously floodable land are not required to flood insurance protection for projects providing 100 year or higher level of protection. It is appropriate to claim as a benefit the expense of servicing these policies and a pro-rata share of FIA's administrative costs. The computation process for the flood insurance costs saved, which are claimed as a benefit of the project, consist in applying to the number of the residential structure subject to flooding FEMA existing island wide percentage (24.6%) of flood insurance policies.

Then, multiplying the resultant figure by the current administrative cost of flood insurance policy. The annual administration cost for flood insurance policies for fiscal year 2003 are estimated in $133 per policy according to the Economic Guidance Memorandum 03-03, of the National Flood Insurance Program Operating Cost. This results in cost saved adding to $27,810 annually for the entire project.

C. Benefits and Costs Analysis.

The total first costs, interest during construction, total investment costs, and annual cost estimates for the alternative plans that were under consideration during FY 1999 are indicated on Table E-13. The evaluation of final plans was performed following ER-1105-2-100 (Principles and Guidelines) procedures. These plans were evaluated at 6 7/8 percent, the prevailing interest rate at the time of analysis during FY 1999. Alternative structural plans for the SPF Plan, the 100-year Plan and the 50-year Plan were considered in the economics for each alternative plan. The 100-year plan had the highest net benefits of $424,000 and was selected as the NED plan with a Benefit to Cost ratio of 2.4 to 1.0. Refer to Table 4, page 33, of the Main Report.

TABLE E-13

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Economic Costs of Alternative Plans
($1,000 of 1999)

Cost Item	Structural Alternatives		
	SPF	100 Year	50 Year
PROJECT COST			
Total Construction Cost	$4,476	$2,781	$2,711
Pre-Construction Eng. and Design	403	250	244
Construction Management	448	278	271
Lands and Damages	720	646	646
Total First Cost	**6,047**	**3,955**	**3,872**
Interest During Construction	205	127	124
Total Investment Cost	**6,252**	**4,082**	**3,996**
Annual Investment Cost	431	282	276
Annual O&M Cost	25	20	20
TOTAL ANNUAL COST	**$456**	**$302**	**$296**

Source: U.S. Army Corps of Engineers. Note: These plan were evaluated at 6 7/8 percent, the prevailing interest rate at the time of analysis during FY 1999.

Table E-14 presents the revised economic analysis for the final assessment of the 100-year plan. The 100-year plan remains as the NED plan recommended. The NED plan was further analyzed and revision of all inundation reduction benefits and other benefits were taken into account following the guidance of ER-1105-2-100. All benefits were evaluated at 5 7/8 percent, the prevailing interest rate for FY 2003. This assessment provides current data for the flood damages reduction benefits considered with the implementation of current construction of the project.

The economics of the recommended plan is shown in Table E-14 for the entire project. The total first cost of the plan [3] is $4,751,400, net benefits are $740,400 and its Benefit to Cost Ratio is 3.3 to 1.0.

[3] The cultural resources preservation was not included as part of the total first cost of the recommended plan for the economic analysis purpose only. ER 1105-2-100 (22 April 2000).

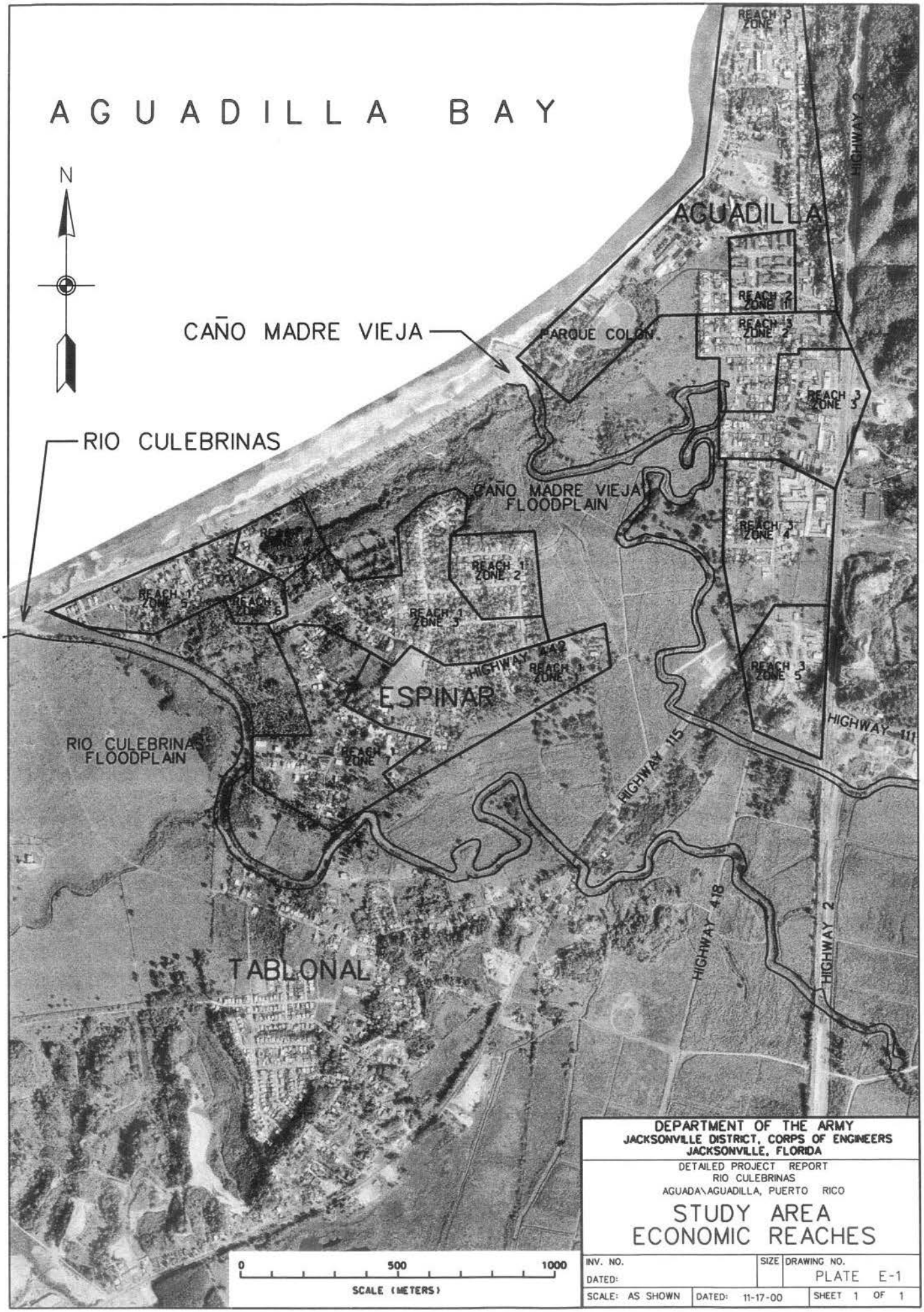
TABLE E-14

RIO CULEBRINAS AT AGUADILLA AND AGUADA, PUERTO RICO
DETAILED PROJECT REPORT

Economics of the Recommended Plan
(In $1,000 of October 2003)

	ESPINAR LEVEE	AGUADILLA LEVEE	ENTIRE PROJECTS
PROJECT COST			
Total First Cost *	1,839.2	2,912.2	4,751.4
Interest During Construction	35.6	75.5	111.1
Total Investment Cost	1,874.8	2,987.7	4,862.5
Annualized Investment Cost	116.9	186.2	303.1
Operation and Maintenance	5.0	10.0	15.0
Total Annual Cost	**121.9**	**196.2**	**318.1**
ANNUALIZED BENEFITS			
Inundation Reduction	193.7	817.5	1,011.2
Employment Benefits	6.2	13.3	19.5
Flood Insurance Cost Savings	11.8	16.0	27.8
TOTAL ANNUAL BENEFITS	**211.7**	**846.8**	**1,058.5**
NET NED BENEFITS	**89.8**	**650.6**	**740.4**
BENEFITS TO COST RATIO	**1.7**	**4.3**	**3.3**

Source: U.S. Army Corps of Engineers. Expected Annual Damages Estimates program. October 2003. Current Discount rate: 5 7/8%.
* Cultural Resources Preservation not included.



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DETAILED PROJECT REPORT
RIO CULEBRINAS
AGUADA\AGUADILLA, PUERTO RICO

STUDY AREA ECONOMIC REACHES

INV. NO.		SIZE	DRAWING NO.
DATED:			PLATE E-1
SCALE: AS SHOWN	DATED: 11-17-00		SHEET 1 OF 1