DECEMBER 1991

# GENERAL DESIGN MEMORANDUM

## VOLUME ONE
## MAIN REPORT

# RIO PUERTO NUEVO

# PUERTO RICO

US Army Corps
of Engineers
Jacksonville District

SERIAL NO.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

CESAJ-EN-HH (1110-2-1150a) 20 December 1991

MEMORANDUM FOR CDR, South Atlantic Division, Atlanta, GA 30335-6801

SUBJECT: General Design Memorandum, Rio Puerto Nuevo, Puerto Rico

1. Fifteen copies of the subject report are forwarded for your review. The report consists of two volumes - a main report and appendices. A seventy-minute video of the Rio Puerto Nuevo project was sent to your office in December 1990.

2. The Rio Puerto Nuevo and its tributaries lie in a highly developed area of San Juan, Puerto Rico. Intense development in the drainage basin has altered the natural drainage patterns, significantly increased the runoff water, and restricted the flows in the flood plain. The existing channels and many bridges are undersized and in poor condition. Development extends to the banks of the channels and hinders flood flows. Floods greater than the two-year event cause extensive damage.

3. The design level of protection is for a 0.01-exceedence probability (100-year) flood event. Our recommended plan provides for a project life of 50 years. That plan calls for improvements to 11.2 miles of the Rio Puerto Nuevo and its tributaries. This includes 1.66 miles of bulkheaded trapezoidal channel and 9.54 miles of concrete rectangular channel. Additional components of the plan are two baffle pier stilling areas, three high velocity flow junctions with tributary streams, and two upstream debris basins with side-overflow spillways.

4. The project will remove 20.5 acres of mangroves along the river estuary and Margarita channel. A mangrove mitigation plan, included as Appendix B, achieves 1.5:1 mitigation through replanting of 30 acres of mixed mangroves, all on project lands. This plan responds to recommendations of cooperating agencies. Material from the lower Rio Puerto Nuevo and the Margarita channel is designated for offshore disposal in the San Juan ODMDS, an EPA-approved site. Sampling of proposed dredged material for retesting under the 1991 "Green Book" began in October 1991 and is being coordinated with EPA Region II.

5. I recommend approval of the plan presented in this report.

Encl

for TERRENCE C. SALT
Colonel, Corps of Engineers
Commanding

## SYLLABUS

The Rio Puerto Nuevo Survey investigation was initiated in 1978 at the request of the Commonwealth of Puerto Rico. Flood control studies were conducted under authority of Section 204 of the Flood Control Act of 1970 (Public Law 91-611). The Rio Puerto Nuevo, Puerto Rico, General Design Memorandum (GDM) was authorized as part of the Water Resources Act of 1986, Public Law 99-662, November 17, 1986. This report presents the findings of the investigations and designs performed under that authorization.

The recommended plan presented in this report consists of improvements to 11.2 miles of the existing channel of Rio Puerto Nuevo and Rio Piedras and five tributaries of the Rio Puerto Nuevo basin. The project plan includes 1.66 miles of bulkheaded trapezoidal channel and 9.54 miles of concrete rectangular channel. Additional features include two baffle pier stilling areas, two high velocity flow junctions with tributary streams Buena Vista Diversion Channel and Guaracanal Channel, and two upstream debris basins with side-overflow spillways. Portions of the channel design were physical-model tested by the Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi.

The authorized plan presented in the 1984 Survey Report has been revised for this GDM. They are comprehensive revisions effecting the entire project and hydraulic design concept. Revisions include the deletion of five stilling basins from the various channels and using extended reaches of high velocity channel and high velocity confluence junctions. The revised design is described in detail in Section E, Hydrology and Hydraulics, of the GDM. Neither the design level of protection nor the project purposes have been changed using this new design concept.

It is recommended that the proposed plan for improvements to 11.2 miles of the existing channel of Rio Puerto Nuevo/Rio Piedras and their five tributaries be approved for construction. Total annual investment costs are estimated to be $30.6 million and annual benefits are $73.5 million. The implementation of the project would result in a benefit to cost ratio of 2.4/1.0. The total estimated cost of implementing the project is $303,245,800. Under the current cost-sharing policy, as established in the Water Resources Development Act of 1986, the Federal Government's share would be $227.3 million while the non-Federal share would be $75.9 million.

## PERTINENT DATA

| | |
|---|---|
| **Puerto Nuevo Channel:** | |
| Total channel length (miles) | 6.46 |
| Bulkheaded trapezoidal channel (miles) | 1.66 |
| Concrete rectangular channel (miles) | 4.80 |
| **Margarita Channel:** | |
| Total channel length (miles) | 1.70 |
| Trapezoidal channel (miles) | 1.03 |
| Concrete rectangular channel (miles) | 0.67 |
| **Josefina Channel:** | |
| Concrete rectangular channel (miles) | 1.46 |
| **Dona Ana Channel:** | |
| Concrete rectangular channel (miles) | 0.62 |
| **Buena Vista Diversion Channel:** | |
| Concrete rectangular channel (miles) | 0.80 |
| **Guaracanal Channel:** | |
| Concrete rectangular channel (miles) | 0.16 |
| **Puerto Nuevo Stilling Area:** | |
| Location (station - feet) | 149+80 |
| Channel bottom elevation | Varies |
| Baffle blocks: | |
| Two rows (height - feet) | 8.00 |
| Six rows (height - feet) | 4.00 |

## PERTINENT DATA (cont.)

Margarita Stilling Basin:

| | |
|---|---|
| Location (station - feet) | 54+10 |
| Design discharge (c.f.s.) | 8012 |
| Apron elevation (feet) | -17.87 |
| Apron length (feet) | 65.00 |
| Endsill height (feet) | 1.83 |
| Baffle block height (feet) | 3.67 |
| Number of rows of baffle blocks | 2 |

Puerto Nuevo Debris Basin:

| | |
|---|---|
| Area (acres) | 9.5 |
| Outlet structure type | "L" shaped side discharge |
| Design headwater elevation (feet) | 96.00 |
| Design tailwater elevation (feet) | 86.70 |
| Design discharge (c.f.s.) | 26,123 |
| Crest length-length x width (feet) | 300 x 75 |
| Crest elevation | 87.40 |

Guaracanal Debris basin:

| | |
|---|---|
| Area (acres) | 6.50 |
| Outlet structure type | "L" shaped side discharge |
| Design headwater elevation (feet) | 74.20 |
| Design tailwater elevation (feet) | 72.90 |
| Design discharge (c.f.s.) | 11,075 |
| Crest length-length x width (feet) | 150 x 50 |
| Crest elevation (feet) | 57.60 |

Note: All elevations refer to National Geodetic Vertical Datum (mean sea level of 1929)

**RIO PUERTO NUEVO, PUERTO RICO**
**GENERAL DESIGN MEMORANDUM**

**VOLUME 1**

**TABLE OF CONTENTS**

TABLE OF CONTENTS (Cont.)



F. SURVEYING AND MAPPING

## TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

## TABLE OF CONTENTS (Cont.)

**TABLE OF CONTENTS (Cont.)**

## TABLE OF CONTENTS (Cont.)



## LIST OF FIGURES

## LIST OF TABLES

## LIST OF TABLES (Cont.)



## LIST OF PLATES

### HYDROLOGY AND HYDRAULICS

## LIST OF PLATES (Cont.)

GEOTECHNICAL

## LIST OF PLATES (Cont.)

STRUCTURAL

## LIST OF PLATES (Cont.)

STRUCTURAL

## LIST OF PLATES (Cont.)

STRUCTURAL

## LIST OF PLATES (Cont.)

STRUCTURAL



EXISTING UTILITIES



RECREATION



## VOLUME 2

## APPENDICES

**RIO PUERTO NUEVO, PUERTO RICO**
**GENERAL DESIGN MEMORANDUM**

## A. INTRODUCTION

1. Authorization. The Rio Puerto Nuevo Survey Investigation was initiated in 1978 at the request of the Commonwealth of Puerto Rico. It was conducted under the authority of Section 204 of the Flood Control Act of 1970 (Public Law 91-611).

The General Design Memorandum for the project for flood control, Rio Puerto Nuevo, Puerto Rico, was authorized as a part of the Water Resources Development Act of 1986, Public Law 99-662, November 17, 1986.

2. Scope and Purpose. This report presents the designs for channel improvements for the Rio Puerto Nuevo/Rio Piedras and its tributaries within the project scope presented in the 1984 Survey Report. This project is designed to provide 0.01 exceedence probability (100-year) flood protection for the areas adjacent to the Puerto Nuevo Channel and its tributaries.

3. Local Cooperation. A Local Cooperation Agreement (LCA) will be required between the U.S. Army Corps of Engineers and the local sponsor. The LCA is a legally binding document between the Federal government and the local sponsor identifying the sponsor's duties and obligations for this project. However, in accordance with current Federal policy, the LCA cannot be executed until construction funds for the project have been appropriated. Details regarding the LCA are described in Appendix F.

The Department of Natural Resources (DNR) as the sponsor and a representative of the Commonwealth of Puerto Rico has clearly expressed their strong support for the proposed flood control project. The DNR has the institutional responsibility for the planning, programming and construction of flood control measures for Puerto Rico and receives an annual allotment to accomplish this mission.

Flood waters from the Rio Puerto Nuevo represent a continuous threat to a significant portion of the population and the economical activity of the San Juan Metropolitan area with over one million people as residents. The DNR has been considering and programming for the construction of a flood control project for Rio Puerto Nuevo since the early 1970's.

The DNR has been programming funds and coordinating with other local agencies (i.e., Puerto Rico Highway Authority, PR Power Authority, etc.) for land acquisition, bridge replacements, and service line relocations since the completion of the survey report. DNR is currently programming funds in accordance with the latest project management plan. They have also initiated the land acquisition process for the first phase of the project.

The Commonwealth of Puerto Rico, Department of Natural Resources, is the body authorized to represent the local interest and is responsible for complying with the following requirements:

a. Flood control local cooperation requirements.

(1) Provide a cash contribution equal to five percent of total project costs;

(2) Provide all lands, easements, rights-of-way, relocations (except railroad bridge alterations), and dredged material disposal areas (referred to as LERRD);

(3) Provide an additional cash payment when the sum of items (1) and (2) are less than 25 percent of total project costs;

(4) Operate and maintain the project after completion, including accomplishment of any needed replacements or rehabilitations of any of its components (referred to as OMR&R);

(5) Hold and save the United States free from damages due to the construction or subsequent maintenance of the project, except damages due to the fault or negligence of the United States or its contractors;

(6) Prevent future encroachments which might interfere with proper functioning of the project;

(7) Participate in and comply with applicable Federal flood plain management and flood insurance programs (i.e., the National Flood Insurance Program), pursuant to Section 402, Public Law 99-662; and,

(8) Provide guidance and leadership to prevent unwise future development in the flood plain.

b. Recreation local cooperation requirements.

(1) Provide one-half of the separable first cost of post authorization planning and construction of recreation facilities, including project land acquired specifically for recreation; and,

(2) All costs and full responsibility for the operation, maintenance, replacement, and management of recreation lands and facilities.

4. <u>Prior Studies and Reports</u>.

a. Rio Puerto Nuevo Survey Report dated October 1984.

b. Phase 1 GDM, San Juan Harbor dated March 1982.

c. Agua - Guagua Project Final Letter Report dated August 1983: Dredging Martin Pena Navigation Channel.

## B. PROBLEM IDENTIFICATION

5. Location and Description of Area. The Rio Puerto Nuevo drainage basin is located within the San Juan Metropolitan Area along the northern coast of Puerto Rico. The basin joins the southeast side of San Juan Harbor and extends south and up into the foothills of the central mountains of Puerto Rico. The basin is traversed by the Rio Piedras, Rio Puerto Nuevo, Quebrada Margarita, Quebrada Josefina, Quebrada Dona Ana, Quebrada Buena Vista, and Quebrada Guaracanal. The study area and these streams are shown on the site plan, Plate H-1.

There are over 240,000 people living in the 25-square mile drainage basin. The area is over 75% developed and is expected to be 100% developed by the year 2000. Over 5,700 families would be subject to flooding from the 100-year flood under existing conditions. The average annual rainfall is about 71 inches.

6. Existing Conditions. Intense development in the basin has altered the natural drainage patterns, significantly increased the runoff rates and restricted the flows in the flood plain. More than thirty bridges have been identified as impeding flood flows and causing increased flooding. Development has progressed to the point where some of the tributary channels are not capable of carrying the two-year storm without causing flooding. In many areas, houses and other buildings are built adjacent to the banks of the channels and further restrict flood flows.

7. Problems and Needs. The existing channels and numerous bridges are undersized and in poor condition. Development frequently extends to the banks of the channels and hinders flood flows. Extensive damage is caused by any flood that exceeds the two-year storm. Improvements are needed for the channels and bridges located within the study area.

## C. DESCRIPTION OF SELECTED PLAN

8. General. The proposed plan calls for improvements to 11.20 miles of the existing channel of Rio Puerto Nuevo and Rio Piedras and five tributaries of the Rio Puerto Nuevo drainage basin. The 25-square mile drainage basin drains into Bahia de San Juan (San Juan Harbor). The project plan of improvement is shown on Plate H-1. Originally, only the lower reach of the Rio Piedras was known as the Rio Puerto Nuevo. For ease of reference, the entire river in this report will be referred to as the Rio Puerto Nuevo. A distinction will be made in this report between existing waterways and the proposed channel improvements for those waterways. For example, the proposed channel improvements

for Rio Puerto Nuevo/Rio Piedras will be referred to as Puerto Nuevo Channel and the proposed channel improvements for Quebrada Guaracanal will be referred to as Guaracanal Channel. The names of highways and streets have been anglicized in this report.

9. Main Channel. The 6.46-mile long Puerto Nuevo Channel consists of 1.66 miles of bulkheaded trapezoidal channel and 4.80 miles of concrete rectangular channel. Five tributaries will also be channelized providing an additional 4.74 miles of channel. Additional features include two baffle pier stilling areas; two high velocity flow junctions with tributary streams Buena Vista Diversion Channel and Guaracanal Channel and two upstream debris basins with side-overflow spillways. Portions of the channel design were physical-model tested by the Corps of Engineers Waterways Experiment Station (WES) in Vicksburg, Mississippi.

10. Margarita Channel. The Margarita Channel is 1.70 miles long, with 0.67 mile of rectangular concrete channel, a baffle pier stilling area, and 1.03 miles of trapezoidal channel. The upstream reach of the high velocity channel was also physical-model tested at WES to determine the flow conditions at the De Diego Expressway bridge. It was determined from the physical model tests that this bridge could pass the design discharge and, therefore, will not have to be replaced.

11. Josefina & Dona Ana Channels. The 1.46 mile long Josefina Channel and its 0.62 mile long tributary, Dona Ana Channel, were also physical model tested at their high velocity confluence. These two high velocity channels will not require a stilling basin for the subcritical flow regime confluence with the main channel.

12. Buena Vista Diversion Channel. The 0.80 mile Buena Vista Diversion Channel is a permanent improvement that eliminated the need for extensive loss of home sites along the existing Quebrada Buena Vista alignment. This new alignment will be excavated through an undeveloped area near the University of Puerto Rico Agricultural Experiment Station and the proposed Botanical Gardens. It has a high velocity junction with the main channel.

13. Guaracanal Channel. The 0.16 mile Guaracanal Channel has a 6.5-acre debris basin situated near the bottom of a steep draw with a 150-foot long side overflow spillway. The Guaracanal Channel confluence with the Puerto Nuevo Channel is also a high velocity junction.

14. Flood Protection. This project is designed to provide 0.01 exceedence probability (100-year) flood protection for the areas adjacent to the Puerto Nuevo and its tributaries.

## D. ECONOMIC ANALYSIS

15. General. In accordance with current policy, economic analyses for projects that are up for construction approval must be no more than two years old. Since the most recent economics for this project is contained in the survey report, completed in 1985, it was necessary to perform an economic update. As part of this effort, the following work was performed:

a. Study update year is 1990, base year 2003, and end of planning period as 2053.

b. Changed conditions in the basin were identified through field visits and current aerial photos;

c. Where appropriate new development and areas or structures whose classification had changed were inventoried;

d. Real Estate values were adjusted based on recent field work.

e. The data base was revised and the inundation damage prevention benefits were recomputed using the new base year of 2003.

f. Location benefits were revised based on changed conditions in the basin as well as new guidance on how these benefits are to be determined.

g. Redevelopment and advanced bridge replacement benefits were computed based on the new design and cost estimates, current income statistics, and the proposed construction schedule.

h. Intensification, recreation, income loss, and emergency benefits were also recomputed, while benefits during construction and flood insurance overhead benefits were added.

i. PL 91-646 authorizes reimbursement for actual moving expenses and losses of personal property for families displaced by the project. An annual benefit equal to the cost is included so it would not influence the benefit-to-cost ratio.

It was found that the study area continues to be one of the leading zones within San Juan in terms of its public and commercial activities. Over 7,500 residences and 700 commercial and public structures are subject to flooding. This includes some of the most important transportation facilities in the San Juan Metropolitan Area as well as major public works complexes, strategic water, sewer, electrical power, and telephone services. Growth continues in this highly urbanized area with diversification being the prevalent trend. The proposed project would provide inundation damage reduction benefits for the over 8,500 structures and facilities that are within the 100 year flood plain.

Detailed information on the economic update is contained in Appendix D, Economic Update. An itemized summary of the updated benefits by category is given below. Based on a current interest rate of 8-3/4 percent and a 50-year project life, project implementation would result in $73.8 million in annual benefits.

SUMMARY OF UPDATED PROJECT BENEFITS
($1,000 of Nov 1990, 8-3/4% Discount Rate)

| Type of Benefit | Annual Benefit |
|---|---|
| Inundation Reduction | $ 36,551 |
| Location | 2,572 |
| Redevelopment | 1,677 |
| Advanced Bridge Replacement | 198 |
| Intensification | 3,600 |
| Recreation | 831 |
| Income Losses | 120 |
| Flood Insurance Overhead | 64 |
| Emergency | 435 |
| Benefits During Construction | 26,763 |
| PL 91-646 | 1,003 |
| TOTAL ANNUAL BENEFITS | $ 73,814 |

## E. HYDROLOGY AND HYDRAULICS

16. Hydrology.

a. General. The Rio Puerto Nuevo basin is a densely populated, 25-square mile section of metropolitan San Juan, Puerto Rico. Most of the area is impervious, fully developed with single family dwellings and pavement. The greatest increase from existing to future flood discharges will not be caused so much by future development, but by future drainage improvements. The Rio Piedras is presently inadequate to receive the flood flow from its tributaries. The tributaries are inadequate to receive flood flow from the surrounding secondary drainage and storm sewer systems. And, the secondary drainage and storm sewer systems are inadequate to eliminate neighborhood flooding. The plan is to provide major outlets works for the Rio Piedras and four of its tributaries. The design hydrology is based on changes that are expected to occur by the year 2035 as a result of the project. Documented in this report are the hydrologic methods and results used at both the Survey and General Design level of the investigation. Some additional hydrologic computations were made and the delineation of the watershed as shown in the Survey Report has been modified. This was done to further sub-divide sub-areas where additional discharge frequency information was needed for design, and to combine areas where no information was needed.

b. Basin Description. The Rio Puerto Nuevo basin was delineated on 1:20,000 scale U.S. Geological Survey topographic quadrangle maps. The basin was divided into 18 hydrologic catchment areas, shown on the map on Plate H-2 and tabulated in Table 1. The numbers run from 1 through 24 but are not continuous. Numbers 4 through 8 and 10 are missing. The sub-basins with numbers higher than 11 are identical with the sub-basins similarly designated and shown in the survey report. Sub-basin number 1 is now a composite of areas 1 through 8 and areas 2 and 3 are now what was area 10 in the survey report. The map also shows subdivision of catchments 12, 13 and 14; Quebrada Buena Vista, Josefina and Dona Ana, respectively.

c. Design Storms. Rainfall frequency was developed using procedures and plates found in the U.S. Weather Bureau Technical Publication No. 42 (TP-42). Balanced storms were developed from 24-hour rainfall with annual exceedence probabilities 0.1, 0.04, 0.02, and 0.01. The frequency of these events are commonly referenced to their recurrence interval of one in 10-, 25-, 50-, and 100-years. The Standard Project Storm (SPS) was also developed. Rainfall depths were obtained from the TP-42 isohyetal maps for two points on the basin: one near the centroid of the upper part of the basin and the other near the centroid of the lower. These rainfall depths were adjusted following the TP-42 depth-area curves and were changed from partial duration to annual series where appropriate. Since the difference between the rainfall values obtained for each point were small, the values were averaged and the average applied to the entire basin. The 24-hour rainfall was distributed into a 4-2-1-3 balanced six hour distribution. The peak 1 hour was distributed in 10-minute increments in accordance with National Oceanic and Atmospheric Administration (NOAA) technical memorandum NWS HYDRO-35 FIVE-TO 60-MINUTE PRECIPITATION FREQUENCY FOR THE EASTERN AND CENTRAL UNITED STATES. This is illustrated in Figure 1.

d. Rainfall Losses. That portion of rainfall that does not runoff is called losses. Most losses result from infiltration, evaporation, and transpiration. However, in some basins, water storage and water use are also major factors. The U.S. Soil Conservation Service (SCS) has devised a method of estimating these losses based upon hydrologic soil classifications, land use, and antecedent moisture conditions. Each type of soil has been analyzed and assigned a rainfall runoff classification of either hydrologic groups A, B, C, or D with classification group A having the most losses (least runoff), and classification group D having the least losses (most runoff). From previous SCS research, each runoff soil group has been assigned a runoff curve value (cn) which varies from zero to 100, and roughly represents the percentage of water that will runoff from a given storm rainfall. The SCS has also made technical studies on the effects that urbanization has in a watersheds on hydrologic parameters that determine runoff volumes and peak discharge rates. Information contained in the following three publication were used to estimate the rainfall losses in the Rio Piedras basin:

(1) SOIL SURVEY OF SAN JUAN AREA OF PUERTO RICO 1978.

(2) SCS NATIONAL ENGINEERING HANDBOOK, SECTION 4, HYDROLOGY.

(3) TR #55, URBAN HYDROLOGY FOR SMALL WATERSHEDS.

e. Hydrologic Models. The Rio Piedras basin was analyzed using HEC-1 which sub-divided the basin into the 18 tributaries, catchments and sub-catchments that drain into the main channel of the Rio Piedras as shown on the basin map. Floods of 10-, 25-, 50-, 100-year, and SPF frequencies were generated. HEC-1 simulated the rainfall runoff response of the watershed by representing the basin as a system of hydraulically connected sub-basins. Each sub-basin was simulated by a group of hydrologic and hydraulic parameters which describe aspects of the rainfall/runoff process within each sub-basin. Principal parameters used in the hydrologic simulation were rainfall, infiltration, rainfall losses, land slope, soils, stream length, soil cover, and land use. Another parameter is a mathematical composite of other parameters as shown by the SCS formula for small watershed Lag Time:

$$\text{Lag time} = \frac{(\text{Stream length})^{0.8} \times ((1000/CN) - 9.0)^{0.7}}{1900 \times (\text{Sq. Root of the Basin Slope})}$$

The key parameters used in each sub-basin are listed in Table 1. Also shown are the peak discharges for each sub-basin for the 10-, 25-, 50-, 100-year, and SPF floods. Table 3 tabulates the 100-year and SPF design floods along the main channel of the Rio Piedras.

In addition to the model of the entire basin, three other HEC-1 models were developed to efficiently design the hydraulic works on three tributaries. Catchments numbers 12, 13, and 14 of the main channel model were subdivided and the 100-year and SPF floods simulated. The same rainfall and hydrologic formulae were used in these models as were used in the main channel model. However, in these sub-divided models, additional physical features of the tributary basins were analyzed which effected the design of the inlet works on those streams. Hydrologic parameters and peak 100-year and SPF discharges for each sub-catchments is tabulated in Table 2. The peak 100-year and SPF discharges along all of the major tributaries of the Rio Piedras are tabulated in Table 4.

17. Hydraulic Design Criteria.

a. General. The hydraulic design of the improvements for the proposed Puerto Nuevo Channel and its five tributaries: Margarita Channel, Josefina Channel, Dona Ana Channel, Buena Vista Diversion Channel, and Guaracanal Channel, is based on approved design practice and applicable criteria set forth in the following: EM 1110-2-1601, Hydraulic Design of Flood Control Channels; EM 1110-2-1602, Hydraulic Design of Reservoir Outlet Works; EM 1110-2-1603, Hydraulic Design of Spillways. A complete list of the references used in the design of this project is located at the end of this section. Water surface profiles for the proposed improvements were computed with the aid of the Hydrologic Engineering Center's HEC-2 program and a computer program called WASURO, developed at the Corps' Los Angeles District and now being supported by WES. This technical section is limited in detail due to the large scale of the project; however, more detailed hydraulic documentation and calculations are maintained in the Hydraulic Data & Design Section, Hydrology and Hydraulics Branch, Engineering Division, Jacksonville District Corps of Engineers.

b. Channels. The proposed plan calls for improvements to 11.6 miles of the existing channel of the Rio Puerto Nuevo/Rio Piedras and five tributaries of the Rio Puerto Nuevo drainage basin. Portions of this channel design were physical model tested by WES. These included the high velocity junctions of Buena Vista Diversion Channel with the main channel and Guaracanal Channel with the main channel; the four bridges of the Las Americas Expressway-Avenida Jesus T. Pinero interchange; the Josefina-Dona Ana Channels high velocity confluence; and the supercritical reach of the Margarita Channel including the De Diego Expressway bridge.

Channel bed slopes for the supercritical reaches were designed such that normal depth was about 80 percent of critical depth. The design criteria for maximum supercritical regime flow depth $D < 0.9\ Dc$ (critical depth) was maintained throughout except for two side inlet locations on the main channel. Froude numbers for the supercritical flow reaches of channel ranged from 1.13 to 2.1.

The Josefina and Dona Ana Channels were designed such that they fit inside of the existing channels, having design flow in the supercritical regime. The design solution for the Quebrada Buena Vista involved creating a permanent diversion channel.

c. Levees. Flood protection will be provided by channelizing the existing floodway of the Rio Piedras and its tributaries. Continuous levees will not be required for this project.

d. <u>Freeboard</u>. Freeboard was set at a minimum of three feet throughout the project design reaches through this highly urbanized area. Guidance contained in EM 1110-2-1601 recommends a two-foot minimum allowance for concrete rectangular channels. However, because of the tight radius curves mandated by the design alignment through the reaches of high velocity flow, a three-foot minimum freeboard allowance was determined to be prudent. This was substantiated by a comparison of the physical model results with the WASURO model results in the reach upstream and through the Las Americas interchange. The enveloping profile of computed superelevation added to the WASURO water surface profile did not cover the peaks of the induced waves produced in the physical model. Therefore, based on the uncertainty of wave action and the high degree of development extending to the channel right-of-way, the three-foot minimum freeboard allowance was determined.

e. <u>Roughness Coefficients</u>. Project channel roughness coefficients were determined according to EM 1110-2-1601, paragraph 8c(4). The k-value for discharge capacity is 0.007 for a straight concrete-lined channel. The coefficient of roughness for use in Manning's formula was calculated using the previously noted k-value of relative roughness. Roughness coefficient values for the various reaches of the main channel and the tributaries are shown in the subsequent paragraphs. A roughness coefficient of 0.015 was used in the WASURO models of the main channel since this is what was tested in the physical model. Verifying the actual theoretical n-value using relative roughness k=0.007, n ranges from 0.0155 to 0.0159.

f. <u>Superelevation</u>. No spiral curves, invert banking, or warped transitions were incorporated in the physical models built by the Waterways Experiment Station for this design effort. These items will be addressed in the final channel design and will adhere to criteria provided in EM 1110-2-1601.

Final design of project channels to be shown in Feature Design Memorandums will incorporate invert banking and modified-spiral entrance and exit alignments for the curved portions of channels. The design alignment for the main channel presented herein includes several curves which do not meet the minimum radius criteria. Tables 5 through 10 show the recommended minimum curve radii and lengths of modified-spiral entrance and exit curves for the main channel and the five tributaries. This information is presented in the tables for a comparison with the design radii used and the respective superelevation values computed for the proposed channel improvements.

The current urban development extends to the existing channel right-of-way. The proposed channel alignments generally follow the existing alignments. This presented a problem maintaining the minimum channel curve radius criteria through the Las Americas Expressway interchange. The main channel curves 11 (just upstream of the Las Americas Expressway bridge), 12, and 13 (immediately downstream of the high velocity junction of the Buena Vista Diversion and main channels) have design radii much less than the minimum suggested by the minimum radius criteria. This reach was physical model tested by WES using the existing radius curves, and without approach or exit spirals. Final design will use a modified-spiral curve into and out of these curves, with zero length of simple curve. A major problem with the present channel design is the tight radius curves mentioned above. WES representatives suggested that invert banking and spiral curve entrance and exit transitions could improve conditions.

The superelevation of the water surface was calculated based on Equation 26, EM 1110-2-1601, as the theoretical rise in a level water surface from the centerline of flow to the outside of curve water surface elevation. This value was added to the average water surface elevation determined by WASURO, beginning at the PT station of a curve and extending through the curve to the PC station. Because spiral curves were not included in the channel design, superelevation allowance was included in the design water surface elevation downstream of the PC until it diminished to zero linearly at a point 1500 feet downstream of the PC. In the locations where an upstream curve has an effect on the water surface profile through another curve further downstream, the extended superelevation allowance may control through that subsequent curve. This process yielded the design water surface profiles shown on the hydraulic profile plates, Plates H-3 through H-7.

g. <u>Bridges</u>. In the scope of this project, 30 bridges are expected to be built, replaced, or retro-fitted for increased hydraulic capacity and structural integrity. Five bridges were tested in the physical model and found to pass the design discharge. The clear span De Diego Expressway Bridge over the Margarita Channel will not require any modifications based on hydraulic considerations. The four bridges over the Puerto Nuevo Channel at the Las Americas Expressway will be fitted with sloping bridge pier extensions. The purpose of the sloping nose is to allow debris to ride up the pier and not reduce the area in flow. The pier extension causes the water surface profile to shift to critical depth further upstream and insures a lower water surface profile underneath the bridge.

h. <u>Sedimentation Potential</u>. Sedimentation of the project channels was studied and the results are presented in Appendix ~~D~~ E. The objective of that study was to determine the sediment load to be expected from areas upstream of and tributary to the project channels. Two debris basins are proposed to insure that sediment material will not impact the operational capability of the project channels or cause long term damage to concrete channel features.

i. Spoil Material Placement. Spoil material from construction of project channels will be disposed of in areas which will not cause restrictions to flood flows which exceed the design channel capacity. Discussion of the placement locations is in paragraph 51.d.

j. Level of Protection. The recommended plan provides a design level of protection is the 0.01-exceedence probability (100-year) flood event and a projected project life of 50 years. The peak flow line on a channel was computed for the 100-year flood event. Freeboard allowance was designed and added to this profile to determine the minimum top of wall.

18. Hydraulic Design Details.

a. Main Channel.

(1) General. For discussion purposes, the Puerto Nuevo Channel has been divided into five distinct reaches. Divisions were made according to flow regime or type of construction. The respective reaches are discussed in detail below. The hydraulic design profiles are shown on Plates H-3 and H-4. Table 11 shows the pertinent hydraulic design data. Plates S-22 through S-37 show the alignment in plan view and profile. The stilling area is shown on Plate S-77.

(2) Reach 1 (Station 0+90 to Station 88+33.2). Reach 1 is an 8,743-foot-long trapezoidal channel with bulkheaded sections in the side slopes. Flow regime is subcritical. The alignment has been shifted away from a sanitary landfill to avoid hazardous waste. The quality of the existing bank material resulted in a design channel side slope of 1 V on 10 H. It is because of the flat channel side slope and the need to reduce the channel width that the channel will be bulkheaded along this reach. The channel lining material is the natural earth. The bulkheads will be constructed to contain the channel cross-section top width. The bottom width is 60 feet and top width is 400 feet. No provision for armoring the bottom will be provided.

The roughness coefficient used for the channel bottom and side slope was Manning's n=0.032. Design velocities range from 6.0 to 9.5 feet per second. The hydraulic design profile is shown on Plate H-3. Table 11 shows the pertinent hydraulic design data. Plates S-22 through S-25 show the alignment in plan view and profile.

The mangrove mitigation plan discussed in Appendix B calls for placement of mangroves in stretches along the banks of the channel within the right-of-way at elevation 0.0 ft., NGVD, on a 60-foot wide strip, between station 3+84 and station 88+30. Flow resistance in the area to be planted in mangroves grow would be very high, therefore, it was assumed that their location constitutes an area of ineffective flow within the full channel cross-section.

(3) <u>Reach 2 (Station 88+33.2 to Station 147+40)</u>. Reach 2 is a wide rectangular shaped channel with flow in the subcritical regime. This reach is 5,910 feet long and extends from the confluence with the Margarita Channel to the stilling area at station 147+40. Bottom width at the Margarita confluence, station 88+33.2 is 340 feet, narrowing to 180 feet wide upstream at station 93+30. The design discharge will flow in the subcritical regime. The channel lining configuration is concrete walls with a tremie concrete bottom. A n-value of 0.02 was determined for the tremie concrete bottom. A composite n-value was determined for the design flow conditions, varying from 0.0189 to 0.0193. Because of the velocities expected in the design channel and the water surface profile's corresponding sensitivity to roughness, n-values were used to the 10-thousandth place in the HEC-2 model for this reach. Design velocities range from 9 to 15 feet per second.

(4) <u>Reach 3 (Station 147+40 to Station 184+48.51)</u>. Reach 3 has a composite cross-section which passes through four bridges of the Las Americas Expressway-Avenida Pinero interchange. Additional conveyance would be created by using a lowered invert center pilot channel, 10 feet deep by 29 feet wide. This reach is 3,710 feet long and extends from the transition to a composite section at station 184+48.51 (beginning 2,140 feet downstream of the Buena Vista Diversion Channel confluence at station 184+48.51), downstream to the location of the hydraulic jump (about station 149+40) above the Josefina Channel confluence. The design is based on the results of the physical model study conducted at WES, using a Manning's n-value of 0.015.

The composite channel configuration was designed for this reach to increase conveyance through the Las Americas Expressway-Avenida Pinero interchange. The composite channel section is a trapezoidal shape with a lowered invert center section of 10-foot-depth and 29-foot bottom-width. The side slopes are 1 vertical to 0.33 horizontal for both the lowered invert center section and the channel side walls. The channel bottom width varies through this reach from 113 feet to 102 feet. The design discharge will flow in the supercritical regime. Design velocities range from 26 to 40 feet per second.

The upstream end of the transition to a composite section has a channel width of 107 feet. In a transition length of 500 feet, the lowered invert center section is formed by an increased bed slope while maintaining the bed slope over the balance of the channel cross-section. The center section begins with a V-shape, expanding in width as it drops below the main channel bed. At the downstream end of the composite section, the transition back to a rectangular section is accomplished in the same manner.

Immediately after the fully formed composite section begins, there is an expansion to 113 feet. The channel passes through the Southeast Access Ramp bridge, then undergoes a contraction to 102 feet. Channel width remains at 102 feet through the next three bridges. This would be followed by an expansion to a 150-foot-width as the channel configuration transitions back to a rectangular section in a length of 500 feet, at station 149+81. A baffle pier field would begin at station 149+41 to fix the location of the hydraulic jump near the break in slope.

(5) Reach 4 (Station 184+48.51 to Station 276+50). Reach 4 ends at the grade break at station 276+50, where flow will transition into the supercritical regime. This reach includes two tributaries discharging into the main channel at high velocity junctions. Reach 4 is 9,200 feet long and extends from the transition to the composite channel section to the grade break at station 276+50 (500 feet upstream of Guaracanal Channel). The alignment has been altered since the completion of the physical model testing to make provision for a future busway alongside the channel and future plans for the adjacent botanical gardens. Since this made, the WES physical model results for this reach invalid, WASURO was used to redesign this reach of the channel. The channel is of rectangular concrete section, varying in width from 60 to 107 feet. A Manning's n-value of 0.015 was used in the WASURO model. Verifying the actual theoretical n-value using relative roughness k=0.007, n-values range from 0.0155 to 0.0159.

The design criteria for maximum supercritical regime flow depth $D < 0.9\ D_c$ (critical depth) was maintained throughout except for two side inlet locations in this reach. These will experience undular flow because of the sudden increase in discharge. Point locations of increased discharge due to local inflow were located at the downstream end of width transitions. This allows for the sudden change in momentum and takes advantage of the increased energy at the bottom of the transitions. The two width transitions in the subject channel reach experience undular flow as a result of large side inlet allowances, extending downstream approximately 120 feet in each case.

(6) Reach 5 (Station 276+50 to Station 341+92.13). Reach 5 begins at the confluence with Quebrada Guaracanal and ends at the debris basin outlet structure. Flow would be in the subcritical regime. This reach has an altered bed slope from that which was modeled by WES. The upstream section would be on a subcritical slope to station 276+50, 500 feet above the confluence with Guaracanal Channel. The downstream 500 foot long supercritical reach is at bed slope S=0.024. The grade break at station 276+50 serves as a control on this reach, with the flow

regime changing from subcritical to supercritical just upstream of the grade break.

(7) Bridges.

(a) General. It was assumed that debris loading on all bridge piers would consist of two feet of debris on each side of a pier. The exception to this is the sloping bridge pier extension, designed to allow debris to ride up on the nose of the pier with the rising river stage. It is assumed that debris will rise out of the area in flow up to the top six feet of pier height. Sloping bridge pier extensions would be fitted to the Pinero Avenue bridge and each bridge of the Las Americas Expressway interchange to minimize loss of conveyance due to debris loading on the piers.

(b) Pinero Avenue. Preliminary numerical modeling analyses (WASURO) of this bridge had shown that the bridge low chord encroached on the 100-year peak flood stage. Modifications were designed and physical modeled in the effort to maximize the hydraulic capacity of this bridge. The WES physical model study data report (27 Nov 89) stated that the bridge would pass the design discharge. However, the report noted that a 100-square foot (at the 1:35 scale of the physical model) obstruction would cause the bridge to overtop.

(c) Las Americas Expressway. The existing bridge piers were designed to be extended upstream over 100 feet. This was done to decrease the effective channel topwidth and thereby reduce wave action induced by the short radius curve immediately upstream of this bridge.

b. Tributary Channels.

(1) Margarita Channel.

(a) General. The 5,410 foot long reach of the Margarita Channel design from the confluence with the Puerto Nuevo Channel upstream to the De Diego Expressway is an entrenched trapezoidal shape channel with containment dikes. This lower reach will not follow the existing stream path because of the adjacent De Diego Expressway and geotechnical considerations. There would be a stilling area on the downstream side of this bridge at the end of the high velocity flow reach. The channel lining would be graded earth except at the upstream transition from the supercritical flow reach, and at the downstream confluence with the Puerto Nuevo Channel. A Manning's n-value of 0.032 was used for the graded earth. Design velocities range from 2 to 5 feet per second. The typical cross-section is a trapezoid with 1 V on 6 H side slopes, bottom width of 50 feet and top width varying from 350 to 450 feet. Exceptions are: at the stilling area transition which is a compound section of wedge-shaped transition with vertical wall extensions; in the area of unstable materials which extends from station 40+00 to 52+00, where the trapezoidal side slopes are 1 V on 8 H; at the Puerto Nuevo confluence where the left bank transitions from 1 V on 6 H earth to vertical concrete wall. The hydraulic design profile is shown on Plate H-5. Table 12 shows the pertinent hydraulic design data. Plates S-38 through S-41 show the alignment in plan view and profile.

The mangrove mitigation plan calls for planting a 60-foot wide berm at elevation 1.0 ft., NGVD, with mangroves on the north bank from station 0+00 through station 42+16. This was done in a manner similar to the Puerto Nuevo Channel plan. It was also assumed to be ineffective for flow similar to the Puerto Nuevo Channel.

(b) Design. The project reach of the Margarita Channel extends from the confluence with the Puerto Nuevo Channel upstream past the De Diego Expressway bridge for a distance of about 3,500 feet. The downstream channel section would consist of 5,410 feet of trapezoid shaped channel which would be in subcritical flow regime. The upstream supercritical reach would consist of 3,550 feet of rectangular concrete channel with a 30 foot wide bottom width. Design velocities range from 18 to 38 feet per second for the upstream reach. The hydraulic design profile is shown on Plate H-5. Table 12 shows the pertinent hydraulic design data. Plates S-38 through S-41 show the alignment in plan view and profile.

A Manning's n-value of 0.0153 was used in the WASURO model of the concrete rectangular channel reach. Verifying the actual theoretical n-value using relative roughness k=0.007, n ranges from 0.0152 to 0.0154. The upstream reach of the design channel above the De Diego Expressway bridge will follow the existing Quebrada Margarita. The channel bed slope will generally follow the existing bed slope after an initial steep reach is designed to induce supercritical flow. The existing bed slope is steep enough to support supercritical flow down to about the location of the De Diego Expressway Bridge.

Design of the stilling area for Margarita Channel followed guidance contained in EM 1110-2-1602 and EM 1111-2-1603. The 100-year design discharge of 8,012 cfs was the controlling factor for lowering the basin apron elevation 3 feet further than that tested by the WES model. The stilling area is shown Plate S-78.

The entrance structure for Margarita Channel would act to receive discharge from the existing culvert structure under San Patricio Shopping Center and to contain and collect overland flow from adjacent parking areas. The project channel would terminate at an existing concrete trapezoidal channel section which conveys flow from the culvert structure under the shopping center. The design discharge at this location is much greater than existing bank full capacity. Design discharge for a 100-year flood event is 6,993 cfs at the downstream side of the San Patricio culverts. This is about 1,000 feet upstream of the upstream limit of the project. The first 1,100 feet of the upstream end of the project reach is designed to allow overland flow into the channel. Because the culverts underneath the San Patricio Plaza have only 1,800 cfs capacity, an expected 7,700 cfs will be flowing in sheet flow into the area of the Caparra Interchange, the PR Hwy 2 and PR Hwy 23 interchange. The channel inlet structure will be just downstream of the Caparra Interchange.

The entrance reach is to connect with the existing concrete trapezoidal section of channel at about station 89+60. The project channel configuration is a concrete rectangular channel with grouted riprap on the overbank side slopes extending to the top of existing slope of the bank. The channel is designed to allow flow to enter the channel by flowing over the channel wall. The design water surface profile is higher than the top of wall elevation. Flow is expected to collect at the area of the Caparra Interchange. The De Diego Expressway will impede flow to the north, away from the channel. The commercial and warehouse area south of the Caparra Interchange will experience extensive flooding because the interchange is a watershed concentration point. The warehouses in this area are within 100 feet of the channel. The flooding problem in this area is not worsened by our project and flood protection features could not be incrementally justified for the area upstream of the project limit.

(c) Upstream of Margarita Channel. The analysis of Quebrada Margarita above the proposed project reach of the Margarita Channel was separated down into three distinct reaches. They are: the double box culvert extending approximately 1,400 feet beneath the San Patricio Plaza shopping center; the open channel reach extending 4,400 feet upstream of the San Patricio Plaza; and, the approximately 1,200 feet of channel downstream of the outlet of the San Patricio Plaza culverts that extends to the upstream end of the proposed project on the Quebrada Margarita.

A field survey was made in July 1988 to verify the size of the existing box culverts under the San Patricio Plaza Shopping Center. Subsequent analyses showed that flow control would be in the constricted cross-section of the culvert with a total capacity for the two culverts was about 1,800 cfs.

Upstream of the San Patricio Plaza, the existing channel is a trapezoidal concrete section. The bed slope of this channel reach is steep enough to support flow in the supercritical regime, with Froude numbers ranging up to 2. However, because of the box culverts downstream, the water surface profile is a backwater curve. The bank full capacity of the channel is about 2,500 cfs. Flows exceeding this discharge will tend to stay close to the channel because of the dense urbanization of the surrounding area. Fences and walls are built all along the top of the channel side slope. Flow would not have an opportunity to be diverted very far from the channel. Upon reaching the box culverts at the San Patricio Plaza, discharge not entering the culverts will flow out across the shopping center in sheet flow, extending over 1,000 feet wide. High ground at an expressway interchange to the west and in a residential area to the east will cause the discharge to converge toward the north-western end of the shopping complex. The slope of the parking area is relatively flat, and the flow will make its way to the downstream open channel near the outlet of the culverts. Discharge collected at this point would then enter the project channel.

(2) Josefina Channel.

(a) General. The Josefina Channel would be a rectangular concrete-lined channel. The project channel would extend from the confluence with the Puerto Nuevo Channel for a distance of 7,700 feet to the Calle 54 SE. bridge. Discharge entering the Josefina Channel at the Calle 54 SE. bridge would be conveyed in supercritical flow regime for a distance of 6,200 feet. The final 1,500 feet to the confluence with Puerto Nuevo would be in the subcritical regime.

(b) Design. The 1,500-foot long subcritical reach is of rectangular concrete section 45 feet wide. Design velocities in this reach range from 8 to 9 feet per second. The 6,200-foot-long supercritical reach is a rectangular concrete section ranging in width from 17 to 22 feet in width. Design velocities range from 19.5 to 26 feet per second. The hydraulic design profile is shown on Plate H-6. Table 13 shows the pertinent hydraulic design data. Plates S-42 through S-44 show the alignment in plan view and profile.

A Manning's n-value of 0.0151 was used in the WASURO model of the supercritical channel reach. Verifying the actual theoretical n-value using relative roughness k=0.007, n-values range from 0.0150 to 0.0151. The subcritical reach was modeled with a n-value of 0.015.

The design channel will be constructed within the existing Josefina Channel. However, a steeper bed slope will decrease the downstream bottom elevation. Although the resulting design water surface profile at the upstream end of the project is just above the adjacent grade elevation, the balance of the water surface profile will be reduced below the adjacent grade.

Revised hydrologic information was determined following a site visit in February 1990. The upper end of the drainage area was analyzed and found to contribute to an attenuation of the peak discharge. Because of the culverts under the new PR Hwy 21 crossing and the inherent upstream constriction of flow, it was thought that this area might be a suitable site for a detention basin. However, an analysis of this site showed that with the area available, attenuation for various storage capacities was limited. The idea for a detention basin was not pursued further.

The channel bed slope at station 15+00 changes from steep (S=0.00574) to mild (S=0.0006), inducing a hydraulic jump. Analysis of the hydraulic property requirements was made to establish the viability of a strong hydraulic jump. The required sequent depth is available for both the 100-year peak discharge and coincident floods on Josefina Channel. At a discharge of 5,000 cfs, about a 10-year flood, the mean low water tailwater elevation=-0.5 feet would be less than sequent depth by 1.5 feet. This would be a very rare event. There are no bridges or other structures within 350 feet upstream or downstream of station 15+00. The current design calls for a concrete-lined channel for both the subcritical and supercritical channel sections. All flow conditions which would produce a hydraulic jump would be confined within the concrete channel. In consideration of the above, a stilling basin is not considered necessary.

(c) Upstream of Josefina Channel. The inlet to the design channel is located upstream of Calle 54 S.E. There is an existing channel in this area. The project would begin with a headwall which ties off to the high ground adjacent to the channel, within about 100 feet at elevation 40.5 feet. A n-value of 0.015 was used for the existing channel and 0.035 for the overbank areas. A backwater profile assuming critical depth at the headwall using HEC-2 indicates that for the 100-year discharge, flooding will not exceed elevation 40.5 feet at the headwall. The project entrance structure provides an adequate (100-year flood) size outlet for this area.

East of the intersection of Avenida De Diego and PR Hwy 21 is a basin control point where three streams come together and form Quebrada Josefina. At the new PR Hwy 21 crossing, the culvert capacity is estimated to be less than 1,700 cfs. The 100-year peak discharge into this area is 4,122 cfs. Routing this flow downstream to the upstream end of the project reduced the peak to 3,897 cfs at the project inlet. Water would flow over the new PR Hwy 21 and to the west to Ave De Diego, back east down and over old PR Hwy 21, and then along the adjacent Calle 54 S.E. until it is picked up by the secondary drainage system at some point downstream of the old PR Hwy 21 crossing.

(3) Dona Ana Channel (Station 34+36 Josefina Channel).

(a) General. The Dona Ana Channel would be a rectangular concrete-lined channel. The project channel would extend from the confluence with the Josefina Channel for a distance of 3,280 feet to a pedestrian bridge. The feasibility report formulation of the project called for providing flood protection for the Dona Ana Basin up to about Sta. 32+80. The GDM hydraulic analyses and design of the project channel showed that the topography at Sta. 45+66 provides a natural control point for the basin. Although extending Dona Ana Channel was not economically justified, the hydraulic design shown in the report is provided for the convenience and possible future use of the local sponsor. Termination of the project channel would be a gradual transition to the existing concrete flood control channel at Sta. 32+80.

(b) Design. The design water surface profile is based on the 100-year peak flood on the Dona Ana Channel. Design velocities range from 20.5 to 27 feet per second. The hydraulic design profile is shown on Plate H-6. Table 14 shows the pertinent hydraulic design data. Plates S-45 and S-46 show the alignment in plan view and profile.

A Manning's n-value of 0.0151 was used in the WASURO model of this supercritical channel. Verifying the actual theoretical n-value using relative roughness k=0.007, n ranges from 0.0150 to 0.0151.

The design channel will fit inside the existing Quebrada Dona Ana Channel, similar to the Josefina Channel. Dona Ana Channel has a steeper bottom slope than the existing bed slope, which will increase conveyance further downstream as the channel becomes deeper. The design water surface profile would begin at the upstream end of the project just above the adjacent grade elevation. The balance of the water surface profile would be well below adjacent grade, which will allow for a significantly reduced tailwater condition at the local inflow points.

(c) Upstream of Dona Ana Channel. The existing channel upstream of the authorized project channel is a rectangular concrete channel with low bridges and utility pipes that impede the flow. The existing channel capacity is less than the two-year storm.

(4) Buena Vista Diversion Channel.

(a) General. The Buena Vista Diversion Channel is a permanent improvement that eliminated the need for extensive loss of home sites along the existing Quebrada Buena Vista alignment. At a point about one-fourth of the way up the Buena Vista drainage basin, the design channel diverts 100 percent of the upstream discharge away from the existing channel. This new alignment will be excavated through an undeveloped area near the University of Puerto Rico Agricultural Experiment Station and proposed Botanical Gardens. The Buena Vista Diversion Channel would be a rectangular concrete-lined channel. The project channel would extend from the confluence with the Puerto Nuevo

Channel for a distance of 4,240 feet to the existing Quebrada Buena Vista, just upstream of the Hwy 21 bridges. Discharges entering the project channel at the upstream end would be conveyed in subcritical flow regime for a distance of 3,790 feet. At a break in grade to a steeper bed slope, flow would then enter a 400 feet long channel contraction. This would produce supercritical regime flow to provide smooth entry into the high velocity confluence with the Puerto Nuevo Channel.

(b) Design. The Buena Vista Diversion Channel has an upstream subcritical reach of channel bed slope 0.0015 and bottom width 36 feet, converging to 16 feet wide in 400 feet length. A grade break would be required 450 feet upstream of the confluence to achieve supercritical flow at the junction with the main channel at station 205+85. A stepped invert of about four feet would be required to form the high velocity confluence with Puerto Nuevo Channel. Design velocities range from 6 to 23 feet per second. The hydraulic design profile is shown on Plate H-7. Table 15 shows the pertinent hydraulic design data. Plates S-47 and S-48 show the alignment in plan view and profile.

A Manning's n-value of 0.0150 was used in the WASURO model of the supercritical channel reach. Verifying the actual theoretical n-value using relative roughness k=0.007, n ranges from 0.0150 to 0.0151. The subcritical reach was modeled with a n-value of 0.0155. The theoretical n-value for the subcritical reach, using relative roughness k=0.007, ranges from 0.0151 to 0.0157.

(c) Upstream of Buena Vista Diversion Channel. The channel entrance structure is upstream of the Hwy 21 bridges. Upstream of the Hwy 21 bridges, the existing channel is of such a slope that the 100-year discharge will flow in the supercritical regime, even with some overbank flooding. Average channel velocities are around 20 fps and depths are about 6 to 9 feet. At the project entrance headwall, the maximum water surface elevation is produced by a backwater effect.

During the design of the project channel, it was assumed that the existing channel upstream of the project was concrete and free of debris. The n-value used in the HEC-2 model was 0.015 for the existing channel and 0.035 for the overbank areas. Noted on the 1988 topographic sheets are areas of sediment and vegetation in the channel bottom extending upstream along the entire length of channel. It has been determined that this sedimentation was the result of bridge construction and upstream development. The channels have been poorly maintained and this will have to be removed. It was determined that there is no sediment source upstream of our project, and a debris basin will not be required.

(5) Guaracanal Channel.

(a) General. The Guaracanal Channel would be a rectangular concrete-lined channel. The project channel would convey flow from the Guaracanal Debris Basin to the confluence with the Puerto Nuevo Channel. The channel length would be 819 feet.

(b) Design. Discharges from the debris basin would be conveyed in subcritical flow regime for a distance of about 300 feet. Bottom width would vary from 50 feet at the debris basin outlet to 26 feet at sta. 5+23. The remaining channel would be sloped to insure supercritical flow regime at the high velocity confluence with Puerto Nuevo Channel. There is a stepped invert of 0.3 feet at the high velocity confluence with the main channel at station 270+65. Design velocities range from 20.5 to 27 feet per second. The hydraulic design profile is shown on Plate H-7. Table 16 shows the pertinent hydraulic design data. Plate S-49 shows the alignment in plan view and profile.

A Manning's n-value of 0.0150 was used in the WASURO model of this channel. The theoretical n-value, using relative roughness k=0.007, ranges from 0.0154 to 0.0160.

19. High Velocity Junctions.

a. General. Three important high velocity junctions were physical model tested by WES. Since completion of that model testing, further developments have necessitated reevaluation and redesign of the three confluences tested.

b. Buena Vista Diversion Confluence with the Main Channel. The design for the Buena Vista Diversion Channel confluence with the Puerto Nuevo Channel that was model tested by WES was revised. Analysis of the preliminary design revealed that initial assumptions concerning the design of the Buena Vista Diversion Channel were no longer valid. The junction with the main channel as physical-modeled by WES assumed normal depth at a point on the Buena Vista Diversion Channel about 450 feet upstream of the confluence. The model study Data Report, dated 27 Nov 89, actually shows (see subject report, Enclosures 26 and 27) a water surface profile of less than normal depth. Due to the constraints determined in the present GDM analyses, this profile was not reproducible. The resultant design attempt yielded a water surface elevation 2 feet greater than the water surface on the main channel at the confluence. This would be unacceptable.

Design criteria requires that water surface elevations between two converging channels should be about the same. This resulted in design of a stepped invert of about 4 feet at the confluence with the main channel. The radius of curvature of the approach to the confluence is given by equations 41 and 42 of EM 1110-2-1601. A modified-spiral curve into the long radius curve of the approach was selected from HDC 660-2/2: No. 237 curve. The length of the entrance spiral and radius of curvature are greater than the required minimums, as determined according to HDC 660-1 & 660-2 to 2/4. The confluence was designed with an entrance angle of 0 degrees. This resulted in a channel bottom width of 106 feet at the confluence. WASURO was used to insure adequate balancing of momentum and to determine the resulting water surface profile. Depth of water in the channels was checked to insure that design depths would be less than 90% of critical depth ($D/Dc < 0.9$).

The preliminary design (physical model) main channel width was changed from 100 feet to 102 feet wide downstream of the confluence. Checking the required minimum downstream width according to Plate 52, that width was 89.8 feet, thus 102-foot width was used in the present design. This required that a transition be made from 106-foot width at the confluence to a narrower channel width of 102 feet downstream of the confluence. Plate 51a shows the center-line offset design. Since the entrance angle is 0 degrees, the confluence length is 0 feet. A length of transition from 106 feet to 102 feet was set at 100 feet. This is greater than the minimum required convergence transition length for channel velocities of 15 to 30 fps ($V_3$=28 fps). The extra length of transition was chosen because there would be a 450-foot radius curve immediately downstream of the BVD confluence. That curve was model tested but has a smaller than the minimum required radius of curvature as per EM 1110-2-1601.

The maximum wave height was calculated at the channel junction according to Plate 49, EM 1110-2-1601. For a side channel flow only condition (a), the Froude number was computed to be 1.20. Reading the curve for entrance angle 15 degrees, the resulting maximum wave height would be 0.11 feet ($y_2$=11.4 feet). For condition (b), main channel flow only, the Froude number above the confluence was 1.24. The resulting minimum wave height would be 0.08 feet ($y_1$=15.5') for entrance angle 15 degrees. EM 1110-2-1601 cites adequate design conditions for wave heights in channel junctions with Froude numbers of 3 or 4. Under the present design, formation of waves and subsequent heights are expected to be minimal.

A design entrance angle of 0 degrees was used to layout the confluences, and the minimum entrance angle shown on Plate 49 is 15 degrees. Therefore, no additional wave height will be included in the design water surface elevation at the confluence. Paragraph 18c, Wave Height Criteria, states that important junctions in rapid flow designed to reduce wave effects should be model tested at all probable flow combinations. In this design, no attempt was made to analyze different flow combinations at the confluence numerically using WASURO. It will be noted that the WES physical model testing previously mentioned examined only the design flow condition at the confluence in the Data Report dated 27 Nov 89.

After review of Plate 48 (location of standing waves), it was determined that because of the low wave heights previously calculated, their location would not significantly impact flow patterns in comparison with the superelevation of the water surface due to flow in curved channels. Further, this confluence was designed with an entrance angle of 0 degrees, which was recommended to reduce wave heights. Following this reasoning, it was determined that this junction design was more stable than that physical model tested by WES.

Tapered junction walls were considered for this confluence (refer to Plate 50). However, because of the low Froude number on the main channel, such a wall for the present design would be almost 900 feet long. It was noted in the WES Data Report that it had been necessary to revise the confluence geometry, which included extending the divider wall. This was done only to simplify the geometry, and it was further noted that there was no apparent change or reduction in wave action due to the 70 foot extension of the divider wall. Inclusion of a divider wall in the current design would require that the approach channel be moved further south (upstream) into the botanical gardens of the university. This was not a desirable option. The confluence has been designed to reduce associated wave action. Calculated wave heights for the curves in the Buena Vista Diversion channel are 0.5 feet for the 494 foot radius approach curve, and 1.4 feet for the 190-foot curve at a point about 250 feet upstream of the confluence. Therefore, based on those low heights, it was determined that a divider wall would not be necessary.

c. <u>Guaracanal Channel Confluence with Main Channel</u>. This confluence is a sidewall offset design. Entrance angle is 0 degrees, confluence width is 88 feet, contracting to 78 feet width downstream in 100 feet. A long radius curve of 640 feet was used to align tributary with main channel.

d. <u>Josefina-Dona Ana Channels Confluence</u>. This is a junction of two channels of equal bottom width of 22.0 feet. The confluence is a center-line off-set design with a downstream width of 45 feet. The design discharges are relatively equal for these channels and the drainage basins are parallel with peak discharges occurring closely in time.

Long radius curves called for according to design guidance, roughly the minimum radius determined by the velocity plus 405 feet, were not used. Instead, the minimum radius criteria previously mentioned was followed. The physical model tests of this confluence for the preliminary design showed this junction to be hydraulically stable.

20. Stilling Areas.

a. Puerto Nuevo Channel. A stilling area is located on the main channel just downstream of the Las Americas Expressway interchange. It consists of a baffle pier field 180 feet in length. Its function is to stabilize the location of a hydraulic jump caused by the change in bed slope from steep to mild downstream of the Las Americas Expressway bridge. The baffle blocks were designed and physical model tested at WES and the recommended design is referred to as Type 4 design baffle blocks. WES Data Report dated 27 November 1989 is available on request for further details. A plan view of the stilling area is shown on Plate S-77.

b. Margarita Channel. A stilling area is located on the Margarita Channel just downstream of the De Diego Expressway bridge where the bed slope changes from steep to mild. The channel cross-section configuration and lining material also changes at this location from concrete rectangular to riprap trapezoidal sections. The baffle pier field was physical model tested at WES. Subsequent to the physical model testing, the alignment and channel configuration was modified at this location.

The stilling area was designed similar to a typical stilling basin according to EM 1110-2-1602, paragraph 5-2g through 5-2i. The design event Froude number is 2.6 and a basin length of 65 feet was determined. Baffle pier height, width, spacing, and endsill dimensions were calculated according to Plate C-41 of EM 1110-2-1602 (stilling basin layout), and are shown on Plate S-78.

The required hydraulic jump sequent depth was determined for a range of discharges. Then a range of discharges were analyzed for three tailwater conditions controlled by the water surface elevation downstream at the confluence with the main channel. These were the mean low water elevation (0.5 ft., NGVD), the 100-year flood peak stage on the Puerto Nuevo Channel, and the flood stage coincident with peak discharge on the Margarita Channel. The tailwater rating curve is shown on Figure 2. In order to achieve the necessary sequent depth, the basin floor elevation was lowered three feet below the downstream design channel bed slope projection. Riprap protection of the downstream channel was extended for a minimum required distance of $10d_2$ which would be 225 feet downstream of the stilling area.

21. Debris Basins Outlet Structure.

a. Rio Piedras Debris Basin. The main channel debris basin would have an area of 9.5 acres. The spillway is a side overflow type with crest length of 300 feet. The outlet structure is shown on Plate S-79.

A conventional spillway structure had been considered for the debris basin outlet; however, this was found to be impractical for the following reasons: the design channel bed slope downstream of the structure is very mild (.001 - .002); a higher debris basin pool elevation would be required for the conventional spillway; the conventional spillway required a greater energy head to execute the transition from the required crest length to the design channel width and water surface elevation; the required higher pool elevation would worsen conditions upstream of the debris basin and this would also have encroached on the Winston Churchill Ave. bridge upstream of the project; widening the channel to accommodate the transition from a conventional spillway would require the acquisition of considerable real estate and extensive excavation to accommodate a conventional spillway and downstream transition. This is because the channel banks downstream of the debris basin are high and there are houses located on the top of the bank near the channel. A side discharge spillway was chosen to minimize real estate requirements, excavation costs, and prevent worsening conditions upstream.

The structure was placed in the lower corner of the debris basin as shown on Plate S-79. This location was selected to take advantage of flow over the end of the structure, as well as the side. This also aligned the outlet of the structure with the channel downstream of the structure. This location provided for maximum utilization of the debris basin storage capacity. The 75-foot by 300-foot side discharge spillway structure was designed based on guidance from EM 1110-2-1603. The design was accomplished with HEC-2 and a Jacksonville District produced computer program (WH39) written specifically for this side discharge spillway analysis. The design procedure began with a HEC-2 backwater calculation along the crest of the structure to the upstream end. The discharge was reduced at each successive cross section to reflect the change in discharge along the crest. This produced a tailwater profile parallel with the crest. The District program WH39 uses the weir equation ($Q=CLH^{3/2}$) and the US Deep Waterways Rating Curve to modify the value of the coefficient C in the weir equation. This program was used to compute the discharge in increments along the spillway crest. The US Deep Waterways curve was used for reduction of the coefficient C when the tailwater elevation rose above the crest elevation and produced tailwater interference. The program pulls data directly from the HEC-2 output to obtain the tailwater elevations at increments along the crest. The HEC-2 input file was then revised by WH39 to reflect the reductions in discharge due to submergence for each incremental reach parallel with the crest. The revised HEC-2 model was run with the adjusted Q's and a new water surface profile computed. The above procedure was repeated until a satisfactory match of tailwater profile and incremental discharge was obtained. Various crest lengths and elevations were tried until the design discharge could be passed with the design headwater.

Design of the low flow outlet of this debris basin is based on experience with similar structures constructed by the Jacksonville District in Puerto Rico. This design concept attempts to resolve serious shortcomings found in the more typical debris basin intake tower used in projects just recently completed. An example is the performance of the nearby Bucana Debris Basin low flow drain. The grated culvert openings plug up quickly with a large amount of floating debris. This produces undesirable stagnant pools and requires frequent maintenance. This experience prompted a search for other alternatives. The design requires a low flow opening that would pass the daily base flow and, more importantly, be far less prone to clogging with floating debris. The notch in the spillway wall design was developed, providing the necessary outlet capacity. The notch entrance sloping side-walls were designed to perform similar to sloping pier nose extensions added to bridge piers. They would allow the floating debris to catch on the wall extensions and float up, passing discharge underneath the debris as the flow and pool elevation increased. The notch opening area keeps the velocities low and sediment loss to a minimum.

b. Guaracanal Channel Debris Basin. The Guaracanal Channel debris basin has an area of 6.5 acres. The spillway is a side overflow type with crest length of 150 feet. The outlet structure is shown on Plate S-80. The design procedure for the outlet structure was similar to that used for the design of the main channel debris basin. The following is a discussion of the design and location of the Guaracanal Channel debris basin outlet structure.

Designs for both a conventional spillway and a side discharge spillway were developed for the Guaracanal Debris Basin outlet structure. A side discharge spillway was chosen for the outlet structure because it required a lower debris basin pool elevation to pass the design discharge and did not require as much real estate. The design requisites for a conventional spillway would have placed the structure further upstream and into the debris basin. That would have provided enough downstream channel length for the converging transition to be accomplished before it joined the Puerto Nuevo channel. That would also have significantly reduced the capacity of the debris basin. Finally, there is existing development upstream that would make placing the debris basin further upstream impractical. The design procedure for the 50-foot by 150-foot Guaracanal side discharge spillway structure was the same as that used for the main channel structure. A containment dike protects development on the west side of the basin.

22. Side Inlets. A side channel spillway inlet concept has been devised for use on the main and tributary channels. It is similar to that shown in EM 1110-2-1601, Plate 53. It was originally designed for use in the Los Angeles County Drainage Area (LACDA) flood control project, though on a much larger

scale. The present application was called for because of the highly urbanized area and lack of available space for typical inlet configurations. Also, the required head for design flood operation is much less. Typical placement will be at bridge crossings of the tributary channels, with spillway crest lengths varying from 18 to 100 feet. Tables 17 through 22 show the location and pertinent data for the existing and proposed side inlets. The following discussion details the design procedure.

The design procedure is taken from a report titled "Analysis of Design, Tujunga Wash Channel Improvement," May 1950, USAED, Los Angeles, California. The subject report details the design for a side channel spillway with a crest length of about 600 feet. However, the design procedure followed is still the same. The crest elevation was set at 0.5 feet above the design water surface elevation and the crest was sloped to match the slope of the design water surface profile. The weir equation ($Q=CLH^{3/2}$) was used with a discharge coefficient C of 3.087 as recommended. A headwater elevation was determined that would produce a discharge of about 5 cubic feet per second (cfs) per lineal foot of crest length. The side inlet design discharge was divided by 5 to determine the crest length. The tapered side inlet channel on the land side of the project channel was designed using HEC-2.

23. Performance of Project Features.

a. General. The purpose of performance analyses was to determine the areal extent of inundation that would remain for both the design flood (100-year) and the Standard Project Flood after implementation of proposed project improvements.

b. Design Flood. The design 0.01-exceedence probability (100-year) flood control project provides an adequate outlet to convey the 100-year flood discharge with appropriate freeboard design. All 100-year event residual flooding will, therefore, be confined to the channel inlets. These are the upstream end-of-project channel entrance structures and the side inlets for local drainage. Analyses of the upstream of channel areas were discussed in paragraph 18, Hydraulic Design Details. The 100-year flood event residual flooding boundaries are shown on Plate H-8. The analyses regarding the localized interior flooding are discussed under Inlet Structure Ponding.

c. Standard Project Flood. The determination of the SPF water surface profile and residual flood boundary was resolved by three analyses. The design assumptions regarding two issues were determined. The SPF residual flood boundaries are shown on Plate H-8.

The primary issue concerns the ability of the secondary drainage system to provide adequate conveyance for the flood waters to enter into the design project system. The current hydrologic analysis of this drainage basin was done assuming that the secondary drainage system will provide the necessary conveyance. The varying flood discharges along the channel alignments were determined by routing the flood events through the sub-divided drainage basins for the design flood and SPF events. The side inlets were designed using the routed design flood discharges. It was concluded that the maximum SPF flooding boundaries would be determined by the resultant channel water surface profiles and interior flooding due to outlet control at the side inlets.

The main and tributary channels were therefore analyzed for their ability to carry a greater than design-flood event. This brings up the second issue of concern regarding conveyance in the channel freeboard zone. Part of this issue is the ability of the channel to convey flow in the freeboard. The other concern is based on Corps' guidance in allowing benefits to be assessed for greater than design floods. The guidance presented in ER 1105-2-20, Project Purpose Guidance, and EP 1105-2-45, Economic Considerations, is summarized as follows: "...there is an allowance for benefits to be claimed for half of the area under the damage-frequency curve between the design discharge and the largest flood that can be conveyed with no freeboard." The latest guidance is ER 1110-2-100, Planning Guidance Notebook. This is still in draft form, but the guidance has not changed. The main channel response to the SPF was analyzed in three different ways.

The first analyses considered the SPF discharge at the various reach locations using one-dimensional steady-state numerical models of the design channel. The reach extending from the San Juan Harbor to the De Diego Expressway bridge had a bankfull capacity which ranged from 8 percent to 42 percent greater than the SPF discharge. The reason for the large bankfull capacity, 42 percent greater than SPF in the downstream reach, is the trapezoidal channel section combined with the three-foot minimum freeboard allowance. The reach extending from just below the Las Americas Expressway interchange upstream to the debris basin was modeled using the WASURO models of the design channel carrying the SPF discharge. At only one location does the SPF water surface profile approach the minimum top of wall elevation, just downstream of the Las Americas Expressway. At all other locations, the SPF discharge is less than the bankfull discharge.

The second analysis assumed that as a worst case for the reach of supercritical channel, flow would go to critical depth continuously along the alignment. The computed water surface elevation (critical depth) was plotted as an overflow boundary and compared to the unimproved conditions, which it approximated.

The third analysis again evaluated the reach of supercritical channel. A one-dimensional model was prepared of the design channel using HEC-2 and adding overbank details for the surrounding flood plain. Hejl's method (see paragraph 27, References) was used to determine a Manning's n-value for the overbank, which ranged from 0.17 to 0.20. A backwater computation including flow in the overbank areas was performed. The slope-area method was utilized to start the water surface profile, assuming the energy slope equal to the bed slope. The computed water surface elevation was plotted as an overflow boundary, and was smaller than the critical depth overflow boundary. However, the volume of the SPF hydrograph would not be large enough to sustain this areal extent of contiguous flooding. This was used only as a point of reference.

The first analysis water surface profile was plotted as an overflow boundary. This water surface profile represents the flow controlling tailwater elevations for the side inlets along the alignment. It was determined by engineering judgement that this is the controlling residual flood boundary. This inundation boundary is shown on Plate H-8. It does not represent a contiguous flooding boundary, but shows the highest inundation elevation at any point along the alignment.

Accordingly, the five tributaries were analyzed for the SPF and a non-contiguous residual flooding boundary was determined in a similar manner for each. This project residual flooding boundary is shown on Plate H-8.

d. Inlet Structure Ponding. The current hydrologic analysis was done assuming that the secondary drainage system would provide the necessary conveyance. The flood discharges along the alignments were determined by routing the flood events through the sub-divided drainage basins for the design flood and SPF events. The side inlets were designed to pass the greater of either 50 percent of the local 100-year flood discharge or the coincident discharge at the time of the peak on the project channel. The maximum ponding elevation was determined to be the greater of the peak stage of the surcharged inlet structure or the peak stage in the project channel at the side inlet.

e. Floodway. Since the 100-year flood is contained in the channel, no floodway need be provided.

24. Physical Model Studies.

a. General. The model study data used in the preparation of this document comes from the data reports sent to Jacksonville District and cited below. The published report available from WES is "Rio Puerto Nuevo Flood Control Project, Hydraulic Model Investigation," 1990, Vicksburg, MS.

b. Puerto Nuevo Channel. Two data reports were submitted to Jacksonville District. The first, dated 27 November 1989, details model study results for a Manning's n-value of 0.015; the second, dated 21 February 1990, details results for an n-value of 0.012.

c. Margarita Channel. The subject data report is dated 12 July 1989. Because of modifications to the alignment and channel configuration after completion of model testing, the physical model test results were used for reference only. The results were used for calibration of the math model WASURO.

d. Josefina-Dona Ana Channels Confluence. The subject data report is dated 7 March 1990. Physical model testing results indicated that this confluence was stable. Modifications to the design channel alignments have since changed the confluence geometry, incorporating larger radius curves into the confluence junction and reducing superelevation of the water surface.

25. Sediment Transport Study.

a. General. A sedimentation study was initiated to analyze sediment production potential of the areas upstream of the proposed project features. The objective of this study was to determine the need for and design of features to protect concrete structures from erosive damage which could be caused by high velocity transport of sand and gravel size sediment particles. As a result of the study, debris basins will be constructed at the upstream end of the Puerto Nuevo Channel and Quebrada Guaracanal.

b. Study Approach. WES performed an initial field investigation and provided a Sediment Assessment for the project basin. A suspended sediment sampling program was initiated in 1988 which established continuous reading stations at four locations on the Rio Piedras and its tributaries. Those stations have been operational since that time. Cross sections and bed gradation samples were taken to determine the composition and geometry of the existing channels. The sediment assessment performed by WES confirmed that potentially damaging sediment loads could be expected from the unchannelized areas upstream of the proposed project channels. Data collected from suspended sediment sampling stations and the channel bed were used to develop sediment transport models to determine expected sediment loads. The Hydrologic Engineering Center computer program HEC-6 was used to model the existing stream bed and proposed debris basins. Appendix E discusses procedures and results of the sediment study in more detail.

c. Puerto Nuevo Debris Basin. Plate S-37 shows a plan view of the debris basin. The debris basin would be constructed in a reach of the natural channel by excavating the east bank to provide a "tear drop" shape. The overall shape of this basin is relatively narrow and elongated. Total volume under the elevation of the top of the outlet structure weir is 104 acre-feet. Basin area is about 9.65 acres. Tieback levees would not be required. The bottom elevation of the basin was set at the elevation of the existing stream bed. This would eliminate head cutting potential. Basin volume would be achieved by excavating the east bank of the river channel.

Basin sediment loads and trap efficiencies were modeled by using HEC-6. A sediment transport computer model was compiled from cross sections of the proposed basin shape and the natural channel of the Rio Piedras upstream of the basin. Hydrographs of the 10-, 25-, 50-, 100-year, and SPF were routed through the basin. Appendix E shows the performance of the basin under the 1-in-10 year through the SPF storm hydrographs.

Flow duration analyses were also performed by routing a histogram of flows based on flow duration data. The histogram simulated three consecutive years of discharges without cleaning and reshaping the basin to design specification. Appendix E shows the expected decrease in trap efficiency over a prolonged period of time. Maintenance clearing and reshaping should be planned on an as needed basis. However, monitoring of basin capacity should performed after each major storm or every three months to insure adequate capacity. Annual cleaning of the proposed basin will be required to insure adequate basin capacity before each wet season.

d. Guaracanal Debris Basin. Plate S-49 shows a plan view of this debris basin. The basin would be constructed in a reach of the natural channel by excavation. The overall shape of this basin is relatively shallow and elongated. The shape was chosen because of limitations imposed by a project containment dike required to protect adjacent property. Total volume under the elevation of the top of the outlet structure weir is 50 acre feet. Basin area is about 5.57 acres. The outlet structure would tie into the containment dike on the south bank. The north side of the basin is bordered by a very high natural ridge which cannot be excavated due to extremely steep natural slopes.

Basin sediment loads and trap efficiencies were modeled using HEC-6. A sediment transport model was compiled from cross sections of the proposed basin shape and the natural channel of Quebrada Guaracanal upstream of the basin. Hydrographs of the 10-, 25-, 50-, 100-year, and SPF were routed through the basin. Appendix E shows the performance of the basin under the 1-in-10 year through the SPF storm hydrographs.

Flow duration analyses were also performed by routing a hydrograph based on a flow duration histogram through the basin. The histogram simulated three consecutive years of discharges without cleaning and reshaping the basin to design specification.

Appendix E shows the expected decrease in trap efficiency over a prolonged period of time. Maintenance clearing and reshaping should be planned on an as needed basis. However, monitoring of basin capacity should be scheduled at three-month intervals to insure adequate capacity.

e. Tributaries.

(1) General. Local runoff from streets, houses and commercial buildings of the area north of Winston Churchill Avenue bridge drain to tributaries which convey flows to Rio Piedras. Three tributaries are large enough to require open channel discharges into the Rio Piedras. Those tributaries (Quebrada Guaracanal, Quebrada Josefina/Dona Ana, and Quebrada Buena Vista) are concrete lined. The areas served by these tributary channels are completely developed. Runoff enters the tributaries through standard street culvert systems and earth lined ditches at the upstream end of each channel. Appendix E shows expected sediment loads for various storms.

Discharges from the remaining tributary areas are small enough to enter the main channel directly through street culvert systems.

(2) Quebrada Margarita. This channel is lined with concrete, and runoff from the surrounding area enters the channel through culverts or inlet structures. Development has reached the right-of-way for the entire length of the channel. Sediment loads are expected to be small. Appendix E shows expected sediment loads for various storms. These tributaries serve areas which are completely developed. Sampling showed that sediment concentrations in discharges are low for areas which are developed to the extent this basin has experienced.

26. Groundwater Study.

a. General. At the request of the Jacksonville District Corps of Engineers, the U.S. Geological Survey (USGS) was funded in January 1989 to conduct a groundwater study of the Puerto Nuevo basin. The objective of the USGS study was to determine the affect of channelization of the Rio Puerto Nuevo on the elevation of the water table surface and the aquifer response to this new hydrologic stress. The USGS study investigated the present relationship between the Rio Puerto Nuevo and the adjacent aquifer. The USGS work included the following:

(1) Drilling 27 wells at 17 well sites (different depths) adjacent to the Rio Puerto Nuevo and the tributaries that will be channelized. These test wells were used to define the water table configuration of the aquifer near the proposed channelized stream and to describe the relationship between the stream and the aquifer.

(2) Established 7 continuous recorders to monitor water level changes. These recorders assisted in the definition of the stream/aquifer relationship.

(3) Measured the water levels at non-recording wells on a monthly basis during the study period.

(4) Determined the elevation of the wells with respect to mean sea level.

(5) Tested the hydraulic properties of the aquifer at each test well site.

(6) Development of a three-dimensional, finite difference groundwater flow model. It was constructed and calibrated to simulate the stream aquifer relationships between Rio Puerto Nuevo and the adjacent water table aquifer, and to determine the impact of channelization on the aquifer water levels and flow regime.

The USGS is producing two reports from this investigation: (1) an Open-File Report and, (2) a Water Resource Investigation Report on the stream/aquifer inter-relationship and the impact of channelization on the groundwater regime and water levels; and, the groundwater flow model. Those reports are scheduled to be available during calendar year 1991. The USGS has provided progress reports, and they are on file in the Jacksonville District Office.

b. USGS Progress Report Summary. Groundwater and surface water data were collected and analyzed periodically at selected wells and surface water stations. The data were used to estimate stream aquifer interactions, update the groundwater elevation contour maps, and calibrate the groundwater flow model. The quantitative results, to date, from USGS are considered provisional and subject to change prior to release of their final reports.

A seepage run was conducted in Rio Puerto Nuevo on 12 June 1990. The results indicate that the stream loses about 1.5 cfs in the upper reaches of the basin and gains between 2 and 4 cfs as it crosses the coastal plains.

The calibrated steady-state groundwater flow model indicates that the total budget of the entire groundwater system in the Rio Puerto Nuevo basin is approximately 14.7 cfs and the Rio Puerto Nuevo surface water system accounts for 40% (5.9 cfs) of the total discharge from the groundwater system.

Model simulations of the stream aquifer relationships after channel modifications of the Rio Puerto Nuevo and tributaries suggested that in some places groundwater levels might rise to land surface. These initial study results showed that significant effects would be incurred if an underdrain system were not installed. The proposed underdrain system to provide uplift pressure relief for the project channels is described in Uplift Pressure Relief System. Plate S-61 shows details of typical drain system. The ongoing USGS study will be finalized in September 1991. At that time a revised underdrain system design will be completed. The design objective is to minimize the differences between post-project and pre-project groundwater conditions.

27. References.


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## F. SURVEYING AND MAPPING

28. General. The topographic information used during the design and analysis of this project is from survey data obtained between April 1987 and February 1988. The topographic maps produced have a 1-foot contour interval, and elevations refer to the National Geodetic Vertical Datum (NGVD) of 1929. The aerial photography was performed by Southern Resource Mapping Corporation in May of 1987 at a scale of 1:2400. An additional aerial photography flight was performed in April 1989 by Continental Aerial Surveys, Inc. The topographic maps produced also have a 1-foot contour interval. A field survey was performed to obtain stream cross-sections in July 1988 of the upstream of project area of the Quebrada Margarita drainage basin.

The topographic information used for the residual flooding analyses of the basin was prepared by Kucera & Associates, Inc. The aerial photography was performed in July of 1978, and the mapping is at a scale of 1:4000. The topographic maps produced have a 1-meter contour interval. This is the same survey data that was used for the analyses of existing conditions shown in the 1984 Survey Report.

## G. GEOLOGY AND SOILS

29. General. The groundwater level data shown on the core borings in Appendix G have been evaluated and are not considered representative in the area where impervious materials have been encountered. Due to the impervious clay encountered in many core borings, the standard 24 hour time period specified for recovering the water level in core borings is insufficient to allow the water in the borings to stabilize to the piezometric level. Prior to plans and specifications, additional core borings will be drilled and water levels will be monitored for sufficient time to allow the water level to reach equilibrium. When this additional information is obtained, the dewatering requirements will be determined. The groundwater levels shown on the geologic sections, from Plates G-1 through G-11, were adjusted using existing stream water surface elevations.

30. Lower Bulkhead Channel (Station 0+90 to Station 88+33.2). The reach from the San Juan Harbor to the confluence with Margarita tributary would be widened and deepened from the

existing 180 foot wide and 10 foot deep channel to a 400 foot wide and 25 foot deep channel. This reach is approximately 1.65 miles long and experiences tidal action. Design velocities range from 4.3 to 14.3 feet per second. A bulkheaded trapezoidal channel is the preferred design alternative for this reach. The proposed Puerto Nuevo Channel crosses two existing southbound lanes of the De Diego Expressway. The relocation of approximately 1,800 feet of the existing expressway will be designed by an A/E firm. Additional borings will be drilled along the proposed relocation alignment and undisturbed samples will be tested to provide A/E with sufficient foundation information. Relocation foundation improvements will be addressed in the Feature Design Memorandum.

a. Investigation Performed.

(1) Core Borings. Seventy-six borings were drilled along the channel alignment from station 0+90 to station 88+33. Three of the borings were drilled at Kennedy Avenue bridge site. Four undisturbed samples were taken, two from CB-PNL-69U and the other two from CB-PNL-75U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-22 through S-25. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. One unconsolidated-undrained triaxial (sat. Q) test, one consolidated- undrained triaxial test with pore pressure measurements (R), one Loss on Ignition test and one consolidation test were performed on the undisturbed very soft organic clay (OH) from CB-PNL-69U. One unconsolidated-undrained triaxial (sat. Q) test, one consolidated-undrained triaxial with pore pressure measurements (R) and one direct shear test were performed on the undisturbed stiff clay (CH) from CB-PNL-69U. One unconsolidated-undrained triaxial (sat. Q) test and one consolidated-undrained with pore pressure measurements (R) were performed on the undisturbed soft clay (CH) from CB-PNL-75U. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level at approximately 0.0 ft., NGVD.

c. Materials Encountered. From station 0+90 to station 88+33.2, the upper layer material encountered was a layer of very soft organic clay (OH) which varied in thickness from 0 feet to 40 feet. Below this very soft organic clay (OH) was stiff clay (CH) containing sand, silt and some pebbles. Underlying the stiff clay (CH) were interbedded clayey sand (SC) and gravels (GW & GC). The geologic section along the channel centerline is shown on Plates G-1 and G-2.

d. Proposed Channel Design. Design analyses performed include channel slope stability analysis, bulkhead retention design and stone protection design. Typical cross sections for this reach of the channel are shown on Plates S-50 through S-56.

(1) Stability Analyses. The channel side slope stability was analyzed using soil strength parameters derived from the blow counts of the Standard Penetration Test and from the triaxial test results. End of construction and long term conditions were both analyzed. An earthquake loading factor of 0.1 for seismic zone 3 was used in the analysis. Based on the triaxial test results (Q tests), the very soft organic clay (OH) has a cohesion of 180 psf and the stiff clay (CH) has a cohesion of 1,260 psf. These shear strength parameters were used for the end of construction loading condition analysis. From the triaxial test results (R & direct shear tests), the very soft organic clay (OH) has an effective friction angle of 32.8 degree and the stiff clay (CH) has an effective friction angle of 28 degree. Due to the fibrous nature of the organic clay (OH), the laboratory shear strength value of $\phi' = 32.8°$ is believed to be artificially high. Since the fibers will decay with time, the long-term strength of the organic clay (OH) should be assumed at a lower value. A reduction in the shear strength to $\phi' = 26°$ is considered reasonable for the long-term loading condition analysis. The slope stability computer program UTEXAS2 was utilized considering both a circular arc and wedge type failure surface. The minimum factors of safety were above 1.0 required by EM 1110-2-1902. From station 0+90 to station 74+32.5, recommended channel interior slopes are 1 vertical on 10 horizontal. From station 76+32.5 to station 88+33.2, recommended channel interior slopes are 1 vertical on 6 horizontal. A channel transition zone is proposed between station 74+32.5 and station 76+32.5. Sections of the channel slope analyzed with the stability results are shown on Plates G-22 and G-23.

(2) Bulkhead System.

(a) King Pile Wall System. A king pile wall system would be constructed from station 3+80 to station 57+40. The king pile wall system would be similar to that constructed previously along the Martin Pena channel. An existing king pile wall located in the northeast side of the channel, between station 3+84.26 and station 24+39.63, is to be removed. Pile analyses for the long term condition were performed. Soil shear strength parameters based on the triaxial test results were used in the pile analyses. Furthermore, the pile loading was assumed to be resisted only by the stiff clay stratum. The soft organic clay stratum overlying the stiff clay was assumed to have no shear strength in the pile analyses. A factor of safety of 2.0 was believed to be sufficient for the pile analyses.

Approximately two-thirds of the pile capacity will be generated by point bearing and the remainder by skin friction.

From station 3+80 to station 35+00, a minimum vertical pile penetration of 23 feet into the stiff clay and a minimum batter pile penetration of 18 feet into the stiff clay are required for the design loads. Top of piles will be at elevation plus 3.0 ft., NGVD, with a pile cap to elevation plus 5.0 ft., NGVD. Average pile length requirements for vertical and batter piles will be 65 and 60 feet, respectively. From station 35+00 to station 57+40, a minimum vertical pile penetration of 20 feet into the stiff clay and a minimum batter pile penetration of 15 feet into the stiff clay are required for the design loads. Top of piles will be at elevation plus 4.2 ft., NGVD, with a pile cap to elevation plus 6.2 ft., NGVD. Average pile length requirements for vertical and batter piles will be 50 and 49 feet, respectively.

(b) Sheetpile Wall System. A steel sheetpile wall with concrete facing is proposed for station 57+40 to station 74+32.5. To reduce pile driving difficulty into the stiff clay stratum, steel sheetpiles are recommended over concrete piling. Since steel sheetpiles are more susceptible to corrosion, a concrete facing will be applied. Sheetpile analysis was performed utilizing the computer program SHTWAL. SHTWAL is a sheetpile program developed by the Oklahoma State University and now being supported by WES. A minimum sheetpile penetration of 17 feet into the stiff clay stratum will be required. Top of the piles will be at elevation plus 3 ft., NGVD. A pile length of 45 feet will be required.

(3) Erosion Protection. Erosion protection will not be provided from station 0+90 to station 16+74 and from station 18+86 to station 57+40. The SPF average channel velocity in these areas will be from 4 to 9.8 feet per second. The channel slopes do not provide support for the king pile wall system therefore the erosion problem will not be critical. The SPF average channel velocity under the Kennedy Avenue Bridge is 14.4 feet per second. Stone protection, from station 16+74 to station 18+86, will be required to prevent scour damage around the bridge piers. A 60-inch thickness of riprap and 18-inch layer of bedding stone are recommended. The stone protection in the deeper portions of the channel, where maximum velocities will occur, will have 5-foot keyed-in toe to protect against undermining. A 6 ounce filter fabric material will be laid beneath all stone protection to aid in supporting the riprap on the weak underlying soils. Refer to Plate S-82. Riprap and bedding stone gradation requirements will be as follows:

| Riprap Stone Weight in Pounds 60" Blanket | %by Weight Consisting of Lighter Stones |
|---|---|
| 4,000 | 100 |
| 2,000 | 35-50 |
| 1,000 | 15-30 |
| 500 | 0-15 |
| 250 | 0-5 |

| Bedding Stone Size | % Passing |
|---|---|
| 6 in | 100 |
| 3 in | 45-70 |
| 1 in | 15-45 |
| No. 4 | 0-10 |

From station 57+40 to station 74+32.5, the maximum channel velocities anticipated will be from 6 to 8 feet per second. Stone protection is required to be placed on the channel slopes in this area because the channel slopes do provide stability support for the retaining bulkhead system. The riprap to be placed will be 12-inches thick and will extend to a depth of 4 feet below the channel invert to prevent under-cutting of the slope. Riprap gradation requirement will be as follows:

| Riprap Stone Weight in Pounds 12" Blanket | %by Weight Consisting of Lighter Stones |
|---|---|
| 20 | 100 |
| 9 | 60-90 |
| 6 | 40-60 |
| 1.5 | 0-30 |

Riprap requirements for the channel banks were determined in accordance with procedures outlined in EM 1110-2-1601 and ETL 1110-2-120. It is proposed that stones weighing at least 165 pcf be used for riprap. Stone sources will be obtained from quarries in San Juan area. Riprap stone samples selected from four quarries are being tested at SAD Laboratory in Marietta, Georgia. Test results will be presented in the forthcoming Concrete DM.

(4) Disposal of Excavated Materials. Most of the excavated materials are very soft clays (OH & CH). Soft clays are not suitable for backfill and must be disposed off-site. It is anticipated that approximately 2.8 million cubic yards of excavated materials will be disposed in an offshore ocean disposal site. Proposed channel cross sections with excavation limits are shown on Plates S-50 through S-55. See paragraph 62 for the location of the offshore disposal area and suitability of the excavated material for this site.

31. Lower Subcritical Channel (Station 88+33.2 to Station 147+40). The proposed channel improvements consist of widening and deepening the existing channel with a channel width of ranging from 180 to 150 feet and invert elevation ranging from -16 to -12.7 ft., NGVD. This entire reach is within the zone of tidal influence and is not considered feasible to dewater in order to construct a conventional concrete channel. The Commonwealth of Puerto Rico Department of Natural Resources (DNR) requested that channel improvements not require removal of existing home sites. Consequently, the construction easement, measured from the edge of channel wall, varies from 30 to 75 feet. Based on the reasons above, three alternate channel sections are considered. They are Relieving Platform Wall, anchored Diaphragm Wall and Soil Anchored Sheetpile Wall with Concrete Facing. Relieving Platform Wall is presented in the GDM for cost estimating purposes. All three alternatives will be thoroughly evaluated in the Feature Design Memorandum.

a. Investigation Performed.

(1) Core Borings. Seventeen borings were drilled along this reach of the channel alignment. Ten of the borings were drilled at three bridge sites. One undisturbed sample was taken from CB-PNM-45U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-25 through S-28. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. One unconsolidated-undrained triaxial (Q) test, one consolidated-undrained triaxial (R) test and one direct shear (S) test were performed on the undisturbed sample from CB-PNM-45U. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level which varies between 9.12 ft. and -7.17 ft., NGVD. Both proposed channel design alternatives will not require dewatering during construction.

c. Materials Encountered. Materials encountered were miscellaneous fills, clays (CH, CL & OH), silts (ML & OL) and sands (SC, SM & SW). The geologic section along the channel centerline is shown on Plates G-2 and G-3.

d. Foundation Condition. Channel invert will be in predominately stiff clay or silt.

e. Excavation. Excavation will involve removal of 11 to 25 feet of medium to stiff clays (CL & CH) and loose to medium silty sand (SM). Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plates S-56 through S-58.

f. Granular Fill. Granular fill will be placed behind the platform. This material will be obtained from off-site sources. See paragraph 40 for gradation criteria.

32. Composite Subcritical Channel (Station 147+40 to Station 184+48.51). The proposed channel improvements consist of widening and deepening the existing channel with a channel width ranging from 150 to 102 feet and an invert elevation ranging from -12.7 to 38.9 ft., NGVD. Inverted tee wall is considered to be the preferred construction alternative for this reach.

a. Investigation Performed.

(1) Core Borings. Thirteen borings were drilled along this reach of the channel alignment. Eleven of the borings were drilled at four bridge sites. Boring logs are included in Appendix G and the boring locations are shown on Plates S-28 through S-30. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level which varies between 3 feet and 8 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were miscellaneous fills, clays (CH & CL), silt (ML) and sands (SC & SM). The geologic section along the channel centerline is shown on Plates G-3 and G-4.

d. Dewatering. A steel sheet-pile cofferdam will be used for by-pass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

e. Foundation Condition. From station 147+40 to station 153+00, the structure will be founded on stiff clay (CL). Tolerable amount of differential settlement underneath the structure will be expected. From station 153+00 to station

172+00, the structure will be founded on loose sand (SC) overlying stiff clay (CL). Approximately 2 inches of immediate settlement is expected. This immediate settlement will occur during construction. From station 172+00 to station 184+49, the structure will be founded on fill materials overlying dense sand (SC), stiff clay (CH) and stiff silt (ML). A tolerable amount of differential settlement underneath the structure will be expected.

f. Excavation. Excavation will involve removal of mostly soft to stiff clays (CL & CH) and some loose clayey sand (SC) and gravel (GM). Excavation depth varies from 0 to 26 feet. Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plate S-59.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Geologic section for this reach shows a very minimum amount of free draining materials will be removed from the proposed channel excavation. Backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plate S-59.

33. Upper Supercritical Channel (Station 184+48.51 to Station 276+50). The proposed channel improvements consist of widening and straightening the existing channel with a channel width ranging from 107 to 60 feet and an invert elevation ranging from 11.5 to 53.4 ft., NGVD. The design velocities range from 24.1 to 39.9 feet per second. An inverted tee wall is considered to be the preferred design alternative for this reach.

a. Investigation Performed.

(1) Core Borings. Sixteen borings were drilled along this reach of the channel alignment. Six of the borings were drilled at two bridge sites. Boring logs are included in Appendix G and the boring locations are shown on Plates S-30 through S-34. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level which varies between 7 ft. and 43 ft., NGVD. Steel sheetpile wall will be used for by-pass during construction. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were miscellaneous fills, clays (CH, CL & OH), silts (MH & ML), clayey sand and gravels (GC & GP). The geologic section along the channel centerline is shown on Plates G-4 and G-5.

d. Dewatering. A steel sheetpile cofferdam will be used for bypass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. From station 184+48.51 to station 263+00, core borings indicate a general groundwater level between 7 and 37 ft., NGVD. The channel invert will be placed above groundwater level; therefore, no dewatering will be necessary during construction. From station 263+00 to station 273+00, core borings indicate a general groundwater level between 37 ft. and 42 ft., NGVD. The channel invert will be placed below groundwater level; therefore, dewatering will be required during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation. From station 273+00 to station 276+50, core boring indicates a groundwater level at approximately 43 ft., NGVD. The channel invert will be placed above groundwater level; therefore, no dewatering will be required during construction.

e. Foundation Condition. From station 184+48.51 to station 218+00, the structure will be founded on fill materials overlying stiff silt (ML) and clay (CH). Tolerable amount of differential settlement underneath the structure will be expected. From station 218+00 to station 276+50, the structure will be founded on soft to medium clays (CL & CH). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 9 feet of the soft to medium clays or pile foundation under the wall will be evaluated during Feature Design Memorandum. Additional borings will be necessary in this area for more detailed design.

f. Excavation. Excavation will involve removal of medium to stiff clays (CL & CH), medium to dense silts (MH & ML), loose clayey sand (SC) and very loose to very dense gravel (GP). Excavation depth varies from 0 to 18 feet. Materials will be excavated by conventional methods with no blasting required. It is assumed that majority of the excavated materials will not satisfy the select backfill gradations and will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plates S-59 through S-63.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Geologic section for this reach shows a very minimum amount of free draining materials will be removed from the proposed channel excavation. Backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plates S-59 through S-63.

34. Upper Subcritical Channel (Station 276+50 to Station 341+92.13). The proposed channel improvements consist of widening, deepening and straightening the existing channel with a channel width ranging from 60 to 70 feet and an invert elevation ranging from 53.4 ft. to 60.5 ft., NGVD. The design velocities range from 12.7 to 24.1 feet per second. An inverted tee wall is considered to be the preferred construction alternative for this reach. Puerto Nuevo Debris Basin is proposed at station 341+92.13 with an area of 9.5 acres.

a. Investigation Performed.

(1) Core Borings. Nineteen borings were drilled along this reach of the channel alignment. Seven of the borings were drilled at three bridge sites. One disturbed sample was taken from CB-PNU-57U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-34 through S-37. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. One unconsolidated-undrained triaxial (sat. Q) test, one consolidated-undrained triaxial test with pore pressure measurements (R), and one consolidation test were performed on the undisturbed sample (stiff CH) from CB-PNM-57U. Results of these tests are shown in Appendix G.

b. Groundwater. Core boring indicate a general groundwater level which varies between 43 ft. and 61.21 ft., NGVD. Steel sheetpile wall will be used for bypass during construction. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were miscellaneous fills, clays (CH & CL), sands (SC & SP), gravel and siltstone. The geologic section along the channel centerline is shown on Plates G-5 and G-6.

d. Dewatering. A steel sheet-pile cofferdam will be used for by-pass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. From station 276+50 to station 309+00, core borings indicate a general groundwater level between 43 ft. and 56.0 ft., NGVD.

The channel invert will be placed above groundwater level; therefore, no dewatering will be necessary during construction. From station 309+00 to station 335+00, core borings indicate a general groundwater level between 56 and 61.21 ft., NGVD. The channel invert will be placed below groundwater level; therefore, dewatering will be required during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

e. Foundation Condition. Between station 276+50 and station 289+50, the foundation will be founded on soft clays (CH & CL). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 10 feet of the soft clays or pile foundation underneath the tee wall will be evaluated during detailed design study. Between 289+50 and station 299+00, the structure will be founded on stiff clay (CH). Tolerable amount of differential settlement underneath the structure will be expected. Between station 299+00 and station 310+00, the structure will be founded on soft to medium clay (CH). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 12 feet of the soft to medium clay or pile foundation underneath the wall will be evaluated during detailed design study. The core boring data in this section may not be applicable to the design due to the change in channel alignment. Additional subsurface data will be required for a detailed design.

f. Excavation. Excavation will involve removal of medium to very stiff clays (CL & CH) and medium to stiff silt (ML). Excavation depth varies from 0 to 33 feet. Materials will be excavated by conventional methods with no blasting required. Approximately 405,000 cubic yards of materials will be excavated from this reach. Twenty-three thousands cubic yards will be used for Guaracanal dike fill and the remainder will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plates S-63 through S-65.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Since no free draining materials will be removed from the proposed channel excavation, backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plates S-63 through S-65.

h. Puerto Nuevo Debris Basin. A side discharge spillway is proposed. The outlet structure is shown on Plate S-79. One core boring was taken in this area. Additional borings and testing will be necessary for Feature Design Memorandum.

35. Margarita Tributary (Station 0+00 to Station 89+60). Between station 0+00 and station 54+10, an Earth Trapezoidal Channel is considered. A small dike will be constructed along the north bank to provide required protection elevation. The mangrove mitigation plan calls for planting a 60-foot wide berm at elevation 0.0 ft., NGVD, with mangroves on the north bank from station 0+00 through station 42+16. Between station 54+10 and station 89+60, an U-Frame channel with bottom width of 30 feet is considered.

a. Investigation Performed.

(1) Core Borings. Fifty-two borings were drilled along this reach of the channel alignment. Four borings were taken at the bridge site. Three undisturbed sample were taken from CB-MC-39U, CB-MC-40U and CB-MC-44U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-38 through S-41. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. One unconsolidated-undrained triaxial (sat. Q) test, one consolidated-undrained triaxial test with pore pressure measurements (R) and one consolidation test were performed on the very soft organic clay (OH) from CB-MC-39U. One unconsolidated-undrained triaxial (sat. Q) test was performed on the undisturbed soft clay (CH) from CB-MC-40U. One consolidated-undrained test with pore pressure measurements (R) was performed on the undisturbed medium clay (CH) from CB-MC-44U. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level between -24 ft. and 11 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were miscellaneous fills, clays (OH, CL & CH), silts (MH & ML) and interbedded clayey sand and clayey gravel. The geologic section along the channel centerline is shown on Plates G-7 and G-8.

d. Proposed Channel Design.

(1) Stability Analysis. The channel side slope stability was analyzed using soil strength parameters derived from the blow counts of the Standard Penetration Test and from the triaxial test results. End of construction and long term condition were both analyzed. An earthquake loading factor of 0.1 for seismic zone 3 was used in the analysis. Based on the

triaxial test results (Q tests), the very soft organic clay (OH) has a cohesion of 180 psf and the soft clay (CH) has a cohesion of 320 psf. These shear strength parameters were used for the end of construction loading condition analysis. Base on the triaxial test results (R tests), the very soft organic clay (OH) has an effective friction angle of 38.7 degree and the medium clay (CH) has an effective friction angle of 33.9 degree. Due to the fibrous nature of the organic clay (OH), the laboratory shear strength value of $\phi' = 38.7°$ is believed to be artificially high. Since the fibers will decay with time, the long-term strength of the organic clay (OH) should be assumed at a lower value. A reduction in the shear strength to $\phi' = 26°$ is considered reasonable for the long-term loading condition analysis. The slope stability computer program UTEXAS2 was utilized considering both a circular arc and wedge type failure surface. The minimum factors of safety were above 1.0 required by EM 1110-2-1902. From station 0+00 to station 39+00, recommended slopes are 1 vertical on 6 horizontal for the channel interior slopes and 1 vertical on 8 horizontal for the stability berm which provides support for the retaining dike with 1 vertical on 3 horizontal slopes. From station 40+00 to station 54+10, recommended slopes are 1 vertical on 8 horizontal for the channel interior slopes and 1 vertical on 8 horizontal for the stability berm which also provides support for the 1 vertical on 3 horizontal retaining dike. A channel transition zone is proposed between station 39+00 and station 40+00. Sections of the channel slope analyzed with the stability results are shown on Plates G-24 and G-25.

(2) Settlement Analysis. Settlement analysis was performed on the dike with 1 vertical on 3 horizontal slopes. Two feet of initial displacement will occur during construction. Two feet of overbuild will be required for post-construction consolidation.

(3) Stone Protection. Stone protection will not be required between station 0+90 to station 51+85. The SPF average channel velocity in this area is less than 4 feet per second. Clay materials (CH & CL) should withstand maximum velocity of 4 feet per second without protection. Hydraulic conditions required riprap protection for a minimum distance of 225 feet downstream of the stilling area. From station 54+10 to station 54+00, turbulent flow condition was assumed. Twenty-seven inches thickness riprap will be placed on the channel slopes and

channel bottom. From station 54+00 to station 51+85, twelve-inch thick riprap will be placed on the channel slopes and channel bottom. Riprap gradation requirements will be as follows:

| Stone Weight in Pounds | % By Weight Consisting of Lighter Stones |
|---|---|
| 27"Blanket | |
| 900 | 100 |
| 300 | 50-70 |
| 150 | 30-45 |
| 40 | 0-25 |
| 12"Blanket | |
| 20 | 100 |
| 9 | 60-90 |
| 6 | 40-60 |
| 1.5 | 0-30 |

Riprap requirements were determined in accordance with procedures outlined in EM 1110-2-1601 and ETL 1110-2-120. It is proposed that stones weighing at least 165 pcf be used for riprap. Stone sources will be obtained from quarries in San Juan area. Riprap stone samples selected from four quarries are being tested at SAD Laboratory in Marietta, Georgia. Test results will be presented in the forthcoming Concrete DM.

e. Excavation. Excavation will involve removal of soft to very stiff clays (OH, CL & CH) and loose clayey sand (SC). Excavation depth varies from 0 to 25 feet. Approximately 0.7 million cubic yards of materials excavated from the lower Margarita tributary will be disposed in an off-shore ocean disposal site. Approximately 96,000 cubic yards will be excavated from the U-Frame channel area. Approximately 60,000 cubic yards will be used for dike fill and the remainder will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plates S-66 through S-70.

f. Dewatering. A steel sheetpile cofferdam will be used for bypass during construction. Cofferdam will be designed to provide protection for 10 year recurrence interval flood. From station 54+10 to station 73+00, the channel invert will be placed below groundwater level. Dewatering will be necessary during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

g. Concrete U-Frame Channel Foundation Condition. From station 55+50 to station 87+00, the structure will be founded on soft clay (CH). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 9 feet of the soft clay or pile foundation underneath the U-Frame channel wall will be evaluated during Feature Design Memorandum.

h. Dike Fill Materials. Dike fill materials will be obtained from the required structure excavation.

i. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Since no free draining materials will be removed from the proposed channel excavation, backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plates S-66 through S-70.

36. Josefina Tributary (Station 0+00 to Station 34+36.72). Between station 0+00 and station 34+36.72, an inverted tee wall with bottom width of 45 feet is considered. Between station 34+36.72 and station 36+78.52, an U-Frame channel with bottom width of 22 feet is considered. Between station 36+78.52 and station 77+28.84, the proposed channel will be constructed within the existing channel. A sheetpile wall channel with bottom width from 17 feet to 22 feet is considered.

a. Investigation Performed.

(1) Core Borings. Twenty-five borings were drilled along this reach of the channel alignment. Nine borings were taken at the bridge sites. One undisturbed sample was taken from CB-QJ-16U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-42 through S-44. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. No laboratory testings were performed on samples from bridge borings. One consolidation test was performed on the medium high plasticity clay from CB-QJ-16U. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level which varies between 8 ft. and 23 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were clays (CH & CL), sands (SC & SM) and silt. The geologic section along the channel centerline is shown on Plate G-9.

d. Dewatering. From station 0+00 to station 34+00, a steel sheetpile cofferdam will be used for bypass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. From station 0+00 to station 55+50, core borings indicate a general groundwater level between 8 and 13 ft., NGVD, the channel invert will be placed below groundwater level; therefore, dewatering will be necessary during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation. However, from station 55+50 to station 73+00, core borings indicate a general groundwater level between 13 and 23 ft., NGVD, the channel invert will be placed above groundwater level, therefore, dewatering will not be required during construction.

e. Foundation Condition. Wall and U-Frame channel structure will be founded on predominately stiff clays (CH & CL). Tolerable amount of differential settlement underneath the structure will be expected.

f. Excavation. Excavation will involve removal of soft to very stiff clays (CL & CH) and loose clayey sand (SC). Excavation depth varies from 4 to 27 feet. Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plates S-71 through S-72.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Since no free draining materials will be removed from the proposed channel excavation, backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plates S-71 through S-72.

37. Dona Ana Tributary (Station 0+00 to Station 32+80). Between station 0+00 and station 5+30.83, a concrete U-Frame wall is considered as the preferred channel design alternative. Between 5+30.83 and station 32+80, the proposed channel will be constructed within the existing channel. A sheetpile wall channel is considered as the preferred channel design alternative.

a. Investigation Performed.

(1) Core Borings. Eleven borings were drilled along this reach of the channel alignment. Three borings were taken at the bridge sites. One undisturbed sample was taken from CB-QDA-8U. The boring logs are included in Appendix G and the

boring locations are shown on Plates S-45 and S-46. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. One unconsolidated-undrained triaxial (Q) test and one consolidation test were performed on the undisturbed very stiff clay (CH) from CB-QDA-8U. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level which varies between 14 ft. and 30 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift relief system definition and gradations.

c. Materials Encountered. Materials encountered were clays (CH & CL), silt, sands (SC & SM). Geologic section along the channel centerline is shown on Plate G-10.

d. Dewatering. A steel sheetpile cofferdam will be used for by-pass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. Geologic section shows the entire proposed channel invert will be placed below groundwater level; therefore, dewatering will be required during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

e. Foundation Condition. Between station 0+00 and station 5+30.83, concrete U-Frame channel will be founded on very dense sand (SC). Tolerable amount of differential settlement will be expected. Between station 5+30.83 and station 32+80, a sheetpile wall channel is considered. Settlement will not be critical.

f. Excavation. Excavation will involve removal of soft to very stiff clays (CL & CH). Excavation depth varies from 4 to 22 feet. Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plate S-73.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Since no free draining materials will be removed from the proposed channel excavation, backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plate S-73.

38. Buena Vista Diversion Channel (Station 0+00 to Station 42+37). The existing Buena Vista tributary traverses through a heavily developed residential area. A diversion channel is proposed to eliminate the need for extensive loss of home sites. A concrete U-Frame channel is considered as the preferred design alternative for this diversion channel.

a. Investigation Performed.

(1) Core Boring. Twelve borings were drilled along this reach of the channel alignment. Four borings were taken at the bridge sites. One undisturbed sample was taken from CB-QBV-8U. The boring logs are included in Appendix G and the boring locations are shown on Plates S-47 and S-48. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level between 17 ft. and 46 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were clays (CL & CH) and silty sand. Geologic section along the channel centerline is shown on Plate G-11.

d. Dewatering. From station 0+00 to station 13+50 and from station 37+50 to station 42+37.79, the channel invert will be placed above groundwater level; therefore, dewatering will not be necessary during construction. However, from station 13+50 to station 37+50, the channel invert will be placed below groundwater level and dewatering will be required during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

e. Foundation Condition. From station 0+00 to station 5+00, the structure will be founded on medium to stiff clay (CL) overlying soft clay (CL). Potential differential settlement in this area will produce adverse effect on the structure. Pile foundation underneath the U-Frame channel wall will be evaluated during detailed design study. From station 5+00 to station 15+00, the structure will be founded on medium clay (CH). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 4 feet of the medium clay will be evaluated during detailed design study. From station 15+00 to station 42+37, the structure will be founded on predominately very stiff materials (CH, SC, MH & ML). Tolerable amount of differential settlement will be expected.

f. Excavation. Excavation will involve removal of soft to very stiff clays (CL & CH), loose to dense clayey sand (SC) and stiff to very stiff silts (MH & ML). Excavation depth varies from 0 to 31 feet. Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plate S-74.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Since no free draining materials will be removed from the proposed channel excavation, backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plate S-74.

39. Guaracanal Tributary (Station 0+00 to Station 8+19). The proposed channel improvements consist of straightening the existing tributary with a concrete U-Frame channel varying in width from 26 to 50 feet. The design invert elevation ranges from 41.5 to 46.3 ft., NGVD. Guaracanal debris basin is proposed at station 8+19 and has an area of 6.5 acres.

a. Investigation Performed.

(1) Core Borings. Four borings were drilled along this reach of the channel alignment. The boring logs are included in Appendix G and the boring locations are shown on Plate S-49. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(2) Laboratory Tests. Gradation tests, Atterberg Limits and water contents were performed on selected samples of material. Results of these tests are shown in Appendix G.

b. Groundwater. Core borings indicate a general groundwater level at approximately 48 ft., NGVD. A permanent uplift pressure relief system will be required to prevent excessive hydrostatic head build-up around the structure. See paragraph 40 for uplift pressure relief system definition and gradations.

c. Materials Encountered. Materials encountered were clays (CH & CL), silt (MH), sand (SC) and gravel (GP). The geologic section along the channel centerline is shown on Plate G-10.

d. Dewatering. A steel sheetpile cofferdam will be used in some areas for bypass during construction. Cofferdam will be designed to provide protection for 10-year recurrence interval flood. The entire proposed channel invert will be placed below groundwater level; therefore, dewatering will be required during construction. A dewatering system consisting of perimeter ditches and sump pumps will be required to control groundwater flow into the structure excavation.

e. Foundation Condition. From station 0+00 to station 3+00, the structure will be founded on soft clay (CL) overlying loose sand (SC). Potential differential settlement in this area will produce adverse effect on the structure. Excavation and replacement of approximately 8 feet of the soft clay or pile foundation will be evaluated during detailed design study. From station 3+00 to station 8+19, the structure will be founded on approximately 20-feet thick soft silt (MH) and soft clay (CH). Pile foundation underneath the U-Frame channel wall will be evaluated during detailed design study.

f. Excavation. Excavation will involve removal of very loose gravel (GP), very soft to medium clay (CH) and medium silt (MH). Excavation depth varies from 0 to 35 feet. Materials will be excavated by conventional methods with no blasting required. The excavated materials will be disposed in upland disposal areas. Proposed channel cross sections with excavation limits are shown on Plate S-75.

g. Select Backfill. Cohesive material was considered unsuitable for structure backfill. Geologic section for this reach shows a very minimum amount of free draining materials will be removed from the proposed channel excavation. Backfill materials will be obtained from off-site sources. See paragraph 41 for select backfill gradations. Proposed channel cross sections with backfill limits are shown on Plate S-75.

h. Guaracanal Debris Basin. A side discharge spillway is proposed. The outlet structure is shown on Plate S-80. A retaining dike is proposed to protect development on the west side of the basin. Borings located at the river area indicated that soft clay (CH) material was encountered. No boring was drilled under the proposed dike alignment. Additional borings and lab testing will be performed prior to Feature Design Memorandum.

40. Uplift Pressure Relief System. An uplift pressure relief system for each reach as described in the previous paragraphs will consist of weepholes and a 12-inch drainage blanket. The drainage blanket will be placed on filter fabric. Drainage blanket gradation will be as follows:

| Draining Blanket Material Size | Percent Passing |
|---|---|
| 1 inch | 100 |
| 1/2 inch | 50-80 |
| #4 sieve | 20-40 |
| #10 sieve | 5-15 |
| #200 sieve | 0-5 |

The proposed channel cross sections show the uplift pressure relief system details.

41. Select Backfill Materials. Select backfill materials for each reach as described in the previous paragraphs will consist of free draining materials. These materials will be restricted to no more than 10% passing a #200 sieve and a maximum particle size of 3 inches.

42. Upland Disposal Area. Two upland disposal sites were identified in the feasibility report. The total disposable area of these two sites are reduced due to the new channel alignment encroachment. Approximately 352,566 square yards in area will be available. These disposal areas is estimated to have an estimated capacity of 3.3 million cubic yards. Approximately 3 million cubic yards of excavated materials will be disposed in these areas.

43. Proposed Bridges to be Modified. Eight bridges are proposed to be modified. See Plate S-81 for the locations of the proposed modified bridges.

a. Kennedy Avenue Bridge. The deepening and widening of the existing channel will result in the exposure of portions of five of the bridge's piling foundations. Refer to Plate S-82.

(1) Investigation Performed.

(a) Core Boring. Three bridge borings, CB-PNB-1 through CB-PNB-3, were taken at the Kennedy bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the three core borings. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -0.78 ft. and 0.73 ft., NGVD.

(3) Materials Encountered. The upper most material encountered was a layer of miscellaneous fill between 14 and 24 feet thick. Below the fill layer was a stratum of very soft organic clay (OH) approximately 20 to 26 feet thick overlying medium to very stiff clay (CH). A cross section of the bridge site is shown on Plate G-12.

(4) Proposed Bridge Modification. The proposed plan will consist of constructing individual steel sheetpile cofferdams around each affected bridge pier. The cofferdam will be permanent and will retain existing soils around the existing bridge foundation piling. Additional borings and lab testing will be performed to develop shear strength data for Feature Design Memorandum.

(5) Stone Protection. Refer to paragraph 30.d.(3).

b. De Diego Expressway Bridge. De Diego bridge is located at station 95+00 of the lower subcritical reach. The proposed channel improvements under De Diego Expressway Bridge will involve deepening the existing invert approximately 20 feet.

(1) Investigation Performed.

(a) Core Boring. Four bridge borings, CB-PNB-4 through CB-PNB-7, were taken at the De Diego expressway bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the four core borings. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -5.92 feet and 2.47 ft., NGVD.

(3) Materials Encountered. The materials encountered contain a thick stratum of miscellaneous fill overlying layers of medium to stiff clays (CH & CL) with interbedded sands (SW & SC). A cross section of the bridge site is shown on Plate G-13.

(4) Proposed Bridge Modification. The proposed channel width is 180 feet which fits within the existing bridge abutments. No impact upon the bridge's substructure is anticipated.

c. Las Americas Expressway Bridge. Las Americas Expressway is located at station 156+00 of the composite supercritical reach.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-15 and CB-PNB-16, were taken at the Las Americas Expressway bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the two core borings. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between 0.86 ft. and 5.61 ft., NGVD.

(3) Materials Encountered. The materials encountered contain a layer of miscellaneous fill overlying layers of medium to hard clays (CL & CH) and silts (MH & ML). A cross section of the bridge site is shown on Plate G-15.

(4) Proposed Bridge Modification. The proposed plan will consist of constructing the required channel cross section under Las Americas Expressway Bridge by stabilizing the slope using soil nailing, and then providing a cast-in-place reinforced concrete channel wall and slab. Refer to Plate S-84.

d. N.E. Ramp Bridge. The existing N.E. Ramp bridge will be modified. The bridge site is located at station 164+00 of the composite supercritical reach.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-17 and CB-PNB-18, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the two core borings. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -2.89 ft. and 6.33 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying layers of medium to hard clays (CH & CL) with interbedded sand layers (SW & SC). A cross section of the bridge site is shown on Plate G-15.

(4) Proposed Bridge Modification. Refer to Las Americas Expressway bridge modification.

e. Pinero Avenue Bridge. Pinero Avenue bridge will be replaced. This bridge site is located at station 169+00 of the composite supercritical reach.

(1) Investigation Performed.

(a) Core Boring. Four bridge borings, CB-PNB-19 and CB-PNB-22, were taken at the existing bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the four core borings. Results of the tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -18.87 ft. and -1.91 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying stiff clay (CH). Below the clay is very hard sand (SM) with interbedded silt (ML). A cross section of the bridge site is shown on Plate G-15.

(4) Proposed Bridge Modification. Refer to Las Americas Expressway Bridge modification.

f. S.E. Ramp Bridge. The S.E. Ramp bridge will be modified. This bridge site is located at station 174+50 of the composite supercritical reach.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-23 and CB-PNB-24, were taken at the existing bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from CB-PNB-24. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between 10.86 ft. and 12.15 ft., NGVD.

(3) Materials Encountered. The materials encountered contain a layer of miscellaneous fill overlying layers of medium to stiff clays (CL & CH). Below the clays is a layer of hard sand (SM) with interbedded silt (ML). A cross section of the bridge site is shown on Plate G-16.

(4) Proposed Bridge Modification. Refer to Las Americas Expressway Bridge Modification.

g. De Diego Expressway Bridge. De Diego Expressway bridge, located at station 61+00 of the Margarita tributary, is proposed to be modified.

(1) Investigation Performed.

(a) Core Boring. Four bridge borings, CB-PNB-37 through CB-PNB-40, were taken at the bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the four borings. Results of these tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between 0.26 and 2.83 ft., NGVD.

(3) Materials Encountered. Materials encountered contain a thick stratum of miscellaneous fill overlying a soft layer of organic clay (OH) with interbedded sand (SC). Below this soft organic clay (OH) is medium to stiff clay (CH) with interbedded sands (SC & SP). Hard limestone was encountered at -45 ft., NGVD, underlying the stiff clay (CH). A cross section of the proposed bridge site is shown on Plate G-13.

(4) Proposed Bridge Modification. Refer to paragraph 43.b., De Diego Expressway Bridge - Lower Subcritical Reach.

h. P.R. 177 Bridge. P.R. 177, located at station 331+00 of the upper subcritical reach, is proposed to be modified.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-35 and CB-PNB-36, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate a general groundwater level between 59.24 and 65.33 ft., NGVD.

(3) Materials Encountered. The materials encountered contain a layer of miscellaneous fill overlying layers of medium clays (CL & CH). Below the clays is a layer of gravel (GM) overlying hard siltstone. A cross section of the proposed bridge site is shown on Plate G-18.

(4) Proposed Bridge Modification. Refer to paragraph 43.b., De Diego Expressway Bridge - Lower Subcritical Reach.

44. Proposed New Bridges. A total of 5 new bridges are to be constructed. See plate S-81 for the locations of the proposed new bridges. All the bridge borings were drilled for GDM scope to collect general geological information at the bridge locations. Prior to the feature design studies, additional field exploration will be conducted. Triaxial and consolidation tests will be performed on undisturbed soil samples from the bridge sites to obtain proper soil properties for detailed bridge design use. Foundation improvements for bridge abutment will be addressed in the Feature Design Memorandums. In areas where abutment fill will be placed on soft clays, removal and replacement with select backfill or stage construction with surcharge load will be considered. If stage construction with surcharge load is selected, settlement gauges will be installed during construction to monitor actual consolidation rate of the problem foundation soil.

a. Station 110+00 Pedestrian Bridge. A new pedestrian bridge is proposed at station 110+00 of the lower subcritical reach. See Plate S-81 for the location of the proposed bridge.

(1) Investigation Performed.

(a) Core Boring. Three bridge borings, CB-PNB-8 through CB-PNB-10, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the three core borings. Results of the tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between 0.74 feet and 4.43 ft., NGVD.

(3) Materials Encountered. The materials encountered contain a thin layer of soft organic clay (OH) overlying medium to hard clays (CL & CH) and silt (ML). A cross section of the bridge site is shown on Plate G-14.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

b. Station 195+00 Pedestrian Bridge. A new pedestrian bridge is proposed at station 195+00 of the composite supercritical reach. See Plate S-81 for the location of the proposed bridge.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-25 and CB-PNB-26, were taken at the existing bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from CB-PNB-26. Results of the tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -27.08 ft. and 14.43 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium to stiff clay (CH). A cross section of the proposed bridge site is shown on Plate G-16.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

c. P.R. 1 Bridge. A new P.R. 1 bridge, is proposed at station 242+00 of the upper supercritical reach. See Plate S-81 for the location of the proposed bridge.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-29 and CB-PNB-30, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate a general groundwater level between 22.75 ft. and 30.24 ft., NGVD. The proposed channel invert is at 31 ft., NGVD. USGS groundwater study for Puerto Nuevo project shows that groundwater level in this area is at 29 ft., NGVD. Dewatering will not be required during bridge construction.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium to stiff clays (CL & CH). Below the clays is a thick stratum of very hard silt (ML). A cross section of the proposed bridge site is shown on Plate G-17.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

d. Station 21+00 Service Road Bridge. A new service road bridge is proposed at station 21+00 of the Buena Vista tributary. See Plate S-81 for the location of the proposed bridge.

(1) Investigation Performed.

(a) Core Boring. Two core borings, CB-PNB-53 and CB-PNB-54 were taken at the bridge site. The boring logs are included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate groundwater level between 23.25 and 28.90 ft., NGVD.

(3) Materials Encountered. The materials encountered contain very stiff clays (CH & CL) overlying stiff to very stiff silt (ML) and sand (SM). A cross section of the proposed bridge site is shown on Plate G-20.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

e. 17th Street Bridge. A new 17th Street bridge is proposed at station 36+00 of the Buena Vista tributary. See Plate S-81 for the location of the proposed bridge.

(1) Investigation Performed.

(a) Core Boring. Two core borings, CB-PNB-55 and CB-PNB-56 were taken at the bridge site. The boring logs are included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate groundwater level at approximately 34.00 ft., NGVD.

(3) Materials Encountered. The materials encountered contain fill material (CH) overlying stiff to hard silt (ML). Siltstone was encountered at 2.15 ft., NGVD, underlying the silt. Cross-section of the proposed bridge site is shown on Plate G-21.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

45. Replacement Bridges. A total of 17 bridges are to be replaced. See Plate S-81 for the locations of the proposed replacement bridges. Refer to paragraph 44 for additional field investigation and laboratory testing requirements and foundation improvements for replacement bridge abutment.

a. Roosevelt Avenue Bridge. Existing Roosevelt Avenue bridge will be replaced. This bridge is located at station 120+50 of the lower subcritical reach.

(1) Investigation Performed.

(a) Core Boring. Three bridge borings, CB-PNB-11 through CB-PNB-13, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from the three core borings. Results of the tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -4.27 ft. and -2.06 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clays (OH & CH). Below the clays is layers of very hard sand (SM), silt (ML) and clay (CL). A cross section of the bridge site is shown on Plate G-14.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

b. Notre Dame Bridge. Notre Dame bridge is proposed to be replaced. The bridge is located at station 196+00 of the composite supercritical reach.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-27 and CB-PNB-28, were taken at the existing bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. Gradation tests, Atterberg Limits and water contents were performed on selected samples of materials from CB-PNB-27. Results of the tests are shown in Appendix G.

(2) Groundwater. Core borings indicate a general groundwater level between -3.17 ft. and 6.16 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium to stiff clays (CH & CL). Below the clays is layers of medium to very stiff silt (ML) and sand (SM). A cross section of the proposed bridge site is shown on Plate G-17.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

c. P.R. 176 Bridge. P.R. 176 bridge is proposed to be replaced. The bridge is located at station 281+00 of the upper subcritical reach.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-31 and CB-PNB-32, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate a general groundwater level between 43.11 ft. and 45.91 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clays (OH, CH & CL). Siltstone was encountered at 28 ft., NGVD, underlying clays. A cross section of the proposed bridge site is shown on Plate G-18.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

d. Station 302+30 Pedestrian Bridge. A pedestrian bridge, located at station 302+30 of the upper subcritical reach, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. Two bridge borings, CB-PNB-33 and CB-PNB-34, were taken at the proposed bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate a general groundwater level at approximately 49 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clay (CH). Below the clay is layers of medium sands (SP & SM) overlying hard silt (ML). Siltstone was encountered at 28 ft., NGVD, underlying silt. A cross section of the proposed bridge site is shown on Plate G-18.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

e. Pinero Avenue Bridge. Pinero Avenue bridge, located at station 24+00 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. Three bridge borings, CB-PNB-41 through CB-PNB-43, were taken at the bridge site. The boring logs are included in Appendix G. The samples from the borings are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate a general groundwater level between -2.59 and 1.68 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying soft to medium clays (CH & CL). Below the clays is a layer of stiff sand (SM) overlying hard to very hard silt (ML). A cross section of the proposed bridge site is shown on Plate G-18.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

f. Andalucia Avenue Bridge. Andalucia Avenue bridge, located at station 31+50 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-44 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at -0.42 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clays (CH & CL). Below the clays are hard silt (ML) and sands (SM & SP). A cross section of the proposed bridge site is shown on Plate G-19.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

g. Josefina Pedestrian Bridge. The pedestrian bridge, located at station 40+50 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-45 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at -0.72 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clays (CH & CL) and silt (ML). A cross section of the proposed bridge site is shown on Plate G-19.

(4) Proposed Bridge design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

h. Americo Miranda Bridge. Americo Miranda bridge, located at station 47+00 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-46 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 1.62 ft., NGVD.

(3) Materials Encountered. The materials encountered contain medium clays (CH & CL) overlying stiff to hard silt (ML) and sand (SM). A cross section of the proposed bridge site is shown on Plate G-19.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

i. 31st S.E. Street Bridge. The 31st S.E. Street bridge, located at station 51+50 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-47 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 11.42 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying soft to stiff clays (CH & CL). A cross section of the proposed bridge site is shown on Plate G-19.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

j. 21st S.E. Street Bridge. The 21st S.E. Street bridge, located at station 63+50 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-48 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 23.0 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium to stiff clays (CH & CL). Below the clays are layers of hard to very hard silt (ML), sand (SM) and Gravel (GM). A cross section of the proposed bridge site is shown on Plate G-19.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

k. 9th S.E. Street Bridge. The 9th S.E. Street bridge, located at station 74+50 of the Josefina tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-49 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 21.22 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying soft clay (CH). Below the soft clay are layers of hard silt (ML) and clay (CL). A cross section of the proposed bridge site is shown on Plate G-20.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

l. 54th S.E. Street Bridge. The 54th S.E. Street bridge, located at station 76+20 of the Josefina tributary, is proposed to be replaced. No boring was drilled at the bridge site. Additional subsurface investigation will be needed for Feature Design Memorandum.

m. Americo Miranda Bridge. Americo Miranda bridge, located at station 15+00 of the Dona Ana tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-50 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 8.48 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying a thin layer of soft clay (CH). Below the clay are layers of hard silt (ML), sands (SM & SP) and gravel (GM). A cross section of the proposed bridge site is shown on Plate G-20.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

n. 29th S.E. Street Bridge. The 29th S.E. Street bridge, located at station 19+50 of the Dona Ana tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-51 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 15.44 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying layers of soft clays (CH & CL), soft sand (SM) and soft silt (ML). Below these soft materials are layers of stiff to hard sands (SM & SP) and silt (ML). A cross section of the proposed bridge site is shown on Plate G-20.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

o. 21st S.E. Street Bridge. The 21st S.E. Street bridge, located at station 28+00 of the Dona Ana tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. CB-PNB-52 was taken at the bridge site. The boring log is included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core boring indicates groundwater level at 15.25 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying soft to stiff clays (CH & CL). Below the clays are layers of hard silt (ML) and sands (SM & SP). A cross section of the proposed bridge site is shown on Plate G-20.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

p. 4th Street Bridge. The 4th Street bridge, located at station 38+50 of the Buena Vista tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. Two core borings, CB-PNB-57 and CB-PNB-58 were taken at the bridge site. The boring logs are included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate groundwater level between 20.93 and 28.79 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying soft to hard clays (CH, OL & CL). Siltstone was encountered at -16 ft., NGVD, underlying the clays. A cross section of the proposed bridge site is shown on Plate G-21.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

q. P.R. 21 Bridge. The P.R. 21 bridge, located at station 40+50 of the Buena Vista tributary, is proposed to be replaced.

(1) Investigation Performed.

(a) Core Boring. Two core borings, CB-PNB-59 and CB-PNB-60 were taken at the bridge site. The boring logs are included in Appendix G. The samples from the boring are stored in the Corps of Engineers San Juan Area Office warehouse.

(b) Laboratory Testing. No laboratory testing was performed.

(2) Groundwater. Core borings indicate groundwater level between 23.08 and 31.24 ft., NGVD.

(3) Materials Encountered. The materials encountered contain miscellaneous fill overlying medium clays (CH & CL) and stiff silt (ML). Siltstone was encountered at 17 ft., NGVD, underlying the clays and silt. A cross section of the proposed bridge site is shown on Plate G-21.

(4) Proposed Bridge Design. The bridge is proposed to be founded on piles. No bridge loading has been determined.

46. Additional Subsurface Investigation Requirements. Additional borings and undisturbed samples will be required prior to each feature design study to fully evaluate the foundation conditions. The majority of the additional laboratory testing requirements will involve moisture content, sieve analysis, and atterberg limits. Triaxial tests will be performed to update soil shear strengths for detail design use. Consolidation tests will be performed on soft materials which would cause unacceptable settlement. Compaction tests will be performed on dike fill and backfill materials.

## H. DESIGN CONSIDERATIONS AND COST ESTIMATES

47. Description of Proposed Improvements.

a. General. The Rio Puerto Nuevo flood control project consists of 11.2 miles of the main river of Puerto Nuevo and its five tributaries: Margarita, Josefina, Dona Ana, Buena Vista, and Guaracanal. The proposed channel improvements would require the replacement of 17 bridges (includes 2 pedestrian bridges), the modification of 8 bridges, and the construction of 5 new bridges (includes 2 pedestrian bridges). The construction of two debris basins with side overflow spillways, two stilling areas, and the relocation of a segment of De Diego Expressway are also proposed. The majority of the project would consist of high velocity, supercritical, concrete channels; however, various types of channel construction are proposed depending on the water and soil conditions encountered, as well as external construction limitations. The proposed improvements would provide 100-year flood protection and would have a 50-year design life.

b. Channel Improvements.

(1) Puerto Nuevo Channel. The channel improvements along Rio Puerto Nuevo involve deepening, widening, and straightening 6.5 miles of the main channel from its outlet in the San Juan Harbor to Winston Churchill Avenue and the construction of a debris basin. The width of the channel varies from 400 feet in the lower reach to 60 feet in the upper reach.

The Puerto Nuevo Channel is divided into 5 hydraulic reaches: from station 0+90 to station 88+33.2 - the Lower Bulkheaded Channel (Reach 1); from station 88+33.2 to station 147+40 - the Lower Subcritical Channel (Reach 2); from station 147+40 to station 184+48.51 - the Composite Section Supercritical Channel (Reach 3); from station 184+48.51 to station 276+50 - the Upper Supercritical Channel (Reach 4); and from station 276+50 to station 341+92.13 - the Upper Subcritical Channel (Reach 5).

(a) Reach 1. The reach from the San Juan Harbor to the confluence with Margarita tributary (station 0+90 to station 88+33.2) would be widened and deepened from the existing 180 foot wide and 10 foot deep channel to a 400 foot wide and 25 foot deep channel. This reach is approximately 1.66 miles long and experiences tidal action. Design velocities range from 4.3 to 14.3 feet per second.

Several factors influenced the alignment of this reach. At the Harbor, an existing mangrove/mudflat system along the west bank was found to be a valuable wildlife habitat. The proposed improvements would maintain the existing west bank and widen 400 feet eastward. The existing mangrove/mudflat system would be designated a National Reserve and managed by the Commonwealth.

A king pile wall system would be constructed from station 3+80 to station 57+40. The channel walls would provide protection to the mangroves from the wake of boats expected from the Agua-Guagua project and the anticipated design velocities. The top of the channel would be at elevation 3 ft., NGVD; however, some areas would have reduced wall heights just below the water surface to allow for tidal flushing necessary for the mangroves to thrive. The existing bulkhead wall along the west bank would not require removal and would be incorporated into the channel improvements.

The original channel design (400 feet wide by 20 feet deep) was modified to ensure the integrity of the existing wall system. A 20 foot wide berm at elevation -10 ft., NGVD, adjacent to the king pile wall and a relatively flat slope (1V on 10H) to the channel invert, elevation -25 ft., NGVD, are proposed as measures to limit erosion.

The new king pile wall system would be similar to that constructed under the Martin Pena contract. Material behind the wall is limited to elevation 0.0 ft., NGVD. Along the east bank, a 60 foot wide berm at elevation 0.0 ft., NGVD, would be constructed to provide an area for mangrove replanting.

The San Juan Municipal Landfill extends along the west bank of the Puerto Nuevo Channel from Kennedy Avenue to the confluence with Margarita tributary. From station 57+40 to station 74+32.5, the landfill encroaches into the existing channel right-of-way. The original alignment would have required extensive excavation into the landfill which was considered undesirable environmentally. In addition, the channel is bound by the De Diego Expressway on the east bank.

Various alignment alternatives were considered. A localized reduction in the channel width and then widening downstream to compensate for the resulting backwater effect was investigated. This alternative was found to be the most costly due to the increased real estate, excavation, and erosion control requirements.

The selected alternative involved the relocation of approximately 1,800 feet of De Diego Expressway. This alignment alternative would avoid excavation in the landfill and only involve two lanes of traffic. These two lanes would be relocated approximately 100 feet east of the existing road and construction could be accomplished with minimal disruption of traffic. Cost comparison of the alignment alternatives determined that the De Diego Expressway relocation alternative was the most cost effective.

A steel sheetpile wall with a concrete facing is proposed for station 57+40 to station 74+32.5. Geotechnical investigations concluded that driving concrete sheetpiles in this reach was not feasible. The concrete facing would provide a relatively smooth surface desirable hydraulically, as well as provide corrosion protection. Riprap protection would be provided at the toe of the sheetpile and extend along the berm and side slopes. Material behind the wall is limited to elevation 3 ft., NGVD.

From station 74+32.5 to station 88+33.2, a trapezoidal earth channel is proposed. Along the west side, a 60 foot wide berm at elevation 0.0 ft., NGVD, would be constructed within the channel to provide a mangrove replanting area.

(b) Reach 2. The proposed channel improvements in this reach (station 88+33.2 to station 147+40) consist of widening and deepening the existing channel with a channel width ranging from 180 to 150 feet and an invert elevation ranging from -16 to -12.7 ft., NGVD. The design velocities range from 19 to 15 feet per second. While this reach is within the subcritical regime, concrete channels would be necessary to provide the required protection and smoothness. This reach is within the zone of tidal influence and it is not considered feasible to dewater in order to construct a conventional concrete channel. A relieving platform wall constructed of steel sheetpile with a concrete facing and a tremie concrete bottom slab are proposed.

(c) Reach 3. The proposed channel improvements in this reach (station 147+40 to station 184+48.51) consist of widening and deepening the existing channel with a channel width ranging from 150 feet to 102 feet and an invert elevation ranging from -12.7 to 11.5 ft., NGVD. The design velocities range from 12.4 to 38.9 feet per second. A stilling area with baffle blocks would be constructed from station 149+60.18 to station 147+41.18. A lowered invert center section would be constructed from station 184+48.51 to station 150+78.52. The lowered invert center section would be 29 feet wide with an invert 10 feet lower than the proposed channel invert.

There are four major existing bridges in this reach: Las Americas Expressway, Pinero Avenue, and the N.E. and S.E. Access Ramp bridges. The composite section was designed to maximize the conveyance through the bridges. Side slopes were established to parallel existing abutment and pier piling. Pier and abutment protection would be provided. Pier extensions would also be constructed.

It was desirable to maintain the cross section dictated by the bridges to extend through the entire reach in order to minimize head losses. The construction of the channel walls would be accomplished by using a counterfort wall system. Stabilization of the bridge side slopes would be accomplished by soil nailing and shotcrete. A cast-in-place concrete channel wall would be placed against the soil nailed face.

The downstream portion of this reach, at the stilling area, is within the zone of tidal influence. Construction methods utilized in Reach 2, which would not require dewatering, were not considered feasible in this area due to hydraulic requirements. Conventional reinforced concrete walls and bottom slab are proposed for the stilling area and the remainder of Reach 3, with counterforts where necessary.

(d) <u>Reach 4</u>. The proposed channel improvements in this reach (station 184+48.51 to station 276+50) consist of widening and straightening the existing channel with a channel width ranging from 107 to 60 feet. The proposed channel invert is 5 to 10 feet higher than the existing channel bottom with a proposed channel invert ranging from 11.5 to 53.4 ft., NGVD. The design velocities range from 24.1 to 39.9 feet per second. Conventional reinforced concrete walls and bottom slab are proposed.

(e) <u>Reach 5</u>. The proposed channel improvements in this reach (station 276+50 to station 341+92.13) consist of widening, deepening, and straightening the existing channel with a channel width ranging from 60 to 75 feet and an invert elevation ranging from 53.4 ft. to 60.5 ft., NGVD. The design velocities range from 12.7 to 24.1 feet per second. Conventional reinforced concrete walls and bottom slab are proposed. Included in the channel improvements is the construction of a debris basin and a side overflow spillway. The spillway would be of similar construction as the channel improvements.

(2) <u>Margarita Tributary</u>. From station 0+00 to station 54+10, the proposed improvements would consist of a earthen trapezoidal channel with 1V on 6H side slopes from station 0+00 to station 39+00 and 1V on 8H side slopes from station 39+00 to station 54+10, a channel bottom width of 30 feet, and invert elevations ranging from -16.0 to -14.9 ft., NGVD. The design velocities range from 1.9 to 4.4 feet per second. A small dike would be constructed along the north bank to provide the required protection elevation. A concrete wall would be constructed on the south side of the tributary at the confluence

of Margarita and the Puerto Nuevo Channel to provide a transition from the rectangular channel section and the trapezoidal section. Within the proposed channel cross section, a 60 foot wide berm at elevation 0.0 ft., NGVD, would be constructed to provide a mangrove replanting area.

The proposed channel would be constructed north of the existing Margarita tributary. The existing Margarita tributary parallels De Diego Expressway. By constructing the channel improvements north of the existing tributary, the existing drainage systems could remain in place without modification and no impact on the expressway would be realized. An inlet for the existing Margarita would be provided at its confluence with the Puerto Nuevo Channel.

From station 54+10 to station 89+60, the proposed channel improvements would consist of a rectangular, concrete U-Frame channel, with a 30 foot bottom width and a channel invert ranging from elevation -17.87 ft. to 12.60 ft., NGVD. Design velocities range from 38.4 to 20.5 feet per second. From station 54+75 to station 54+10, a stilling area would be constructed. Riprap protection would be provided at the downstream end of the stilling area. At station 89+60, the proposed channel improvements would tie into an existing concrete trapezoidal channel.

(3) <u>Josefina Tributary</u>. The proposed channel improvements consist of deepening the existing channel 20 feet in the lower reach to 5 feet in the upper reach. From station 0+00 to 34+36.72, the channel width would be 45 feet and the invert ranges from -13.5 ft. to -1.4 ft., NGVD. Design velocities range from 8.3 to 24.4 feet per second. In this reach, the proposed method of construction would be conventional reinforced concrete walls and bottom slab. From station 34+36.72 to station 77+28.84, the proposed channel width varies from 22 to 17 feet and the invert ranges from elevation -1.44 ft. to 27.40 ft., NGVD. The design velocities range from 17.1 to 26.4 feet per second. From station 34+36.72 to station 36+78.52, a reinforced concrete U-Frame channel is proposed. From station 36+78.52 to station 77+28.84, the proposed channel would be constructed within the existing channel. Steel sheetpile channel walls with concrete facing and a reinforced concrete slab are proposed. Headwalls are proposed at the upstream end of the channel improvements which tie into high ground to provide an inlet to the design channel.

(4) <u>Dona Ana Tributary</u>. The proposed channel improvements consist of deepening the existing channel 20 feet in the lower reach to 5 feet in the upper reach. The proposed bottom width is 22 feet and the invert ranges from elevation -1.4 to 36.5. The design velocities range from 18.1 to 26.9 feet per second. From station 0+00 to station 5+30.83, a reinforced

concrete U-Frame channel is proposed. From station 5+30.83 to station 32+80, the proposed channel would be constructed within the existing channel walls. Steel sheetpile channel walls with concrete facing and a reinforced concrete slab are proposed.

(5) Buena Vista Diversion Channel. A new channel is proposed to be constructed in lieu of improving the existing channel which traverses through a heavily developed residential area. Construction of the diversion channel would eliminate the excessive loss of homes as it would be constructed in a relatively undeveloped tract. The proposed channel width would range from 16 to 36 feet with an invert elevation ranging from 22.3 ft. to 31.18 ft., NGVD. The design velocities would range from 23.0 to 6.1 feet per second. A reinforced concrete U-Frame channel is proposed. Headwalls are proposed at the upstream end of the channel which tie into high ground to provide an inlet to the design channel.

(6) Guaracanal. The proposed channel improvements would consist of straightening the existing tributary with a channel width ranging from 26 to 50 feet and an invert elevation ranging from 41.5 ft. to 46.3 ft., NGVD. The design velocity ranges from 29.6 to 8.4 feet per second. The proposed channel would be a reinforced concrete U-Frame channel from station 0+00 to station 8+19. The channel improvements include the construction of a debris basin and a side overflow spillway. The spillway would be of similar construction as the channel improvements. The debris basin would require the construction of a dike and floodwalls where the necessary easements for dike construction are not available.

c. Bridges. The proposed channel improvements involve 30 bridges. Eight of these bridges are existing bridges which would not require replacement but would require abutment and pier protection due to widening and deepening the channel. Costs for the protection of these bridges are included in the channel improvement costs. Seventeen bridges would require replacement: fifteen highway bridges and two pedestrian bridges. Five new bridges are required: 3 highway bridges and two pedestrian bridges. Costs for these bridges would be included in the relocation costs, which would be the responsibility of the Commonwealth of Puerto Rico.

48. Corrosion Mitigation Investigations.

a. General. A corrosion mitigation investigation was conducted along a 1.7 mile reach of Rio Puerto Nuevo, from the San Juan Harbor to the confluence with Margarita tributary. This area was of greatest concern due to the tidal action, proximity to industry and the municipal landfill, and slow velocity.

b. Laboratory Test Results. A site visit was conducted in June 1990 to obtain pertinent information pertaining to the environment along the proposed channel. During the course of the site evaluation, soil resistivity measurements and water oxygen concentrations, pH and conductivity values were recorded on regular intervals along the river. In addition, soil and water samples were obtained at various locations.

Eight borings were made along the proposed channel route at regular intervals. Samples obtained at depths of 5, 10, 20, and 30 feet were submitted for analysis.

The samples were sent to a qualified laboratory where analysis was performed with respect to conductivity, pH, chloride, sulfate, moisture content, redox potential, and total alkalinity.

On-site soil resistivity measurements were taken at 200 foot intervals along the proposed channel. The average resistivity at 2.5, 5.0, 7.5, 10.0, 15.0, and 20.0 feet was measured.

Water samples on 900 foot centers were obtained at the surface and the channel bottom and shipped to a qualified laboratory for analysis. The constituents evaluation included conductivity, pH, chlorides, sulfates, redox, total alkalinity and hardness.

On-site water analysis was conducted on 200 foot centers at the surface and the channel bottom. The tests conducted included temperature, dissolved oxygen, pH and conductivity.

An evaluation of the soil and water samples indicates that the environment to which the channel structures would be exposed is an extremely aggressive marine environment. The test results indicate that a salt water wedge is present at the bottom of the river along the entire section evaluated. This intrusion results in high concentrations of chlorides and sulfates in both the water and soil along the river.

For soil and water sample locations, see Plate S-123. For soil sample analysis, see Table 25. For on-site resistivity data, see Table 26. For water sample analysis, see Table 27. For on-site water test data, see Table 28.

c. Corrosion Mitigation Requirements.

(1) Prestressed Concrete. The most important factors in achieving a desirable life for prestressed concrete are the quality of the concrete and the depth of cover over prestressing wires. The quality of the concrete is dependent on cement composition, aggregate size and purity, water quality and mix

design. The depth of cover of the concrete over prestressing wires is critical to act as a buffer between the steel wires and the corrosive environment. In addition, by maintaining a desirable depth of cover, the chance of exposing the prestressing wires by way of surface cracks in the concrete would be limited.

Based on the test data accumulated, chlorides and sulfates are in sufficient concentrations to warrant concern over the deterioration of prestressed concrete piles proposed at the project site. Chlorides would penetrate the concrete and lead to corrosion on the prestressing wires. This would be most pronounced in the tidal zone where free oxygen accelerates the corrosion reactions. If left unchecked, spalling and eventual wall failures would result. Sulfates in the soil and water would directly attack the concrete, eventually leading to spalling. Sulfates also accelerate the attack of chloride on the prestressing wires by breaking down the concrete's ability to buffer.

To mitigate the corrosion activity, the prestressed piles should be of superior quality. Mixing water would be of potable quality. The use of sea water would be prohibited. Portland cement would have a $C_3A$ content of 5 to 6% and alkali content of not more than 0.65%. Aggregates would be strong, durable, free from chlorides, non-alkali reactive, and graded to obtain dense concrete. Prestressing concrete would be free of contamination with a minimum depth of cover of two inches. Epoxy coated strands would be used. The piles would be furnished with a factory applied coating.

The application of cathodic protection to control corrosion activity on prestressed concrete has been extremely limited due to the possible embrittlement of the wires by hydrogen generated at the cathode surface. Because of this complexity and the difficulty in maintaining proper protection levels, cathodic protection of the prestressed piles does not appear technically or economically feasible for this project.

(2) Carbon Steel Sheetpiles. Carbon steel sheetpiles and associated tiebacks would be subject to severe corrosion attack. This attack would be most pronounced in the tidal zone and at the mud line due to oxygen differential concentrations.

The use of a good quality, factory applied coating would significantly reduce the extent of corrosion on the sheetpiles. A 6-inch concrete facing for the steel sheet piling is proposed to provide a smoother surface needed for hydraulic requirements. This concrete would provide additional protection from the corrosive environment. The coating of any exposed portions of steel sheetpile would require regular maintenance.

An impressed current cathodic protection system would be a possible method to control corrosion on the submerged and buried portions of the sheetpiles; however, due to the required frequency of inspection and monitoring in order to have an effective system, it is not recommended for this project.

49. Structural Design.

a. General. The recommended plan of improvements includes several proposed channel sections. The selection of channel sections is dependent upon the various soil and water conditions encountered, as well as external construction limitations, and was used as a basis for cost estimates. Conservative assumptions were made based upon preliminary soil properties. Future feature design memorandums will investigate alternative wall systems with updated soil parameters. These will include systems such as slurry walls, box type steel sheetpiles, soil anchors, multi-layered tiebacks, etc. The final wall system selection will be based on serviceability, cost, and constructability. The structural design is based on standard practice as set forth by the Engineering and Design Manuals (EM 1110 Series) letters, Corps of Engineers, U.S. Army, and Building Code Requirements for Reinforced Concrete (A.C.I. Code), subject to modifications indicated by engineering judgement and experience.

b. Design Criteria.

(1) Concrete. Design is based on the requirements of ETL 1110-2-265, "Strength Design Criteria of Reinforced Concrete Hydraulic Structures." Concrete compressive strength is 3,000 p.s.i. Reinforcing steel is Grade 60 with a yield stress of 48,000 p.s.i.

(2) Structural Steel. The allowable working stresses are in accordance with EM 1110-2-2101, "Working Stresses for Structural Design", and applicable codes and standards of other agencies.

(3) Design Analysis. Design analysis, including seismic analysis, will be provided in the feature design memorandums.

c. Proposed Channel Sections.

(1) King Pile Channel Wall. The king pile channel wall is proposed for the Puerto Nuevo Channel from station 3+80 to station 57+40. The walls would consist of 24-inch, longitudinally slotted, prestressed concrete vertical piles, driven at 8-foot centers with 18-inch square, prestressed concrete, battered piles driven behind the wall as a tieback. Prestressed concrete panels, 6-inches thick, would be inserted

in the slots and span the vertical piles to retain the soil behind the wall. The average length of the vertical piles would be 60 feet. Refer to Proposed Channel Section A on Plate S-19.

(2) Sheetpile Channel Wall. The sheetpile channel wall is proposed for the Puerto Nuevo Channel from station 57+40 to station 74+32.50. The walls would be steel sheetpile with a 6-inch thick concrete facing. Eighteen inch square, prestressed concrete battered piles would be driven behind the wall at 8-foot centers as a tieback. The average length of the piles would be 45 feet. Refer to Proposed Channel Section B on Plate S-19.

(3) Relieving Platform Channel Wall. The relieving platform channel wall is proposed for the Puerto Nuevo Channel from station 88+33.2 to station 147+40. The walls would consist of steel sheetpiling with a 6-inch concrete facing. A reinforced concrete platform would be supported partly on the sheetpiling and on prestressed concrete battered piles. A four foot thick tremie concrete slab would be placed along the channel bottom due to high velocities. Refer to Proposed Channel Section D on Plate S-20.

This type of construction was selected to reduce the lateral pressure acting on the steel sheetpiling. The surcharge and a portion of the weight of the fill are carried as vertical load to a deeper level where they do not have influence on the steel sheet piling. This allows for deeper walls to be built and heavier loads to be supported within the strength limitations of the sections of steel sheetpiling commercially available.

(4) Inverted Tee Channel Wall. Inverted tee channel walls are proposed for the Puerto Nuevo Channel from station 147+40 to station 150+78.52 and from station 179+48.51 to station 338+92.13, and Josefina tributary from station 0+00 to station 34+36.72. The inverted tee walls and bottom slab would be constructed of reinforced concrete. An uplift pressure relief system would be required to prevent excessive hydrostatic head build-up beneath the slab. Foundation improvements may be required for various reaches. Refer to Proposed Channel Section E on Plate S-20. For further information regarding the uplift pressure relief system, see paragraph 40, and for foundation conditions, see Section G, "Geology and Soils."

(5) Trapezoidal Channel with Lowered Invert Center Section. The trapezoidal channel with lowered invert center section is proposed for the Puerto Nuevo Channel from station 150+78.52 to station 184+48.51. The sloped channel wall would be a counterfort wall, where the base slab and wall span between vertical triangular braces (counterforts). The wall, braces, and base, as well as the bottom slab and lowered invert center

section, would be reinforced concrete. An uplift pressure relief system would be required to prevent excessive hydrostatic head built-up beneath the slab. Foundation improvements may be required. Refer to Proposed Channel Section F on Plate S-20. For further information regarding the uplift pressure relief system, see paragraph 40, and for foundation conditions, refer to Section G, "Geology and Soils."

(6) Concrete U-Frame Channel. A concrete U-Frame channel is proposed for Margarita tributary from station 54+10 to station 89+60, Josefina tributary from station 34+36.72 to station 36+78.52, Dona Ana tributary from station 0+00 to station 5+30.83, Buena Vista Diversion Channel from 0+00 to station 42+37.79, and Guaracanal from station 0+00 to station 8+19. The channel would be constructed of conventional reinforced concrete. An uplift pressure relief system would be required to prevent excessive hydrostatic head build-up beneath the structure. Foundation improvements may be required for various reaches. Refer to Proposed Channel Section G on Plate S-21. For further information regarding the uplift pressure relief system, see paragraph 40, and for foundation conditions, refer to Section G, "Geology and Soils."

(7) Sheetpile Wall Channel. The sheetpile wall channel is proposed for Josefina tributary from station 36+78.52 to station 77+28.84, and Dona Ana tributary from station 5+30.83 to station 32+80. Steel sheetpiling would be driven within the existing channel walls and braced internally with wales and struts. A 6-inch concrete facing would be applied over the exposed surfaces of the steel sheetpile. The channel would be founded on a 4-inch thick mud slab. A concrete bottom slab would be placed over the mud slab. Refer to Proposed Channel, Section H, on Plate S-21.

d. Bridge Modifications.

(1) General. There are eight bridges within the project limits which would not require replacement. Construction of the required channel cross sections beneath these bridges without disrupting vehicular traffic and without replacing the bridges were the foremost objectives. Treatment of the exposed foundation or providing pier and abutment protection were the primary concerns.

(2) Kennedy Avenue. The proposed channel improvements under Kennedy Avenue bridge would result in a channel with a design invert of -25 ft., NGVD,, and a channel width of 400 feet and a design velocity of 8.5 feet per second. The deepening and widening of the existing channel would result in the exposure of portions of five of the bridge's piling foundations. The original substructure is cast-in-place concrete piers resting on pile foundations.

The proposed plan would consist of constructing individual steel sheetpile cofferdams around each affected bridge pier. The cofferdam would be permanent and would retain existing soils around the existing bridge foundation piling. Each cofferdam must have sufficient width to be outside of the existing battered bridge piling. Since the depth of channel and pile batter varies at each pier, each of the five cofferdams would have different widths. The width of the cofferdams would restrict the flow opening beneath the bridge and cause increased velocities at the bridge opening.

The combined width of the required cofferdams at each pier location reduces the hydraulic bridge opening by 28%. This restriction would cause the design channel velocity to increase from 8.5 feet per second to 14.4 feet per second and the upstream water surface elevation to be 3.1 feet. Adequate scour protection would be provided to negate the scour potential of the increased velocity.

The overhead clearance beneath the bridge is approximately 20 feet. The restricted overhead clearance would require that the sheet piling be spliced about every 10 feet with a full depth weld and splice plate. A compact, vibratory pile driver would be required because of the restricted overhead clearance.

Tie rods would be installed between the cofferdam walls, near the top, on 6 foot centers. The top edge of the sheetpile cofferdams would be encased in a reinforced concrete cap to strengthen the cofferdam and provide the upper portion of the steel sheetpile from the more aggressive corrosion action experienced in the tidal zone. Refer to Plate S-82.

(3) <u>De Diego Expressway</u>. Construction of the proposed bridge section beneath this bridge would involve deepening the existing invert approximately 20 feet. The proposed channel width is 180 feet which fits within the existing bridge abutments. The proposed channel section would be reinforced concrete inverted tee walls and slab. A portion of the pile caps would become exposed as a result of the channel deepening, however, no impact upon the bridge's substructure is anticipated. Refer to Plate S-83.

(4) <u>Las Americas Expressway</u>. The required channel cross section under Las Americas Expressway bridge would be constructed by stabilizing the slope using soil nailing, and then providing a cast-in-place reinforced concrete channel wall and slab. Soil nailing would be constructed by staged excavations from top down. Shotcrete would be sprayed onto the exposed face. Holes would be drilled for the soil nails,

usually reinforcing bars, and the nails would be inserted and grouted. A second layer of shotcrete would be applied. Refer to Plate S-84 and S-88.

The proposed construction method was selected due to the very limited clearances available. The construction equipment required for soil nailing would be drilling rigs for reinforcement installation and guns for shotcrete application which are relatively small scale, mobile, and quiet. Soil nailing could proceed rapidly and would be applied at the earliest possible time after excavation. This would minimize the disturbance to the ground and the possibility of damage being caused to the bridge.

Additional improvements to the bridge include pier protection and bridge pier extensions. The individual column piers would be encapsulated in concrete to provide a single pier (pier protection). These piers would be extended beyond the upstream face of the bridge and shaped to deter trash accumulation. Refer to Plate S-89.

(5) N.E. Access Ramp. Similar construction methods are proposed for the N.E. Access Ramp as Las Americas Expressway. Refer to above paragraph and Plates S-85, S-88, and S-89.

(6) Pinero Avenue. Similar construction methods are proposed for Pinero Avenue as Las Americas Expressway. Refer to above paragraph and Plates S-86, S-88, and S-89.

(7) S.E. Access Ramp. Similar construction methods are proposed for the S.E. Access Ramp as Las Americas Expressway. Refer to above paragraph and Plates S-97, S-88, and S-89.

(8) P.R. 177. Similar construction methods are proposed for P.R. 177 as De Diego Expressway. Refer to above paragraph and Plate S-90.

(9) De Diego Expressway - Margarita Tributary. The proposed channel cross section under this bridge would be a reinforced concrete U-Frame channel. The proposed invert is approximately 3 feet below the existing channel and no impact to the existing bridge abutments is anticipated. Refer to Plate S-91.

50. Construction Procedure and Diversion Plans.

a. Construction Methods. Excavation would be accomplished by dragline or backhoe for all reaches of the Puerto Nuevo Channel and its tributaries except Reach 1 and the lower portion of the Margarita tributary. Excavation for these reaches would be accomplished by mechanical dredging. The dredging operation would consist of a clamshell mounted on a barge, loading into scows. Material would be hauled to an EPA approved disposal area located approximately 6 miles from the project. Material excavated from the existing channel bed of the Margarita is unsuitable for ocean disposal due to industrial contaminants. Material obtained from station 19+00 to station 21+00, where the old Rio Puerto Nuevo river bed feeds the Margarita, would be placed in an upland disposal area adjacent to the Margarita.

Equipment used for the excavation of the remaining reaches of Puerto Nuevo and tributaries would work from the banks of the channel with the exception of the Josefina and Dona Ana tributaries. Due to limited access along the majority of these tributaries, work would be accomplished within the channel. Extensive hauling of the material to be disposed is anticipated. Hauling equipment delays are also anticipated due to traffic congestion and limited access.

Excavation in certain reaches would require the installation of steel sheetpiling or timber shoring where the right-of-way is limited. Where right-of-way permits, excavation construction slopes would be used. Unsuitable and excess excavation materials would be placed in disposal areas as discussed in paragraph 51.d. Placement of concrete materials would generally be accomplished by conventional methods; however, due to restricted access at some points along the construction alignment, pumping of concrete materials would be permitted. For additional discussion, refer to paragraph 49, "Structural Design."

b. Sequence of Construction. The proposed channel improvements would be constructed under several contracts starting from the downstream end of the Puerto Nuevo Channel. The reasoning behind the construction sequence is the consideration of traffic problems and the construction activities in heavily populated areas. Another consideration is the limits of the contracts. Since most of the work would be done in the existing streambeds, each contract must be terminated at a location where the situation is not worsened by heavy rainfall prior to the start of the next contract. Other considerations in establishing the number and limits of these contracts included the contract price of each segment and the number of bridges involved.

c. Diversion Plans. In general, where construction of conventional reinforced concrete would be placed within the existing channel, phased construction utilizing steel sheetpile cofferdams would permit flow around the construction area. Diversion of water would not be required for the Puerto Nuevo Channel, Reaches 1 and 2, as construction would be accomplished without dewatering. Diversion of water would not be required for the construction of the Buena Vista Diversion Channel as the existing Buena Vista tributary would carry the flow. Diversion flow would not be provided for the sheetpile wall channel sections of Josefina and Dona Ana tributaries. Instead, a mud slab would be constructed to provide an adequate construction foundation.

d. Traffic Control During Construction. Construction of the proposed improvements is expected to have a significant impact on the movement of vehicular and pedestrian traffic through and around the proposed construction. Construction would be accomplished by dividing the work into separate contracts to minimize the impact of construction on the flow of traffic. Close coordination would be maintained with the local sponsor and the Puerto Rico Highway Authority, to minimize traffic disruption. A detailed analysis of traffic control during construction will be provided in the feature design memorandums.

e. Access. Numerous existing streets would provide construction access along the alignment of the proposed construction. Most residential streets and roads have load or weight limitations, and therefore, most accesses would be restricted. Existing streets would provide suitable access for future maintenance of the channel system. Access roads are indicated on the Aerial Plan, Right-of-Way and Control Plates S-2 through S-16.

f. Protection of Existing Structures from Construction Activities. In order to monitor and ensure prevention of building foundation movement during the construction of the channel improvements in close proximity to buildings, the contractor would be responsible for determining and documenting the preconstruction condition of existing structures within a designated zone of influence, monitoring construction activities and taking appropriate measures to prevent damage to any structures during construction, and for performing a post-construction verification inspection of those structures previously inspected.

The contractor and his vibration control specialist would be responsible for determining the distance from existing structures, based upon technical characteristics of material in the area, contractor equipment, and current condition of nearby structures and their foundations, at which vibration producing equipment can operate safely without causing damage to existing structures, either directly to the structure or indirectly through consolidation of the foundation material which would result in settlement or movement of structural features. This distance would be defined as the vibration impact distance.

Any existing structure at a distance equal to or less than the vibratory impact distance from any point on the boundary of the project work area would be inspected prior to commencement of work. After completion of work, the contractor would conduct a post-construction structural inspection/evaluation. The contractor would be responsible for remedying any damage resulting from construction activities.

The contractor would be responsible for implementing a vibration monitoring plan. Vibration levels would be continuously monitored at structures within the vibratory impact distance. An allowable vibration level would be determined based upon the maximum level of vibration which does not cause structural damage. The contractor must immediately halt operation of vibration producing equipment whenever a vibration monitoring station records a reading above the allowable vibration level. The contractor would adjust his operation through the use of modified procedures or smaller equipment in order to continue work without producing vibrations above the allowable level.

51. Construction Materials.

a. Concrete. A Concrete Materials Investigation Report will be prepared in accordance with Appendix A of EM 1110-2-2000, "Standard Practice for Concrete," and will be presented in a separate design memorandum. Approximately 450,000 cubic yards of concrete (includes 150,000 cubic yards of tremie concrete) would be required for the project construction as well as prestressed concrete piles.

b. Fill and Backfill. Approximately 1.7 million cubic yards of fill and backfill would be required. Suitable backfill material would be obtained from an off-site source.

c. Stone Protection. Approximately 26,000 cubic yards of riprap would be required. It is proposed that stones weighing at least 165 pcf be used for riprap.

d. Disposal of Excavated Materials. The proposed channel improvements would require the excavation of approximately 6.5 million cubic yards of material. Little of this material is suitable for backfill and must be disposed in off-site disposal areas. It is anticipated that 2.8 million cubic yards excavated from the lower Puerto Nuevo Channel and 0.7 million cubic yards excavated from the lower Margarita Channel would be disposed in an off-shore ocean disposal site. The remaining 3.0 million cubic yards would be disposed in upland disposal areas. Two upland disposal areas have been indicated; one along the lower Puerto Nuevo Channel and the other along the Margarita tributary. The total estimated capacity of these disposal areas is 3.3 million cubic yards assuming that 30 feet of material is permitted. Should the height be limited, additional disposal areas must be obtained.

52. Relocations.

a. General. The local sponsor is required to assume the costs for all relocations and alterations. Costs relating to Public Law 91-646 requirements are also borne by the local sponsor. Relocation of some families would be required due to construction of this project. All residents involved would be compensated under Public Law 91-646. Facilities to be relocated or altered include streets, highway bridges, homes, buildings, electric transmission lines, and local drainage structures. While generally it is standard practice for the local sponsor to relocate all affected facilities in advance of construction activities, this is not practical or economically feasible for the proposed project. With the exception of temporary relocation of electric transmission lines and relocation of homes, all other relocation and alteration items would be accomplished under the project construction contract. All costs related to these items would still be paid by the local sponsor. For affected utilities which cannot be relocated by the local sponsor in advance of construction activities, some interruption in utility service would occur. To keep these interruptions to a minimum, close coordination and cooperation would be necessary between the Corps of Engineers, the Commonwealth of Puerto Rico, and the construction contractor.

b. Bridges. Highway and pedestrian bridges to be replaced or newly constructed are identified on Plate S-81 and bridge sections are provided on Plates S-92 through S-115. The costs associated with the bridges are provided in Tables 29 through 42.

c. De Diego Expressway. The proposed Puerto Nuevo Channel crosses the two existing southbound lanes of the De Diego Expressway. Approximately 1,800 feet of the existing expressway would be affected. Phased construction would minimize the disruption of traffic. The first phase would be to construct the center portion of the relocated expressway as well as temporary bypass roads. Traffic would remain on the existing highway during this phase. Traffic would then be routed to the temporary bypass roads while the tie-ins were being constructed between the existing expressway and the relocated road. Traffic would then be rerouted to the relocated expressway. For relocation plan and cross sections, refer to Plates S-16 through S-20.

d. Utilities.

(1) General. The existing utilities constructed along and crossing the Puerto Nuevo Channel and its tributaries are shown on Plates ME-1 and ME-2. The local agencies in Puerto Rico were familiarized with the project scope and channel construction schedule under various contracts, see Appendix A, Coordination. Thus, efforts were made to procure most of the information on the interfering utilities from the respective local agencies and same has been summarized on Plates ME-1 and ME-2.

The following agencies were contacted for various utilities:

- Puerto Rico Aqueduct and Sewer Authority (PRASA) - Water/Sewer Lines
- Puerto Rico Electric Power Authority (PREPA) - Electrical Lines
- Puerto Rico Telephone Co. - Telephone Lines
- Pipeline Co. of Puerto Rico - Fuel Lines
- San Juan Gas Co. - Gas Lines
- Cable Television of Greater San Juan - Cable TV

There are numerous underground and overhead utilities crossing the channel and supported on the bridges which will require close coordination with the local agencies. The necessary modifications and relocation plan and details for the utilities will be developed during FDM stage for each contract. The majority of relocations will be performed by the Corps of Engineers Construction contractor. However, some of the more critical relocations, specifically the installation and connections of electrical and telephone cables will be done by the local agencies. All necessary telephone conduits and manholes, transmission towers and poles, water, gas and sewer pipelines will be constructed by the COE contractor. The major relocation work that will be handled by the COE will be included in the plans and specifications and designed according to the local agencies design requirements, standard drawings, and rules, regulations and their final approval. All costs related to these relocations would still be paid by the local sponsor.

(2) Sewer Lines. The sanitary sewer lines crossing the channel and its tributaries are shown on Plate ME-1. Most of the sewer lines are underground and are gravity sewers. The most critical sewer lines that will require major relocation are as follows:

(a) 84-Inch Miramar Trunk Sewer. This is one of the major wastewater arteries to the Puerto Nuevo Plant. This large interceptor sewer collects flows from Old San Juan, Santurce, Condado, and Puerto Tierra and conveys this to the Puerto Nuevo

Sewage Treatment Plant. This reinforced concrete sewer is located about 15 meters south of the Constitution Bridge in the vicinity of Parque Central. The crossing is comprised of influent and effluent double barrel siphon structures located about 325 feet apart. The barrels are comprised of 48-inch and 30-inch reinforced concrete pipes encased in concrete. The hydraulic capacity of the siphon is limited by the upstream sewer slopes and is calculated to be 49.6 MGD.

(1) The crossing will be destroyed by the construction of the King pile walls. Also, the encased pipe will be exposed by the required channel excavation to elevation -25.00.

(2) The relocation will require that a second siphon crossing be constructed 15 meters south of the existing siphon. Sewage will be diverted from the existing siphon by installing a diversion manhole adjacent to the upstream manhole. By this method, flow can easily be diverted to the new siphon crossing. Sewage will be diverted from the upstream manhole to the new influent siphon via the diversion manhole. The new influent siphon will regulate flows to the new effluent siphon (located on the other side of the channel approximately 500 feet away). The new effluent manhole will convey the flows on to the Puerto Nuevo Plant.

(3) The new influent siphon will be similar in size structurally to the existing siphon. However, the barrels must be increased to 48-inch and 42-inch pipe sizes to retain comparable hydraulic capacity. The new effluent siphon will be similar in size to the existing siphon except that the new siphon structure will change the flow direction so that the effluent pipe can be transitioned into the existing effluent siphon (i.e., the pipe must make a right angle turn).

(4) The existing effluent siphon will require modification and reinforcement to accept the pipe entering from a different direction. The concrete encased pipe will require integration into the proposed Kingpile wall. The foundation for the encased pipe and siphons will require evaluation to determine any special requirements. Construction of the encased pipe under wet or dry installation procedures will be evaluated to determine the best value method for construction.

(5) A detailed lay-out will be depicted in the FDM after approval from the Commonwealth Water and Sewer Authority: PRASA.

(b) <u>The 90-inch San Jose Trunk Sewer</u>. This major interceptor sewer collects flows from Hato Rey, Port of Santurce, San Patricio, Fort Buchanan, and several other areas of the city. The concrete reinforced sewer crosses de Diego Expressway at Plaza de Las Americas (by Toys R Us) and proceeds to the influent siphon about 10 meters off the edge of the expressway. Approximate channel location is station 75+85. The siphon crossing is comprised of influent and effluent double barreled siphon structures located about 300 feet apart. The two barrels are a 60-inch and 48-inch concrete reinforced pipe encased in concrete. A 36-inch water-line shares the same concrete encasement. The hydraulic capacity of the siphon has been calculated as 52.75 MGD.

(1) The crossing will be exposed by the excavation to widen and deepen the channel. Also, the encased pipe will be exposed by the required channel excavation to elevation -21.90.

(2) The relocation will require that a second siphon crossing be constructed 15 meters west of the existing siphon. Sewage will be diverted from the existing siphon by installing a diversion manhole adjacent to the influent siphon. By this method, flow can easily be diverted to the new influent siphon crossing. Sewage will be diverted from the existing influent siphon to the new influent siphon via the diversion manhole. The new influent siphon will regulate flows to the new effluent siphon (located on the other side of the channel approximately 500 feet away). The new effluent siphon will convey the flows on to the nearest down stream manhole and subsequently to the Puerto Nuevo Plant.

(3) The new influent siphon will be similar in size structurally to the existing siphon. However, the barrels must be increased to 60-inch and 54-inch barrel sizes to retain comparable hydraulic capacity. The new effluent siphon will be similar in size to the existing siphon except that the structure will change the flow direction so that the effluent pipe can be transitioned into the existing down stream manhole.

(4) The existing effluent siphon will require modification and reinforcement to accept the pipe entering from a different direction. The foundation for the encased pipe and siphons will require evaluation to determine any special requirements. Construction of the encased pipe under wet or dry installation procedures will be evaluated to determine the best value construction method.

(5) A detailed lay-out will be depicted in the FDM after approval from the Commonwealth Water and Sewer Authority: PRASA.

(c) Other Sewer Lines. Other sewer lines as shown on Plate ME-1 are a 36-inch line crossing the channel south of De Diego Expressway, a 21-inch and a 42-inch line crossing in the vicinity of Pinero Avenue and Highway Las Americas. The proposed channel width in this area is approximately 100 feet. An existing 30-inch line constructed parallel to the Guaracanal will be in conflict with the proposed Guaracanal debris basin. There are several sewer lines ranging from 8-inch to 21-inch crossing different tributaries. Some of the small sewer lines crossing Dona Ana, Josefina, and Buena Vista may not require relocation as channel construction in this area is of reinforced concrete U-Frame channel and these sewer lines could be left in place.

(3) Water Lines. Plate ME-1 illustrates the major water lines crossing the main channel and its tributaries. According to Puerto Rico Aqueduct and Sewer Authority (PRASA) the water lines greater than 8-inches in diameter and crossing the main channel are underground and most of the small water lines crossing the tributaries Dona Ana and Josefina are supported on bridges. With construction of new bridges and the channel most of the water lines will have to be temporarily relocated and installed permanently as the construction progresses.

(4) Electrical Lines. Electrical transmission and distribution lines crossing the Puerto Nuevo channel and its tributaries are illustrated on Plate ME-2. Most of the lines are overhead except two underground crossings at Roosevelt Avenue and Pinero Avenue. During construction the secondary distribution lines will be energized and de-energized as needed in coordination with the local power company (PREPA). But the interfering underground lines and few overhead transmission lines will need to be relocated and reinstalled as follows.

(a) The 38 KV underground line crossing Roosevelt bridge consists of two 38 KV circuits in 6-inch conduit. This 38 KV line and 13.2 KV underground line at Pinero Avenue bridge will have to be temporarily relocated overhead during bridge construction and then installed permanently underground with minimum interruptions.

(b) The 115 KV transmission lines crossing the main channel south of Kennedy Avenue are major transmission lines from San Juan Steam Plant and feeding Viaducto and Hato Rey switch yards. These lines are at 72-feet low wire elevation and will require minor alterations during channel construction to provide clearances, etc. The towers are located far enough and will not interfere with the widening of the channel.

(c) Overhead lines between Pinero Avenue and PR-1 consist of 4 KV distribution lines constructed parallel to the channel, a 38 KV transmission line crossing the channel at the southeast ramp of Las Americas Expressway, and a 38 KV line crossing north of PR-1. These lines will have to be relocated and modified with new poles and towers to provide required channel width and overhead clearances, etc.

(d) The 115 KV transmission line and a distribution line constructed south of Route 177 will be in conflict with the proposed Puerto Nuevo debris basin and will have to be relocated permanently with new poles and towers to clear the debris basin area.

(e) A 38 KV line constructed along Dona Ana tributary has poles in the middle of the channel. This line will have to be completely relocated and removed from the channel area. The 4 KV lines in this area will need minor modifications to provide required clearances during construction.

(f) Other lines interfering with the construction will require minor modifications. The 38 KV and 4 KV lines starting from Adelina Substation, north of Roosevelt Avenue and crossing the channel will require few changes to provide sufficient clearance. Similarly, the 115 KV transmission line has steel towers very close to the Margarita tributary and may have sufficient clearance to leave the towers in place. The two 38 KV lines crossing Margarita tributary, De Diego Expressway, and the main channel are currently being designed and constructed by PREPA as they were damaged by Hurricane Hugo. PREPA's design will include sufficient clearances to avoid any interference with the channel construction.

(5) Telephone Lines. The telephone system consists of underground lines at two locations and others are overhead or supported on bridges as shown on Plate ME-2. Thus, with the replacement and modifications of bridges, the telephone lines will have to be temporarily relocated and reinstalled with minimum interruption in service. This work has to be done in close coordination with the Puerto Rico Telephone Company due to the complicated nature of the telephone cables and connections.

The major underground telephone system consisting of 15 conduits and several circuits is constructed along Roosevelt Avenue which serves Old San Juan, Santurce, Candado, and several other areas. The other underground system is at Pinero Avenue bridge. The relocation work for the telephone system is going to be expensive due to the temporary and permanent installation required at each location and cable connections being labor intensive. Sufficient cost savings can be achieved by supporting some of the telephone systems in place during bridge construction. Each location will be evaluated in depth with the bridges to be constructed under separate contracts and Feature Design Memorandums for the same.

(6) Gas Lines. Two natural gas lines, 4-inch and 8-inch, are constructed along Pinero Avenue as shown on Plate ME-1. These lines are crossing the main channel and Josefina tributary and are supported on the Pinero Avenue

bridges. Both lines are pressured at 30 p.s.i. and are main transmission and distribution lines for the Rio Piedras area. These lines will have to be maintained in service at all times during bridge construction; therefore, temporary relocation and permanent installation of these lines will be required.

(7) Fuel Lines. Plate ME-1 illustrates two fuel lines crossing the main channel at Kennedy Avenue bridge and parallel to Margarita tributary. The 6-inch fuel line supported on the Constitution bridge supplies fuel (JP-4) to Louise Munoz Marin International Airport. This line will be supported and protected in place during construction. The channel will be widened from 200 feet to 400 feet in this area but the fuel line being supported under the bridge will not interfere with the channel construction. The 8-inch fuel line along Margarita tributary supplies gasoline to Catano terminal from the nearby refinery. This will be protected in place during construction and will not interfere with the construction.

(8) Cable Television Lines. There are a few overhead cable TV lines crossing Margarita, Josefina, and Dona Ana tributaries. These lines are at approximately 15 feet low wire elevation and will need to be temporarily relocated or altered during construction.

53. Operation and Maintenance. The local sponsor would be responsible for the maintenance of the proposed channel improvements upon completion of the construction contract. The contractor would be responsible for all maintenance during the construction contract.

It is expected that the channels would require occasional maintenance. In order to provide as much available debris storage capacity as possible, it would be necessary to remove debris after each significant accumulation. The channels would require ordinary maintenance of the floodway section, including removal of debris and vegetation. Maintenance of mangroves, grass, etc., would be accomplished as necessary to provide good ground cover and an attractive appearance.

54. Design and Construction Schedules. The project would be constructed under six contracts starting from the downstream end of the Puerto Nuevo Channel. It is anticipated that all construction would be accomplished within 11 years. A break down of the contracts is shown on Plate S-121. Pending approval of this report, a feature design memorandum and contract plans and specifications would be prepared for the first contract. The first contract is scheduled to be advertised in the third quarter of FY-93. Refer to Plate S-122 for additional information on design and construction schedules.

55. Quantities and Cost Estimates. Estimated quantities, unit prices, and contract prices are presented in Tables 29 through 42. Also included are real estate and relocation costs.

## I. REAL ESTATE REQUIREMENTS

56. General. The lands, easements, and rights-of-way needed for the construction, operation, and maintenance of the project will be acquired by the Department of Natural Resources of the Commonwealth of Puerto Rico pursuant to Public Law 99-662. Relocation of families and businesses involved in the acquisition will be performed in accordance with P.L. 91-646, as amended.

Lands required for the debris basin, channels, floodwalls and maintenance berms will be acquired in fee.

Acquisition for the project will involve an estimated 153 parcels. The acquisition includes 457.1 acres (not including existing river lands) and 54 structures for a total cost, including severance, of $10,395,000. The combined Federal/non-Federal administration cost to acquire this land is estimated at $1,375,000. The relocation cost, in accordance with P.L. 91-646, is estimated at $1,003,400. This results in a total combined cost of $15,966,800, which includes a 25% contingency of $3,193,400. Further description of the real estate aspects of this project is provided in Appendix C.

## J. PLAN IMPLEMENTATION

57. General. After the Government has turned the completed Rio Puerto Nuevo Flood Control Project, or functional portion of the project, over to the local sponsor (Puerto Rico Department of Natural Resources), the local sponsor shall operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project in accordance with regulations or directions prescribed by the Government.

The Government will preserve the right to operate and maintain the project in the event the local sponsor fails to fulfill their responsibilities. The general provisions; obligations of the parties; value of lands and facilities; construction phasing and management; method of payment; disputes; recreational development; operation, maintenance, repair, replacement, and rehabilitation; release of claims; maintenance of records; government audit; and other conditions and responsibilities are set forth in the Local Cooperation Agreement (LCA) found in Appendix F. Appendix F also contains a draft Escrow Agreement between the Commonwealth of Puerto Rico and the Department of the Army.

## K. SUMMARY OF BENEFITS AND COSTS

58. General. The economics for the entire project are shown below. Taken together or separately, the project improvements show solid economic justification. Each segment is also fully justified on inundation damage reduction benefits alone. The overall benefit-to-cost ratio is 2.4 to 1. Net national benefits are on the order of $42.9 million annually, which would produce a net regional annual income of over $25.0 million and over 1,050 permanent jobs. The total first cost of construction is $303.3 million (1990 dollars). Interest during construction computed over the 10-year implementation period is $38.9 million. The total annualized investment cost, including operation and maintenance is $30.6 million.

A comparative summary of Survey Report and General Design Memorandum Benefits is included in Appendix D, along with explanations of the changes. The most dramatic changes occurred in location benefits, which decreased significantly because of new policy guidance which established an upper limit to the value that can now be claimed.

ECONOMICS OF RECOMMENDED PLAN
(8-3/4%, $1,000 of 1990)

| | |
|---|---|
| FIRST COSTS: | |
| Total Project Cost.................. | $303,284 |
| Interest During Construction........ | 38,906 |
| TOTAL INVESTMENT COST............. | $342,190 |
| ANNUAL COSTS: | |
| Annualized Investment Cost.......... | $ 30,400 |
| Operation and Maintenance........... | 214 |
| TOTAL ANNUAL COST................. | $ 30,614 |
| TOTAL ANNUAL BENEFIT.............. | $ 73,465 |
| NET ANNUAL BENEFITS............... | $ 42,851 |
| BENEFIT-TO-COST RATIO............. | 2.40 |

## L. COST APPORTIONMENT

59. General. Project first costs are apportioned between Federal and non-Federal interests in accordance with current law as contained in the 1986 Water Resource Development Act. The prescribed cost sharing for a flood control project is 75 percent Federal. However, the sponsor is responsible for the costs associated with all lands, easements, rights-of-way,

relocations, and damages (LERRD). In addition, a five percent cash contribution is required, even if the costs for LERRD exceed 25 percent. The apportionment of project costs is summarized below:

COST APPORTIONMENT

1. Total Project Cost:

| | | |
|---|---|---|
| a. | Flood Control | $302,820,000 |
| b. | Recreation | 464,000 |
| | TOTAL | $303,284,000 |

2. Participation:

| | | Non-Federal | Federal |
|---|---|---|---|
| a. | Lands and Damages | $ 15,967,000 | $ 0 |
| b. | Bridges and Roads | 5,484,000 | 0 |
| c. | Utilities | 15,159,000 | 0 |
| d. | Cash Contribution | 39,124,000 | 227,086,000 |
| e. | Recreation | 232,000 | 232,000 |
| | TOTAL | $ 75,966,000 | $227,318,000 |

The 1986 Water Resources Development Act contained provisions for reducing the sponsor's share of flood control projects in some exceptional cases based on per capita income and the benefit-to-cost ratio. It has been determined that Puerto Rico is eligible for this reduced share. The sponsor's minimum cost share percentage as prescribed in ER 1165-2-121 is one-fourth of the benefit-to-cost (B/C) ratio. Since the Puerto Nuevo Project has a B/C ratio of 2.4, the computed minimum share would be 38 percent. The sponsor's contribution, normally computed, is less than this, hence the eligibility to pay reduction is not applicable in this case.

## M. ENVIRONMENTAL CONSIDERATIONS

60. Environmental Status, Compliance and Unresolved Issues.

a. Status. A Final Environmental Impact Statement (FEIS) was filed on December 6, 1985. Comments by the Environmental Protection Agency (EPA) detailing environmental work then pending (letter of January 6, 1986; Appendix A) are addressed in the attached Environmental Assessment and Wetlands Mitigation Plan (Appendix B), which update the FEIS. The proposed action was coordinated under all applicable Federal and Commonwealth environmental statutes and was in full compliance with all but the Marine Protection, Research and Sanctuaries Act (MPRSA), and the Clean Water Act. The Río Puerto Nuevo, Puerto Rico, General Design Memorandum (GDM) was authorized under the Water Resources Act of 1986. Major issues, coordination and compliance are summarized below and detailed in the enclosed EA. Environmental issues now being resolved relate to re-coordination of Endangered Species Act and Fish and Wildlife Coordination Act compliance, Clean Water Act compliance (wetlands impacts and water quality certification), ocean disposal of dredged materials, and potential hazardous and toxic materials in the project route.

b. Compliance. The project discussed in this General Design Memorandum is in compliance with or will be in compliance with all applicable Federal and Commonwealth of Puerto Rico laws, regulations and executive orders by the conclusion of coordination of the first Feature Design Memorandum. Sampling of proposed dredged material for retesting to determine compliance with MRPSA was accomplished in November 1991. Re-coordination under the Fish and Wildlife Coordination Act began in September 1991; an interagency meeting on wetlands valuation and wetlands replacement was held in San Juan on October 1, 1991, and a new Wetlands Mitigation Plan has been written (Paragraph 61 and Appendix B) to reflect the consensus of that meeting. When the mitigation plan is accepted and material sampling results are available, sufficient information will be available to allow for application for a Water Quality Certificate. Re-coordination under the Endangered Species Act began in July 1991. A Biological Assessment was prepared for endangered marine turtles (NMFS), and for two avian species, the brown pelican (T) and the yellow-shouldered blackbird (E). The Corps determined that the proposed activities will not affect the above species for reasons documented in the Environmental Assessment. Conditional concurrence has been received on the turtles; concurrence is expected from FWS on the avian species.

c. Unresolved Issues. It is not possible to identify a borrow site for materials needed to build features in some upstream reaches at the present time. It is presumed that clean virgin material will be used, most probably from an existing quarry. There are several such quarries along upstream reaches. No toxic or hazardous materials are expected to be encountered in upstream excavation areas, but if ongoing studies indicate the potential for such materials, environmental testing will be carried out and contaminated material will not be used.

61. Wetlands.

a. Impact. As unanimously agreed upon during the October 1, 1991 coordination meeting held with representatives of FWS, EPA and DNR, project wetlands impact was recalculated based on actual survey maps overlain by the project features. Planimetry of wetlands was accomplished at a scale of 1:600 for the first phase of the project, and at scales ranging from 1:2400 to 1:20,000 for other areas (mostly the Margarita Creek wetlands). Stage 1 of the project (widening and bulkheading of the channel from Puerto Nuevo river mouth to the Highway 22 crossing) will remove 16.1 acres of mangroves, consisting of a mixed stand northeast of the Highway 2 bridge, two small stands southeast of the bridge in Central Park, and the mangroves lining both sides of the Puerto Nuevo channel proper, beginning at its junction with Martín Peña, up to Highway 22. These stands are dominated by mixed white, black and red mangroves near the mouth, then by mixed black and white mangroves, and finally, by a thin line of white mangroves upstream. Improvements to Quebrada Margarita and use of the adjacent disposal area (the "Rupert Armstrong" property) will inevitably remove an additional 4 acres of mainly black mangroves. Mangrove impacts have decreased in comparison to former estimates because: (1) Slight alterations in the channel alignment and use of the vertical-walled concrete pile and panel bulkhead minimize project wetlands impact; (2) A considerable acreage along the Martín Peña segment was already removed (in 1987) when this channel was widened in the expansion of the San Juan Ferry system.

The "Constitution Bridge mudflats" discussed briefly in the FEIS no longer exist. They were located offshore of the tip of the northeast mangrove stand (mouth of Martín Peña-Puerto Nuevo channel) and were removed during the ferry dredging. Mitigation for this unrelated project was achieved by a mixture of mangrove restoration and mudflat creation using dredged materials. The mudflats were expanded in mid 1991 during the first maintenance dredging for the ferry channel. There is now more acreage in mudflats adjacent to the Central Park mangroves than existed naturally in 1980. The Puerto Nuevo channel will abut the newly created mudflats. The side adjacent to the new bulkhead will probably naturally become colonized by mangroves.

b. Mitigation. On-site and in-kind mitigation is proposed to the maximum extent feasible. The consensus of cooperating wetlands biologists as expressed to the Corps at the October 1, 1991 meeting was that compensation should be in the ratio of 1.5 acres for every acre destroyed. The rationale for greater than 1:1 mitigation is that up to 10 years will be required for complete structural development of the created mangroves, and that some reduction in productivity functions (compared to the natural stands) may occur, due to restrictions to circulation and flushing through the concrete bulkhead system. The Mitigation Plan (Appendix B) reflects this ratio. Since the total projected loss is of 20 acres, 30 acres of restored and replanted mangroves will be created. The plan calls for 16 acres of creation along the first stage channel, and 16 acres additional in the wetlands adjacent to the abandoned Puerto Nuevo channel and second disposal area. The planting strips will be located behind the concrete king pile bulkheads. Red mangroves will be planted along Martín Peña channel, and white and black mangroves will be broadcast-sown along the Puerto Nuevo upstream. Black mangroves will be sown in the Margarita area. Planting elevations will vary and will follow levels in adjacent healthy mangrove stands. Appendix B provides additional details. Monitoring will be continued for five years and an 80% survival rate will be considered successful. The project will not impact upon the southwest "Constitution Bridge" parcel, but assistance will be provided to place this parcel under permanent conservation easement as recommended in the Coastal Zone Management Plan.

62. Suitability for Ocean Disposal of Dredged Material. Material from the lower portion of the Río Puerto Nuevo and the Margarita Channel are designated for offshore disposal in the San Juan Ocean Dredged Material Disposal Site (ODMDS). The San Juan ODMDS is a designated ODMDS located approximately one-and-one-half miles offshore from San Juan Harbor in about 1,200 feet of water. Though most of the material planned for disposal is virgin material and should present no problems, testing conducted in 1988 under the 1977 "Green Book" was not conclusive for all stations. The Corps concluded that problem areas noted were laboratory artifacts and no conclusions could be made from them. Nonetheless, EPA expressed concerns about the suitability of the material for ocean disposal that were not resolved. Retesting of the material, under the 1991 "Green Book," began with field collections conducted in November 1991. This effort has been coordinated with EPA Region II. Based on the results of the retesting, concurrence from EPA for ocean disposal of all, or acceptable portions of, this dredged material will be sought in early 1992.

63. Hazardous and Toxic Wastes Considerations. Preliminary concerns with this item centered on the possibility of excavating material buried in the sanitary landfill adjacent to the lower reaches of the river. Initial design documents showed the excavation cutting through the landfill significantly at one bend in the alignment. Design changes were made that eliminated a great deal of this problem even though the design changes were not made specifically for HTW consideration. Review, to date, on information from the upper reaches of the project indicated that modifications will be made primarily within the confines of the existing channel boundaries. No information has been found that shows areas that may contain or may have been contaminated with hazardous and toxic wastes.

64. Aesthetic Mitigation. The Puerto Nuevo Flood Control Project is located within a heavily populated section of San Juan. Almost all of the land in the immediate area of the project has been urbanized or will be by the beginning of the next century.

The visual impact of the Puerto Nuevo Flood Control Project on this large population will be a determining factor in the "acceptability" of it. Therefore, the design for the project has to take visual aesthetics into consideration through:

a. the use of screening with berms, fencing materials and vegetation to hide the channel from view wherever practical;

b. the addition of colors and or pebbles to the concrete used in the channel walls to reduce its stark visual impact in areas where it cannot be successfully screened;

c. keeping the ground elevation and the channel walls as close to each other as possible to reduce the feeling that the channel is a "barrier" of some type; and,

d. careful selection of the fencing materials used, where needed, to provide the necessary security and public safety while reducing the "barrier" effect.

During construction of the recreation features, existing vegetation, particularly the larger trees, should be disturbed as little as possible to preserve the area's vegetation and park like character as much as possible. Spoil removed from the stream during construction can be used for berm building. This will reduce the cost of transportation as well as construction costs during the recreation development phase. Visually, concealing the channel through the use of these types of screening materials will be the most effective means of gaining acceptability of the project from an aesthetics viewpoint.

65. Cultural Resources. A cultural resources reconnaissance was conducted by Mobile District in 1980 to determine the potential for locating cultural resources in the Rio Puerto Nuevo Flood Control Project area (A Cultural Resources Reconnaissance of Five Projects in Puerto Rico). The report recommended further examination of three areas. One, the historic Norzagary Bridge, will not be affected by the project. The remaining two areas encompassed approximately 27.8 hectares (68.7 acres) and were subjected to a more intensive field investigation (A Cultural Resources Reconnaissance and Survey of the Rio Puerto Nuevo Flood Control Project, San Juan, Puerto Rico, prepared by Garrow and Associates, Inc., February 1989).

No significant resources were found in most of the areas examined. The majority of land has either been disturbed by urbanization or sugar cane fields or is too swampy. One site was deemed eligible for the National Register of Historic Places (NRHP). This site includes Hacienda San Jose, an early to mid-nineteenth century sugar processing plant, and old water filtration works.

The State Historic Preservation Officer (SHPO) agreed with the assessment of significance for this site (letter dated January 19, 1989). The standing structures will not be affected by the project. There will be some impacts to the parking lot associated with the water works and an adjacent diked area. Archeological data recovery will be necessary. A mitigation plan will be developed, in consultation with the SHPO, and will be completed prior to construction.

This work will be completed in compliance with the National Historic Preservation Act of 1966, as amended (PL 89-665); the Archeological and Historic Preservation Act, as amended (PL 93-291); and Executive Order 11593.

## N. RECREATION

66. Introduction. The large concentration of people living in the San Juan Metropolitan Area interested in bicycling for recreation or willing to use bicycles as a means of transportation has grown and will continue to grow over the next quarter century, according to the Puerto Rico State Comprehensive Outdoor Recreation Plan (SCORP). The major hinderance to this use has been and continues to be traffic congestion and safety. A proposed city-wide bikeway will not only serve recreational purposes but will help alleviate a known transportation problem in the area. The Puerto Nuevo Project Bicycle Path and Linear Path will be part of an overall system which will ultimately range into the heart of old San Juan from an area to the south of the proposed University of Puerto Rico Botanical Gardens.

The Puerto Nuevo bicycle path and linear park will also be a major link in the bicycle and linear park system being planned as part of the 500th anniversary celebration of the discovery of the Americas in 1992. The Department of Natural Resources has committed to this flood control project and has signed a letter of intent to cost share in its completion. Recreational development is being funded by DNR and is being coordinated with the Fideicomiso de Parques Nacionales de Puerto Rico. The Fideicomiso de Parques Nacionales de Puerto Rico is developing the adjoining portions of the bike path for the anniversary celebration. The Fideicomiso and the Corps of Engineers are working closely to provide compatible recreational development for the joint part of the project being constructed in conjunction with the Rio Puerto Nuevo Flood Control Project. This cost shared portion of this path will follow the channel right of way from just south of the Botanical Gardens to Luis Munoz Marin Park, where it will connect with a path coming from the north.

67. Project Description. The bike path and linear park will incorporate similar design features being planned for the non-cost shared portion of the path in order to achieve maximum compatibility. These design features include planters, rest stops, benches and the path surface itself. A variety of native plant species will be used, in planters where necessary, in order to shade the path and make it visually pleasing. Screening the channel through the use of berms, fencing materials and plants will be done where possible to reduce its visibility and increase its "acceptability" to the local population. The addition of colors and or pebble surfaces to the concrete used in the channel walls will increase its "blending in" where it cannot be successfully screened otherwise.

68. Recreational Development. Plate R-1 shows the tentative alignment of the Bicycle Path and Linear Park. From the upstream end of the path to where it enters the Luis Munoz Marin Park, the following description applies:

a. Beginning at an existing parking area used by the University of Puerto Rico at their gardens, near Puerto Rico Highway 1 and on the east side of the Rio Puerto Nuevo channel, the path will proceed across the existing P.R. 1 bridge and drop down to the east side of the realigned channel. It will pass under a new P.R. 1 bridge and then proceed north, crossing onto the Botanical Gardens section of the University of Puerto Rico property at a bicycle/pedestrian only bridge with a connector path. This connector path will provide pedestrians and cyclists coming from the main portion of the university, as well as residents on the east of the channel, access to the bike path. The connector path will terminate at a nearby bus stop on the metrobus route.

There is a fee imposed by the university for parking on the university gardens property. Although this fee is small, assurance that the fee is uniformly applied is necessary for the Corps to approve its application in conjunction with the cost shared development. The Fideicomiso de Parques Nacionales de Puerto Rico is working with the university to obtain approval for use of the parking facilities. If some type of arrangement cannot be worked out with the University, it may be possible to construct a small parking area in the vicinity of the old channel.

b. Once on the Botanical Gardens portion of the university property, the path will split into two lanes. Benches, a bicycle rack and trash receptacles will be located at this split in the paths. One of the lanes will be a loop primarily for pedestrian access while the other lane will handle bike traffic and pedestrians using the path system for longer distance travel. The pedestrian lane will be six feet in width, while the main bike path will be eight feet wide. The paths will meander north, but within the channel right-of-way, between ponds which will be constructed by the university as part of the Botanical Gardens and the project lands for the channel. The paths will be screened from both the ponds and the channel by berms and vegetation. The bike path will be concrete and the pedestrian path will be a mixture of terracotta colored ornamental blocks and exposed aggregate within a concrete base. A running bond cobble pattern in terracotta colored concrete is an acceptable alternative surface for the pedestrian path. Other construction materials, final alignment and vegetative screening will be coordinated with the university to make the bike path system as compatible with their work as possible. With the exception of the bike path itself, the bulk of the facilities to be included in the cost shared portion of the Puerto Nuevo development will occur in the Botanical Gardens area. This will include benches, trash receptacles, berms, plant material and planters.

c. Near the northern end of the university property, the paths will merge and pass under the proposed elevated metrobus roadway. It is near this point that the pedestrian path loop will tie into the main bike path allowing pedestrians to either return to the beginning of the path system or continue along the bike path for a greater walking distance. A bench will be located at this intersection of the two paths.

d. Continuing north, the single, eight feet wide path will pass over another pedestrian and bicycle only bridge at a crossing on the Buena Vista Diversion Channel. A bench and trash receptacle will be located on the south side of this bridge. Native plant material will be used as much as possible to screen the Buena Vista Channel from the Botanical Gardens and the residential area to the north.

e. After crossing the Buena Vista Diversion Channel, the single unit path will continue north and closely follow the channel alignment until it reaches the Notre Dame Bridge where it will cross to the east side of the channel. Within the confines of the channel right-of-way, the path will meander as much as possible to prevent cyclists from reaching racing speeds, reduce the number of straight stretches and add more character to the path.

f. Once on the east side of the channel again, the path will meander north within the channel right-of-way until it reaches the southeastern access ramps at J.T. Pinero Avenue. Two benches with planters and trash receptacles will be spaced at approximately equal distances along this section of the path. These can be used by bikers and pedestrians as rest stops, or by nearby residents who may wish to sit and view the area.

Additional trees and shrubs not in planters will add to the park-like atmosphere of the area and will be used to provide screening of the channel.

g. When the bike path reaches the J.T. Pinero Avenue Bridge and the access ramps to it, it will be necessary to provide overpass structures of some type for the pedestrians and cyclists to use in crossing these heavily traveled streets safely. The smaller of the two will cross the access ramps while a larger one will be necessary to cross J.T. Pinero Avenue. Once on the north side of Pinero Avenue, the path will follow Pinero Avenue under the Las Americas Expressway. The Puerto Rico Department of Transportation requires these structures to have a minimum of 5 meters (16.2 ft.) of clearance for vehicular traffic. Maintenance vehicles will be permitted controlled access to the bike path.

h. After passing under the Las Americas Expressway, the path will pass into the inside of the northwest cloverleaf of the intersection. The path will approach the access ramps, but will cross these on a third elevated structure designed for both pedestrians and bicycle traffic. This elevated structure is necessary to prevent pedestrians and cyclists from having to compete with vehicular traffic entering or leaving the Las Americas Expressway. Once off the structure, the path will quickly enter the Luis Munoz Marin Park. Here it will join with the interconnecting roads and paths inside the park and link with the bike path coming from the northern section of the city.

The bike path and linear park will include the following features:

24 flowering trees compatible to the area
3 laminated pedestrian bridges
3 concrete and steel overpasses for pedestrians
10 backless concrete benches
6 planters, 4' diameter
4 trash receptacles
1 bicycle rack
6,000 linear feet of concrete bicycle path, 8' wide
1,000 linear feet of concrete pedestrian path, 6' wide

69. Boat Ramp. A boat ramp located near the mouth of the river, in the Margarita Channel, will be constructed as part of Contract 1. The ramp will be designed and constructed as part of the channel wall itself. The ramp site is located on the right descending bank of the channel north of the Martin Pena Canal. The selected site will be inside an existing park and the parking lot will be connected with established roads in the park. The single lane ramp, parking, and access will be a part of the cost shared portion of the project. However, parking and access into the site will not be provided until after the site

is no longer needed for project construction. This boat ramp will complement the facilities planned for the San Juan Municipal Park proposed by the Commonwealth.

70. Justification. The cost estimate for the recreational development plan is $464,000. The annualized replacement and maintenance cost is $44,000. With annual net recreation benefits of $831,000, the benefit-to-cost ratio for the Recreation Development Plan is 9.2 to 1. The benefit analysis is covered in detail in Appendix D, Economic Update, and the cost is included in the project cost estimate.

## O. DEPARTURE FROM SURVEY REPORT

71. General. The authorized plan presented in the 1984 Survey Report has been revised for this GDM. They are comprehensive revisions effecting the entire project and hydraulic design concept. Revisions include the deletion of five stilling basins from the various channels and using extended reaches of high velocity channel and high velocity confluence junctions. The revised design described below is presented in the hydraulic design data tables. Neither the design level of protection nor the project purposes have been changed using this new design concept.

72. Main Channel. The main channel design configuration was changed from a wide trapezoidal section with subcritical flow to a rectangular section with supercritical flow. The upstream reach of the project channel carries flow in the subcritical regime as it leaves the debris basin at the upstream project limit. A grade break to a steeper bed slope transitions flow into the supercritical regime below Puerto Rico (PR) Highway (Hwy) 176 at station 276+50. The existing Rio Piedras begins to meander near PR Hwy 1 (near station 241+50) as it enters the flood plain and the existing channel bed slope flattens. The design channel extends the steeper upstream bed slope out into the flood plain. The steeper slope was achieved by straightening the meanders and shortening the channel reach length by excavating a new channel through the an area of the University of Puerto Rico Agricultural Experiment Station. Maintaining the supercritical flow regime into the downstream reach provided the opportunity to eliminate several bridge replacements called for in the previously authorized plan.

The supercritical channel bed slope was extended through the Las Americas Expressway-Avenida Jesus T. Pinero interchange by incising the design channel invert below the existing Rio Piedras thalweg. This moved the stilling area from upstream of this location to just downstream of the Las Americas Expressway bridge. The design channel passes through the Las Americas Expressway interchange under four bridges using a lowered invert center pilot channel 10 feet deep by 29 feet wide. The lowered invert center pilot channel provides the additional conveyance necessary to pass the design discharge in the supercritical flow regime through these existing four bridges. A sloping bridge pier extension will be retro-fitted to each of the piers of these four bridges. This will reduce debris accumulation in the channel flow area at the upstream side of each bridge. A stilling area is located downstream of the Las Americas Expressway bridge to stabilize the location of the hydraulic jump and the transition to tranquil flow. The channel reach extending downstream from the stilling area to the confluence with the Margarita Channel is an entrenched rectangular section.

73. Margarita Channel. At the confluence with the Margarita Channel, the invert elevation is -16.0 ft., NGVD. The reach downstream of Margarita Channel would be a deeply entrenched trapezoidal section with bulkheads on the sloping banks. The design for the Margarita Channel was similarly revised. The upstream supercritical channel reach was extended through the De Diego Expressway bridge. The new design features a concrete rectangular section and eliminates the need to replace the De Diego Expressway bridge. A stilling area is located immediately downstream of the bridge. The downstream channel reach is an entrenched trapezoidal section, with low levees extending downstream to the confluence with the main channel.

74. Josefina and Dona Ana Channels. The design revision for the Josefina and Dona Ana Channels eliminated the stilling basin on each channel and extends the high velocity flow reaches through their mutual confluence. The design channels will be placed inside of the existing channels. The location of the transition of the flow regime from supercritical to subcritical is accomplished downstream of the Josefina-Dona Ana Channel confluence. The location of the hydraulic jump is stabilized by the tailwater effect of the main channel confluence.

75. Buena Vista Diversion Channel. The design for the Buena Vista Diversion Channel was also revised. The upstream reach of the channel will be on a subcritical bed side slope, using a grade break to cause flow to transition to the supercritical regime. The confluence with the main channel is a high velocity flow junction.

## P. RECOMMENDATIONS

76. General. It is recommended that the proposed plan for improvements to 11.2 miles of the existing channel of Rio Puerto Nuevo and Rio Piedras and five tributaries of the Rio Puerto Nuevo be approved for construction. The recommended plan is described in Section C of this report.

77. <u>Local Cooperation</u>. It is also recommended that the project be constructed, operated, and maintained under the following terms of the local cooperation:

a. Flood control local cooperation requirements.

(1) Provide a cash contribution equal to five percent of total project costs;

(2) Provide all lands, easements, rights-of-way, relocations (except railroad bridge alterations), and dredged material disposal areas (referred to as LERRD);

(3) Provide an additional cash payment when the sum of items (1) and (2) are less than 25 percent of total project costs;

(4) Operate and maintain the project after completion, including accomplishment of any needed replacements or rehabilitations of any of its components (referred to as OMR&R);

(5) Hold and save the United States free from damages due to the construction or subsequent maintenance of the project, except damages due to the fault or negligence of the United States or its contractors;

(6) Prevent future encroachments which might interfere with proper functioning of the project;

(7) Participate in and comply with applicable Federal flood plain management and flood insurance programs (i.e., the National Flood Insurance Program), pursuant to Section 402, Public Law 99-662; and,

(8) Provide guidance and leadership to prevent unwise future development in the flood plain.

b. Recreation local cooperation requirements.

(1) Provide one-half of the separable first cost of post authorization planning and construction of recreation facilities, including project land acquired specifically for recreation; and,

(2) All costs and full responsibility for the operation, maintenance, replacement, and management of recreation lands and facilities.

TERRENCE C. SALT
Colonel, Corps of Engineers
Commanding

# ENVIRONMENTAL ASSESSMENT

## GENERAL DESIGN MEMORANDUM

## RIO PUERTO NUEVO, PUERTO RICO

NOVEMBER, 1991

**ENVIRONMENTAL ASSESSMENT**
**RIO PUERTO NUEVO, PUERTO RICO**

1. **SUMMARY**. This Draft Environment Assessment updates prior NEPA documents and environmental compliance of the Río Puerto Nuevo Flood Control Project, located along 11.2 miles of the Río Puerto Nuevo and its tributaries Quebrada Margarita, Quebrada Doña Ana, Quebrada Josefina, Quebrada Buena Vista and Quebrada Guaracanal, in San Juan and Guaynabo, Puerto Rico. A Final Environmental Impact Statement was filed in December of 1985. The Río Puerto Nuevo Project was authorized by the 1986 Water Resources Act. The purpose of the present Environmental Assessment is to provide documentation of the state of NEPA (National Environmental Policy Act) compliance at this stage in project development and to reflect changes in project scope, impacts and/or mitigation actions subsequent to the FEIS, as well as changes in environmental laws and regulations. It also shows ongoing environmental commitments made at and subsequent to the completion of the Environmental Impact Statement Review. The level of protection of the project (100-year floods) has remained unchanged. Predicted project impacts include disturbance to a parking lot associated with an identified historic site and removal of about 20.5 acres of mangrove wetlands. Mitigation for cultural resources impacts will be by survey for, avoidance and/or salvage of culturally significant materials prior to project construction. A mangrove mitigation plan, included as GDM Appendix B, proposes creation of 30 acres of mixed mangrove along the lower Puerto Nuevo channel, immediately behind and adjacent to the bulkheaded lower channel segment, as well as adjacent to the Margarita Channel disposal area. This mangrove mitigation plan incorporates many recommendations made by the U.S. Fish and Wildlife Service, and responds to comments by other cooperating resource agencies. It differs from the mitigation plan included in the FEIS, which proposed to claim a mitigation credit for preservation of a 7.5 ha mangrove parcel west of Constitution Bridge while replanting only 6 ha (15 acres). While the project will still allow the Constitution Bridge West parcel to remain intact (the channel passes to the east of the stand), no overt mitigation credit is claimed for its preservation.

A linear park will be built along the channel in cooperation with the Puerto Rico National Parks Trust. A recreational bikeway, partially cost-shared with the Trust, is included in the park design.

Data, tables and figures included in the General Design Memorandum (GDM) are incorporated by reference into this Draft Environmental Assessment (EA).

## 2. INTRODUCTION: PROPOSED ACTION, LOCATION, PRIOR NEPA DOCUMENTATION AND COMMITMENTS.

**2.1 DESCRIPTION OF THE PROPOSED ACTION:** The recommended plan consists of improvements to 11.2 miles of the existing channel of Río Puerto Nuevo and Río Piedras and to five tributaries of the Río Puerto Nuevo Basin (Quebrada Margarita, Quebrada Doña Ana, Quebrada Josefina, Quebrada Buena Vista and Quebrada Guaracanal). The plan will provide 0.01 exceedence probability (100-year) flood protection for areas adjacent to the river and the above tributaries. It includes 1.66 miles of bulkheaded trapezoidal channel and 9.54 miles of concrete rectangular channel. Additional features include two baffle pier stilling areas, two high velocity flow junctions with tributary streams (Buena Vista Diversion Channel and Guaracanal Channel), and two upstream debris basins with side-overflow spillways. Some of the mangroves now lining the tidal downstream section of Río Puerto Nuevo and the combined Puerto Nuevo-Martín Peña Channel will be removed by channel widening. The significant Constitution Bridge west parcel will be preserved. Porous concrete king pile and panel bulkhead, similar to bulkheads successfully emplaced in Martín Peña channel, will line most of the tidal section of the channel. An estimated 16 acres (6.5 ha) of mangroves will be removed during the first phase of the project (up to the De Diego Expressway Bridge). An additional 4 acres (1.6 ha) of mixed wetlands will be impacted by dredging and deposition of dredged materials in Disposal Area II when the Quebrada Margarita tributary is channeled, leading to a total loss of 20 acres (8 ha). The wetlands mitigation plan developed to compensate for this loss would replace wetlands at a ratio of 1.5:1 (wetlands created:wetlands destroyed). A boat ramp, bicycle path and linear park will be developed along the channel in cooperation with the Municipality of San Juan. Cultural resources mitigation work will include archeological data recovery and will be completed according to a mitigation plan developed in coordination with the State Historic Preservation Officer (SHPO), prior to construction.

**2.2 LOCATION:** The project area is located in metropolitan San Juan, on the north coast of Puerto Rico. The river arises in the foothills of Río Piedras and flows northward, emptying into the southeast corner of San Juan Bay through a channel it shares with Martín Peña channel. Portions of some tributaries flow through adjoining Guaynabo municipality.

**2.3 PROJECT HISTORY.** The Puerto Nuevo River drainage is intensively developed. Originally emptying into San Juan Bay through the wetlands of Guaynabo (an area now occupied by the Puerto Nuevo Docks), the river was re-routed to the east in the 1950's to join the Martín Peña Channel before entering San Juan Harbor. The entire watershed lies within the developed metropolitan San Juan region, which has experienced continuous rapid growth since the 1940's. Due to frequent flooding along the river and major tributaries, and at the request of the Government of Puerto Rico, studies for flood mitigation began in 1978, under the authority of Section 204 of the Flood Control Act of 1970. A Survey Report and Draft Environmental Impact Statement were circulated in 1984, and a Final Environmental Impact Statement was filed on December 6, 1985. The Río Puerto Nuevo, Puerto Rico, Flood Control Project was authorized under the Water Resources Act of 1986.

**2.4 DESIGN CHANGES SINCE FEASIBILITY REPORT.** The authorized plan presented in the 1984 Survey Report has been revised for the present GDM. Revisions include the deletion of five stilling basins from the various channels, and using extended reaches of high velocity channel and high velocity confluence junctions. The design level of protection and the project purposes have remained the same. Because of general urban development that has occurred since the original biological assessments were prepared (in 1980; refer to Appendix A) existing wetlands are smaller. Mudflats described in the EIS as occurring at the mouth of Martín Peña were removed when this channel was widened for the San Juan ferry project, Agua-Expreso. Replacement mudflats built to the northeast of the original site as mitigation will not be in the zone of impact of the Puerto Nuevo project. A concrete king pile and panel bulkhead system, like that used in Martín Peña, will minimize the project's footprint in tidal wetlands and provide a mangrove replanting strip immediately behind the bulkheads at each side of the channel. A Wetlands Mitigation Plan (Appendix B) details changes in wetlands impacts, evaluates options for creating and restoring wetlands on-site, and proposes compensatory mitigation at a ratio of 1.5:1 (30 acres created or restored/20 acres impacted). This ratio is based on a consensus of wetlands biologists regarding the functional values of the wetlands to be impacted versus the value of replanted mangroves, as expressed at a 1991 coordination meeting.

**2.5 COMMITMENTS MADE IN PRIOR NEPA DOCUMENTS.** Commitments were made in the FEIS to (1) Conduct a survey for and recover culturally significant materials in identified historic sites along the project route; (2) develop recreation features, including a bike path, linear park and a boat ramp, along segments of the project; (3) track project wetlands impacts and produce a Wetlands Mitigation Plan providing for 1:1 replacement of wetlands function; (4) conduct environmental testing to assure that dredged materials designated for offshore disposal comply with requirements under the Marine Research Protection and Sanctuaries Act; (5) conduct surveys and testing if necessary to verify the absence of toxic or hazardous materials in areas subject to excavation or dredging; (6) obtain a Water Quality Certificate from the Commonwealth Environmental Quality Board

(EQB) when sufficient information on water and sediment quality and a wetlands mitigation plan were available.

**3 AFFECTED ENVIRONMENT.** Synopsis: The Río Puerto Nuevo arises in the moist to wet hills south of San Juan, where average annual rainfall is up to 80" (2000 mm). The basin is under suburban residential and light commercial use up to headwaters areas; downstream it drains successively more densely urbanized and paved areas, until it reaches tidewater. Upstream, most land use is for separate single-family residences on small land lots. There are a few larger open spaces, including some grassy pasture, the stream rights-of-way (generally a mixture of exotic and native grasses and such exotic trees as African tulip, immortelle, albizias, poinciana and other fast-growing species) and playing fields, especially baseball diamonds. The mid-reaches of the main river pass through the Agricultural Experiment Station, an area of grassy fields and wooded paths almost completely surrounded by densely developed and paved areas including small industries, housing developments, shopping strips, highways and roads, and medium to high rise apartments. Below the Experiment Station the river crosses a series of residential developments and flows under Las Américas Expressway before entering the large green spaces of Luís Muñoz Marín Park. To the north (downstream) of this park, the river runs through a nearly sterile channel past the municipal Coliseum, Hiram Bithorn Stadium, under Roosevelt Avenue and past the large public housing project Nemesio Canales. Here the river becomes tidal, crosses under the De Diego Expressway and turns sharply to the east. From this point to its mouth it is lined with mangroves that first form a thin line on the north bank, widening to solid stands on both bulkheaded channel sides from the Kennedy Avenue bridge to the mouth. Most of the river channel has been highly altered by clearing and grubbing, rechannelling, paving, or other disturbance. Significant resources include historic structures, green areas and corridors, wildlife habitats, native wildlife (mostly represented by bird species), threatened and endangered species, wetlands (estuarine mangroves), and recreational areas. These are described briefly below. The mudflat habitats described in the Biological Assessment appended to the FEIS (Appendix A) were destroyed by an unrelated project. New mudflats, created in compensation, lie northeast of the Puerto Nuevo channel route. Recently expanded during a channel maintenance dredging, they have replaced acreage lost.

**3.01 CULTURAL RESOURCES.** A cultural resources reconnaissance was conducted in 1980 to determine the potential for locating cultural resources in the Rio Puerto Nuevo Flood Control Project Area. (A Cultural Resources Reconnaissance of Five Projects in Puerto Rico). The report recommended further examination of three areas. One, the historic Norzagaray Bridge, will not be affected by the project. The remaining two areas encompassed approximately 27.8 hectares (68.7 acres) and were subjected to a more intensive field investigation (A Cultural Resources Reconnaissance and Survey of the Rio Puerto Nuevo Flood Control Project, San Juan, Puerto Rico, prepared by Garrow and Associates, Inc., February 1989). No significant resources were found in most of the areas examined. The majority of the land has either been disturbed by urbanization or sugar cane fields or is too swampy. One site was deemed eligible for the National Register of Historic Places (NRHP). This site includes Hacienda San José, an early to mid-nineteenth century sugar processing plant, and old water filtration works.

**3.02 AESTHETIC RESOURCES.** Because of the dense urbanization of metropolitan San Juan, where about half of Puerto Rico's 3.9 million residents live, green spaces are at a premium. Land lots of single family houses tend to be very small and are generally occupied up to zoning limits by structures. Community parks, required by Planning regulations in each new housing development, have traditionally been interpreted as playing fields (generally, a baseball diamond or basketball court). In this context, green spaces are especially important to the quality of both the human and the natural environment. The main channel and tributaries of the Puerto Nuevo provide vital green corridors from their headwaters, through the large parks of the mid-river, to the mangrove-lined estuarine channels leading to the bay. Although not all residential communities have incorporated the stream channels into community public spaces (some merely fence them out of their backyards), others, including University Gardens in Río Piedras, have landscaped the river bank and use these public lands for passive recreation. The strips of green along both banks provide a wildlife corridor between larger habitat areas like the Botanic Garden and Experiment Station and other areas like the large Muñoz Marín Park downstream, while they afford human residents some visual relief from an otherwise concrete-dominated landscape.

**3.03 BIOLOGICAL RESOURCES.** Wildlife diversity is moderate to low along the Puerto Nuevo, even in upstream reaches. Upland areas are generally a mixture of abandoned pastures, suburban or rural housing and new suburban developments, some very dense. The largest area of tree-covered wildlife habitat along the upper river is found inside the grounds of the University of Puerto Rico Agricultural Experiment Station. The Station, in addition to housing the President of the University of Puerto Rico, agricultural and forestry libraries and laboratories, preserves, on its extreme south side, a small stand of native mesic forest dominated by *algarrobo* Hymenea courbaril. It also includes, to the south of Highway 1, a small botanic garden, collections of bamboo and palm species, and, north of Highway 1, some agricultural fields used for sugar cane and other large crops in the past. Other green areas along the lower main river include the large Luís Muñoz Marín Park (off Piñeiro Avenue) and, north of the De Diego Expressway, small but significant linear stands of black, white and red mangroves. Wildlife resources are mainly associated with these green areas and with the green strips that occur directly along the river. These strips serve as wildlife corridors for small land animals, particularly birds, lizards and other non-flying animals. In addition to well-known feral urban animals like city pigeons, cats, dogs, mongoose, rats and mice, open green areas support a considerable avian population dominated by seed, nectar and insect-eaters, including finches, bananaquits, grassquits, kingbirds, ground and zenaida doves, European rock doves, anis and others. At least one pair of red-tailed hawks generally patrols the lower river, usually nesting somewhere on the grounds of the Experiment Station. The Station, especially the south parcel, and the University of Puerto Rico main campus (nearby but not affected by the project) provide the best avian forest habitat in urban San Juan, due mainly to the large numbers of mature trees preserved there. Any green space, however, offers some wildlife habitat. Exotic bird species are common and are often associated with the wooded or grassy parts of the river corridor; they may include whydahs, many species of finches, parakeets, conures and some introduced parrots. Migratory birds often seen, even in the city, include peregrine falcon, warblers, kingfishers and the spotted sandpiper. Herpetofauna includes the large exotic toad <u>Bufo marinus</u>, the white-lipped frog, and lizards including the common grass anole, the tree anole <u>Anolis cristatellus</u> and the ground lizard <u>Ameiva exsul</u>.

The mangrove forests of the mouth of the Puerto Nuevo and other remnant stands along the old river channel are the most important wildlife habitat area under the project footprint. These estuarine forests support a variety of insect life, both in the canopy and on the ground. They provide cover, shade, elevated perches and food for a great diversity of bird species, including residents, transient migrants and regular winter residents. Martín Peña Channel and Puerto Nuevo River mangroves, though reduced in area compared to earlier years, still provide significant habitat for resident birds and invertebrates. All of the locally resident waders (herons, egrets and rails) can be readily observed in the area (Refer to Biological Assessment, Appendix A, for a list of bird species observed). In the autumn, remnant sand and mudflats on the western bay shore adjacent to the river are visited by flocks of shorebirds, including western and least sandpipers, dowitchers, yellowlegs, turnstones and several plover species. The mudflat area, recently refurbished, is reduced functionally in comparison to the pre-1987 condition, however, and shorebirds are no longer observed by the hundreds, as they were prior to the dredging and bulkheading of Martín Peña channel. The upper Puerto Nuevo tidal reach, above the Martín Peña junction, never yielded high census counts, probably because the mangroves occurred as a thin line immediately adjacent to the shore.

Fish fauna of the Puerto Nuevo is depauperate in the tidal reaches, probably a reflection of poor water quality and low dissolved oxygen levels. Surveys conducted by the Department of Natural Resources in 1982 (Díaz et al. 1983) identified 8 species of largely estuarine fish in the lower channel near the bay, including small tarpon, snook and several mojarra species. Upstream fish fauna includes the introduced Tilapia, as well as other common species like bigmouth sleeper, guppies, mosquitofish and white mullet.

**3.04 ENDANGERED SPECIES.** In informal consultation with the U.S. Fish and Wildlife Service (FWS), the yellow shouldered blackbird (Agelaius xanthomus, E) and the brown pelican (Pelecanus occidentalis, T) were identified as listed species whose known range includes the project area, while endangered sea turtles were identified by the National Marine Fisheries Service (NMFS), but not by FWS, as present in the area.

Brown pelicans are known to loaf and roost in all mangrove areas around San Juan's many bays. In the early 1980's when mangrove acreage both east and west of the Puerto Nuevo River mouth was larger, pelicans commonly rested on the mangrove trees in large flocks. In 1987, mangroves were cut back on both sides of the combined Martín Peña channel - Puerto Nuevo River mouth for the San Juan Ferry Project (the former "Agua-guagua" project, now called "Agua-expreso"). Later still, in late September, 1989, hurricane Hugo severely damaged these trees. After the hurricane a mangrove die-back occurred throughout northeastern Puerto Rico, thought to be a belated consequence of salt burn or bark stripping caused by hurricane winds, compounded by subsequent drought stress. The Puerto Nuevo mangroves have regenerated well and are now sprouting stems and shoots up to 20 feet tall, but shoots are still thin and apparently most are not yet strong enough to support pelicans. Fewer pelicans are generally using the river mouth than in the early 1980's. A few resting pelicans were observed on mangroves during brief field visits in October and December, 1991, but pelican guano was found on the tops of the concrete bulkheading on both sides of the channel, indicating that the birds may be using channel king piles as substitute resting sites. The birds that rest near the channel mouth probably feed in adjacent San Juan Bay and opportunistically use any sturdy, elevated support to rest between fishing, for they can also be seen on channel navigation towers and buoys.

One yellow-shouldered blackbird nest was observed in a royal palm tree in Parque Central adjacent to the Martín Peña channel in 1979-1980, and search in the mangroves subsequently found more birds. (FWS Biological Assessment 1980, Appendix A). This nest had been under observation by DNR personnel at the time. (J. Moreno, PR DNR Endangered Species Coordinator, telcom. 11/21/91). It is probable that blackbirds nested in the Puerto Nuevo mangroves up until the late 1970's, since mangroves are a favorite habitat. The Yellow-shouldered blackbird, once common in coastal Puerto Rico, began to suffer a dramatic population decline in the 1970's, leading to its designation as endangered in 1976. Experts believe its precarious status is due to nest parasitism by the shiny cowbird, a recent invader of the Caribbean. The cowbird deposits its eggs in blackbird nests. When they hatch, the precocious cowbird chicks are reared by blackbird parents, leading to greatly reduced blackbird fledging success. The islandwide blackbird population was decreasing in 1980. In spite of energetic recovery efforts, including cowbird control practices, the blackbird population has not recovered significantly nor expanded into former habitat areas. Sightings outside of the southwestern Puerto Rico core habitat are now unusual. The birds disperse widely after the nesting season and they can basically appear almost anywhere in Puerto Rico, including San Juan. Although blackbirds have been sighted on several occasions during the 1980's in the greater San Juan area none are known to have nested in Martín Peña or Río Puerto Nuevo since 1982, in spite of repeated and intensive searches by ornithologists in this area, which is highly accessible and visible. No blackbirds were observed in Puerto Nuevo or Martín Peña mangroves during October and December, 1991, field visits.

The National Marine Fisheries Service identified endangered sea turtles as species of concern on the Puerto Nuevo Project. The Corps initiated consultation on endangered marine turtles under the Endangered Species Act. Three species of sea turtles (leatherback, green and hawksbill) are commonly observed in waters adjacent to the north coast of Puerto Rico: The endangered leatherback (Dermochelys coriacea) is seen mainly during its nesting season (March-June) and is believed to return to northern waters. It does not typically enter shallow river estuaries or backwaters. The endangered green turtle (Chelonia mydas) nests very rarely in Puerto Rico but is quite commonly observed in nearshore waters as juveniles and subadults (Rathbun et al. 1985). The hawksbill (Eretmochelys imbricata, E) is also endangered and is often observed in nearshore waters near reefs and soft coral bottoms. Of these species, subadult green turtles (10-12" diameter) are sometimes observed in Puerto Rican estuaries including Culebra's bays and Boca de Cangrejos. In its letter response to informal Section 7 consultation in July, 1991, NMFS stated that sea turtles may occur in the Puerto Nuevo channel (Appendix A). However, there is no evidence that any species of marine turtle uses Martín Peña channel waters (PR DNR and USFWS, December 1991 telcom and verbal consultation). No turtle sightings have been reported. Waters in Martín Peña and the river are brackish, turbid and low in dissolved oxygen; there are no typical root communities growing on the mangroves (black and white mangroves are dominant and have no arching stilt roots), and neither the mangroves nor the aquatic environment are suitable turtle habitat. The Corps, FWS and DNR have no information, other than the NMFS letter, to indicate that sea turtles now use, or ever have used, the Puerto Nuevo River as habitat.

**3.05 WETLANDS.** Freshwater wetlands remnants exist in protected areas, including the Botanical Garden and Muñoz Marín Park, but none are due to be impacted. However, the mangrove-dominated tidal wetlands found along the Puerto Nuevo and in adjacent basins are extremely valuable in both human and wildlife terms, as they represent the last remnant of a once extensive forest that stretched from the present center of Cataño, along the whole south shore of San Juan Bay, in a solid, gently curving wall that reached Santurce. Some of these lands once formed part of the San Juan Insular Forest, but most have been filled to create uplands (for port or airport use) or removed to widen open water channels. A large percentage of the City of San Juan's public infrastructure, including the municipal landfill, animal shelter, Municipal Public Works Department, Nemesio Canales housing project, the Ochoa ferry terminal, parts of Parque Central, the central Puerto Nuevo Sewage Treatment Plant, and the entire Puerto Nuevo port facilities (docks, parking areas and road network) were built over fill in what once was the Martín Peña-Río Puerto Nuevo mangroves.

The remnants of this mangrove forest are now confined to the bay shore just east and west of the Puerto Nuevo channel mouth, the Martín Peña channel east to the Barbosa Avenue bridge, and basin stands around Tres Monjitas channel (Hato Rey), the Bechara area (including Disposal area 2 of this project) and several isolated stands near Kennedy Avenue. The Environmental Assessment (Appendix A) prepared under the Fish and Wildlife Coordination Act for the Puerto Nuevo Survey Report by the Fish and Wildlife Service identified the remnant mangroves as highly significant wetlands, in spite of their limited structural development. According to this study, written in 1980, most are secondary or new growth over recent delta deposits. The downstream end of the stand was dominated by red mangroves, while black, and then white mangroves became dominant in upstream progression.

The "Consitution Bridge Mudflats" (an area encompassing both unvegetated and mangrove-dominated shallows) is the name locally given to the mangrove stands located on both sides of the channel downstream from the Kennedy Avenue bridge. This site was recognized by Commonwealth planning and resource agencies in the early 1970's as an area requiring special management. However, The Coastal Zone Management Plan for Puerto Ricò, approved in 1978, recognized the site as a Coastal Natural Reserve while noting that development of the "Martín Peña Channel project" (ultimately called "Agua-Expreso:" the ferry project) would be given priority over preservation (Puerto Rico Coastal Management Programs and Final EIS, 1978). It also stated that mangroves were invading former mudflats and converting the entire site to mangrove, reducing its value for sea-and shorebirds. The Constitution Avenue Bridge site is still a "priority acquisition site" on the Puerto Rico Natural Heritage Program's priority wetlands list, as well as appearing on the Fish and Wildlife Service Southeastern Wetlands Priority List.

Today, white and black mangroves dominate the entire stand. Unlike red mangroves, these species can regenerate after cutting or breakage. Examination of old maps and aerial photos shows that mangroves were completely absent north of Kennedy Avenue in 1950, when the Constitution Bridge crossed a shallow cove of San Juan Bay. Essentially all of the mudflat and mangrove acreage north of this bridge has grown during the past 35 years. In the 1950's the Río Puerto Nuevo was diverted into Martín Peña; this must have increased the suspended sediment load and accelerated the mudflat-building process. The mudflats first described by H. Raffaele (1976, 1979) in the mid-1970's were, unknown to him, less than 20 years old. The area had already been altered by fill deposited for Central Park and the Puerto Nuevo docks (east and west side of the bridge, respectively) when the Final Coastal Zone Management Plan was approved (1978). Almost the entire northeastern spit was removed by the 1987 Martín Peña dredging, yet the spit appears to have rebuilt through consolidation of fine sediments and mangrove colonization between 1987 and the present. The trees are already regenerating vigorously after weathering the 90+ mph winds of Hugo in September 1989, and the recently completed first maintenance dredging of Martín Peña channel has added new fine material on which more mangrove stands can be expected to grow. It seems reasonable to conclude that shoaling in this area has been a continual process, somewhat aided and accelerated by manmade fills, and that it will continue into the foreseeable future. Mangrove acreage (vegetated mudflats) is expected to increase, while unvegetated mudflat acreage is expected to decrease.

Tidal wetlands provide many benefits in addition to their wildlife habitat value. As noted, the mangrove trees are capable of extremely rapid growth, during which their extensive superficial root systems stabilize fine sediments and absorb some of the excess nutrients from the water column. Although pollution and high turbidities limit the fish nursery functions of these stands, they do export large quantities of particulate and dissolved organic matter to San Juan Bay and the nearshore Atlantic. Dense stems and pneumatophores serve as a strainer, settling coarse floating material out of channels and encouraging sedimentation. These mangroves are still foraging and resting habitat for many species of northern migrants, including warblers, waterthrushes, kingfishers, bitterns and rails.

**3.06 AIR QUALITY**. The western part of the metropolitan San Juan basin is a non-attainment area for particulates. The major causes of air pollution are two oil-fired electric generating plants (Palo Seco and Puerto Nuevo), personal and commercial motor vehicles emitting hydrocarbons, particulates and sulfur compounds, and marine-derived aerosols. Although the predominant trade winds blow strongly from the east during most of the year, periods of calm, downslope ("land breeze"), early morning winds and thermal inversions can cause episodes of moderate air pollution.

**3.07 WATER QUALITY.** The quality of water in the lower Puerto Nuevo has been described in reports of the Puerto Rico Environmental Quality Board (Lebrón et al. 1977) as poor. This waterway is in violation of local and federal standards for total and fecal coliform, turbidity and other parameters most of the time. As described in the 1980 Biological Assessment (Appendix A), several major storm sewers empty into either the Puerto Nuevo or Martín Peña channel. Runoff from the municipal landfill also reaches the river, as does storm drainage from the Matadero Industrial Park (drained by Margarita Creek).

**3.08. NOISE.** The entire length of the river and its tributaries lie in an area characterized by the high ambient noise levels typical of freeways, truck traffic, and urban life. Exceptions are upstream segments that pass through residential areas.

**3.09 HAZARDOUS AND TOXIC WASTE.** The San Juan municipal landfill is located on a site northwest of the curve of the Puerto Nuevo, south of Avenida Kennedy and north of the junction with Caño Martín Peña. At an earlier design stage it appeared that the project would cross a corner of this site. Realignment of the channel for hydraulic reasons allowed it to be routed to the southeast, away from the area. Although the municipality also used the triangular parcel across the river (the first disposal area, see GDM Plate S-2), preliminary investigations indicated that this site contains only clean material and concrete rubble. No areas known to contain hazardous and toxic waste are believed to lie under the project footprint, either in upstream or downstream reaches.

**3.10 COASTAL BARRIER RESOURCES.** Puerto Rico was added to the Coastal Barrier Resources System by the 1990 amendments to the Coastal Barrier Resources Act. No designated Coastal Barrier segments lie in the project area.

**3.11 PRIME AND UNIQUE FARMLAND SOILS.** Land use in the Rio Piedras/Puerto Nuevo drainage is dominantly residential/urban in character. No significant agricultural areas remain, although casual or backyard gardening may include production of small plots of bananas, plantains, root crops and minor fruits for family use.

**3.12 RECREATION.** Recreational opportunities along the river and its tributaries are limited to the large parks operated by the

University of Puerto Rico (the "Jardín Botánico" or Botanical Garden, on the Experiment Station Grounds south of Highway 1 in Río Piedras ward) and Puerto Rico National Parks Trust (Luís Muñoz Marín Park on Piñeiro Avenue in Hato Rey ward and Parque Central or Central Park in Santurce) and to neighborhood ball courts and paths. Bicycling is a popular activity, but it is perceived as somewhat dangerous on city streets with their heavy traffic, and generally undertaken only on holidays when traffic is light, or in specially escorted large groups. The two large parks noted above are presently separated by more than a mile of high speed highways and busy streets. Bike paths are a rarity in San Juan.

There is a large concentration of people living in the San Juan metropolitan area interested in bicycling for recreation or willing to use bicycles as a means of transportation. This group has grown in size and will continue to grow over the next quarter century (Puerto Rico State Comprehensive Outdoor Recreation Plan [SCORP]). In fact, many kinds of active outdoor activity have grown in popularity as people become more exercise-conscious. Biking, walking and jogging are activities that now generate a demand for developed paths or trails in excess of the available resources. The Puerto Nuevo project links the two large green areas of the University Experiment Station and Muñoz Marín Park, providing an unique opportunity for linkage and an alternate connector separate from vehicular traffic. The Puerto Nuevo Project Bicycle Path and Linear Park will be part of an overall system that will eventually stretch into old San Juan from a site south of the Botanic Gardens.

Recreational boating is another activity that has increased in popularity during the past decade in Puerto Rico. A problem in almost all areas is a lack of public boat launching facilities. This problem is especially acute in San Juan Bay, whose shoreline is basically taken up with commercial port facilities. A small boat ramp and associated parking facilities are proposed as part of Contract 1.

**4 ENVIRONMENTAL IMPACTS DUE TO THE PROJECT** Synopsis: a total of 20 acres of mangrove wetlands will be removed in the lower Puerto Nuevo and Margarita channels. The project will cross a parking area associated with the Hacienda San José site, which was assessed as significant, and archeological data recovery will be necessary at this site. Large sections of grassy or shrub-covered sloping banks will be replaced by concrete vertical-walled channels in upstream and midstream reaches. A linear park and bicycle path paralleling the channel improvements is planned in cooperation with the city of San Juan. This park will provide visual relief from the concrete walled channel and maintain wildlife corridors. Construction of the project will generate 7.5 million cubic yards of material. Contract 1 will generate 2.8 million cubic yards. Disposal areas have been designated for upstream stages. Dredged material generated under Contracts 1 and 2, in excess of that disposable on land and eligible for offshore disposal, after testing, will be deposited at the designated offshore disposal site. Material excavated during later stages will be deposited at Disposal Area 1 (Plate S-2) and Disposal Area 2 (Plate S-8). No lands containing toxic or hazardous waste are known to exist along the present project route, which does not intersect the sanitary landfill along the north shore of the Puerto Nuevo as earlier alignments threatened to do. The project will not significantly impact known threatened or endangered species or their habitat, prime or unique farmlands, coastal barriers, or significant estuaries. Mitigation for wetlands losses will be achieved by mangrove creation and enhancement along the tidal channel of the Puerto Nuevo, as well as adjacent to Disposal Area 2 (north of Caño Margarita).

**4.01 CULTURAL RESOURCES IMPACTS.** Cultural resources surveys found no significant resources in most of the areas examined intensively. The majority of land has either been disturbed by urbanization or sugar cane fields, or is too swampy. The State Historic Preservation Officer (SHPO) agreed with the assessment of significance for the Hacienda San José Site, which includes a nineteenth century sugar processing plant and old water filtration works. The standing structures of this site will not be affected, but there will be some impacts to the parking lot near the water works and to an adjacent diked area. Additional archeological surveys and data recovery will be necessary. A mitigation plan will be developed in consultation with the SHPO. Mitigation will be completed prior to construction, in compliance with the Archeological and Historic Preservation Act, as amended, and with Executive Order 11593.

**4.02 AESTHETIC IMPACTS.** As noted, replacement of vegetated earthen slopes of the existing channel by vertical-walled concrete or concrete-faced sheet pile structures could have a negative impact on the visual environment of the residential and public areas abutting the river. However, plans developed in cooperation with the Commonwealth Department of Natural Resources and the Fideicomiso de Parques Nacionales (P.R. National Parks Trust) call for construction of a linear park and bikeway, to become part of a network of linear parks stretching from south of the Botanic Gardens to Old San Juan. The cost-shared portion of the bikeway will follow the channel right of way from south of Highway 1 in the Agricultural Station to Parque Luís Muñoz Marín in Hato Rey. (Refer to GDM Plate R-1). Visual screening of the concrete channel will be provided with berms and ornamental vegetation. Large trees will be preserved wherever feasible.

**4.03 EFFECTS ON BIOLOGICAL RESOURCES.** No lasting significant impacts are expected on fish resources or wildlife of upland areas. As noted in Paragraph 3.03, species present are typical of urban and suburban areas. Existing fish fauna will be displaced to adjacent undisturbed areas during construction; but populations are expected to recover once structures are in place. The linear park and bikeway,to be planned and planted with suitable ornamentals, can become an asset to bird observation as well as the recreational life of the city. However, habitat for species requiring shallow banks, such as the native freshwater turtle, will diminish along the project route. Due to the highly urban character of all surrounding lands, this loss is considered insignificant.

Dredging will increase depth and frequency of flushing in the tidal reaches of the main river and the new Margarita channel. This should increase habitat for salt water and estuarine fish, and the greater volume of water in the channels should assist in flushing contaminants out of the system. Growth is expected to be rapid in the replanted mangrove strips, due to high nutrient availability.

**4.04 EFFECTS ON THREATENED OR ENDANGERED SPECIES.** The National Marine Fisheries Service provided a conditional concurrence with the Corps' determination of no effect on marine turtles due to proposed dredging or ocean disposal of dredged materials in an EPA approved offshore disposal site (Appendix A). However, some of the conditions under which concurrence was determined suggest that this agency may have assumed that hydraulic dredging would be the method for excavating the mouth of Puerto Nuevo channel. Dredging will be mechanical on this project. In the tidal section a clamshell or bucket dredge will operate from a barge. Upstream, dredging will be accomplished from channel banks, using the same type of equipment. Although no scientific data or observations suggest that sea turtles regularly or even occasionally enter the Puerto Nuevo River or Martín Peña channel (waters are dark, brackish and low in oxygen; turtles have not been observed in the river), mechanical dredging does not generally place sea turtles at risk. There is no mangrove root community or habitat in the Puerto Nuevo channel, since the water is nearly opaque and very low in dissolved oxygen, and mangrove roots cannot overhang the channel due to the presence of concrete bulkheads.

No significant impacts are expected on either the brown pelican or the yellow shouldered blackbird as a result of the proposed tidal channel widening, even though 16 acres of mangroves will be destroyed. The reason for the Corps conclusion of no significant impact is that present pelican use of the mangrove stands in question is low, and no blackbirds have been seen there since 1981. There is no designated critical habitat for either the pelican or the blackbird in San Juan Bay. The Puerto Rican population of brown pelicans nests on an offshore island near Vieques, and on some cays near La Parguera in southwestern Puerto Rico, but not in or near San Juan (Collazo and Klaas 1985). Although the mangroves at the river mouth were sometimes used by large groups of pelicans in the early 1980's, only a handful of birds appear to rest in the area at present. Existing mangroves were damaged in 1987 by channel widening and again in 1989 by Hurricane Hugo, and have not fully recovered their structure, although they are growing vigorously. Furthermore, pelican fishing in the channel immediately outside the Puerto Nuevo mouth is now somewhat impeded by the constant ferry traffic through the channel itself. The yellow shouldered blackbird apparently nested in these mangroves in the late 1970's, and one nest was found in 1980, but the bird has since disappeared from the area except as an occasional visitor. (J. Moreno, P.R. DNR, 1991 telcom.). Disappearance of the yellow shouldered blackbird as a nesting species from the north coast is not directly related to habitat changes in Martín Peña channel, since it was gone in 1983, when Department of Natural Resources biologists conducted extensive and intensive searches for birds and nests, during data collection for the ferry channel project (Díaz et al., 1983). The channel had not been altered in any way at the time of these surveys, but the birds were gone.

**4.05 EFFECTS ON WETLANDS.** No significant effects on riparian or floodplain wetlands are expected as a result of project construction. Basically, the Puerto Nuevo River and its major tributaries drain a basin that has been almost totally paved-over during the past half century. Adoption of a vertical-walled channel section allows the new channel to be built largely within the present course by deepening, rather than widening, the river's footprint. The few parklike areas along the river will remain or be enhanced. Tidal wetlands (mangroves) will be impacted, however. Planimetry over 1990 survey maps, spot checked against aerial photographs and by walkovers of doubtful areas, showed that 16 acres of mangroves will be cut away by channel widening planned under Contract 1, from the river mouth to the De Diego expressway bridge. An estimated 4 additional acres will be lost along the Margarita channel route and in the adjacent disposal area, under Contract 2. Due to constraints on channel width in the vicinity of the San Juan municipal landfill, about 16 acres of new mangroves can be created by planting or grading and planting, on the outside of the concrete panel bulkheads, allowing an on-site creation of about 16-18 acres for about 1:1 mitigation under the first contract. The estimate of 16 acres' impact during Contract 1 is a considerable reduction from the estimates cited in the FWS Biological Assessment (Appendix A). Four reasons for the decrease in mangrove area (and the present project's impact) are (1) some acreage of mangroves was lost from both the northeast and southwest banks of the Puerto Nuevo, north of Constitution Bridge, when the "Agua-Guagua" ferry route was dredged in Martín Peña channel; (2) the channel of the present project has been slightly realigned to the east, reducing impacts on existing mangrove wetlands on the north(west) bank upstream from Constitution Bridge; (3) it appears that the landfill itself has expanded into the mangroves somewhat on its southeast and south sides; (4) Margarita channel and parts of the old Puerto Nuevo River were cleaned by the municipality in the late 1980's. Some mangrove stands were cleared or reduced during this cleaning and grubbing.

It also appears that prior estimates of mangrove coverage may have been in error. Planimetry of the parcel north and west of Constitution Bridge, in Ports Authority property, showed an area (in mangroves and mudflats) of only 7.5 acres, not 7.5 ha as estimated in earlier documents.

During Contract 2, about 4 acres of mangrove wetlands will be removed to construct the new Margarita channel and its tie-in to the Puerto Nuevo estuary, and by deposit of dredged material over Disposal Site 2. Most of the rest of Disposal Site 2 was described by FWS in 1980 as "marginal" land dominated by a mix of wetland and upland species; this description still applies to most of the site, which supports a dense vegetation that includes exotic albizias, grasslands, leather ferns and other species. At the suggestion of the mitigation panel consulted in October, 1991, the area near the proposed disposal area (the "Rupert Armstrong" parcel) was examined. It was determined that a total of 14 acres are available for enhancement and replanting to mangroves. The mitigation plan proposed in this document (Appendix B) thus proposes to create a total of 30 acres of mangrove, to replace a total of 20.5 acres removed, in two stages. Under Contract 1, which will cover the main river channel up to the De Diego Expressway, 16 acres of mixed (white, black and red) mangroves will be destroyed. Replanting strips, illustrated in Plate S-2, will be to red mangroves downstream from the Constitution Bridge, white and black mangroves above this bridge, and black mangroves along the northwest bank upstream from the landfill. During Contract 2 the remaining mitigation acreage will be prepared and planted. Planting techniques and spacing are detailed in the mitigation plan (they vary, depending on the species planted). Standard monitoring requirements applicable to EPA-endorsed wetlands Individual Permits will apply: monitoring will be for five years, and achievement of 80% cover will denote success.

**4.06 EFFECTS ON AIR QUALITY.** No significant impacts on air quality should occur as a result of the project. Equipment operated by contractors will be in compliance with all federal and Commonwealth emissions standards.

**4.07 EFFECTS ON WATER QUALITY.** Dredging in the river channel will cause transient increases in suspended solids and turbidity, possibly leading to lowered dissolved oxygen levels. These parameters will return to without-project levels or improve slightly when the project is finished. Deepening and widening of the channel will increase tidal flushing of the estuary.

Contractors will be required to comply with all applicable federal and Commonwealth Water Quality Regulations, including preparation of a Plan for Control of Erosion and Sedimentation (Plan CEST).

Materials from the lower portion of the Rio Puerto Nuevo and the Margarita Canal are designated for offshore disposal in the San Juan Ocean Dredged Material Disposal Site (ODMDS). The San Juan ODMDS is a designated ODMDS located approximately one-and-one-half miles offshore from San Juan Harbor. Though most of the material planned for disposal is virgin material and should present no problems, testing conducted in 1988 under the 1977 "Green Book", was not conclusive for all stations. Test results at some stations may be a reflection of poor testing procedures. EPA expressed concerns about the suitability of the material for ocean disposal that were not resolved. Retesting of the material, under the 1991 "Green Book", began with field collections conducted in November 1991. This effort has been coordinated with EPA Region II. Based on the results of the retesting, concurrence from EPA for ocean disposal of all, or acceptable portions, of this dredged material will be sought in early 1992.

Since most of the material to be removed from the river bottom and sides in upstream areas is virgin material, most samples are expected to present no problems. No known contaminated areas occur along upstream reaches of the project. Should new information concerning such areas arise, testing will be conducted according to applicable regulations.

Water Quality Certification will be requested from the Commonwealth of Puerto Rico. The Corps has reviewed the WQC criteria and Standards and is coordinating the project with PR EQB. All present indications are that certification will be granted. When the mitigation plan is accepted and material sampling results are available, sufficient information will be available to allow for application for a Water Quality Certificate.

**4.08 EFFECTS ON AMBIENT NOISE.** The noise level along many reaches of the river and its tributaries is already rather high. This is especially true in the reaches covered under Contracts 1 2. No special noise abatement precautions are believed necessary in areas where no residences occur, as is true of the river downstream of the Las Américas bridges. However, in residential areas all applicable regulations of the Environmental Quality Board regarding maximum noise levels and hours of operation will be strictly followed.

**4.09 IMPACT ON TOXIC AND HAZARDOUS WASTE SITES.** Preliminary concerns with this item centered on the possibility of excavating material buried in the sanitary landfill adjacent to the lower reaches of the river. Initial design documents showed the excavation cutting through the landfill significantly at one bend in the alignment. Design changes were made that eliminated a great deal of this problem even though the design changes were not made specifically for HTW consideration. Review, to date, on information from the upper reaches of the project indicates that modifications will be made primarily within the confines of the existing channel boundaries. No information has been found that shows areas that may contain or may have been contaminated with hazardous and toxic wastes.

**4.10 IMPACT ON COASTAL BARRIERS.** Puerto Rico was added to the Coastal Barrier Resources System by amendment to the Coastal Barrier Resources Act in October of 1990. No designated Coastal Barrier Reserves occur along the project.

**4.11 IMPACT ON PRIME AND UNIQUE FARMLAND.** The entire watershed of the Puerto Nuevo and its five major tributaries, except for the wetlands at the estuary, is densely populated commercial, industrial and residential land. There is essentially no agricultural potential for lands in this drainage, except for small plots, parks and backyard gardens.

**4.12 RECREATIONAL DEVELOPMENT.** The bikeway plan is described in detail in Chapter N (Recreation) of the General Design Memorandum, and Figure R-1 shows the proposed bikeway route. The Puerto Nuevo bicycle path and linear park will be a major link in the bicycle and linear park system being planned as part of the 500th anniversary celebration of the discovery of the Americas in 1992. The Department of Natural Resources has committed to this flood control project and has signed a letter of intent to cost share in its completion. Completion of the bikeway system will greatly improve biking opportunities and safety in metropolitan San Juan.

The proposed boat ramp will be located near the Martín Peña channel junction with the Río Puerto Nuevo channel. It will be located on land currently operated as a park by the National Parks Trust (Parque Central) and designated for future regional park development. The ramp will be included in the north floodwall channel construction contract, although the parking lot development will not occur until some time in the future. This will avoid the necessity of cutting through the channel wall in order to connect the ramp, and avoid destruction of mangroves to be planted shoreward of the channel bulkheads. Parking is currently available at other sites in Parque Central. The ramp will face downstream, towards the bay, and be 16 feet wide. An existing ball field in the area will be partly removed by channel widening, and the ramp will provide another form of recreational opportunity.

**5 ENVIRONMENTAL COMMITMENTS.**

The Corps and contractors commit to avoiding, minimizing or mitigating for adverse effects during construction activities by including the following commitments into the project contract specifications:

(1) To avoid any potential impact to marine turtles at the offshore disposal site, the Contractor will conduct a short information program for its employees regarding pertinent aspects of sea turtle protection. This program will include appropriate materials to familiarize all employees involved in offshore disposal with sea turtles, habits, endangered status, and associated penalties. The contractor will instruct all personnel associated with the project about the presence of endangered turtles and the need to avoid collisions with them.

(2) Dredge personnel and Corps dredge inspectors will post a lookout on vessels when operating near or in the Offshore Disposal Area to aid in locating sea turtles. All personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing any endangered species which are protected under the Endangered Species Act of 1973, as amended, and the Marine Mammal Protection Act of 1972.

(3) There are no known recent observations to suggest that yellow shouldered blackbirds presently use the mangroves in the vicinity of the Puerto Nuevo River estuary. A final survey be conducted during the winter '91-92 nesting season. If nesting birds are found, consultation will be re-initiated immediately with the Boquerón Field Office, U.S. Fish and Wildlife Service.

(4) Detailed archeological survey and recovery operations will be conducted in the parking lot area of the Water Filtration Plant site prior to beginning construction on this river segment.

(5) A mangrove mitigation plan (Appendix B) is being circulated with this Environmental Assessment and General Design Memorandum. This mitigation plan has been sent to all cooperating resource agencies. The Corps is committed to seek complete replacement of mangrove functional values on the project. Mitigation will be entirely or mostly on site, will be by creation or restoration of mangroves and it will involve grading to no more than +0.4 foot msl. Planting will be as follows: red mangroves on 1 m centers north of Constitution Bridge and around Parque Central; black and white mangroves (broadcast sewn) along the Puerto Nuevo above the Martín Peña junction; white and black or black mangroves near Margarita Creek and the Rupert Armstrong parcel. Monitoring will continue for five years and 80% survival on the red mangroves; full canopy closure will be required for the black/white mangrove plantings. A total of 30 acres of mangrove wetlands is proposed for creation or enhancement.

## 6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

**6.01 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 AS AMENDED (NEPA).** A Draft Environmental Impact Statement was circulated in 1984. The Final EIS was filed in December, 1985. The project was authorized in the Water Resources Development Act of 1986. An EPA letter of January 1986 requested that the Corps re-visit the mitigation plan during the design phase; more specifically, that the feasibility of constructing mudflats for mitigation be examined, and that the Corps look for alternatives to preservation of the Constitution Bridge west parcel to reach 1:1 replacement of wetlands functions. This Environmental Assessment updates project environmental compliance; it includes a new wetlands mitigation plan that does not count preservation of the west parcel as part of the mitigation, and discusses post authorization changes in the project and the natural and man-made environment. The EPA's request for consideration of mudflat creation has been addressed: the mudflats, removed during channel widening for the ferry project in 1987, have been replaced by created mudflats at a site immediately to the east. No additional space is available near the project. The present project will not destroy mudflat acreage.

**6.02 ENDANGERED SPECIES ACT OF 1973 AS AMENDED (ESA).** Informal consultation was initiated with the U.S. Fish and Wildlife Service on June 13, 1991, and continues to the present. The service has identified two listed avian species, the brown pelican and the yellow shouldered blackbird. The Service made the following comments:

Comment A): Mangrove areas will be eliminated by the project, areas used for roosting by the brown pelican, a species designated endangered in Puerto Rico; please provide more information.

Response: as noted in Paragraph 4.04, pelican use of the Martín Peña channel mouth has sharply decreased since 1980. Among probable causes are (1) increased boat and passenger ferry traffic through the area; (2) Small size and narrow branch diameter of outermost branches, due to hurricane breakage that occurred in 1989; (3) possible movement of the entire roosting group to another site, after serious disturbance during the 1987 dredging and channel widening. Brown pelican use of this area now appears casual, at most. The Corps expects no significant disturbance to pelicans to occur as a result of construction in Contract 1. The existing ferry traffic through Martín Peña channel is probably a more significant disturbance factor, since it interferes with pelican fishing at the river mouth. Since pelicans no longer fish here in large numbers, the roost has decreased in size. Only five birds were observed near the mangroves in December 1991.

Comment B): The yellow shouldered blackbird has been reported from the area. These mangroves have already been impacted by the Agua-Guagua waterway project. The mangroves in the lower Martín Peña channel have already been impacted by the navigational channel bulkhead. We would like to know if the Corps plans to use the existing bulkheaded navigation channel, or will it eliminate the current bulkhead and cause further impacts.

Response: a major search was conducted for the Yellow shouldered blackbird in the Martín Peña-Puerto Nuevo mangroves in 1982-83, when the Puerto Rico Department of Natural Resources prepared a Biological Assessment for the Commonwealth Public Works Department's Agua-guagua project (Díaz et al. 1983). Not a single nest was seen, although active nests had been found as late as 1980. Several censuses since 1983 have not found either birds or nests. The YSBB can be seen occasionally almost anywhere on the island; small flocks have been sighted several times in Piñones Forest, east of San Juan. After consulting with J. Moreno, DNR Endangered Species Coordinator, in November 1991, the Corps has concluded that it is extremely improbable that blackbirds still nest in or even frequent these mangroves. However, a survey for blackbirds nesting or utilizing the mangroves could be carried out during the 1992 winter nesting season. A short survey by a Corps biologist in December, 1991 spotted no blackbirds either in the mangroves or in the Central Park palm grove. The same type of bulkhead installed for the Martín Peña channel will be used; the north bank of the combined channel will be widened, requiring removal of the old bulkhead (refer to GDM Plates S-2 and S-20) and installation of new piles and panels. Existing bulkheading along the south bank will remain undisturbed.

C) In order to ... evaluate the impacts of the project, (the Service) requests that the Corps provide . . . a map which includes areas designated for mitigation, a copy of the mitigation plan, and the total area of mangrove habitat that will be eliminated by the proposed bulkhead.

Response: as requested, the mitigation plan (Appendix B) is new; it reflects the Service's request, initially made verbally at an October 1, 1991 coordination meeting held at the Puerto Rico Department of Natural Resources in San Juan, that the Corps re-planimeter impacts, examine the potential for on-site planting or restoration of mangrove wetlands, and prepare new maps. Structure Plates S-2 and S-8 show mangrove replanting areas in plan view. The Corps intends to continue close coordination with FWS Caribbean Field Office personnel until a mitigation plan satisfactory to all is achieved. However, the Corps notes that project mangrove impacts have decreased in comparison to earlier estimates. As documented here and in the Mitigation Plan (Appendix B), the concrete king pile and panel bulkhead system like the one used in the Martín Peña Channel dredging will be used as far upstream as possible in the Puerto Nuevo channel.

Existing pile and panel bulkheads on the west side of the joint channel will remain.

There are several hundred acres of existing mangrove wetlands available as blackbird habitat islandwide, while the blackbird population capable of exploiting this habitat remains largely restricted to southwest Puerto Rico. According to the appended mangrove mitigation plan, the restored and replanted mangroves (30 acres) should be mature well in advance of any conceivable recovery of the blackbird from its present population numbers, even under the most favorable circumstances.

The National Marine Fisheries Service was consulted on impacts to marine turtles at the ODMDS site. A Biological Assessment and determination of no significant adverse effects were submitted to NMFS in July of 1991. A letter of conditional concurrence was received on September 12, 1991 (Appendix A). The Corps will implement appropriate precautionary measures to avoid any adverse impact on sea turtles at the ODMDS site.

Conditions for NMFS concurrence included in their letter include the following, however, which appear not applicable to the Puerto Nuevo project:

> " 5) Sea turtles occasionally feed on organisms attached to mangrove roots. Construction personnel will also be educated on the importance and value of preserving intact the mangrove habitat during construction. Mangroves are especially valuable because they function as nursery areas for desirable species targeted by both recreational and commercial fisheries. Every attempt shall be made to minimize construction impacts on the mangrove ecosystem."

Response: Sea turtles do not occur in the Puerto Nuevo River, either above or below its junction with Martín Peña channel. This information was provided by the FWS Boquerón Field office and by the Puerto Rico DNR Endangered Species Coordinator (FWS meeting on 9 December, 1991; PRDNR-Corps telcom on 21 November, 1991). The Corps recognizes the need to minimize project impacts on mangroves and mitigate for mangrove acreage unavoidably lost due to the channel widening in the EIS. These impacts are discussed in Paragraph 4.05 of this Assessment and in the Mangrove Mitigation Plan, Appendix B. However, since red mangrove is no longer the dominant species in the channel, trees are further isolated from the channel behind a bulkhead, and channel waters are dark, turbid and low in oxygen, there is no "mangrove root community" to be protected.

> 6) If hopper dredges are used in Section 1, they shall not be used south of the confluence of the Martín Peña Canal with Río Puerto Nuevo, or south of the northernmost limit of the existing mangrove community."

Response: dredging will be strictly mechanical, by means of a bucket or clamshell mounted on a barge. The river is presently too shallow to dredge by any other means. There is no likelihood of dredge impact on sea turtles in the shallow, brackish and polluted river.

**6.03 FISH AND WILDLIFE COORDINATION ACT, AS AMENDED.** A Biological Assessment was prepared for the Environmental Impact statement. Re-coordination with FWS began in September, 1991. A Coordination meeting, primarily to discuss wetlands mitigation issues, was held in San Juan as discussed in Par. 6.02, above, on October 1, 1991. This meeting was attended by representatives of the Department of Natural Resources, Technical Guidance Division (representing the fish and wildlife management area of DNR), U.S. EPA Caribbean Field Office, FWS (Boquerón Field Office), and the Corps (Planning Division). Resource agency representatives urged that mitigation be re-examined, and that the new plan present an evaluation of project impacts, a discussion of the condition of existing stands, and a detailed description of mitigation proposed. The condition of existing stands of mangroves along the river was assessed in terms of species dominance, structure, wetlands function and wildlife habitat value. Based on this group assessment, a mitigation ratio of 1.5:1 was recommended, on the understanding that 5-10 years would be required to reach full canopy closure and habitat value for the newly created stands, and that some residual loss of function was likely, because circulation or sheet water flow would be somewhat restricted behind the bulkheads.

The mitigation plan now described in this document and Appendix B reflects a projected loss of 20 acres of mixed mangrove and black mangrove stands; replacement by 30 acres of planted mixed and black mangroves stands is proposed. In comparison to the old mitigation plan, the preservation component, while still implicit (the west Constitution Bridge stand will not be altered or impacted), is not claimed as mitigation. At least 16 acres of mangroves can be planted directly behind the bulkheaded areas along the Puerto Nuevo channel in Contract 1; an additional 14 acres will be created north of and adjacent to the Margarita Channel during Contract 2. The mudflat mitigation area east of the original mudflats has been visited and documented photographically. Full replacement of mudflats (impacted by another project) has already been achieved, and there appears to be no additional space available in the Anegado area to create more without interfering with small boat or ship navigation.

**6.04 ARCHEOLOGICAL AND HISTORIC PRESERVATION ACT, AS AMENDED.** The project will be in full compliance with this law, and with Executive Order 11593, prior to construction. A mitigation plan will be developed in consultation with the SHPO, for archeological data recovery in the identified significant site.

**6.05 CLEAN WATER ACT OF 1972, AS AMENDED.** The project will be in full compliance with the Clean Water Act and Puerto Rico's Water Quality Standards Regulation, as amended, when a water quality certificate is received from the Puerto Rico Environmental Quality Board. The Corps is coordinating the project with EQB. A Certificate will be applied for when the mitigation plan is accepted and material sampling results are available. All present indications are that certification will be granted.

**6.06 CLEAN AIR ACT OF 1972, AS AMENDED.** The Corps and its contractors will comply with all provisions of this law and Commonwealth of Puerto Rico Environmental Quality Board, Air Quality Division. No permits will be required for this project. Full Compliance will be achieved with receipt of comments on this EA from the U.S. Environmental Protection Agency.

**6.07 COASTAL ZONE MANAGEMENT ACT OF 1972, AS AMENDED.** The project was evaluated in accordance with Puerto Rico Planning Board guidelines for federal projects in the coastal zone of Puerto Rico, pursuant to Puerto Rico's approved Coastal Zone Management Plan and determined to be consistent with this Plan. This project will impact mangroves in an area proposed for Natural Reserve status in the CZMP. The CZMP also recognizes coastal flood hazards as an area of serious government concern. The Puerto Nuevo project is an approved flood control project of the government of Puerto Rico, as reflected in the Master Flood Control Plan of 1989 (PR DNR, 1989). As such, it has already been reviewed in concept by government agencies administering the CZMP in Puerto Rico (P.R. Planning Board and P.R. DNR). The alignment chosen for the channel mouth is the one that preserves the maximum unaltered mangrove acreage (the western stand is not touched).

**6.08 FARMLAND PROTECTION POLICY ACT OF 1981.** No prime or unique farmland will be impacted by implementation of this project. This Act is not applicable. Land use in the Puerto Nuevo basin is overwhelmingly urban-commercial and residential.

**6.09 WILD AND SCENIC RIVER ACT OF 1968, AS AMENDED.** This law is not applicable. There are no designated Wild and Scenic river reaches in Puerto Rico.

**6.10 MARINE MAMMAL PROTECTION ACT OF 1972, AS AMENDED.** No hydraulic dredging is projected for any stage of this project. No impacts on species protected under this law are likely. Therefore, this project is in compliance.

**6.12 FEDERAL WATER PROJECT RECREATION ACT, AS AMENDED.** The principles of the Federal Water Project Recreation Act (PL 89-72) as amended, have been fulfilled by complying with the recreation cost sharing criteria.

**6.13 RESOURCE CONSERVATION AND RECOVERY ACT OF 1976.** Information presently available indicates that no items regulated under this law are either proposed for disposal or affected by this project.

**6.14 TOXIC SUBSTANCES CONTROL ACT OF 1976.** Information presently available indicates that no items regulated under this law are either proposed for disposal or affected by this project.

**6.15. EXECUTIVE ORDER #11990, PROTECTION OF WETLANDS.** Twenty acres of mangrove wetlands will be affected by the project (most will be converted to open water channels; about 3.5 acres, located in Disposal Area 2, will be converted to uplands). A Wetlands Mitigation Plan providing for the creation of 30 acres of mangroves by grading and replanting lands adjacent to the channel and disposal site is included in GDM Appendix B. The Río Puerto Nuevo Project is water-related; the present plan and channel alignments reflect the smallest possible mangrove wetlands impact consistent with providing 100 year flood protection, and provide for protection of the highest-value remaining mangrove stand near the river mouth (the Consitution Bridge West parcel). This project is in compliance with the goals of the above Executive Order.

**6.16 EXECUTIVE ORDER #11988, FLOODPLAIN MANAGEMENT.** Most of the channel alterations that form the essence of this project will occur in the flood plain of the Puerto Nuevo/Río Piedras. This floodplain is sited at the core of the developed San Juan metropolitan area. The purpose of the project is not to make additional areas available for development, since no such areas exist along the project route, but rather to avoid serious and recurring damage to developed properties and hazard to human safety as a result of floods along the river. This project is in compliance with the goals of the above Executive Order.

**6.17 MARINE RESEARCH, PROTECTION AND SANCTUARIES ACT.** Sampling of proposed dredged material for retesting to determine compliance with MRPSA was accomplished in November 1991. The Corps is working closely with the U.S. Environmental Protection Agency (EPA) to ensure that the material is adequately tested and fully suitable for ocean disposal. Following completion of sediment testing, a Section 103 Evaluation Report will be prepared.

**7 COORDINATION.** This proposed project is being coordinated with the following agencies: U.S. Fish and Wildlife Service; National Marine Fisheries Service; State Historic Preservation Officer; Environmental Protection Agency; Puerto Rico Department of Natural Resources, Puerto Rico Environmental Quality Board. This document will be circulated for public review prior to its preparation as a Final Environmental Assessment. The Wetlands mitigation plan has been provided as a draft to the following cooperating agencies: Puerto Rico Department of Natural Resources, Technical Guidance Division (Research Area) and Design Division, Flood Control Area; U.S. EPA, Water Division, San Juan Field Office and Wetlands Branch Region II; U.S. Fish and Wildlife Service, Boquerón Field Office, Puerto Rico; National Marine Fisheries Service, Environmental Branch, Panama City.

Endangered species coordination is ongoing. Conditional concurrence on the Corps determination of no impact on endangered marine turtles has been received from NMFS. The Corps has received information from FWS and the Puerto Rico Department of Natural Resources that suggests that NMFS conditions for dredging are probably unnecessarily strict, since turtles are absent from the project dredging site. Coordination under both ESA and the Fish and Wildlife Coordination Act is ongoing. A preliminary draft of this EA and Mitigation Plan has been provided to the FWS Boquerón Field Office.

Coordination with the SHPO is ongoing. Recovery of cultural materials from historically significant sites will be completed prior to project construction.

8. **PUBLIC INVOLVEMENT.** A series of public meetings and hearings was held on the Environmental Impact Statement previously circulated for this project. This Draft Environmental Assessment is being circulated for a thirty (30) day public review. Comments will be incorporated into the Final EA as Attachment B.

9. **LIST OF PREPARERS.** This EA was prepared by : Barbara Cintrón, Biologist and principal author; USACE; Robert Pennington, Biologist, USACE; Annon Bozeman, Recreation Planner, USACE; Rona Mazer, Anthropologist, USACE; James Mc Adams, Environmental Engineer, USACE.

This DEA was reviewed by: Gerald Atmar, Chief, Environmental Studies Section, USACE;Rona Mazer, Chief, Environmental Resources Section, USACE; Hanley Smith, Chief, Environmental Resources Branch, USACE.

## 10. REFERENCES

Cardona, Julio E. and M. Rivera. 1988. Critical Coastal Wildlife Areas of Puerto Rico. Puerto Rico Department of Natural Resources, Research Area, Wildlife Section. Report for the Coastal Zone Management Program (Task 7.3). 84 pp., maps.

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Rathbun, G., T. Carr, N. Carr and C.A. Woods. 1985. The distribution of manatees and sea turtles in Puerto Rico, with emphasis on Roosevelt Roads Naval Station. Draft Report prepared by the U.S. Fish and Wildlife Service and the Florida State Museum for the Atlantic Division, Naval Facilities Engineering Command, Norfolk, Va.

## 11. ATTACHMENTS

1. **ATTACHMENT A.** Coastal zone consistency determination.

## ATTACHMENT A

Certification of Consistency with the Puerto Rico Coastal Management Program

Name of Federal Agency: Department of the Army
Jacksonville District Corps of Engineers

Federal Program Catalog Number:

Type of Action: Federal Activity (Flood Control)

Name of Applicant: Jacksonville District Corps of Engineers

Address: P.O. Box 4970, Jacksonville, Fl. 32232

Physical Description of Project Location: (Please refer to the attached General Design Memorandum): Río Puerto Nuevo Drainage, including parts of Guaynabo and San Juan Municipalities.

Type of construction proposed: Channel improvements to the lower 11.2 miles of the Río Puerto Nuevo and Rio Piedras and five tributary streams, as described in the accompanying General Design Memorandum and Environmental Assessment. Protection would be provided against 100-year floods. Excavation will be by mechanical dredging from a barge or from the bank.

Natural, artificial, historic or cultural systems likely to be affected by the project: Paragraph 60 of the GDM and Ch. 4 of the Environmental Assessment summarize impacts. Biological and cultural resources surveys have been carried out. An agreement has been made between the SHPO and the Corps to recover any cultural materials located in areas identified as significant, before project construction begins. The project will impact a parking lot associated with one historic site, and will cause the removal of 20 acres of mangrove wetlands in the tidal portion of Río Puerto Nuevo and the combined Puerto Nuevo-Martín Peña channel. Wetlands mitigation proposed consists of grading and planting lands adjacent to the new channel: 16 acres of mixed mangrove stands will be created during the first stage (replacing 16 acres to be destroyed by dredging). At a later stage, an additional 4 acres will be impacted by dredging of the new Margarita channel and use of a designated disposal site in Puerto Nuevo for dredged materials. Compensatory mitigation in lands adjacent to the channel and disposal site will cover 14 acres, and will include grading, channel cleanout and planting to black and white mangrove. Mitigation sites will be monitored for five years and 80% survival will be considered successful.

Other permits, approvals and endorsements from federal and Puerto Rican Government Agencies required: Refer to EA Chapter 6, Compliance with Environmental Requirements:

1. Water Quality Certificate ( EQB): Yes, pending.
2. Regulation and Permits Administration: No
3. Department of Natural Resources: yes (Local Cooperation Agreement; various Letters of Intent: The Puerto Rico Department of Natural Resources is the Co-Sponsor of this action).
7. State Historic Preservation Office Yes.
8. U.S. Army Corps of Engineers: not applicable
7. U.S. Coast Guard: No
8. Endangered Species Concurrence, Determination of No Impact(National Marine Fisheries Service: received September 12, 1991; Fish and Wildlife Service: Pending.
9. Other: Refer to EA Chapter 6.

**CERTIFICATE:** The U.S. Army Corps of Engineers certifies that the Rio Puerto Nuevo Flood Control Project is consistent with the Puerto Rico Coastal Zone Management Program to the maximum extent practical.

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**FIGURES**

100-YR RAINFALL HYETOGRAPH

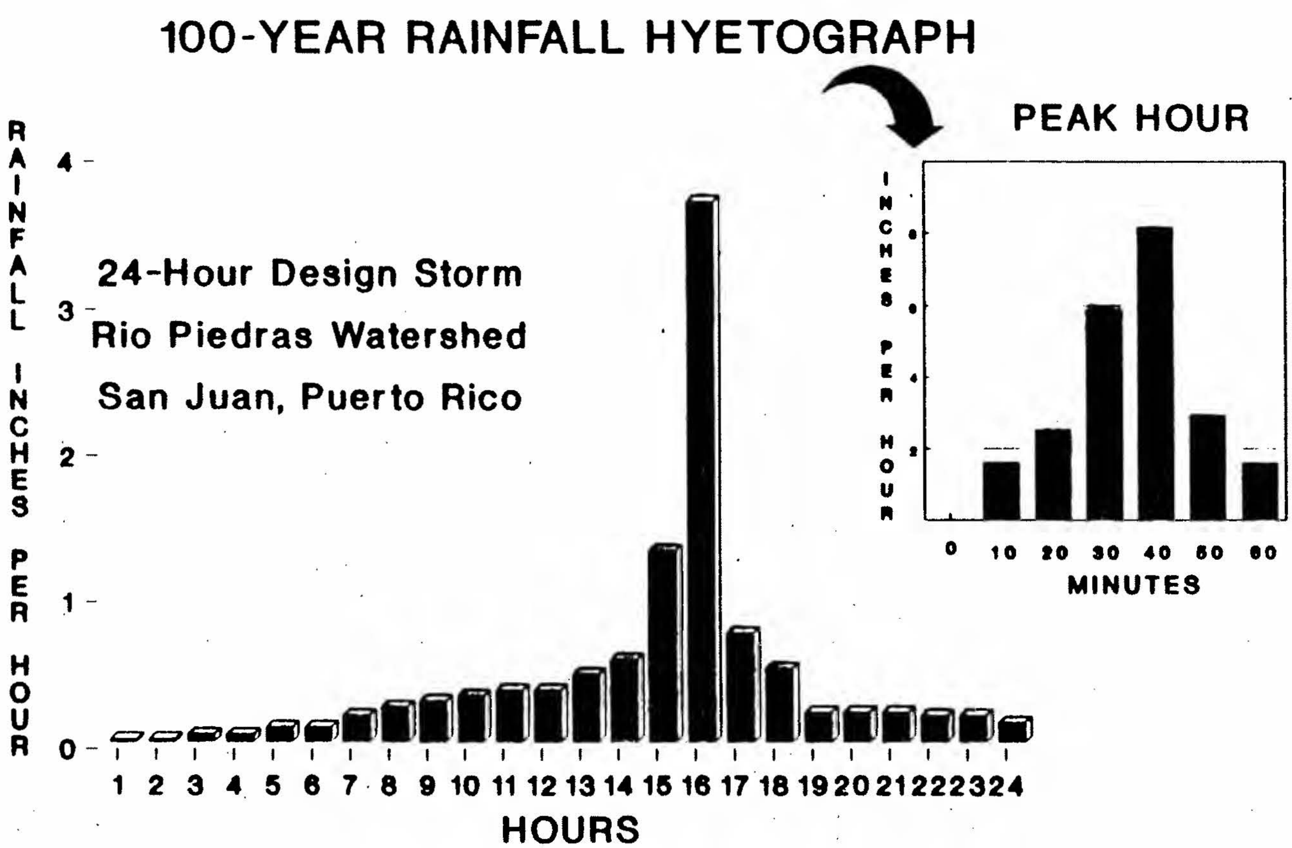
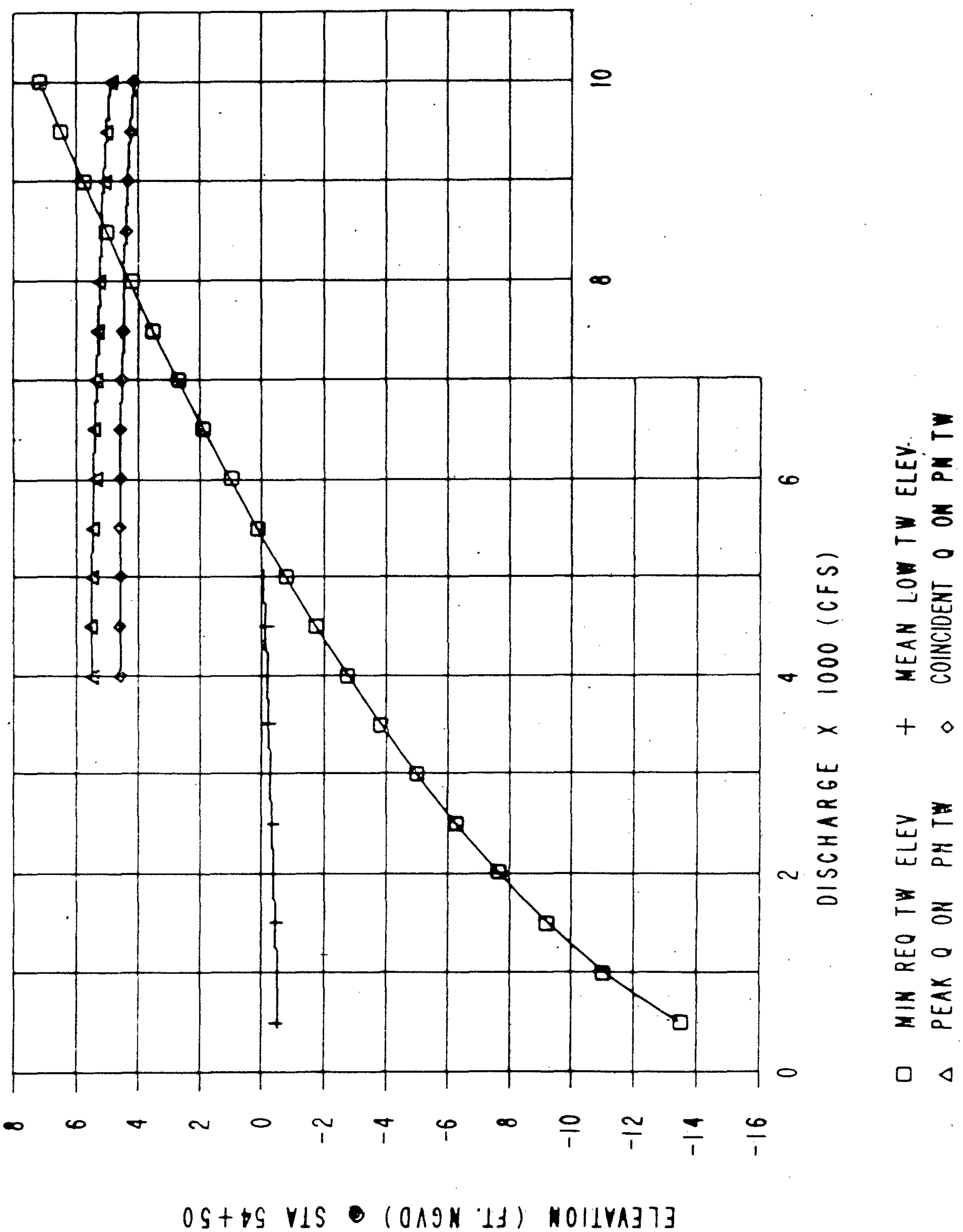
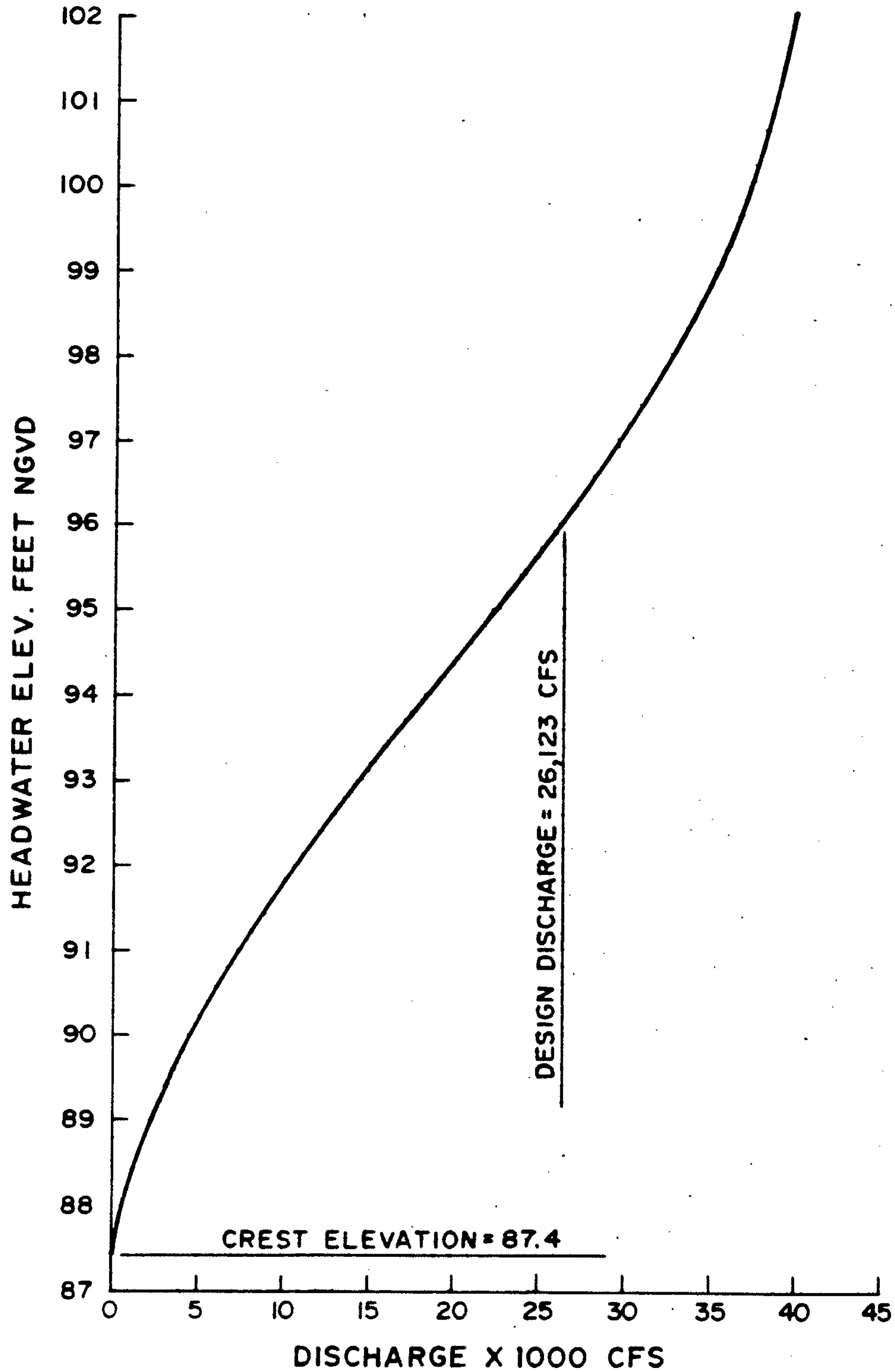



FIGURE 1




MARGARITA CHANNEL STILLING AREA
TAILWATER RATING CURVE

FIGURE 2



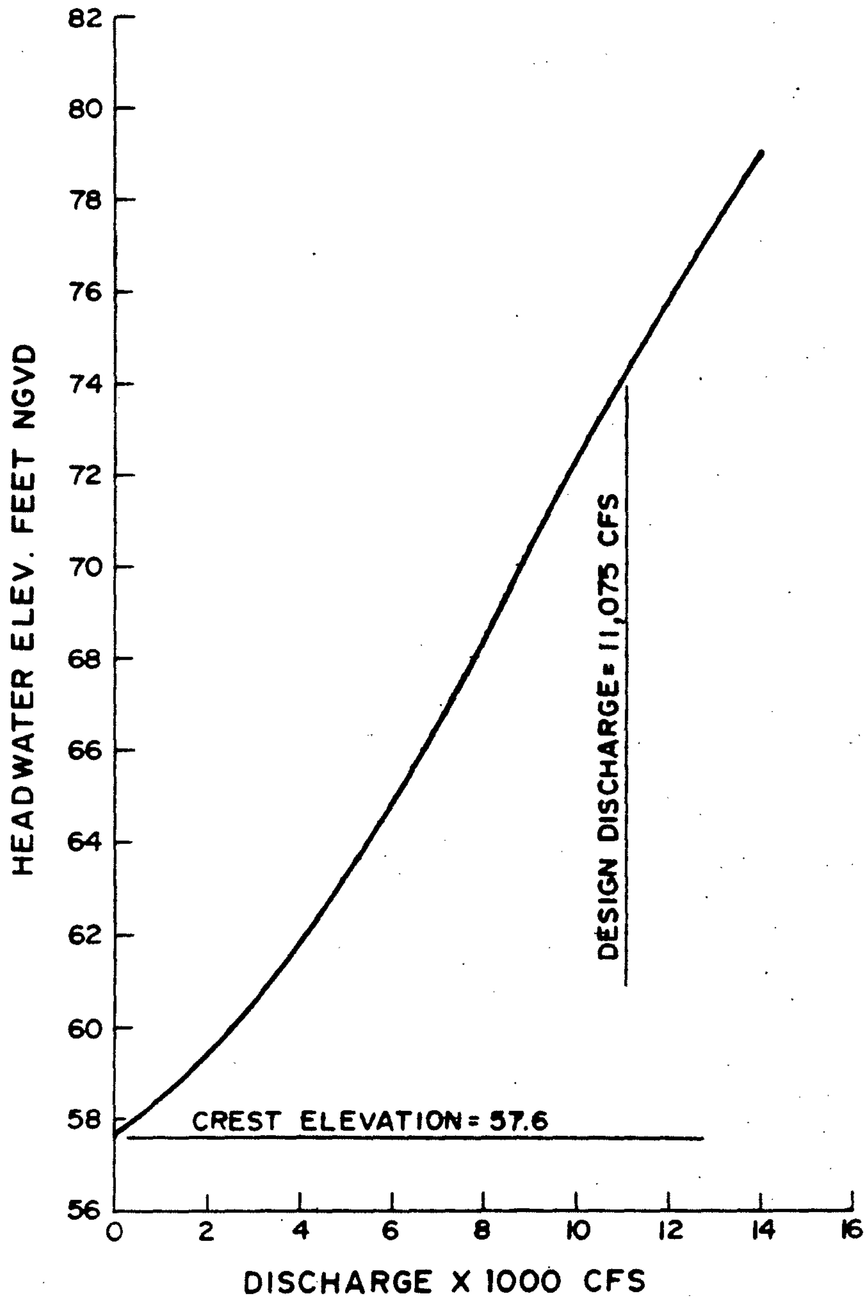

BASIS FOR DISCHARGE RATING

$Q = CLH^{3/2}$

U.S. DEEP WATERWAYS CURVE USED
FOR C REDUCTION FOR SUBMERGENCE

**PUERTO NUEVO**
**DEBRIS BASIN OUTLET**
**DISCHARGE RATING CURVE**

FIGURE 7




BASIS FOR DISCHARGE RATING

$Q = CLH^{3/2}$

U.S. DEEP WATERWAYS CURVE USED
FOR C REDUCTION FOR SUBMERGENCE

**GUARACANAL**
**DEBRIS BASIN OUTLET**
**DISCHARGE RATING CURVE**

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**TABLES**

TABLE 1

## PUERTO NUEVO MAIN CHANNEL MODEL
## SUB-BASIN PARAMETERS AND DISCHARGES

| SUB BASIN | AREA ACRES | LENGTH FT | BASIN (S) % | CN | LAG HRS | PEAK DISCHARGE IN CFS 10-yr | 25-yr | 50-yr | 100-yr | SPF |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4749 | 17167 | 10 | 95 | .55 | 18,492 | 21,750 | 23,420 | 24,397 | 26,926 |
| 2 | 320 | 4500 | 17 | 96 | .14 | 2,133 | 2,498 | 2,689 | 2,795 | 2,999 |
| 3 | 653 | 7667 | 17 | 96 | .19 | 4,012 | 4,701 | 5,060 | 5,260 | 3,649 |
| 9 | 1856 | 17060 | 16 | 96 | .41 | 8,429 | 9,889 | 10,644 | 11,075 | 12,028 |
| 11 | 429 | 5577 | 13 | 92 | .22 | 4,455 | 2,894 | 3,122 | 3,250 | 3,517 |
| 12 | 1210 | 15748 | 7 | 95 | .62 | 4,412 | 5,192 | 5,591 | 5,827 | 6,496 |
| 13 | 1158 | 16404 | 8 | 95 | .61 | 4,262 | 5,014 | 5,400 | 5,627 | 6,266 |
| 14 | 1133 | 13123 | 5 | 96 | .58 | 4,306 | 5,058 | 5,443 | 5,670 | 6,273 |
| 15 | 1178 | 9842 | 8 | 86 | .57 | 4,170 | 5,006 | 5,428 | 5,690 | 6,477 |
| 16 | 448 | 7218 | 3 | 95 | .51 | 1,816 | 2,135 | 2,299 | 2,394 | 2,628 |
| 17 | 410 | 8281 | 4 | 96 | .47 | 1,739 | 2,041 | 2,196 | 2,286 | 2,497 |
| 18 | 166 | 5578 | 2 | 96 | .53 | 663 | 779 | 839 | 873 | 960 |
| 19 | 710 | 10499 | 3 | 95 | .74 | 2,342 | 2,759 | 2,971 | 3,099 | 3,527 |
| 20 | 115 | 2625 | 2 | 92 | .34 | 558 | 662 | 708 | 740 | 806 |
| 21 | 237 | 3281 | 5 | 90 | .26 | 1,260 | 1,498 | 1,605 | 1,679 | 1,830 |
| 22 | 314 | 8202 | 6 | 88 | .52 | 1,193 | 1,425 | 1,539 | 1,612 | 1,807 |
| 23 | 448 | 7874 | 9 | 88 | .42 | 1,900 | 2,270 | 2,447 | 2,563 | 2,844 |
| 24 | 467 | 6000 | 2 | 97 | .51 | 1,909 | 2,238 | 2,408 | 2,506 | 2,744 |

TABLE 2

## PUERTO NUEVO TRIBUTARIES
## SUB-BASIN PARAMETERS AND DESIGN DISCHARGES

| SUB BASIN | AREA ACRES | LENGTH FT | BASIN (S) % | CN | LAG HRS | PEAK DISCHARGE IN CFS 100-yr | SPF |
|---|---|---|---|---|---|---|---|
| **QUEBRADA BUENA VISTA** | | | | | | | |
| 12A | 153 | 3100 | 4 | 95 | 0.22 | 1,167 | 1,258 |
| 12B | 66 | 3550 | 1 | 95 | 0.52 | 349 | 384 |
| 12C | 18 | 1200 | 1 | 95 | 0.20 | 143 | 154 |
| 12D | 114 | 3600 | 5 | 95 | 0.22 | 877 | 946 |
| **QUEBRADA JOSEFINA** | | | | | | | |
| 13A | 36 | 1950 | 2 | 95 | 0.20 | 286 | 308 |
| 13B | 53 | 2100 | 3 | 95 | 0.17 | 436 | 471 |
| 13C | 11 | 1000 | 1 | 95 | 0.22 | 87 | 93 |
| 13D | 50 | 2000 | 3 | 95 | 0.18 | 411 | 441 |
| 13E | 17 | 675 | 1 | 95 | 0.13 | 147 | 158 |
| 13F | 16 | 1700 | 4 | 95 | 0.13 | 140 | 150 |
| 13G | 39 | 1600 | 4 | 95 | 0.13 | 345 | 370 |
| 13H | 44 | 1800 | 3 | 95 | 0.16 | 377 | 405 |
| 18A | 98 | 2430 | 2 | 95 | 0.21 | 760 | 819 |
| 18B | 43 | 1880 | 1 | 95 | 0.27 | 307 | 332 |
| 18C | 12 | 1000 | 1 | 95 | 0.17 | 96 | 104 |
| 18D | 84 | 2470 | 2 | 95 | 0.29 | 583 | 630 |
| **QUEBRADA DONA ANA** | | | | | | | |
| 14A | 49 | 2320 | 2 | 96 | 0.21 | 384 | 414 |
| 14B | 11 | 1700 | 1 | 96 | 0.44 | 61 | 68 |
| 14C | 58 | 2625 | 2 | 96 | 0.25 | 425 | 461 |
| 14D | 32 | 2000 | 1 | 96 | 0.42 | 428 | 337 |
| 14E | 80 | 2780 | 3 | 96 | 0.24 | 597 | 643 |
| 14F | 20 | 1500 | 2 | 96 | 0.18 | 161 | 174 |

TABLE 3

## DESIGN DISCHARGES ON THE MAIN CHANNEL OF THE RIO PIEDRAS (PUERTO NUEVO)

| | 100-YEAR (cfs) | SPF (cfs) |
|---|---|---|
| **J.F. KENNEDY AVENUE (STATION 00+00)** | | |
| Peak Q at Constitution Bridge | 71,455 | 80,643 |
| **CONFLUENCE OF MARGARITA CHANNEL (STATION 20+80)** | | |
| Peak Q, upstream of junction | 59,446 | 66,830 |
| Coincedent Q, from the Margarita Channel | 11,162 | 12,592 |
| Peak Q, downstream of junction | 69,154 | 78,081 |
| Peak Q, form Margarita Channel | 11,162 | 12,592 |
| **CONFLUENCE OF JOSEFINA CHANNEL (STATION 35+00)** | | |
| Peak Q, upstream of junction | 44,932 | 50,290 |
| Coincedent Q, from Josefina Channel | 9,480 | 11,461 |
| Peak Q, downstream of junction | 56,351 | 63,303 |
| Peak Q, from Josefina channel | 10,585 | 12,424 |
| **CONFLUENCE BUENA VISTA (4200 CFS DIVERTED)** | | |
| Peak Q, upstream of Buena Vista Channel | 42,264 | 46,787 |
| Coincedent Q, from Buena Vista Channel | 872 | 1,437 |
| Peak Q, downstream of Buena Vista junction | 43,335 | |
| Peak Q, from Buena Vista Channel | 2,035 | 2,197 |
| Peak Q, if 100% of the flow would be diverted | 2,035 | 2,197 |
| **CONFLUENCE OF THE PROPOSED 4200 CFS PLAN FOR BUENA VISTA DIVERSION CHANNEL (STATION 57+20)** | | |
| Peak Q, upstream of B.V. Diversion junction | 37,929 | 42,381 |
| Coincedent Q, from B.V. Diversion | 4,335 | 4,406 |
| Peak Q, downstream of B.V. Diversion junction | 42,264 | 46,787 |
| Peak Q, from 4200 cfs Diversion Channel | 4,406 | 4,486 |
| Peak Q, if 100% of the flow would be diverted | 4,881 | 5,385 |
| **CONFLUENCE OF GUARA CANAL (STATION 76+96)** | | |
| Peak Q upstream of the Guara Canal junction | 26,123 | 29,585 |
| Coincedent Q from Guara Canal | 9,606 | 10,456 |
| Peak Q downstream of Guara canal | 35,162 | 39,082 |
| Peak Q on Guara Canal | 11,075 | 12,028 |

TABLE 4

| DESIGN DISCHARGES ON THE TRIBUTARIES OF THE RIO PIEDRAS (PUERTO NUEVO) | 100-YEAR (CFS) | SPF (CFS) |
|---|---|---|
| **MARGARITA CHANNEL** | | |
| Peak Q, at mouth & confluence with Rio Piedras | 11,162 | 12,592 |
| Coincedent Q on Rio Piedras | 59,336 | 60,011 |
| Peak Q at De Diego Avenue underpass | 10,585 | 11,952 |
| Peak Q at De Diego Expressway overpass | 9,620 | 10,866 |
| Peak Q, at the upstream end of the Margarita Project | 8,012 | 9,062 |
| **JOSEFINA CHANNEL** | | |
| Peak Q, at mouth & confluence with Rio Piedras | 10,585 | 12,424 |
| Coincedent Q on Rio Piedras | 30,685 | 34,255 |
| Peak Q at Avenida Pinero | 9,850 | 11,409 |
| Peak Q below Dona Ana junction | 9,376 | 10,826 |
| Peak Q above Dona Ana junction | 4,626 | 5,622 |
| Upstream end of Josefina Project, S.E. 31 st. | 4,063 | 4,815 |
| **DONA ANA CHANNEL** | | |
| Peak Q, at mouth & confluence with Josefina | 4,896 | 5,515 |
| Peak Q at De Diego Avenue | 4,038 | 4,516 |
| **LOWER BUENA VISTA CHANNEL** | | |
| Peak Q, at mouth before any diversion plan | 5,102 | 5,835 |
| Peak Q, at mouth after 4200 cfs diversion plan | 2,035 | 2,192 |
| Peak Q, downstream of the 4200 cfs diversion channel | 364 | 823 |
| Peak Q, upstream of the 4200 cfs diversion channel | 4,564 | 5,023 |
| **4,200 CFS BUENA VISTA DIVERSION CHANNEL** | | |
| Peak Q, at mouth & confluence with Rio Piedras | 4,406 | 4,486 |
| Coincedent Q, on Rio Piedras | 35,889 | 40,933 |
| Peak Q, at the upstream end of the diversion channel | 4,080 | 4,129 |
| **GUARACANAL** | | |
| Peak Q, at mouth & confluence with Rio Piedras | 11,075 | 12,028 |
| Coincedent Q, on Rio Piedras | 22,336 | 25,588 |

TABLE 5
SUPERELEVATION DATA
PUERTO NUEVO CHANNEL

Superelevation Formula Coefficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapezoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Rectangular | Spiral Transition | 0.5 |
| Rapid | Trapezoidal | Spiral Transition | 1.0 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
C = coefficient
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline
*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth
*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Spiral Unbanked *(3) feet | Length of curve banked 30* Y feet | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 338+04.3 | 0.5 | 72.6 | 13.95 | 338 | 25.80 | 0.65 | 6.53 | 68 | 64.0 | 19.5 | CURVE 24 | PT |
| 337+76.8 | 0.5 | 71.8 | 14.13 | 338 | 25.75 | 0.66 | 6.46 | 69 | 64.1 | 19.8 | CURVE 24 | PC |
| 332+95.8 | 0.5 | 60.0 | 17.83 | 325 | 24.42 | 0.91 | 5.40 | 97 | 69.4 | 27.3 | CURVE 23 | PT |
| 329+83.1 | 0.5 | 60.0 | 17.89 | 325 | 24.33 | 0.92 | 5.40 | 98 | 69.8 | 27.5 | CURVE 23 | PC |
| 326+35.8 | 0.5 | 60.0 | 17.97 | 1200 | 24.23 | 0.25 | 5.40 | 99 | 70.3 | 7.5 | CURVE 22 | PT |
| 325+37.5 | 0.5 | 60.0 | 18.00 | 1200 | 24.19 | 0.25 | 5.40 | 100 | 70.4 | 7.5 | CURVE 22 | PC |
| 319+74.9 | 0.5 | 60.0 | 18.15 | 1200 | 23.99 | 0.26 | 5.40 | 102 | 71.3 | 7.7 | CURVE 21 | PT |
| 319+51.1 | 0.5 | 60.0 | 18.15 | 1200 | 23.99 | 0.26 | 5.40 | 102 | 71.3 | 7.7 | CURVE 21 | PC |
| 288+33.9 | 0.5 | 60.0 | 19.85 | 1000 | 21.94 | 0.37 | 5.40 | 134 | 81.6 | 11.0 | CURVE 20 | PT |
| 282+20.5 | 0.5 | 60.0 | 20.78 | 1000 | 20.96 | 0.40 | 5.40 | 154 | 87.4 | 12.1 | CURVE 20 | PC |
| 279+97.6 | 0.5 | 60.0 | 21.34 | 500 | 20.41 | 0.85 | 5.40 | 166 | 90.9 | 25.5 | CURVE 19 | PT |
| 276+37.8 | 1 | 60.0 | 26.55 | 500 | 16.40 | 2.63 | 5.40 | 320 | 126.2 | 78.8 | CURVE 19 | PC |
| 263+28.2 | 1 | 78.0 | 24.57 | 750 | 10.87 | 1.95 | 7.02 | 538 | 186.4 | 58.5 | CURVE 18 | PT |
| 255+31.1 | 1 | 78.0 | 31.39 | 750 | 13.92 | 3.18 | 7.02 | 686 | 210.5 | 95.5 | CURVE 18 | PC |
| 255+31.1 | 1 | 78.0 | 31.39 | 1010 | 13.92 | 2.36 | 7.02 | 686 | 210.5 | 70.9 | CURVE 17 | PT |
| 248+66.6 | 1 | 78.0 | 30.28 | 1010 | 14.45 | 2.20 | 7.02 | 615 | 199.3 | 66.0 | CURVE 17 | PC |

TABLE 5 (cont'd)
SUPERELEVATION DATA
PUERTO NUEVO CHANNEL

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 242+19.2 | 1 | 83.0 | 28.03 | 1000 | 15.37 | 2.03 | 7.47 | 527 | 190.3 | 60.8 CURVE 16 | PT |
| 232+23.7 | 1 | 83.0 | 28.66 | 1000 | 15.20 | 2.12 | 7.47 | 557 | 195.7 | 63.5 CURVE 16 | PC |
| 214+89.9 | 1 | 88.0 | 27.93 | 750 | 15.30 | 2.84 | 7.92 | 557 | 201.5 | 85.3 CURVE 15 | PT |
| 212+15.2 | 1 | 88.0 | 27.03 | 750 | 15.95 | 2.66 | 7.92 | 501 | 191.0 | 79.9 CURVE 15 | PC |
| 209+33.8 | 1 | 88.0 | 27.44 | 600 | 15.71 | 3.43 | 7.92 | 524 | 195.4 | 102.9 CURVE 14 | PT |
| 208+02.6 | 1 | 88.0 | 27.59 | 600 | 15.62 | 3.47 | 7.92 | 533 | 197.0 | 104.0 CURVE 14 | PC |
| 204+85.4 | 1 | 102.0 | 27.87 | 450 | 14.82 | 5.47 | 9.18 | 664 | 236.8 | 164.0 CURVE 13 | PT |
| 200+56.9 | 1 | 102.0 | 28.09 | 450 | 14.71 | 5.55 | 9.18 | 680 | 239.6 | 166.6 CURVE 13 | PC |
| 193+18.4 | 1 | 102.0 | 28.29 | 1100 | 14.60 | 2.30 | 9.18 | 695 | 242.2 | 69.1 CURVE 12 | PT |
| 175+52.4 | 1 | 113.0 | 34.32 | 1100 | 8.18 | 3.76 | 10.17 | 2021 | 434.9 | 112.7 CURVE 12 | PC |
| 163+46.3 | 1 | 102.0 | 30.35 | 500 | 10.58 | 5.84 | 9.18 | 1103 | 305.2 | 175.1 CURVE 11 | PT |
| 158+02.3 | 1 | 102.0 | 22.83 | 500 | 15.81 | 3.30 | 9.18 | 418 | 187.8 | 99.1 CURVE 11 | PC |
| 132+27.8 | 1 | 180.0 | 13.42 | 600 | 23.66 | 1.68 | 16.20 | 170 | 159.3 | 50.3 CURVE 10 | PT |
| 130+33.2 | 1 | 180.0 | 13.43 | 600 | 23.65 | 1.68 | 16.20 | 171 | 159.4 | 50.4 CURVE 10 | PC |
| 124+23.8 | 1 | 180.0 | 13.45 | 600 | 23.62 | 1.69 | 16.20 | 171 | 159.8 | 50.6 CURVE 9 | PT |
| 122+07.7 | 1 | 180.0 | 13.45 | 600 | 23.61 | 1.69 | 16.20 | 171 | 159.8 | 50.6 CURVE 9 | PC |
| 118+46.5 | 1 | 180.0 | 13.62 | 890 | 23.32 | 1.17 | 16.20 | 178 | 162.8 | 35.0 CURVE 8 | PT |
| 113+51.7 | 1 | 180.0 | 14.48 | 890 | 22.81 | 1.32 | 16.20 | 206 | 175.0 | 39.5 CURVE 8 | PC |
| 107+90.7 | 1 | 180.0 | 14.69 | 890 | 22.49 | 1.36 | 16.20 | 215 | 178.8 | 40.7 CURVE 7 | PT |
| 100+16.3 | 1 | 180.0 | 14.87 | 890 | 22.22 | 1.39 | 16.20 | 223 | 182.1 | 41.7 CURVE 7 | PC |
| 93+13.94 | 1 | 180.0 | 16.31 | 600 | 20.22 | 2.48 | 16.20 | 294 | 209.4 | 74.4 CURVE 6 | PT |
| 88+83.22 | 1 | 288.0 | 9.34 | 600 | 22.11 | 1.30 | 25.92 | 141 | 183.5 | 39.0 CURVE 6 | PC |
| 74+32.50 | 0.5 | 470.4 | 7.20 | 1500 | 30.97 | 0.25 | 42.33 | 98 | 195.2 | 7.6 CURVE 5 | PT |
| 69+74.10 | 0.5 | 439.5 | 7.29 | 1500 | 30.77 | 0.24 | 39.56 | 94 | 185.3 | 7.3 CURVE 5 | PC |

TABLE 6
SUPERELEVATION DATA
MARGARITA CHANNEL

Superelevation Formula CoeFficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapizoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Rectangular | Simple Circular | 0.5 |
| Rapid | Trapezoidal | Spiral Transition | 1.0 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
C = coeficient
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline
*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth
*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Spiral Unbanked *(3) | Length of curve banked 30* Y | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86+81.38 | 1 | 30.0 | 26.03 | 265 | 10.26 | 2.38 | 2.70 | 246 | 78.2 | 71.5 | CURVE M6 | PT |
| 85+90.86 | 1 | 30.0 | 26.74 | 265 | 9.99 | 2.51 | 2.70 | 267 | 81.4 | 75.4 | CURVE M6 | PC |
| 75+75.06 | 1 | 30.0 | 24.57 | 210 | 10.87 | 2.68 | 2.70 | 207 | 71.7 | 80.3 | CURVE M5 | PT |
| 74+97.31 | 1 | 30.0 | 24.45 | 210 | 10.92 | 2.65 | 2.70 | 204 | 71.2 | 79.6 | CURVE M5 | PC |
| 67+26.44 | 1 | 30.0 | 23.88 | 200 | 11.18 | 2.66 | 2.70 | 190 | 68.7 | 79.7 | CURVE M4 | PT |
| 66+64.90 | 1 | 30.0 | 23.85 | 200 | 11.20 | 2.65 | 2.70 | 189 | 68.6 | 79.5 | CURVE M4 | PC |
| 62+64.48 | 1 | 30.0 | 23.84 | 200 | 11.20 | 2.65 | 2.70 | 189 | 68.5 | 79.4 | CURVE M3 | PT |
| 60+61.15 | 1 | 30.0 | 23.84 | 200 | 11.20 | 2.65 | 2.70 | 189 | 68.5 | 79.4 | CURVE M3 | PC |
| 58+35.00 | 1 | 30.0 | 23.84 | 200 | 11.20 | 2.65 | 2.70 | 189 | 68.5 | 79.4 | CURVE M2 | PT |
| 55+90.56 | 1 | 30.0 | 23.84 | 200 | 11.20 | 2.65 | 2.70 | 189 | 68.5 | 79.4 | CURVE M2 | PC |

TABLE 7
SUPERELEVATION DATA
JOSEFINA CHANNEL

Superelevation Formula Coefficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapezoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Rectangular | Spiral Transitions | 0.5 |
| Rapid | Trapezoidal | Spiral Transitions | 1.0 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
C = coefficient
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline
*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth
*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Spiral Unbanked *(3) feet | Length of curve banked 30* Y feet | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77+29.49 | 1 | 17.0 | - | 240 | - | - | - | - | - | - | CURVE J8 | PT |
| 75+70.63 | 1 | 17.0 | 25.95 | 240 | 8.84 | 1.48 | 1.53 | 161 | 47.6 | 44.4 | CURVE J8 | PC |
| 75+70.62 | 1 | 17.0 | 25.95 | 220 | 8.84 | 1.62 | 1.53 | 161 | 47.6 | 48.5 | CURVE J7 | PT |
| 73+69.29 | 1 | 19.0 | 24.08 | 220 | 8.88 | 1.56 | 1.71 | 154 | 49.2 | 46.7 | CURVE J7 | PC |
| 58+46.54 | 1 | 22.0 | 22.23 | 1000 | 8.77 | 0.34 | 1.98 | 154 | 53.0 | 10.1 | CURVE J6 | PT |
| 54+03.45 | 1 | 22.0 | 21.01 | 1000 | 9.41 | 0.30 | 1.98 | 128 | 48.3 | 9.0 | CURVE J6 | PC |
| 36+78.52 | 1 | 22.0 | 21.85 | 185 | 9.62 | 1.76 | 1.98 | 136 | 49.7 | 52.9 | CURVE J5 | PT |
| 34+77.72 | 1 | 22.0 | 22.32 | 185 | 9.42 | 1.84 | 1.98 | 145 | 51.3 | 55.2 | CURVE J5 | PC |
| 34+09.81 | 1 | 45.0 | 23.70 | 400 | 8.79 | 1.96 | 4.05 | 357 | 115.4 | 58.9 | CURVE J4 | PT |
| 28+53.18 | 1 | 45.0 | 24.67 | 400 | 8.53 | 2.13 | 4.05 | 399 | 121.9 | 63.8 | CURVE J4 | PC |
| 23+01.19 | 1 | 45.0 | 23.28 | 375 | 9.17 | 2.02 | 4.05 | 330 | 110.9 | 60.6 | CURVE J3 | PT |
| 21+39.55 | 1 | 45.0 | 23.75 | 375 | 8.99 | 2.10 | 4.05 | 351 | 114.3 | 63.1 | CURVE J3 | PC |
| 19+23.96 | 1 | 45.0 | 23.01 | 540 | 9.51 | 1.37 | 4.05 | 311 | 107.7 | 41.1 | CURVE J2 | PT |
| 17+33.76 | 1 | 45.0 | 23.71 | 540 | 9.23 | 1.45 | 4.05 | 340 | 112.6 | 43.6 | CURVE J2 | PC |

TABLE 8
SUPERELEVATION DATA
DONA ANA CHANNEL

Superelevation Formula Coefficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapezoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Rectangular | Spiral Transitions | 0.5 |
| Rapid | Trapezoidal | Spiral Transitions | 1.0 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline

*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth

*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Spiral Unbanked *(3) feet | Length of curve banked 30* Y feet | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44+56.36 | 1 | 22.0 | 26.62 | 250 | 6.89 | 1.94 | 1.98 | 281 | 71.6 | 58.1 | CURVE DA7 | PT |
| 43+61.4 | 1 | 22.0 | 26.20 | 250 | 7.01 | 1.88 | 1.98 | 268 | 69.8 | 56.3 | CURVE DA7 | PC |
| 41+34.14 | 1 | 22.0 | 25.34 | 100 | 7.22 | 4.39 | 1.98 | 243 | 66.5 | 131.6 | CURVE DA6 | PT |
| 41+28.82 | 1 | 22.0 | 25.41 | 100 | 7.22 | 4.41 | 1.98 | 244 | 66.7 | 132.3 | CURVE DA6 | PC |
| 27+98.57 | 1 | 22.0 | 23.78 | 1212 | 8.21 | 0.32 | 1.98 | 188 | 58.6 | 9.6 | CURVE DA5 | PT |
| 23+17.17 | 1 | 22.0 | 23.68 | 1212 | 8.52 | 0.32 | 1.98 | 180 | 57.2 | 9.5 | CURVE DA5 | PC |
| 20+06.93 | 1 | 22.0 | 23.30 | 1000 | 8.93 | 0.37 | 1.98 | 166 | 55.0 | 11.1 | CURVE DA4 | PT |
| 18+79.99 | 1 | 22.0 | 21.62 | 1000 | 9.92 | 0.32 | 1.98 | 129 | 48.4 | 9.6 | CURVE DA4 | PC |
| 16+67.26 | 1 | 22.0 | 23.23 | 325 | 9.24 | 1.13 | 1.98 | 160 | 53.9 | 34.0 | CURVE DA3 | PT |
| 15+13.70 | 1 | 22.0 | 23.81 | 325 | 9.01 | 1.19 | 1.98 | 172 | 56.0 | 35.8 | CURVE DA3 | PC |
| 13+18.72 | 1 | 22.0 | 24.27 | 250 | 8.84 | 1.61 | 1.98 | 182 | 57.6 | 48.3 | CURVE DA2 | PT |
| 12+21.30 | 1 | 22.0 | 24.41 | 250 | 8.79 | 1.63 | 1.98 | 185 | 58.1 | 48.9 | CURVE DA2 | PC |
| 5+30.83 | 1 | 22.0 | 23.13 | 250 | 9.48 | 1.46 | 1.98 | 154 | 53.0 | 43.9 | CURVE DA1 | PT |
| 2+80.95 | 1 | 22.0 | 22.93 | 250 | 9.56 | 1.44 | 1.98 | 150 | 52.3 | 43.1 | CURVE DA1 | PC |

TABLE 9
SUPERELEVATION DATA
BUENA VISTA DIVERSION CHANNEL

Superelevation Formula Coefficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapezoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Spiral Transitions | 1.0 |
| Rapid | Rectangular | Spiral Transitions | 0.5 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
C = coefficient
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline
*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth
*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Spiral Unbanked *(3) feet | Length of curve banked 30* Y feet | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00.01 | 1 | 16.0 | 22.95 | 494 | 11.44 | 0.53 | 1.44 | 92 | 34.8 | 15.9 | CURVE BVD1 | PC |
| 1+00.02 | 1 | 16.0 | 22.83 | 494 | 11.50 | 0.52 | 1.44 | 90 | 34.5 | 15.7 | CURVE BVD1 | PT |
| 2+25.49 | 1 | 16.0 | 22.59 | 190 | 11.62 | 1.33 | 1.44 | 87 | 34.0 | 40.0 | CURVE BVD2 | PC |
| 4+2.19 | 1 | 16.0 | 12.05 | 190 | 21.79 | 0.38 | 1.44 | 13 | 13.2 | 11.4 | CURVE BVD2 | PT |
| 8+84.33 | 0.5 | 36.0 | 6.10 | 102 | 19.10 | 0.20 | 3.24 | 9 | 16.1 | 6.1 | CURVE BVD3 | PC |
| 9+29.63 | 0.5 | 36.0 | 6.10 | 102 | 19.00 | 0.20 | 3.24 | 9 | 16.2 | 6.1 | CURVE BVD3 | PT |
| 29+58.99 | 0.5 | 36.0 | 7.10 | 150 | 16.30 | 0.19 | 3.24 | 14 | 20.3 | 5.6 | CURVE BVD3 | PC |
| 30+64.31 | 0.5 | 36.0 | 7.20 | 150 | 16.20 | 0.19 | 3.24 | 14 | 20.7 | 5.8 | CURVE BVD3 | PT |
| 34+91.7 | 0.5 | 36.0 | 7.40 | 150 | 15.60 | 0.20 | 3.24 | 16 | 21.6 | 6.1 | CURVE BVD4 | PC |
| 35+19.86 | 0.5 | 36.0 | 7.40 | 150 | 15.60 | 0.20 | 3.24 | 16 | 21.6 | 6.1 | CURVE BVD4 | PT |
| 37+86.98 | 0.5 | 36.0 | 7.60 | 120 | 15.20 | 0.27 | 3.24 | 17 | 22.5 | 8.1 | CURVE BVD5 | PC |
| 39+36.46 | 0.5 | 36.0 | 7.70 | 120 | 15.10 | 0.28 | 3.24 | 18 | 22.9 | 8.3 | CURVE BVD5 | PT |

TABLE 10
SUPERELEVATION DATA
GUARACANAL CHANNEL

Superelevation Formula Coefficients

| Flow Type | Channel Cross-section | Type Curve | Value C |
|---|---|---|---|
| Tranquil | Rectangular | Simple Circular | 0.5 |
| Tranquil | Trapezoidal | Simple Circular | 0.5 |
| Rapid | Rectangular | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Simple Circular | 1.0 |
| Rapid | Trapezoidal | Spiral Transitions | 1.0 |
| Rapid | Rectangular | Spiral Transitions | 0.5 |
| Rapid | Rectangular | Spiral Banked | 0.5 |

*(1) Formula Delta Y = C*( V^2 *W/(g*r))
Delta Y= rise in water surface above level surface
C = coefficient
W = Channel topwidth
g = Gravitional constant
r = radius of channel Centerline
*(2) r (min) = 4 * V^2 * W/(g * d)
V = average channel velocity
d = average depth
*(3) Ls= 1.82 * V * W/(sqrt(g * d))

| Sta | Coef C (Table) | Width Channel | V fps | DESIGN r feet | Straight Depth flow feet | Super Elevation Computed Y *(1) feet | Allow Y' 0.09*W feet | MINIMUM Radius Curve *(2) feet | Ls, Length of Spiral curve Unbanked *(3) | banked 30* Y | CURVE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+04.01 | 1 | 26.0 | 29.55 | 640 | 14.42 | 1.10 | 2.34 | 196 | 64.9 | 33.1 | CURVE G1 | PC |
| 5+23.60 | 1 | 26.0 | 23.92 | 640 | 17.81 | 0.72 | 2.34 | 104 | 47.3 | 21.7 | CURVE G1 | PT |

TABLE 11
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT) | MINIMUM TOP OF LEVEE OR WALL ELEV (FT) | FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+90 | DOWNSTREAM END OF PUERTO NUEVO CHANNEL | 71455 | 1.0 | -32.00 | 4.0 | 31.0 | 4.3 | CHANNEL SECT DAYLIGHTS INTO HARBOR BED SLOPE=0.1 | 675 | - | | | existing mat'l |
| 1+60 | GRADE BREAK | 71455 | 0.9 | -25.00 | 3.9 | 26.0 | 4.3 | ___/ S=0 | 60 | 1 on 10 | | | existing mat'l |
| 6+40 | BEGIN BULKHEAD | 71455 | 0.4 | -25.00 | 3.4 | 25.4 | 9.8 | '-___/-' | 60 | 1 on 10 | | | existing mat'l |
| 17+34 | CONSTITUTION BRIDGE | 71455 | 0.3 | -25.00 | 3.3 | 25.3 | 14.4 | '-___/-' | 60 | 1 on 10 | | | existing mat'l |
| 20+00 | 170' U/S OF CONSTITUTION BRIDGE | 71455 | 3.1 | -25.00 | 6.1 | 28.1 | 8.5 | '-___/-' | 60 | 1 on 10 | | | existing mat'l |
| 30+00 | CANO DE MARTIN PENA | 69154 | 3.8 | -25.00 | 6.8 | 28.8 | 7.9 | '-___/-' | 60 | 1 on 10 | | | existing mat'l |
| 46+00 | | 69154 | 4.7 | -25.00 | 7.7 | 29.7 | 7.6 | '-___/-' | 60 | 1 on 10 | | | existing mat'l |
| 74+32.5 | GRADE BREAK END TRANSITION | 69154 | 6.0 | -25.00 | 9.0 | 31.0 | 7.2 | '-___/-' S=0.0155 | 60 | 1 on 10 | 8 | | existing mat'l |
| 76+32.5 | BEGIN TRANSITION GRADE BREAK | 69154 | 6.2 | -21.90 | 9.2 | 28.1 | 6.4 | ___/ S=0.00055 | 200 | 1 on 6 | 14 | | existing mat'l |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT) | MINIMUM TOP OF LEVEE OR WALL ELEV (FT) | FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 83+40 | END TRANSITION | 69154 | 6.5 | -21.51 | 9.5 | 28.0 | 6.5 | __/ | 200 | 1 on 6 | 10 | | existing mat'l |
| 87+80 | GRADE BREAK | 69154 | 6.7 | -21.27 | 9.7 | 28.0 | 5.9 | __! S=0.1054 | 326 | L: 1 on 6; R: 1 on 0.612 | 8 | | existing w conc left sideslope |
| 88+30 | GRADE BREAK BEGIN TRANSITION CONFLUENCE W/ MARGARITA | 69154 | 6.5 | -16.00 | 9.5 | 22.5 | 7.9 | _l__l S=0.00055 | 340 | L: 1 on 6; R: 1 on 0 | 7 | | existing w concrete retaining on left |
| 88+33.2 | 3' U/S OF CONFL W/ MARGARITA; END TRANSITION | 59466 | 6.2 | -15.94 | 9.2 | 22.1 | 9.3 | l__l | 288 | 1 on 0 | 7 | | conc walls tremmy conc bottm |
| 90+80 | (IN TRANSITION) | 59466 | 5.2 | -15.80 | 8.2 | 21.0 | 13.7 | | | 1 on 0 | | | conc walls tremmy conc bottm |
| 93+30 | U/S BEGIN WIDTH TRANSITION | 59466 | 4.6 | -15.66 | 7.6 | 20.2 | 16.3 | l___l | 180 | 1 on 0 | | | conc walls tremmy conc bottm |

TABLE 11 (cont'd)

HYDRAULIC DESIGN DATA FOR CHANNELS

100-YEAR DESIGN

PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT) | MINIMUM TOP OF LEVEE OR WALL ELEV (FT) | FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 93+58 | DE DIEGO EXPWY BRIDGE | 59466 | 4.6 | -15.64 | 7.6 | 20.2 | 16.3 | l___l | 180 | 1 on 0 | | | conc walls tremmy conc bottm |
| 95+92 | U/S SIDE BRIDGE | 59466 | 6.5 | -15.51 | 9.5 | 22.1 | 15.0 | l___l | 180 | 1 on 0 | 14.5 | 20 | conc walls tremmy conc bottm |
| 110+00 | PEDESTRIAN BRIDGE | 59466 | 7.6 | -14.75 | 10.6 | 22.3 | 15.3 | l___l | 180 | 1 on 0 | 12 | 10 | conc walls tremmy conc bottm |
| 110+06 | U/S SIDE BRIDGE | 59466 | 7.6 | -14.75 | 10.6 | 22.4 | 15.3 | l___l | 180 | 1 on 0 | 12 | 10 | conc walls tremmy conc bottm |
| 119+50 | ROOSEVELT AVE BRIDGE | 57166 | 8.8 | -14.23 | 11.8 | 23.1 | 14.5 | l___l | 180 | 1 on 0 | 14.6 | 16.1 | conc walls tremmy conc bottm |
| 120+60 | U/S SIDE BRIDGE | 57166 | 9.0 | -14.17 | 12.0 | 23.1 | 14.5 | l___l | 180 | 1 on 0 | 14.6 | 14.3 | conc walls tremmy conc bottm |
| 132+80 | END TRANSITION JCT W/ JOSEFINA | 57166 | 10.2 | -13.50 | 13.2 | 23.7 | 13.4 | l___l | 180 | 1 on 0 | | | conc walls tremmy conc bottm |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT) | MINIMUM TOP OF LEVEE OR WALL ELEV (FT) | FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133+50 | BEGIN TRANSITION | 45971 | 10.5 | -13.46 | 13.5 | 24.0 | 12.8 | l__l | 150 | 1 on 0 | | | conc walls tremmy conc bottm |
| 144+00 | | 44932 | 11.2 | -12.88 | 14.2 | 24.1 | 12.4 | l__l | 150 | 1 on 0 | 16 | | conc walls tremmy conc bottm |
| 147+40 | D/S END FINISHED RECT CONCRETE SECTION | 44932 | 11.4 | -12.69 | -- | 24.1 | 12.4 | l__l | 150 | 1 on 0 | 16.8 | | CONCRETE RECT SECT |

TABLE 11 (cont'd)

HYDRAULIC DESIGN DATA FOR CHANNELS

100-YEAR DESIGN

PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | LOW FLOW CHANNEL INVERT (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | LOW FLOW CHANNEL BOTTOM WIDTH (FT) | LOW FLOW CHANNEL SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 147+60.18 | D/S END BAFFLE BLOCK CONFIG (TYPE 4) | 44932 | 11.4 | -12.68 | - | 14.7 | 24.1 | 12.4 | l__l CHANNEL LINING MAT'L IS CONCRETE | 150.0 | 1 on 0 | - | - | 16.80 | |
| 149+41.18 | U/S BEGIN BAFFLE BLOCK CONFIG | 44932 | - | -12.59 | - | 15.9 | - | - | l__l | 150.0 | 1 on 0 | - | - | 16.60 | |
| 149+81.18 | GRADE BREAK | 44932 | -3.2 | -12.56 | - | 15.9 | - | - | l__l S=0.02532 | 150.0 | 1 on 0 | - | - | 16.50 | |
| 150+78.52 | D/S END WIDTH & INVERT CONFIGURATION (LOW FLOW) TRANSITION | 44932 | -2.0 | -10.10 | -10.10 | 17.6 | 7.7 | 38.9 | l__l | 150.0 | 1 on 0 | 0.00 S=0.00065 | - | 16.60 | |
| 154+78.52 | GRADE BREAK | 44932 | 13.6 | 0.03 | -9.84 | 17.8 | - | - | l_,_,_l S=0.00398 | 111.6 | IN TRANSITN | 23.20 | 1 ON 0.33 | 17.70 | |
| 155+78.52 | U/S BEGINNING WIDTH & INVERT CONFIGURATION (LOW FLOW) TRANSITION | 44600 | 12.9 | 0.43 | -9.57 | 18.2 | 10.7 | 23.5 | l_,_,_l | 102.0 | 1 ON 0.33 | 29.00 S=0.004 | 1 ON 0.33 | 18.00 | 18.20 |
| 156+65 | LAS AMERICAS EXPWY BRIDGE | | | | | 25.0 | | | | | | | | | |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | LOW FLOW CHANNEL INVERT (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | LOW FLOW CHANNEL BOTTOM WIDTH (FT) | LOW FLOW CHANNEL SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 158+02.37 | PC CURVE 11 r=500' | 44600 | 14.8 | 1.32 | -8.68 | 22.6 | 11.1 | 22.9 | l__,_,__l | 102.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 20.00 | 18.00 |
| 163+46.34 | PT CURVE 11 | 44600 | 20.4 | 3.48 | -6.52 | 28.3 | 15.3 | 18.3 | l__,_,__l | 102.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 32.50 | 23.00 |
| 163+85 | NORTHEAST RAMP BRIDGE | | | | | 28.4 | | | | | | | | | |
| 169+22 | J. T. PINERO AVE BRIDGE | | | | | 23.6 | | | | | | | | | |
| 171+98.51 | D/S END WIDTH TRANSITION | 44600 | 20.5 | 6.88 | -3.12 | 24.7 | 12.8 | 20.8 | l__,_,__l | 102.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 42.60 | 22.00 |
| 173+28.51 | U/S BEGIN WIDTH TRANSITION | 44600 | 19.4 | 7.39 | -2.61 | 25.2 | 10.5 | 21.2 | l__,_,__l | 113.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 42.00 | 26.50 |
| 174+50 | SOUTHEAST RAMP BRIDGE | | | | | 28.5 | | | | | | | | 39.00 | 36.30 |
| 175+52.40 | PC CURVE 12 r=1100' | 44600 | 19.5 | 8.28 | -1.72 | 25.3 | 9.9 | 18.2 | l__,_,__l | 113.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 38.00 | 31.00 |
| 177+18.51 | D/S END WIDTH TRANSITION | 44600 | 17.0 | 8.95 | -1.05 | 26.0 | 7.7 | 25.5 | l__,_,__l | 113.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 28.00 | 27.40 |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | LOW FLOW CHANNEL INVERT (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | LOW FLOW CHANNEL BOTTOM WIDTH (FT) | LOW FLOW CHANNEL SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 178+48.51 | U/S BEGIN WIDTH TRANSITION | 44600 | 22.4 | 9.43 | -0.57 | 26.7 | 9.9 | 25.2 | l__,_,__l | 107.0 | 1 ON 0.33 | 29.00 | 1 ON 0.33 | 26.80 | 27.10 |
| 179+48.51 | GRADE BREAK, U/S BEGIN OF LOW FLOW CHANNEL, D/S END OF INVERT CONFIG TRANSITION | 44600 | 21.6 | 9.85 | -0.15 | 27.1 | 10.0 | 25.1 | l__,_,__l S=0.00326 | 107.0 | 1 ON 0.33 | 29.00 S=0.02326 | 1 ON 0.33 | 26.00 | 26.60 |
| 184+48.51 | U/S BEGIN OF INVERT CONFIG TRANSITION | 43924 | 29.2 | 11.48 | 11.48 | 32.2 | 15.5 | 26.6 | l______l | 107.0 | 1 ON 0 | 0.00 | - | 27.50 | 25.80 |
| 186+25 | D/S END WIDTH TRANSITION side inlet location | 43924 | 28.9 | 12.05 | - | 31.9 | 14.5 | 27.9 | l______l | 107.0 | 1 ON 0 | 0.00 | - | 25.60 | 25.50 |
| 187+00 | U/S BEGIN WIDTH TRANSITION | 43324 | 30.0 | 12.29 | - | 33.0 | 15.3 | 26.9 | l______l | 105.0 | 1 ON 0 | 0.00 | - | 25.20 | 26.00 |
| 189+25 | D/S END WIDTH TRANSITION side inlet location | 43324 | 31.0 | 13.03 | - | 34.0 | 15.7 | 26.3 | l______l | 105.0 | 1 ON 0 | 0.00 | - | 26.30 | 27.00 |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | LOW FLOW CHANNEL INVERT (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | LOW FLOW CHANNEL BOTTOM WIDTH (FT) | LOW FLOW CHANNEL SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 190+25 | EXISTING BUENA VISTA CHANNEL U/S BEGIN WIDTH TRANSITION | 42710 | 31.4 | 13.35 | - | 34.4 | 15.8 | 26.6 | l______l | 102.0 | 1 ON 0 | 0.00 | - | 25.60 | 26.50 |
| 193+18.41 | PT CURVE 12 (delta y=2.3') | 42129 | 31.7 | 14.31 | - | 34.7 | 14.6 | 28.3 | l______l | 102.0 | 1 ON 0 | - | - | 26.70 | 28.00 |
| 200+56.96 | PC CURVE 13 r=450' delta y=5.6' | 42129 | 37.0 | 16.72 | - | 40.0 | 14.7 | 28.1 | l______l | 102.0 | 1 ON 0 | - | - | | |
| 204+85.44 | PT CURVE 13 D/S END WIDTH TRANSITION | 42129 | 38.5 | 18.12 | - | 41.5 | 14.8 | 27.9 | l______l | 102.0 | 1 ON 0 | - | - | | |
| 205+85.45 | BUENA VISTA DIVERSION CONFLUENCE (STA 0+00 ON BUENA VISTA) | 37929 | 35.9 | 18.44 | - | 38.9 | 15.5 | 27.8 | l_l_____l | 88.0 | 1 ON 0 | - | - | | |
| | | | | | | | | | (BUENA VISTA | 16.0 ) | | | | | |
| | | | | | | | | | (DIVIDER WALL | 2.0 ) | | | | | |
| | | | | | | | | | ( TOTAL | = 106.0 ) | | | | | |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 208+02.69 | PC CURVE 14 r=600' delta y=1.7' | 37929 | 37.1 | 19.15 | 40.1 | 15.6 | 27.6 | l____l | 88.0 | 1 ON 0 | 15 | 32 | CONCRETE |
| 209+33.89 | PT CURVE 14 | 37929 | 37.9 | 19.57 | 40.9 | 15.7 | 27.5 | l____l | 88.0 | 1 ON 0 | 15 | 29 | CONCRETE |
| 212+15.26 | PC CURVE 15 r=750' delta y=3.3' | 37929 | 39.8 | 20.49 | 42.8 | 16.0 | 27.0 | l____l | 88.0 | 1 ON 0 | 14 | 27 | CONCRETE |
| 214+89.97 | PT CURVE 15 | 37929 | 41.0 | 21.39 | 44.0 | 16.3 | 26.4 | l____l | 88.0 | 1 ON 0 | 30 | 30 | CONCRETE |
| 219+50.71 | D/S END WIDTH TRANSITION | 37529 | 38.6 | 22.89 | 41.6 | 15.4 | 27.6 | l____l | 88.0 | 1 ON 0 | 32 | 26 | CONCRETE |
| 220+00.71 | GRADE BREAK | 36162 | 37.2 | 23.05 | 40.2 | 13.8 | 30.6 | l____l S=0.00373 | 85.5 | 1 ON 0 | 36 | 32 | CONCRETE |
| 220+50.71 | U/S BEGIN WIDTH TRANSITION | 36162 | 38.6 | 23.23 | 41.6 | 14.9 | 29.3 | l____l | 83.0 | 1 ON 0 | 38 | 34 | CONCRETE |
| 232+23.79 | PC CURVE 16 r=1000' delta y=2.1' | 36162 | 44.9 | 27.61 | 47.9 | 15.2 | 28.7 | l____l | 83.0 | 1 ON 0 | 40 | - | CONCRETE |
| 240+90.71 | C.L. HWY 1 BRIDGE | 36162 | 49.1 | 30.84 | 52.1 | 16.2 | 26.9 | l____l | 83.0 | 1 ON 0 | 44 | - | CONCRETE |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 242+19.23 | PT CURVE 16 | 36162 | 50.0 | 31.31 | 53.0 | 16.6 | 26.3 | l____l | 83.0 | 1 ON 0 | 44 | - | CONCRETE |
| 244+40.71 | GRADE BREAK | 35762 | 49.6 | 32.15 | 52.6 | 15.7 | 27.6 | l____l S=0.00343 | 83.0 | 1 ON 0 | 44 | - | CONCRETE |
| 247+66.59 | D/S END WIDTH TRANSITION | 35762 | 51.5 | 33.27 | 54.5 | 16.0 | 27.5 | l____l | 83.0 | | - | 35 | |
| 248+66.59 | PC CURVE 17 r=1010' delta y=2.4' U/S BEGIN WIDTH TRANSITION | 34095 | 50.4 | 33.61 | 53.4 | 14.4 | 30.3 | l____l | 78.0 | 1 ON 0 | - | 39 | CONCRETE |
| 255+31.11 | PT CURVE 17 | 34095 | 53.4 | 35.89 | 56.4 | 13.9 | 31.5 | l____l | 78.0 | 1 ON 0 | 44 | 50 | CONCRETE |
| 255+31.12 | PC CURVE 18 r=750' delta y=3.6' | 34095 | 53.4 | 35.89 | 56.4 | 13.9 | 31.5 | l____l | 78.0 | 1 ON 0 | 44 | 50 | CONCRETE |
| 263+28.28 | PT CURVE 18 | 34095 | 55.3 | 38.62 | 58.3 | 13.0 | 33.6 | l____l | 78.0 | 1 ON 0 | 54 | 47 | CONCRETE |
| 269+65 | D/S END WIDTH TRANSITION | 34095 | 54.5 | 41.27 | 57.5 | 12.2 | 35.9 | l____l | 78.0 | 1 ON 0 | 57 | 95 | CONCRETE |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 270+65 | U/S BEGIN WIDTH TRANSITION, D/S END GUARACANAL CONFLUENCE (STA 0+00 ON GUARACANAL) | 26123 | 54.0 | 41.15 | 57.0 | 11.1 | 39.9 | l_l___l<br>GUARACANAL<br>DIVIDER WALL<br>TOTAL | 60.0<br>26.0<br>2.0<br>88.0 | 1 ON 0 | 63 | 60 | CONCRETE |
| 271+15 | U/S BEGINNING OF CONFLUENCE DIVIDER WALL | 26123 | 54.2 | 41.32 | 57.2 | 11.0 | 39.7 | l_l___l | 60.0 | 1 ON 0 | 63 | 60 | CONCRETE |
| 271+50.11 | GRADE BREAK | 26123 | 54.3 | 41.44 | 57.3 | 10.9 | 39.9 | l___l<br>S=0.024 | 60.0 | 1 ON 0 | 63 | 60 | CONCRETE |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 272+00 | | 26123 | 55.8 | 42.64 | 58.8 | 11.1 | 39.2 | l___l | 60.0 | 1 ON 0 | 63.7 | 61.6 | CONCRETE |
| 276+37.86 | PC CURVE 19 r=500' delta y=2.4' | 26123 | 72.0 | 53.15 | 75.0 | 16.4 | 26.6 | l___l | 60.0 | 1 ON 0 | 64.8 | 65.5 | CONCRETE |
| 276+50 | GRADE BREAK | 26123 | 72.6 | 53.44 | 75.6 | 18.1 | 24.1 | l___l S=0.001 | 60.0 | 1 ON 0 | 65.6 | 67.0 | CONCRETE |
| 279+80 | HWY 176 | 26123 | 75.2 | 53.77 | 78.2 | 20.4 | 21.4 | l___l | 60.0 | 1 ON 0 | 64.0 | 67.0 | CONCRETE |
| 279+97.66 | PT CURVE 19 | 26123 | 75.3 | 53.79 | 78.3 | 20.4 | 21.3 | l___l | 60.0 | 1 ON 0 | 65.0 | 67.0 | CONCRETE |
| 282+20.56 | PC CURVE 20 r=1000' delta y=0.4' | 26123 | 75.4 | 54.01 | 78.4 | 21.0 | 20.8 | l___l | 60.0 | 1 ON 0 | 64.3 | 61.0 | CONCRETE |
| 288+33.95 | PT CURVE 20 | 26123 | 77.0 | 54.62 | 80.0 | 21.9 | 19.9 | l___l | 60.0 | 1 ON 0 | 69.4 | 66.5 | CONCRETE |
| 301+25 | STEEL PEDESTRIAN BRIDGE | 26123 | 79.0 | 55.91 | 82.0 | 23.1 | 18.9 | l___l | 60.0 | 1 ON 0 | 77.9 | 72.3 | CONCRETE |
| 319+51.10 | PC CURVE 21 r=1200' delta y=0.3' | 26123 | 82.0 | 57.74 | 85.0 | 24.0 | 18.2 | l___l | 60.0 | 1 ON 0 | 90.6 | 84.5 | CONCRETE |

TABLE 11 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
PUERTO NUEVO CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 319+74.90 | PT CURVE 21 | 26123 | 82.0 | 57.76 | 85.0 | 24.0 | 18.1 | l___l | 60.0 | 1 ON 0 | 91.0 | 85.0 | CONCRETE |
| 325+37.52 | PC CURVE 22 r=1200' delta y=0.3' | 26123 | 82.8 | 58.33 | 85.8 | 24.2 | 18.0 | l___l | 60.0 | 1 ON 0 | 93.6 | 95.0 | CONCRETE |
| 326+35.82 | PT CURVE 22 | 26123 | 83.3 | 58.43 | 86.3 | 24.2 | 18.0 | l___l | 60.0 | 1 ON 0 | 94.3 | 99.5 | CONCRETE |
| 328+20 | D/S END WIDTH TRANSITION | 26123 | 83.6 | 58.61 | 86.6 | 24.3 | 18.0 | l___l | 60.0 | 1 ON 0 | 95.3 | 100.5 | CONCRETE |
| 329+40 | U/S BEGIN WIDTH TRANSITION | 26123 | 86.0 | 58.73 | 89.0 | 26.7 | 13.0 | l___l | 75.0 | 1 ON 0 | 96.3 | 101.0 | CONCRETE |
| 329+65 | HWY 177 BRIDGE | 26123 | 87.2 | 58.75 | 90.2 | 27.8 | 14.0 | l___l | 75.0 | 1 ON 0 | 96.3 | 101.0 | CONCRETE |
| 333+50 | GRADE BREAK | 26123 | 87.2 | 59.14 | 90.2 | 27.5 | 12.7 | l___l S=0.002 | 75.0 | 1 ON 0 | - | - | CONCRETE |
| 338+92.13 | END SPILLWAY | 26123 | 86.8 | 60.23 | 89.8 | 26.5 | 13.1 | l___l | 75.0 | 1 ON 0 | - | - | CONCRETE |
| 341+92.13 | U/S BEGIN SPILLWAY | 26123 | | 60.53 | | | | | | | | | |

TABLE 12
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
MARGARITA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00 | CONFLUENCE WITH PUERTO NUEVO CHANNEL | 11162 | 6.5 | -16.00 | 9.5 | 22.5 | 4.4 | ___l S=0.00021 | 50.0 | L - 1 ON 6<br>R - 1 ON 0 | - | - | EARTH W/ CONCRETE RETAINING WALL @ RT. SIDE |
| 2+05.93 | PC CURVE M1 r=4015' delta y=0 | 11162 | 6.6 | -15.96 | 9.6 | 22.6 | 4.4 | ___l | 50.0 | L - 1 ON 6<br>R - 1 ON 0 | - | - | EARTH W/ CONCRETE RETAINING WALL |
| 4+00 | END TRANSITION FROM TRAP SECT TO 1 ON 6 LEFT SIDE SLOPE, VERT. RIGHT WALL | 11162 | 6.6 | -15.92 | 9.6 | 22.5 | 4.4 | ___l | 50.0 | L - 1 ON 6<br>R - 1 ON 0 | - | - | EARTH W/ CONCRETE RETAINING WALL |
| 5+00 | BEGIN TRANSITION | 11162 | 6.7 | -15.90 | 9.7 | 22.6 | 2.4 | ___/ | 30.0 | 1 ON 6 | - | - | EARTH |
| 20+00 | SIDE INLET LOCATN | 11162 | 7.1 | -15.58 | 10.1 | 22.6 | 3.1 | ___/ | 30.0 | 1 ON 6 | - | - | EARTH |
| 35+00 | SIDE INLET LOCATN | 10585 | 7.3 | -15.27 | 10.3 | 22.6 | 2.9 | | | | | | |

TABLE 12 (Cont'd)

HYDRAULIC DESIGN DATA FOR CHANNELS

100-YEAR DESIGN

MARGARITA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38+37.54 | PT CURVE M1 | 9620 | 7.4 | -15.21 | 10.4 | 22.6 | 2.7 | ____/ | 30.0 | 1 ON 6 | - | - | EARTH |
| 39+00 | END TRANSITION IN SIDESLOPES FROM 1 ON 8 TO 1 ON 6 | 9620 | 7.4 | -15.18 | 10.4 | 22.6 | 2.7 | ____/ | 30.0 | 1 ON 6 | - | - | EARTH |
| 40+00 | BEGIN TRANSITION TO 1 ON 6 SIDESLOPES | 9620 | 7.4 | -15.16 | 10.4 | 22.6 | 1.9 | ____/ | 30.0 | 1 ON 8 | - | - | EARTH |
| 42+16 | U/S BEGINNING MANGROVE MITIGATION PLANTINGS, LEFT BANK | 9620 | 7.5 | -15.12 | 10.5 | 22.6 | 2.0 | ____/ | 30.0 | 1 ON 8 | - | - | EARTH |
| 51+50 | SIDE INLET | 9620 | 7.5 | -14.92 | 10.5 | 22.4 | 2.6 | ____/ | 30.0 | 1 ON 8 | - | - | EARTH |
| 53+70 | GRADE BREAK | 8012 | 7.1 | -14.87 | 10.1 | 21.9 | 7.4 | ____/ S=-0.1 | 30.0 | 1 ON 8 | - | - | RIPRAP |
| 54+00 | GRADE BREAK | 8012 | 6.8 | -17.87 | 9.8 | 24.6 | 9.3 | ____/ S=0.0 | 30.0 | 1 ON 8 | - | - | RIPRAP |

TABLE 12 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
MARGARITA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54+10 | STILLING BASIN ENDSILL BEGIN 1 ON 8 SIDESLOPES | 8012 | 6.4 | -17.87 APRON ELEV | 9.4 | 24.3 | 11.0 | \l____l/ | 30.0 | 1 ON 8 & 1 ON 0 | - | - | RIPRAP CONCRETE |
| 54+75 | GRADE BREAK BEGIN STILLING BASIN | 8012 | -8.1 | -17.87 | 9.1 | 7.4 | 38.4 | l____l S=0.09761 | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 55+90.56 | GRADE BREAK PC CURVE M2 r=200' delta y=2.65' | 8012 | 7.3 | -6.59 | 10.3 | 11.2 | 23.8 | l____l S=0.005 | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 58+35.00 | PT CURVE M2 | 8012 | 8.5 | -5.36 | 11.5 | 11.2 | 23.8 | l____l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 60+61.15 | PC CURVE M3 r=200' delta y=2.65' | 8012 | 9.6 | -4.23 | 12.6 | 11.2 | 23.8 | l____l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 62+64.48 | PT CURVE M3 | 8012 | 10.7 | -3.22 | 13.7 | 11.2 | 23.8 | l____l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 66+64.90 | PC CURVE M4 r=200' delta y=2.66' | 8012 | 12.7 | -1.21 | 15.7 | 11.2 | 23.9 | l____l | 30.0 | 1 ON 0 | - | - | CONCRETE |

TABLE 12 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
MARGARITA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67+26.44 | PT CURVE M4 | 8012 | 13.0 | -0.91 | 16.0 | 11.2 | 23.9 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 74+97.31 | PC CURVE M5<br>r=210' delta y=2.68' | 8012 | 16.6 | 2.95 | 19.6 | 10.9 | 24.5 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 75+75.06 | PT CURVE M5 | 8012 | 16.9 | 3.34 | 19.9 | 10.9 | 24.6 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 84+85 | GRADE BREAK | 8012 | 20.0 | 7.89 | 23.0 | 9.8 | 27.4 | l___l<br>S=0.00992 | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 85+90.86 | PC CURVE M6<br>r=265' delta y=2.5' | 8012 | 21.4 | 8.94 | 24.4 | 10.0 | 26.8 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 86+81.38 | PT CURVE M6 | 8012 | 22.6 | 9.84 | 25.6 | 10.2 | 26.1 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |
| 89+60 | U/S END<br>OF PROJECT<br>EXISTING CONCRETE<br>TRAPEZOIDAL SECTION | 8012 | 25.7 | 12.60 | 28.7 | 13.1 | 20.5 | l___l | 30.0 | 1 ON 0 | - | - | CONCRETE |

TABLE 13
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
JOSEFINA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00 | BEGIN CONFLUENCE W/ PUERTO NUEVO CHANNEL | 9480 | 10.1 | -13.46 | 13.1 | 23.6 | 8.9 | l_______l S=0.0006 | 45 | 1 ON 0 | - | - | CONCRETE |
| 13+00 | SIDE INLET LOCATION | 9480 | 10.9 | -12.68 | 13.9 | 23.6 | 8.3 | l_______l | 45 | 1 ON 0 | 14.8 | 14.6 | CONCRETE |
| 15+00 | GRADE BREAK | 8822 | 10.9 | -12.56 | 13.9 | 23.5 | 8.4 | l_______l S=0.00574 | 45 | 1 ON 0 | 14.0 | 15.7 | CONCRETE |
| 17+33.76 | PC CURVE J2 r=540' delta y=1.45' | 9850 | -0.4 | -11.21 | 2.6 | 9.2 | 23.7 | l_______l | 45 | 1 ON 0 | 17.3 | 15.8 | CONCRETE |
| 19+23.96 | PT CURVE J2 | 9850 | 1.2 | -10.12 | 4.2 | 9.5 | 23.0 | l_______l | 45 | 1 ON 0 | 18.6 | 19.2 | CONCRETE |
| 21+39.55 | PC CURVE J3 r=375' delta y=2.10' side inlet location | 9850 | 3.4 | -8.89 | 6.4 | 10.2 | 21.5 | l_______l | 45 | 1 ON 0 | 19.2 | 16.7 | CONCRETE |
| 23+01.19 | PT CURVE J3 | 9610 | 3.3 | -7.96 | 6.3 | 9.2 | 23.3 | l_______l | 45 | 1 ON 0 | 18.5 | 17.2 | CONCRETE |
| 23+60 | PINERO AVE BRIDGE | 9610 | 3.3 | -7.62 | 6.3 | 9.3 | 23.1 | l_______l | 45 | 1 ON 0 | | | CONCRETE |

TABLE 13 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
JOSEFINA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24+00 | SIDE INLET LOCATION | 9610 | 3.4 | -7.39 | 6.4 | 9.3 | 22.9 | l_______l | 45 | 1 ON 0 | 18.8 | 18.3 | CONCRETE |
| 28+53.18 | PC CURVE J4 r=400' delta y=2.13' | 9376 | 5.9 | -4.79 | 8.9 | 8.5 | 24.4 | l_______l | 45 | 1 ON 0 | 18.2 | 22.4 | CONCRETE |
| 31+75 | CALLE ANDALUCIA BRIDGE | 9376 | 7.7 | -2.95 | 10.7 | 8.6 | 24.0 | l_______l | 45 | 1 ON 0 | | | CONCRETE |
| 33+87 | D/S END CONFLUENCE | 9376 | 9.2 | -1.72 | 12.2 | 8.8 | 23.7 | l_______l | 45 | 1 ON 0 | 18.5 | 19.9 | CONCRETE |
| 34+09.81 | PT CURVE J4 | 9376 | 9.6 | -1.60 | 12.6 | 9.2 | 22.5 | l_______l | 45 | 1 ON 0 | 18.4 | 20.0 | CONCRETE |
| 34+36.72 | GRADE BREAK U/S BEGIN CONFLUENCE W/ DONA ANA | 4626 | 9.8 | -1.44 | 12.8 | 9.4 | 22.4 | l_______l S=0.00633 | 22 | 1 ON 0 | 18.6 | 19.9 | CONCRETE |
| 34+77.72 | PC CURVE J5 r=185' delta y=1.84' | 4626 | 10.1 | -1.18 | 13.1 | 9.4 | 22.3 | l_______l | 22 | 1 ON 0 | 18.6 | 19.8 | CONCRETE |
| 36+78.52 | PT CURVE J5 | 4626 | 11.6 | 0.09 | 14.6 | 9.6 | 21.9 | l___l | 22 | 1 ON 0 | 21.6 | 19.6 | CONCRETE |

TABLE 13 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
JOSEFINA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39+00 | SIDE INLET LOCATION | 4626 | 11.7 | 1.49 | 14.7 | 10.2 | 20.6 | l____l | 22 | 1 ON 0 | 21.1 | 18.6 | CONCRETE |
| 40+35 | STEEL FOOT BRIDGE SIDE INLET LOCATION | 4600 | 12.8 | 2.35 | 15.8 | 10.4 | 20.1 | l____l | 22 | 1 ON 0 | 21.7 | 18.6 | CONCRETE |
| 47+00 | AMERICO MIRANDA AVE BRIDGE | 4600 | 17.9 | 6.56 | 20.9 | 9.7 | 21.1 | l____l | 22 | 1 ON 0 | - | - | CONCRETE |
| 48+00 | SIDE INLET LOCATION | 4508 | 17.6 | 7.19 | 20.6 | 10.2 | 20.1 | l____l | 22 | 1 ON 0 | 22.7 | 22.1 | CONCRETE |
| 50+00 | SIDE INLET LOCATION | 4465 | 19.0 | 8.45 | 22.0 | 10.3 | 19.8 | l____l | 22 | 1 ON 0 | 23.9 | 23.3 | CONCRETE |
| 51+95 | CALLE 31 SE BRIDGE side inlet location | 4415 | 20.1 | 9.69 | 23.1 | 10.1 | 19.9 | l____l | 22 | 1 ON 0 | 24.8 | 24.3 | CONCRETE |
| 54+03.45 | PC CURVE J6 r=1000' delta y=.34' side inlet location | 4350 | 20.8 | 11.01 | 23.8 | 9.4 | 21.0 | l____l | 22 | 1 ON 0 | 23.7 | 25.4 | CONCRETE |
| 58+46.54 | PT CURVE J6 | 4290 | 22.9 | 13.81 | 25.9 | 8.8 | 22.2 | l____l | 22 | 1 ON 0 | 25.4 | 27.6 | CONCRETE |

TABLE 13 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
JOSEFINA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63+15 | D/S END WIDTH TRANSITION side inlet location | 4290 | 26.3 | 16.78 | 29.3 | 9.0 | 21.7 | l___l | 22 | 1 ON 0 | 27.3 | 27.3 | CONCRETE |
| 63+45 | CALLE 21 SE BRIDGE | 4063 | 25.7 | 16.97 | 28.7 | 8.2 | 24.2 | l___l | 21 | 1 ON 0 | 27.7 | 27.5 | CONCRETE |
| 63+75 | U/S BEGIN WIDTH TRANSITION | 4063 | 27.3 | 17.16 | 30.3 | 9.6 | 22.4 | l___l | 19 | 1 ON 0 | 28.0 | 27.7 | CONCRETE |
| 73+69.29 | PC CURVE J7 r=220' delta y=1.62' | 4063 | 34.0 | 23.45 | 37.0 | 8.9 | 24.1 | l___l | 19 | 1 ON 0 | | | CONCRETE |
| 74+32 | CALLE 9 SE BRIDGE D/S END WIDTH TRANS. side inlet location | 4063 | 34.3 | 23.95 | 37.3 | 8.8 | 24.4 | l___l | 19 | 1 ON 0 | - | - | CONCRETE |
| 74+50 | U/S BEGIN WIDTH TRANSITION | 3897 | 34.7 | 23.96 | 37.7 | 9.1 | 25.1 | l___l | 17 | 1 ON 0 | - | - | CONCRETE |
| 75+70.62 | PT CURVE J7 | 3897 | 35.2 | 24.72 | 38.2 | 8.8 | 26.0 | l___l | 17 | 1 ON 0 | | | CONCRETE |
| 75+70.63 | PC CURVE J8 r=240' delta y=1.48' | 3897 | 35.2 | 24.72 | 38.2 | 8.8 | 26.0 | l___l | 17 | 1 ON 0 | | | CONCRETE |

TABLE 13 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
JOSEFINA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75+92 | CALLE 54 SE BRIDGE | 3897 | 33.6 | 24.86 | 36.6 | 8.7 | 26.1 | l___l | 17 | 1 ON 0 | - | - | CONCRETE |
| 76+30 | GRADE BREAK | 3897 | 33.8 | 25.10 | 36.8 | 8.7 | 26.4 | l___l S=0.100 | 17 | 1 ON 0 | - | - | CONCRETE |
| 76+50 | GRADE BREAK HEADWALL LOCATION | 3897 | 39.0 | 27.10 | 42.0 | 11.8 | 19.5 | l___l S=0.00349 | 17 | 1 ON 0 | - | - | CONCRETE |
| 77+28.84 | U/S END OF PROJECT | 3897 | 39.2 | 27.40 | DAYLIGHT TO EXIST SIDE SLOPE | 11.8 | 17.1 | l___l | 17 | 1 ON 0 | - | - | CONCRETE |

TABLE 14
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
DONA ANA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00 | BEGIN CONFLUENCE W/ JOSEFINA CHANNEL | 4896 | 9.8 | -1.46 | 12.8 | 10.0 | 22.2 | l__l__l S=0.006 | 22 | 1 ON 0 | 20 | 20 | CONCRETE |
| 2+80.95 | PC CURVE DA1 r=250' delta y=1.5' side inlet | 4896 | 12.1 | 0.23 | 15.1 | 10.4 | 21.4 | l___l | 22 | 1 ON 0 | 20 | 20 | CONCRETE |
| 5+30.83 | PT CURVE DA1 | 4825 | 12.7 | 1.72 | 15.7 | 9.5 | 23.1 | l___l | 22 | 1 ON 0 | 20 | 20 | CONCRETE |
| 6+70 | GRADE BREAK side inlet | 4825 | 13.0 | 2.56 | 16.0 | 9.4 | 23.3 | l___l S=0.008 | 22 | 1 ON 0 | 23 | 25 | CONCRETE |
| 12+21.30 | PC CURVE DA2 r=250' delta y=1.6' | 4721 | 17.4 | 6.97 | 20.4 | 8.8 | 24.4 | l___l | 22 | 1 ON 0 | 25 | 25 | CONCRETE |
| 13+18.72 | PT CURVE DA2 | 4721 | 18.2 | 7.75 | 21.2 | 8.8 | 24.3 | l___l | 22 | 1 ON 0 | 25 | 25 | CONCRETE |
| 15+13.70 | AVE AMERICO MIRANDA PC CURVE DA3 r=325' delta y=1.2' | 4721 | 19.6 | 9.31 | 22.6 | 9.0 | 23.8 | l___l | 22 | 1 ON 0 | 33 | 30 | CONCRETE |
| 16+67.26 | PT CURVE DA3 | 4721 | 21.0 | 10.54 | 24.0 | 9.3 | 23.2 | l___l | 22 | 1 ON 0 | 28 | 35 | CONCRETE |

TABLE 14 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
DONA ANA CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18+79.99 | PC CURVE DA4<br>r=1000' delta y=.4' | 4721 | 22.6 | 12.24 | 25.6 | 10.0 | 21.6 | L___L | 22 | 1 ON 0 | 38 | 30 | CONCRETE |
| 19+50 | CALLE 29 SE<br>side inlet | 4721 | 23.8 | 12.80 | 26.8 | 10.6 | 20.2 | L___L | 22 | 1 ON 0 | 38 | 30 | CONCRETE |
| 20+06.93 | PT CURVE DA4 | 4580 | 22.6 | 13.26 | 25.6 | 9.0 | 23.2 | L___L | 22 | 1 ON 0 | 35 | 31 | CONCRETE |
| 23+17.17 | PC CURVE DA5<br>r=1212' delta y=.3'<br>side inlet | 4580 | 26.2 | 15.74 | 29.2 | 10.1 | 20.6 | L___L | 22 | 1 ON 0 | 35 | 32 | |
| 27+98.57 | PT CURVE DA5<br>CALLE 21 SE<br>side inlet | 4440 | 30.2 | 19.59 | 33.2 | 10.3 | 19.5 | L___L | 22 | 1 ON 0 | 35 | 34 | CONCRETE |
| 29+25 | SIDE INLET | 4293 | 29.6 | 20.60 | 32.6 | 8.6 | 22.6 | L___L | 22 | 1 ON 0 | 37 | 35 | CONCRETE |
| 32+80 | U/S END OF PROJECT | 4293 | 33.5 | 23.44 | 36.5 | 9.3 | 21.0 | L___L | 22 | 1 ON 0 | 39 | 38 | CONCRETE |

TABLE 15
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
BUENA VISTA DIVERSION CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD) | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00 | BEGIN CONFLUENCE W/ PUERTO NUEVO CHANNEL | 4200 | 34.9 | 22.35 | 37.9 | 11.4 | 23.0 | l___l S=0.007 | 16 | 1 ON 0 | - | - | CONCRETE |
| 0+00.01 | PC CURVE 1 r=494' delta y=0.5' | | | | | | | | | | | | |
| 1+00.02 | PT CURVE 1 | 4200 | 35.8 | 23.05 | 38.8 | 11.5 | 22.8 | l___l | 16 | 1 ON 0 | - | - | CONCRETE |
| 2+25.49 | PC CURVE 2 r=190' delta y=1.3' | 4200 | 36.9 | 23.93 | 39.9 | 11.6 | 22.6 | l___l | 16 | 1 ON 0 | - | - | CONCRETE |
| 4+02.19 | PT CURVE 2 | 4200 | 38.5 | 25.17 | 41.5 | 12.1 | 21.8 | l___l | 16 | 1 ON 0 | - | - | CONCRETE |
| 4+50 | GRADE BREAK D/S END WIDTH TRANSITION | 4200 | 38.4 | 25.50 | 41.4 | 12.9 | 20.4 | l___l S=0.0015 | 16 | 1 ON 0 | - | - | CONCRETE |
| 8+50 | U/S BEGIN WIDTH TRANSITION | 4200 | 45.2 | 26.10 | 48.2 | 19.1 | 6.1 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 8+84.33 | PC CURVE 2 r=190' delta y=1.3' | 4200 | 45.3 | 26.15 | 48.3 | 19.1 | 6.1 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 9+29.63 | PT CURVE 2 | 4200 | 45.2 | 26.22 | 48.2 | 19.0 | 6.1 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |

TABLE 15 (cont'd)
HYDRAULIC DESIGN DATA FOR CHANNELS
100-YEAR DESIGN
BUENA VISTA DIVERSION CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELOCITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29+58.99 | PC CURVE 3 r=102' delta y=0.2' | 4200 | 45.6 | 29.26 | 48.6 | 16.3 | 7.2 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 30+64.31 | PT CURVE 3 | 4200 | 45.6 | 29.42 | 48.6 | 16.2 | 7.2 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 34+91.70 | PC CURVE 4 r=150' delta y=0.2' | 4200 | 45.7 | 30.03 | 48.7 | 15.7 | 7.4 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 35+19.86 | PT CURVE 4 | 4200 | 45.7 | 30.10 | 48.7 | 15.6 | 7.5 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 37+86.98 | PC CURVE 5 r=150' delta y=0.2' | 4200 | 45.8 | 30.51 | 48.8 | 15.3 | 7.6 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 39+36.46 | PT CURVE 5 | 4200 | 45.8 | 30.73 | 48.8 | 15.1 | 7.7 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |
| 42+37.79 | U/S END OF PROJECT | 4200 | 45.8 | 31.18 | 48.8 | 14.8 | 7.9 | l___l | 36 | 1 ON 0 | - | - | CONCRETE |

TABLE 16

HYDRAULIC DESIGN DATA FOR CHANNELS

100-YEAR DESIGN

GUARACANAL CHANNEL

| STATION (increases in u/s direction) (FT) | LOCATION (LOOKING DOWNSTREAM) | DESIGN DISCH (CFS) | DESIGN WATER SURFACE ELEV (FT-NGVD) | DESIGN INVERT ELEV (FT-NGVD | MINIMUM TOP OF CHANNEL WALL ELEV (FT-NGVD) | AVE FLOW DEPTH (FT) | AVE CHANNEL VELO-CITY (FT/S) | CONFIGURATION OF CROSS-SECTION (looking d/s) | BOTTOM WIDTH (FT) | SIDE SLOPES (V on H) | EXISTING GRADE ELEVATION ADJ. TO CHANNEL LEFT SIDE | EXISTING GRADE ELEVATION ADJ. TO CHANNEL RIGHT SIDE | CHANNEL LINING MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+00 | BEGIN CONFLUENCE W/ PUERTO NUEVO CHANNEL | 11075 | 57.0 | 41.47 | 60.0 | 14.4 | 29.6 | l___l S=0.00840 | 26 | 1 ON 0 | - | 85 | CONCRETE |
| 0+04.01 | PC CURVE G1 r=640' delta y=1.1' | 11075 | 57.0 | 41.50 | 60.0 | 14.4 | 29.6 | l___l | 26 | 1 ON 0 | - | 85 | CONCRETE |
| 5+23.60 | GRADE BREAK D/S END WIDTH TRANSITION PT CURVE G1 | 11075 | 64.8 | 45.86 | 67.8 | 17.8 | 23.9 | l___l S=0.00122 | 26 | 1 ON 0 | 62 | 55 | CONCRETE |
| 8+19 | BEGIN WIDTH TRANS. U/S END OF CHANNEL D/S END DEBRIS BASIN OUTLET STRUCTURE | 11075 | 72.5 | 46.27 | 75.5 | 26.2 | 8.4 | l___l | 50 | 1 ON 0 | 70 | 140 | CONCRETE |

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

TABLE 17
PUERTO NUEVO CHANNEL SIDE INLETS

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET: NUMBER | SIDE INLET: DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT: NO. AND DIAM. (IN.) | CULVERT: INVERT ELEV. (FT.NGVD) | CULVERT: FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET: CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET: LENGTH (FT.) | SIDE SPILLWAY INLET: SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET: SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 + 25 R | 1 | | 4.17 | 1 - 30 | 1.68 | FLUSH | | | | | 20.0 | 2 |
| 93 + 50 L | 2 | | 3.27 | 1 - 72 | -3.73 | FLUSH | | | | | 7.5 | 3 |
| OLD MARGARITA FLUSHING CLVT. | 2a | | | 2 -48 | -4.00 | FLUSH | | | | | | 3 |
| 96 + 37 R | 3 | | 5.64 | 2 - -- | 1.83 | FLUSH | | | | | 10.0 | 2 |
| 99 + 92.5 L | 4 | | 5.97 | 1 - 42 | --- | FLUSH | | | | | 10.0 | 2 |
| 100 + 05 L | 5 | | 5.98 | 1 - 30 | --- | FLUSH | | | | | 10.0 | 2 |
| 101 + 10 R | 6 | | 6.08 | 1 - 36 | 0.84 | FLUSH | | | | | 8.0 | 2 |
| 113 + 10 R | 7 | | 7.35 | 1 - 24 | 4.61 | | | | | | 9.0 | 4 |
| | | | 7.35 | 2 - 72 | 0.35 | FLUSH | | | | | 9.0 | |
| 113 + 90 L | 8 | | 7.47 | 4 - 72 | 0.47 | FLUSH | | | | | 10.0 | 3 |
| 114 + 90 R | 9 | | 7.62 | 1 - 24 | 4.83 | | | | | | 12.4 | 4 |
| | | | 7.62 | 2 - 72 | 0.62 | FLUSH | | | | | 12.4 | |
| 116 + 20 R | 10 | | 7.81 | 1 - 18 | 6.00 | | | | | | 15.6 | 4 |

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

Table 17 (cont'd)
PUERTO NUEVO CHANNEL SIDE INLETS

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET: NUMBER | SIDE INLET: DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT: NO. AND DIAM. (IN.) | CULVERT: INVERT ELEV. (FT.NGVD) | CULVERT: FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET: CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET: LENGTH (FT.) | SIDE SPILLWAY INLET: SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET: SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 7.81 | 2 - 72 | 0.81 | FLUSH | | | | | 15.6 | |
| 117 + 00 L | 11 | | 7.93 | 2 - 72 | 0.93 | FLUSH | | | | | 10.0 | 3 |
| 118 + 80 R | 12 | | 8.20 | 1 - 48 | 2.49 | | | | | | 15.0 | 4 |
| | | | 8.20 | 2 - 72 | 1.20 | FLUSH | | | | | 15.0 | |
| 119 + 02 L | 13 | | 8.23 | 1 - 24 | 2.02 | | | | | | 14.4 | 4 |
| | | | 8.23 | 2 - 72 | 1.23 | FLUSH | | | | | 14.4 | |
| 122 + 22 L | 14 | | 8.57 | 1 - 36 | 0.71 | FLUSH | | | | | 14.0 | 2 |
| 122 + 45 L | 15 | | 8.60 | 1 - 36 | 1.30 | FLUSH | | | | | 14.0 | 2 |
| 122 + 57 L | 16 | | 8.61 | 1 - 36 | 1.40 | FLUSH | | | | | 14.0 | 2 |
| 123 + 52 L | 17 | | 8.71 | 1 - 36 | 1.16 | FLUSH | | | | | 14.0 | 2 |
| 124 + 58 L | 18 | | 8.82 | 1 - 36 | 1.30 | FLUSH | | | | | 14.0 | 2 |
| 126 + 12.5 R | 19 | | 8.99 | 1 - 24 | 6.46 | FLUSH | | | | | 12.9 | 2 |
| 131 + 17.5 R | 20 | | 9.53 | 1 - 12x6 | 0.35 | FLUSH | | | | | 15.3 | 2 |

Table 17 (cont'd)
PUERTO NUEVO CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 132 + 50 L | 21 | | 9.67 | 1 - 36 | 1.83 | FLUSH | | | | | 14.2 | 2 |
| 133 + 30 L | 22 | | 9.99 | 1 - 48 | 4.23 | | | | | | 15.0 | 4 |
| | | | 9.99 | 1 - 72 | 2.99 | FLUSH | | | | | 15.0 | |
| 136 + 65 R | 23 | | 10.31 | 1 - 12 | 3.11 | --- | | | | | --- | 4 |
| | | | 10.31 | 2 - 72 | 3.31 | --- | | | | | --- | |
| 138 + 12.5 L | 24 | | 10.41 | 1 - 36 | 4.59 | | | | | | 12.0 | 4 |
| | | | 10.41 | 1 - 72 | 3.41 | FLUSH | | | | | 12.0 | |
| 142 + 00 R | 25 | | 10.67 | 2 - 72 | 3.67 | FLUSH | | | | | 15.0 | 3 |
| 143 + 00 L | 26 | | 10.73 | 1 - 72 | 3.73 | FLUSH | | | | | 15.0 | 3 |
| 145 + 07.5 L | 27 | | 10.93 | 1 - 30 | 3.01 | FLUSH | | | | | 16.5 | 2 |
| 152 + 11 L | 28 | | 3.17 | 1 - 42 | 6.99 | RECESSED | | | | | 17.0 | 2 |
| 155 + 14 R | 29 | | 13.35 | 1 - 18 | 4.51 | | | | | | 20.0 | 4 |
| | | | 13.35 | 1 - 72 | 6.35 | RECESSED | | | | | 20.0 | |

Table 17 (cont'd)

PUERTO NUEVO CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 155 + 50 L | 30 | | 13.10 | 1 - 72 | 6.10 | RECESSED | | | | | 15.0 | 3 |
| 156 + 67.5 R | 31 | | 13.66 | 1 - 24 | 13.86 | RECESSED | | | | | 20.4 | 2 |
| 161 + 15 R | 32 | | 18.02 | 2 - 48 | --- | --- | | | | | --- | 2 |
| 161 + 35 R | 33 | | 18.22 | 1 - 60 | --- | RECESSED | | | | | 20.5 | 2 |
| 168 + 02 L | 34 | | 20.45 | 1 - 18 | 9.99 | RECESSED | | | | | 21.0 | 2 |
| 168 + 02 L | 35 | | 20.45 | 1 - 36 | --- | RECESSED | | | | | 21.0 | 2 |
| 168 + 05 R | 36 | | 20.45 | 1 - 18 | 7.23 | RECESSED | | | | | 21.0 | 2 |
| 174 + 55 L | 38 | | 19.46 | 1 - 60 | 5.56 | RECESSED | | | | | 37.5 | 2 |
| 175 + 65 R | 39 | | 19.31 | 1 - 48 | 8.42 | RECESSED | | | | | 26.0 | 2 |
| 181 + 00 L | 40 | | 23.90 | 2 - 72 | 16.90 | RECESSED | | | | | 25.0 | 3 |
| 184 + 00 R | 41 | | 28.46 | 1 - 72 | 21.46 | FLAP GATE | | | | | 25.0 | 3 |
| 186 + 60 L | 42 | | 29.41 | 1 - 18 | 11.80 | | | | | | 25.0 | 4 |

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

Table 17 (cont'd)
PUERTO NUEVO CHANNEL SIDE INLETS

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 29.41 | 4 - 72 | 22.41 | FLAP GATE | | | | | 25.0 | |
| 189 + 50 L | 43 | | 31.10 | 4 - 72 | 24.10 | FLAP GATE | | | | | 25.0 | 3 |
| 191 + 70 L | 44 | | 31.55 | 4 - 72 | 24.55 | FLAP GATE | | | | | 25.0 | 3 |
| 195 + 77 R | 45 | | 33.56 | 1 - 3x3 | 16.95 | FLAP GATE | | | | | 28.4 | 2 |
| 208 + 20 R | 46 | | 37.21 | 1 - 48 | 19.45 | FLAP GATE | | | | | 30.0 | 2 |
| 208 + 25 R | 47 | | 37.24 | 1 - 48 | 19.36 | FLAP GATE | | | | | 30.0 | 2 |
| 218 + 70 R | 48 | | 39.02 | 9 - 72 | 32.02 | FLAP GATE | | | | | 35.0 | 3 |
| 219 + 70 L | 50 | | 38.06 | 2 - 72 | 31.06 | FLAP GATE | | | | | 35.0 | 3 |
| 244 + 40 L | 51 | | 49.60 | 3 - 72 | 42.60 | FLAP GATE | | | | | 50.0 | 3 |
| 245 + 30 L | 52 | | 50.12 | 3 - 72 | 43.12 | FLAP GATE | | | | | 45.0 | 3 |
| 248 + 00 R | 53 | | 51.17 | 8 - 72 | 44.17 | FLAP GATE | | | | | 40.0 | 3 |
| 253 + 10 L | 54 | | 52.44 | 3 - 72 | 45.44 | FLAP GATE | | | | | 45.0 | 3 |

Table 17 (cont'd)

PUERTO NUEVO CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 263 + 50 R | 55 | | 55.29 | 3 - 72 | 48.29 | FLAP GATE | | | | | 55.0 | 3 |
| 267 + 70 L | 56 | | 55.13 | 3 - 72 | 48.13 | RECESSED | | | | | 55.0 | 3 |
| 275 + 62.5 R | 57 | | 69.21 | 1 - 24 | 51.60 | FLAP GATE | | | | | 61.5 | 3 |
| 278 + 33 R | 58 | | 74.04 | 1 - 24 | 55.50 | FLAP GATE | | | | | 64.0 | 3 |
| 280 + 50 L | 59 | | 75.32 | 1 - 12 | 63.13 | FLAP GATE | | | | | 70.0 | 2 |
| 281 + 30 R | 60 | | 75.36 | 3 - 72 | 68.36 | FLAP GATE | | | | | 60.0 | 3 |
| 294 + 47 R | 61 | | 77.95 | 1 - 24 | 60.83 | FLAP GATE | | | | | 65.0 | 2 |
| 296 + 90 R | 62 | | 78.33 | 1 - 18 | 60.62 | FLAP GATE | | | | | 70.5 | 2 |
| 303 + 95 L | 63 | | 79.44 | 1 - 60 | 60.18 | RECESSED | | | | | 80.1 | 2 |
| 308 + 50 R | 64 | | 80.19 | 1 - 48 | 64.63 | FLAP GATE | | | | | 77.8 | 2 |
| 309 + 52 R | 65 | | 80.36 | 1 - 24 | 62.49 | RECESSED | | | | | 84.4 | 2 |
| 316 + 00 R | 66 | | 81.42 | 1 - 48 | 64.24 | FLAP GATE | | | | | 76.5 | 2 |
| 319 + 97.5 L | 67 | | 82.03 | 1 - 2x3 | 72.54 | RECESSED | | | | | 90.5 | 2 |

Table 17 (cont'd)
PUERTO NUEVO CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 320 + 85 R | 68 | | 82.16 | 1 - 60 | 83.00 | RECESSED | | | | | 85.0 | 2 |
| 323 + 93 L | 69 | | 82.67 | 1 - 4x4 | 66.19 | RECESSED | | | | | 92.5 | 2 |
| 327 + 57.5 R | 70 | | 82.97 | 1 - 54 | 68.52 | RECESSED | | | | | 102.0 | 2 |

TABLE 18

MARGARITA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new
(5) Discharges into existing channel which will be used as a collector channel

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | | |
| 16 + 15 R | 1 | | 5.68 | 1 - 42 | -0.91 | | | | | | 7.0 | 1,5 |
| 19 + 80 R | 2 | | 5.70 | 1 - 43X68 | -0.63 | | | | | | 7.0 | 1,5 |
| 20 + 30 L | 3 | 428 | 5.70 | 4 - 72 | -3.00 | FLAP GATE | | | | | 5.0 | 3 |
| 26 + 40 R | 4 | | 5.80 | 1 - 36X72 | 1.99 | | | | | | 7.0 | 1,5 |
| 35 + 90 R | 5 | | 5.90 | 2 - 48 | 0.58 | | | | | | 6.0 | 1,5 |
| 37 + 10 R | 6 | | 6.00 | 1 - 46 | | | | | | | 6.0 | 1,5 |
| 42 + 10 R | 7 | 334 | 6.10 | 1 - 58X91 | -1.03 | | | | | | 8.0 | 1,5 |
| 44 + 20 R | 8 | | 6.10 | 2 - 42 | 0.3/0.5 | | | | | | 8.0 | 1,5 |
| 47 + 70 R | 9 | | 6.10 | 1 - 60 | 0.71 | | | | | | 9.0 | 1,5 |
| 48 + 90 R | 10 | | 6.10 | 1 - 45 | -1.75 | | | | | | 8.0 | 1,5 |
| 64 + 75 L | 11 | | 11.80 | | 4.50 | RECESSED | | | | | 16.0 | 2 |
| 66 + 50 R | 12 | 100 | 12.60 | | 2.10 | FLAP GATE | | | | | 10.0 | 3 |

TABLE 19
JOSEFINA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | | |
| 7 + 72 R | 1 | | 10.2 | 1 - 12 | 6.61 | RECESSED | | | | | 11 | 2 |
| 10 + 65 R | 2 | | 10.4 | 1 - 12 | 8.1 | RECESSED | | | | | 13 | 2 |
| 10 + 65 L | 3 | | 10.4 | 1 - 24 | 4.99 | RECESSED | | | | | 12 | 2 |
| 13 + 00 L | 4 | 500 | 10.5 | | | | 11.0/10.8 | 100 | 6.1 | 18.0/1.5 | 14 | 3 |
| 13 + 00 R | 5 | 235 | 10.5 | | | | 11.0/10.9 | 48 | 6 | 10.0/1.5 | 13.5 | 3 |
| 19 + 51 L | 6 | | 1.2 | 1 - 8 | 13.61 | RECESSED | | | | | 15 | 2 |
| 21 + 40 L | 7 | 40 | 3.4 | 1 - 48 | -1 | RECESSED | | | | | 15 | 3 |
| 21 + 40 R | 8 | 200 | 3.4 | | | | 3.9/3.7 | 40 | -0.1 | 9.0/1.5 | 15 | 3 |
| 23 + 53 L AVENIDA JESUS T. PINERO | 9 | | 3.3 | 1 - 66 | 8.94 | RECESSED | | | | | 18 | 2 |
| 23 + 74 R AVENIDA JESUS T. PINERO | 10 | | 3.4 | 1 - 18 | 9.8 | RECESSED | | | | | 16 | 2 |
| 24 + 00 L | 11 | 117 | 3.4 | | | | 3.9/3.7 | 24 | -0.2 | 5.0/1.5 | 18 | 3 |

TABLE 19 (CONT'D)

JOSEFINA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | | |
| 24 + 00 R | 12 | 117 | 3.4 | | | | 3.9/3.7 | 24 | -0.2 | 5.0/1.5 | 18 | 3 |
| 24 + 79 R AVENIDA JESUS T. PINERO | 13 | | 3.8 | 1 - 24 | 8.8 | RECESSED | | | | | 17 | 2 |
| 30 + 14 R | 14 | | 6.9 | 1 - 24 | 15.09 | RECESSED | | | | | 18 | 2 |
| 31 + 76 L CALLA ANDALUCIA | 15 | | 7.9 | 1 - 24 | 13.88 | RECESSED | | | | | 20 | 2 |
| 32 + 00 L CALLA ANDALUCIA | 16 | | 8 | 1 - 24 | 13.88 | RECESSED | | | | | 18 | 2 |
| 35 + 00 R CONFLUENCE W/ DONA ANA | 17 | | 10.1 | 1 - ? | ? | RECESSED | | | | | 19 | 2 |
| 39 + 00 L | 18 | 26 | 11.7 | 1 - 36 | 8 | RECESSED | | | | | 19.5 | 3 |
| 40 + 23 L | 19 | | 12.8 | 1 - 18 | 13.24 | RECESSED | | | | | 21 | 2 |
| 40 + 35 R | 20 | 92 | 12.8 | | | | 13.3/13.2 | 18 | 9.3 | 4.0/1.5 | 21 | 3 |

TABLE 19 (CONT'D)
JOSEFINA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | | |
| 40 + 46 R STEEL FOOT BRIDGE | 21 | | 13 | 1 - 72X72 | 13.9 | RECESSED | | | | | 21 | 2 |
| 40 + 82 L | 22 | | 13.1 | 1 - 18 | 13.12 | RECESSED | | | | | 21 | 2 |
| 41 + 67 L | 23 | | 13.6 | 1 - 10 | 15.79 | RECESSED | | | | | 21 | 2 |
| 47 + 00 L CALLE AMERICO MIRANDA | 24 | | 17 | 1 - 24 | ? | RECESSED | | | | | 22 | 2 |
| 47 + 02 R CALLE AMERICO MIRANDA | 25 | | 17 | 1 - 24 | ? | RECESSED | | | | | 22 | 2 |
| 48 + 00 L | 26 | 43 | 17.6 | 1 - 48 | 13 | RECESSED | | | | | 24 | 3 |
| 50 + 00 R | 27 | 50 | 19 | 1 - 48 | 14 | RECESSED | | | | | 25 | 3 |
| 51 + 94 R CALLE 31 SE | 28 | | 20.1 | 1 - 24 | ? | RECESSED | | | | | 24 | 2 |
| 51 + 95 L | 29 | 65 | 20.1 | | | | 20.6/20.5 | 14 | 16.6 | 4.0/1.5 | 25 | 3 |

TABLE 19 (CONT'D)
JOSEFINA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET NUMBER | SIDE INLET DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT NO. AND DIAM. (IN.) | CULVERT INVERT ELEV. (FT.NGVD) | CULVERT FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET CREST LENGTH (FT.) | SIDE SPILLWAY INLET SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET SUPPLY CHAN. WIDTHS UPPER/LOWER (FT. NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 + 76 L | 30 | | 20.7 | 1 - 24 | 19.04 | RECESSED | | | | | 26 | 2 |
| 54 + 03.45 R | 31 | 60 | 20.8 | | | | 21.3/21.2 | 12 | 17.3 | 4.0/1.5 | 28 | 3 |
| 54 + 56 R | 32 | | 21.1 | 1 - 24 | 19.36 | RECESSED | | | | | 26 | 2 |
| 63 + 15 L | 33 | 114 | 26.3 | | | | 26.8/26.7 | 24 | 22.9 | 5.0/1.5 | 28.5 | 3 |
| 63 + 15 R | 34 | 114 | 26.3 | | | | 26.8/26.7 | 24 | 22.9 | 5.0/1.5 | 28.5 | 3 |
| 63 + 25 L | 35 | | 26.3 | 1 - 48X24 | 22.43 | RECESSED | | | | | 28 | 2 |
| 63 + 49 R | 36 | | 26.7 | 1 - 29X31 | 22.61 | RECESSED | | | | | 28 | 2 |
| 63 + 58 L | 37 | | 27.1 | 1 - 30 | 25.08 | RECESSED | | | | | 28 | 2 |
| 68 + 45 L | 38 | | 30.5 | 1 - 24 | 25.59 | RECESSED | | | | | 33 | 2 |
| 71 + 96 R | 39 | | 32.8 | ? | ? | RECESSED | | | | | 35 | 2 |
| 74 + 32 L | 40 | 83 | 34.3 | | | | 34.8/34.7 | 18 | | | 35 | 3 |
| 74 + 32 R | 41 | 83 | 34.3 | | | | 34.8/34.7 | 18 | | | 35 | 3 |

TABLE 20

DONA ANA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT.NGVD) | | |
| 1 + 20 R | 1 | 15 | 10.90 | 1 - 36 | 7.00 | RECESSED | | | | | 19 | 3 |
| 1 + 80 L | 2 | 96 | 11.50 | | | | 12 | 20 | 8.72 | 4.5/1.5 | 19 | 3 |
| 6 + 63 L | 3 | | 13.00 | 1 - 48 | 14.56 | RECESSED | | | | | 21 | 2 |
| 15 + 30 W | 4 | 106 | 21.40 | | | | 20.2/20.0 | 22 | 16.88 | 5.0/1.5 | 33 | 3 |
| 16 + 12 R | 5 | 107 | 20.50 | | | | 21.0/20.8 | 22 | 17.68 | 5.0/1.5 | 29 | 3 |
| 17 + 64 R | 6 | | 21.70 | 1 - 24 | 22.23 | RECESSED | | | | | 28.5 | 2 |
| 19 + 41 L CALLE 29 | 7 | | 23.50 | 1 - 36 | 25.60 | RECESSED | | | | | 35.4 | 2 |
| 25 + 45 L | 8 | | 28.10 | 1 - 48 | 27.90 | RECESSED | | | | | 39 | 2 |
| 27 + 95 L CALLE 21 | 9 | | 30.10 | 1 - 10 | 27.99 | RECESSED | | | | | 33.8 | 2 |
| 27 + 98 L CALLE 21 | 10 | | 30.10 | 1 - 24 | 27.99 | RECESSED | | | | | 33.8 | 2 |

TABLE 20 (cont'd)

DONA ANA CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET: NUMBER | SIDE INLET: DESIGN DISCHARGE (CFS) | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT: NO. AND DIAM. (IN.) | CULVERT: INVERT ELEV. (FT.NGVD) | CULVERT: FLAP GATES OR RECESSED INLET | SIDE SPILLWAY INLET: CREST ELEV. (UPP/LOW) (FT.NGVD) | SIDE SPILLWAY INLET: CREST LENGTH (FT.) | SIDE SPILLWAY INLET: SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SIDE SPILLWAY INLET: SUPPLY CHAN. WIDTHS UPPER/LOWER (FT.NGVD) | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 + 2 R CALLE 21 | 11 | | 30.10 | 1 - 30 | 28.89 | RECESSED | | | | | 33.8 | 2 |
| 30 + 49 R | 12 | | 30.20 | 1 - 30 | 29.49 | RECESSED | | | | | 36.4 | 2 |

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

TABLE 21
BUENA VISTA DIVERSION CHANNEL SIDE INLETS

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT.NGVD) | | |
| 2 + 00 L | 1 | - | 11.50 | 1 - 48 | 24.50 | RECESSED | | | | | 28 | 3 |
| 41 + 90 L | 2 | - | 45.80 | 1 - 48 | 31.60 | _ | | | | | | 3 |

FLUSHING CULVERT TO QUEBRADA BUENA VISTA

TABLE 22

GUARACANAL CHANNEL SIDE INLETS

(1) Not to be Disturbed
(2) Modify existing culvert
(3) New culvert/side spillway
(4) Replace old culvert with new

| STATION AND BANK (LOOKING DOWNSTREAM) | SIDE INLET | | CHANNEL WATER SURFACE ELEVATION (FT.NGVD) | CULVERT | | | SIDE SPILLWAY INLET | | | | AVERAGE GROUND ELEV. AT STATION (FT.NGVD) | ACTION TO BE TAKEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | DESIGN DISCHARGE (CFS) | | NO. AND DIAM. (IN.) | INVERT ELEV. (FT.NGVD) | FLAP GATES OR RECESSED INLET | CREST ELEV. (UPP/LOW) (FT.NGVD) | CREST LENGTH (FT.) | SIDE CHAN. INV. ELEV. AT UPPER END (FT. NGVD) | SUPPLY CHAN. WIDTHS UPPER/LOWER (FT.NGVD) | | |
| 2 + 00 L | 1 | - | 59.00 | 1 - 48 | 43.50 | RECESSED | | | | | 54 | 3 |
| 2 + 50 R | 2 | - | 59.60 | 1 - 48 | 44.00 | RECESSED | | | | | 60 | 3 |

TABLE 23

PUERTO NUEVO DEBRIS BASIN OUTLET WORKS

SIDE DISCHARGE SPILLWAY

SUMMARY OF HYDRAULIC DESIGN DATA

| | |
|---|---|
| Location | Puerto Nuevo Debris Basin |
| Station | 341+92.13 |
| Design conditions (100-year) | |
| Discharge (c.f.s.) | 26,123 |
| Headwater elevation | 96.00 |
| Tailwater elevation | 86.7 |
| Stilling basin design | |
| structure discharges directly into | - |
| downstream channel | - |
| SPF condition | |
| Discharge (c.f.s.) | 29,585 |
| Headwater elevation | 96.9 |
| Tailwater elevation | 89.0 |
| Crest | |
| Shape | sharp crested weir |
| Crest elevation | 87.4 |
| Design head (hd) (ft.) | 8.6 |
| Crest length (side) (FT.) | 300.0 |
| Crest length (end) (ft.) | 75.0 |
| Corner radius (ft.) | 3.44 |
| Net crest length (ft.) | 373.5 |
| Pool drain (notch) | |
| Intake dimensions (WxH, ft.) | 1.5 x 18.2 |
| Time to drain pool (below fixed crest) | Less than 1 day |
| Drain invert elevation | 69.2 |
| Channel section | |
| Upstream bottom width (ft.) | 375.0 |
| Upstream bottom elevation | 69.2 |
| Upstream side slopes | 1 on 3 |
| Downstream bottom width (ft.) | 75.0 |
| Downstream bottom elevation | 60.23 |
| Downstream side slopes | vertical |
| Protection elevation | 99.0 |

All elevations are in feet NGVD

TABLE 24

GUARACANAL DEBRIS BASIN OUTLET WORKS

SIDE DISCHARGE SPILLWAY

SUMMARY OF HYDRAULIC DESIGN DATA

| | |
|---|---|
| Location | Guaracanal Debris Basin |
| Station | 8+19 |
| Design conditions (100-year) | |
| Discharge (c.f.s.) | 11,075 |
| Headwater elevation | 74.20 |
| Tailwater elevation | 72.9 |
| Stilling basin design | |
| structure discharges directly into | - |
| downstream channel | - |
| SPF condition | |
| Discharge (c.f.s.) | 12,028 |
| Headwater elevation | 75.8 |
| Tailwater elevation | 74.0 |
| Crest | |
| Shape | sharp crested weir |
| Crest elevation | 57.6 |
| Design head (hd) (ft.) | 16.6 |
| Corner radius (ft.) | 6.64 |
| Net crest length (ft.) | 197.2 |
| Pool drain (notch) | |
| Intake dimensions (WxH, ft.) | 1.5 x 11.2 |
| Time to drain pool (below fixed crest) | Less than 1 day |
| Drain invert elevation | 46.4 |
| Channel section | |
| Upstream bottom width (ft.) | 200.0 |
| Upstream bottom elevation | 46.4 |
| Upstream side slopes | 1 on 3 |
| Downstream bottom width (ft.) | 50.0 |
| Downstream bottom elevation | 46.27 |
| Downstream side slopes | vertical |
| Protection elevation | 78.8 |

All elevations are in feet NGVD

**TABLE 25**

CORROSION MITIGATION SURVE
RIO PUERTO NUEVO
SAN JUAN, PUERTO RICO

SOIL SAMPLE ANALYSIS
AT BORING DEPTH AND LOCATION NOTED

| SAMPLE No. | CONDUCTIVITY (micro-mhos) | pH | CHLORIDE (ppm) | SULFATE (ppm) | REDOX | ALKAL. (ppm) | MOISTURE (ppm) |
|---|---|---|---|---|---|---|---|
| B1- 5' | 978 | 7.3 | 190 | 108 | +238 | 3.0 | 50 |
| -10' | 960 | 7.1 | 170 | 85 | +287 | 3.0 | 46 |
| -20' | 729 | 7.4 | 160 | <50 | + 86 | 3.0 | 45 |
| -30' | 444 | 7.8 | 110 | <50 | +244 | 4.0 | 38 |
| B2- 5' | 838 | 7.4 | 140 | 80 | + 67 | 3.0 | 37 |
| -10' | 580 | 7.1 | 110 | 100 | +201 | 4.0 | 51 |
| -20' | 914 | 6.8 | 230 | 90 | +294 | 3.0 | 47 |
| -30' | 947 | 6.9 | 250 | 50 | +132 | 5.0 | 50 |
| B3- 5' | 223 | 7.9 | 9 | 55 | +287 | 2.0 | 20 |
| -10' | 158 | 5.7 | 19 | 50 | +401 | 3.0 | 17 |
| -20' | 240 | 8.1 | 14 | 55 | +249 | 6.0 | 22 |
| -30' | 2202 | 7.1 | 620 | 85 | +287 | 2.0 | 20 |
| B4- 5' | 7011 | 7.6 | 2000 | 125 | - 86 | 7.0 | 49 |
| -10' | 15456 | 7.3 | 4100 | >200 | +152 | 3.0 | 166 |
| -20' | 9117 | 7.0 | 5100 | 200 | +191 | 6.0 | 128 |
| -30' | 3102 | 6.8 | 2000 | 100 | + 18 | 2.0 | 44 |
| B5- 5' | 996 | 7.6 | 400 | 150 | +226 | 10.0 | 31 |
| -10' | 3752 | 7.3 | 1000 | >200 | + 57 | 9.0 | 57 |
| -20' | 7280 | 7.9 | 2800 | 110 | +157 | 2.0 | 60 |
| -30' | 15680 | 7.1 | 4500 | >200 | +209 | 5.0 | 137 |

TABLE 25 (Cont.)

| SAMPLE No. | CONDUCTIVITY (micro-mhos) | pH | CHLORIDE (ppm) | SULFATE (ppm) | REDOX | ALKAL. (ppm) | MOISTURE (ppm) |
|---|---|---|---|---|---|---|---|
| B6- 5' | 1743 | 6.7 | 1600 | 55 | + 25 | 5.0 | 46 |
| -10' | 5174 | 7.90 | 2500 | 125 | + 90 | 4.0 | 21 |
| -20' | 17561 | 7.0 | 5400 | >200 | +120 | 3.0 | 231 |
| -30' | 21907 | 6.6 | 5200 | >200 | +218 | 8.0 | 288 |
| B7- 5' | 2700 | 9.6 | 760 | 150 | +116 | 2.0 | 21 |
| -10' | 3877 | 8.3 | 1000 | 200 | +164 | 2.0 | 31 |
| -20' | 14267 | 7.1 | 3200 | >200 | +215 | 3.0 | 319 |
| -30' | 13781 | 6.7 | 3500 | >200 | +226 | 2.0 | 244 |
| B8- 5' | 2354 | 9.5 | 1300 | 200 | +114 | 4.0 | 21 |
| -10' | 2927 | 7.6 | 1600 | 200 | - 90 | 5.0 | 39 |
| -20' | 9331 | 7.9 | 3200 | 200 | +138 | 6.0 | 97 |
| -30' | 2592 | 7.2 | 1600 | 75 | + 44 | 2.0 | 38 |

**TABLE 26**

CORROSION MITIGATION SURVEY
RIO PUERTO NUEVO
SAN JUAN, PUERTO RICO

ON SITE SOIL RESISTIVITIES
(ohm-cm)

| RDG. NO. | LOCATION | DEPTH (FEET) 2.5 | 5 | 7.5 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|---|
| 1 | "A" @ Dirt Road | 3064. | 2585. | 1723. | 1302. | 545.77 | 766. |
| 2 | 200 ft S "A" | 2824. | 2202. | 617.5 | 383. | 287.25 | 191.5 |
| 3 | 400 ft S "A" | 4021. | 5170. | 4883. | 4404. | 287.25 | 1915. |
| 4 | 600 ft S "A" | 1771. | 2585. | 3303. | 3064. | 3447. | 3332. |
| 5 | 800 ft S "A" | 1962. | 3255. | 3877. | 4404. | 4596. | 4596. |
| 6 | 1000 ft S "A" | 3973. | 5553. | 7468. | 7277. | 6894. | 4979. |
| 7 | 1200 ft S "A"-*- | 5745. | 5936. | 6463. | 6702. | 5745. | 4979. |
| 8 | 1400 ft S "A" | 4356. | 5745. | 5745. | 5745. | 5457.7 | |
| 9 | 1600 ft S "A" | 0532. | 11490. | 8904. | 7277. | 3734.2 | 2298. |
| 10 | 1800 ft S "A" | 5266. | 5074. | 3877. | 3830. | 976.65 | |
| 11 | 2000 ft S "A" | 3638. | 2681. | 2154. | 1819. | 833.02 | 383. |
| 12 | 2200 ft S "A"-**- | 1149. | 746.8 | 574.5 | 478.7 | 373.42 | 375.3 |
| 13 | 2400 ft S "A" | 1532. | 957.5 | 732.4 | 727.7 | 517.05 | 421.3 |
| 14 | 2600 ft S "A" | 1101. | 957.5 | 833. | 804.3 | 574.5 | 383. |
| 15 | 2800 ft S "A" | 718.1 | 507.4 | 445.2 | 402.1 | 287.25 | 344.7 |
| 16 | 3000 ft S "A" | 574.5 | 459.6 | 430.8 | 421.3 | 315.97 | 172.3 |
| 17 | 3200 ft S "A" | 574.5 | 325.5 | 258.5 | 248.9 | 261.39 | 245.1 |
| 18 | 3400 ft S "A"-***- | 813.8 | 421.3 | 287.2 | 229.8 | 186.71 | 122.5 |
| 19 | 3600 ft S "A" | 1340. | 861.7 | 531.4 | 459.6 | 315.97 | 222.1 |
| 20 | 3800 ft S "A" | 1771. | 813.8 | 588.8 | 402.1 | 287.25 | 210.6 |
| 21 | 4000 ft S "A"-****- | 1579. | 1532. | 1149. | 823.4 | 402.15 | 233.6 |
| 22 | @ Boring #4 | 2076. | 11490. | 1579. | | | 0 |
| 23 | 200 ft W rdg 22 | 10053. | 11490. | 6606. | 5745. | 373.42 | |
| 24 | 400 ft W rdg 22 | 10053. | 2872. | 4596. | | 0 | 0 |
| 25 | 600 ft W rdg 22 | 3877. | 2776. | 5314. | 2298. | 2039.4 | 1991. |
| 26 | 800 ft W rdg 22-+- | 9096. | 16277. | 14075. | 15703. | 15798. | 9575. |
| 27 | Adj to Boring #7 | 7181. | 3830. | 2872. | | 0 | 0 |
| 28 | Adj to Boring #8 | 2010. | 1532. | 1364. | 727.7 | | 0 |
| 29 | Adj to Boring #6 | 392.5 | 258.5 | 229.8 | 210.6 | 103.41 | |
| 30 | 200 ft S rdg 29 | 2010. | 1723. | 1364. | 823.4 | 315.97 | 352.3 |
| | MEAN VALUES | 4502. | 3737. | 3095. | 2557. | 1831.8 | 1269. |

Notes:
-*- rdg. is 60 ft. S. of Boring #3
-**- rdg. is 80 ft. S. of Boring #2
-***- rdg. is at Boring #1
-****- rdg. is at junction of Rio Puerto Nuevo & Rio Margarita
-+- rdg. is at Boring #5

**TABLE 27**

CORROSION MITIGATION SURVEY
RIO PUERTO NUEVO
SAN JUAN, PUERTO RICO

WATER SAMPLE ANALYSIS
SAMPLES BEGIN AT THE HIGHWAY AND END AT THE CHANNEL MOUTH

| SAMPLE No. | CONDUCTIVITY (micro-mhos) | pH | CHLORIDE (ppm) | SULFATE (ppm) | REDOX | HARDNESS (ppm) | ALKAL. (ppm) |
|---|---|---|---|---|---|---|---|
| WS1-B | 44690 | 6.9 | 7800 | >200 | +230 | 1319 | 2.2 |
| -S | 2344 | 7.1 | 2344 | 105 | +304 | 169 | 3.4 |
| WS2-B | 37496 | 7.3 | 10000 | >200 | +300 | 3250 | 2.4 |
| -S | 3782 | 7.2 | 3782 | 100 | +260 | 118 | 3.0 |
| WS3-B | 50249 | 6.9 | I3000 | >200 | +284 | 6450 | 2.2 |
| -S | 6889 | 7.0 | 200 | 125 | +295 | 828 | 3.0 |
| WS4-B | 50249 | 7.1 | 1400 | >200 | +267 | 6667 | 2.2 |
| -S | 6311 | 7.2 | 170 | 150 | +276 | 796 | 2.8 |
| WS5-B | 50031 | 6.9 | 15000 | 150 | +257 | 15478 | 2.4 |
| -S | 7096 | 7.1 | 140 | 200 | +282 | 1209 | 3.2 |
| WS6-B | 50903 | 7.0 | 7600 | 200 | +203 | 6458 | 2.4 |
| -S | 6725 | 7.1 | 1600 | 125 | +255 | 796 | 3.2 |
| WS7-B | 50576 | 7.0 | 9000 | >200 | +281 | 6854 | 2.4 |
| -S | 7390 | 7.2 | 3500 | >200 | +260 | 873 | 3.4 |
| WS8-B | 51339 | 7.0 | 11000 | >200 | + 77 | 6409 | 4.4 |
| -S | 8916 | 7.1 | 5800 | 200 | +248 | 1015 | 3.0 |
| WS9-B | 49050 | 6.9 | 13000 | 200 | - 16 | 5244 | 9.6 |
| -S | 20906 | 7.0 | 9000 | >200 | +240 | 2457 | 2.8 |
| WS1O-B | 51775 | 7.3 | 15000 | 200 | +218 | 6761 | 2.2 |
| -S | 45017 | 7.0 | 14000 | >200 | +153 | 5833 | 2.4 |

**TABLE 28**
CORROSION MITIGATION SURVEY
RIO PUERTO NUEVO
SAN JUAN, PUERTO RICO

ON SITE WATER TESTING

| Rdg. No. | LOCATION & DEPTH | Temp., C | Diss. Oxy. mg/l | pH | Rho, ohm-cm | Sample Taken |
|---|---|---|---|---|---|---|
| 1A | Under Rt. 22 Bridge (surf) | 27 | 1.6 | 6.0 | 470 | WS-1 (S) |
| 1B | Bottom- 3 ft. depth | 29 | 0.2 | 6.0 | 24 | WS-1 (B) |
| 2A | 200 ft. N (surf) | 27 | 1.8 | 6.0 | 180 | ---- |
| 28 | Bottom- 3 ft. Depth | 29 | 1.2 | 6.0 | 27 | ---- |
| 3A | 400 ft. North (surf) | 27 | 1.2 | 6.5 | 170 | ---- |
| 38 | Bottom- 5 ft. Depth | 28 | 0.2 | 7.0 | 23 | ---- |
| 4A | 600 ft. North (surf) | 27 | 1.0 | 6.5 | 230 | ---- |
| 4B | Bottom- 3 ft. Depth | 29 | 1.3 | 6.5 | 22 | ---- |
| 5A | 800 ft. North (surf) | 27 | 0.8 | 6.5 | 300 | WS-2 (S) |
| 5B | Bottom-6 ft. Depth | 28.5 | 1.1 | 6.5 | 33 | WS-2 (B) |
| 6A | 1000 ft. North (surf) | 27 | 1.0 | 6.5 | 250 | ---- |
| 6B | Bottom-3 ft. Depth | 28.5 | 1.2 | 8.5 | 22 | ---- |
| 7A | 1200 ft. North (surf) | 27.5 | 0.7 | 6.5 | 190 | ---- |
| 78 | Bottom- 3 ft. Depth | 28.5 | 1.3 | 6.5 | 25 | ---- |
| 8A | 1400 ft. North (surf) | 28.5 | 0.7 | 8.5 | 130 | ---- |
| 8B | Bottom- 4 ft. Depth | 28 | 1.0 | 6.5 | 24 | ---- |
| 9A | 1600 ft. North (surf) | 27.5 | 0.8 | 6.5 | 120 | ---- |
| 9B | Bottom- 4 ft. Depth | 28 | 1.4 | 6.5 | 26 | ---- |
| 10A | 1800 ft. North (surf) | 28 | 0.4 | 6.5 | 170 | WS-3 (S) |
| 10B | Bottom- 4 ft. Depth | 28 | 1.8 | 6.5 | 22 | WS-3 (B) |
| 11A | 2000 ft. North (surf) | 27.5 | 0.5 | 6.5 | 69 | ---- |
| 11B | Bottom- 4 ft. Depth | 28.2 | 1.7 | 6.5 | 23 | ---- |
| 12A | 2200 ft. North (surf) | 27.5 | 0.4 | 6.5 | 170 | ---- |
| 12B | Bottom- 4 ft. Depth | 28 | 1.2 | 6.5 | 26 | ---- |
| 13A | 2400 ft. North (surf) | 28 | 0.4 | 6.5 | 50 | ---- |
| 13B | Bottom- 4 ft. Depth | 28 | 1.4 | 6.5 | 22 | ---- |
| 14A | 2600 ft. North (surf) | 28 | 0.5 | 6.5 | 62 | ---- |
| 14@ | Bottom- 4 ft. Depth | 28 | 2.1 | 6.5 | 23 | ---- |
| 15A | 2800 ft. North (surf) | 28 | 0.6 | 6.5 | 190 | WS-4 (S) |
| 15B | Bottom- 4 ft. Depth | 28 | 2.7 | 6.5 | 23 | WS-4 (B) |
| 16A | 3000 ft. North (surf) | 28 | 0.2 | 6.5 | 140 | ---- |
| 16B | Bottom- 3 ft. Depth | 28 | 2.8 | 6.5 | 23 | ---- |
| 17A | 3200 ft. North (surf) | 28 | 0.5 | 6.5 | 100 | ---- |
| 17B | Bottom- 3 ft. Depth | 28 | 3.0 | 6.5 | 25 | ---- |
| 18A | 3400 ft. North (surf) | 28 | 0.4 | 6.5 | 160 | ---- |
| 18B | Bottom- 3 ft. Depth | 28 | 2.7 | 6.5 | 25 | ---- |
| 19A | 3600 ft. North (surf) | 28 | 0.6 | 6.5 | 180 | ---- |
| 19B | Bottom- 4 ft. Depth | 28 | 2.3 | 6.5 | 23 | ---- |
| 20A | 3800 ft. North (surf) | 28 | 0.2 | 6.5 | 160 | WS-5 (S) |
| 20B | Bottom- 4 ft. Depth | 28 | 2.4 | 6.5 | 25 | WS-5 (B) |
| 21A | 4000 ft. North (surf) | 28 | 0.2 | 6.5 | 180 | ---- |
| 21B | Bottom- 3 ft. Depth | 28 | 2.5 | 6.5 | 20 | ---- |
| 22A | 4200 ft. North (surf) | 28.5 | 0.1 | 6.5 | 180 | ---- |
| 22B | Bottom- 3 ft. Depth | 28.5 | 2.5 | 6.5 | 21 | ---- |

TABLE 28 (Cont.)

| Rdg. No. | LOCATION & DEPTH | Temp., C | Diss. Oxy. mg/l | pH | Rho, ohm-cm | Sample Taken |
|---|---|---|---|---|---|---|
| 23A | 4400 ft. North (surf) | 28.5 | 0.2 | 6.5 | 180 | ---- |
| 23B | Bottom- 3 ft. Depth | 28.5 | 2.3 | 7.0 | 26 | ---- |
| 24A | 4800 ft. North (surf) | 29 | 0.1 | 7.0 | 200 | ---- |
| 24B | Bottom- 3 ft. Depth | 28 | 2.7 | 7.0 | 21 | ---- |
| 25A | 4800 ft. North (surf) | 29 | 0.2 | 7.5 | 160 | WS-6 (S) |
| 25B | Bottom- 3 ft. Depth | 28 | 2.1 | 7.5 | 20 | WS-6 (B) |
| 26A | 5000 ft. North (surf) | 29 | 0.7 | 7.0 | 150 | ---- |
| 26B | Bottom- 4 ft. Depth | 28 | 2.3 | 7.0 | 24 | ---- |
| 27A | 5200 ft. North (surf) | 30 | 0.2 | 7.0 | 150 | ---- |
| 27B | Bottom- 4 ft. Depth | 28 | 2.8 | 7.0 | 24 | ---- |
| 28A | 5400 ft. North (surf) | 30 | 0.2 | 7.0 | 150 | ---- |
| 28B | Bottom- 4 ft. Depth | 28 | 2.7 | 7.0 | 21 | ---- |
| 29A | 5600 ft. North (surf) | 30 | 0.1 | 7.5 | 160 | ---- |
| 29B | Bottom- 4 ft. Depth | 28 | 3.0 | 7.5 | 20 | ---- |
| 30A | 5800 ft. North (surf) | 30 | 0.1 | 7.5 | 130 | WS-7 (S) |
| 30B | Bottom- 4 ft. Depth | 28 | 3.0 | 7.5 | 19 | WS-7 (B) |
| 31A | 6000 ft. North (surf) | 30 | 0.1 | 7.5 | 130 | ---- |
| 31B | Bottom- 3 ft. Depth | 28 | 3.0 | 7.5 | 20 | ---- |
| 32A | 6200 ft. North (surf)* | 30 | 0.2 | 7.5 | 140 | ---- |
| 32B | Bottom- 3 ft. Depth | 28 | 2.8 | 7.5 | 23 | ---- |
| 33A | 6400 ft. North (surf) | 30 | 0.3 | 7.0 | 150 | ---- |
| 33B | Bottom- 3 ft. Depth | 28 | 2.5 | 7.0 | 21 | ---- |
| 34A | 6600 ft. North (surf) | 30.5 | 0.2 | 7.0 | 110 | ---- |
| 34B | Bottom- 5 ft. Depth | 28 | 2.4 | 7.0 | 28 | ---- |
| 35A | 6800 ft. North (surf) | 30 | 0.4 | 7.5 | 130 | WS-8 (S) |
| 35B | Bottom- 5 ft. Depth | 27.5 | 2.4 | 7.5 | 23 | WS-8 (B) |
| 36A | 7000 ft. North (surf) | 30.5 | 0.4 | 7.5 | 120 | ---- |
| 38B | Bottom- 5 ft. Depth | 27.5 | 2.3 | 7.5 | 23 | ---- |
| 37A | 7200 ft. North (surf) | 30.5 | 0.4 | 7.5 | 120 | ---- |
| 37B | Bottom- 5 ft. Depth | 27.5 | 2.4 | 7.5 | 21 | ---- |
| 38A | 7400 ft. North (surf) | 30.5 | 0.2 | 7.5 | 91 | ---- |
| 38B | Bottom- 5 ft. Depth | 27.5 | 2.8 | 7.5 | 20 | ---- |
| 39A | 7800 ft. North (surf) | 30.5 | 0.1 | 7.5 | 45 | ---- |
| 39B | Bottom- 5 ft. Depth | 27.5 | 2.6 | 7.5 | 20 | ---- |
| 40A | 7800 ft. North (surf) | 30.5 | 0.4 | 7.5 | 47 | WS-9 (S) |
| 40B | Bottom- 7 ft. Depth | 27.5 | 2.6 | 7.5 | 25 | WS-9 (B) |
| 41A | 8000 ft. North (surf) | 30.5 | 0.2 | 7.0 | 47 | ---- |
| 41B | Bottom- 6 ft. Depth | 27.5 | 2.2 | 7.5 | 23 | ---- |
| 42A | 8200 ft. North (Surf) | 31 | 0.4 | 7.5 | 65 | ---- |
| 42B | Bottom- 6 ft. Depth | 27.5 | 2.6 | 7.5 | 23 | ---- |
| 43A | 8400 ft. North (surf) | 30.5 | 0.4 | 7.5 | 22 | ---- |
| 43B | Bottom- 6 ft. Depth | 27.5 | 2.9 | 7.5 | 24 | ---- |
| 44A | 8600 ft. North (surf) | 30.5 | 11.8 | 8.0 | 22 | ---- |
| 44B | 5 ft. Depth | 28 | 3.8 | 7.5 | 21 | ---- |
| 44C | Bottom- 7 ft. Depth | 27.5 | 3.2 | 7.5 | 22 | ---- |
| 45A | Mouth of R. Puerto N. | 29 | 10.8 | 8.0 | 23 | WS-10 (S) |
| 45B | 5 ft. Depth | 28 | 7.5 | 8.0 | 20 | ---- |
| 45C | Bottom- 7 ft. Depth | 28 | 6.7 | 8.0 | 20 | WS-10 (B) |

TABLE 29

**PROJECT COST SUMMARY**

Rio Puerto Nuevo

November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 08--- | ROADS, RAILROADS & BRIDGES | $10,574,000 | $1,903,000 | 18% | $12,477,000 |
| 09--- | CHANNELS AND CANALS | 180,565,000 | $30,663,000 | 17% | $211,228,000 |
| 14--- | RECREATION FACILITIES | $328,000 | $62,000 | 19% | $390,000 |
| | TOTAL CONSTRUCTION COSTS =====> | 191,467,000 | $32,628,000 | 17% | $224,095,000 |
| 01--- | LANDS AND DAMAGES | $12,773,400 | $3,193,400 | 25% | $15,966,800 |
| 02--- | RELOCATIONS | $17,805,000 | $2,838,000 | 16% | $20,643,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $17,233,000 | $2,936,000 | 17% | $20,169,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $19,146,000 | $3,264,000 | 17% | $22,410,000 |
| | TOTAL PROJECT COSTS ==========> | 258,424,400 | $44,859,400 | 17% | $303,283,800 |

TABLE 30

**CONTRACT # 1 COST SUMMARY**

Rio Puerto Nuevo

November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 08--- | ROADS, RAILROADS & BRIDGES | $4,572,000 | $701,000 | 15% | $5,273,000 |
| 09--- | CHANNELS AND CANALS | $35,670,000 | $6,307,000 | 18% | $41,977,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $40,242,000 | $7,008,000 | 17% | $47,250,000 |
| 01--- | LANDS AND DAMAGES | $559,500 | $140,000 | 25% | $699,500 |
| 02--- | RELOCATIONS | $2,112,000 | $327,000 | 15% | $2,439,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $3,622,000 | $631,000 | 17% | $4,253,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $4,024,000 | $701,000 | 17% | $4,725,000 |
| | TOTAL PROJECT COSTS ==========> | $50,559,500 | $8,807,000 | 17% | $59,366,500 |

TABLE 31

**CONTRACT # 2 COST SUMMARY**

Rio Puerto Nuevo

November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 08--- | ROADS, RAILROADS & BRIDGES | $2,364,000 | $473,000 | 20% | $2,837,000 |
| 09--- | CHANNELS AND CANALS | $59,104,000 | $9,697,000 | 16% | $68,801,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $61,468,000 | $10,170,000 | 17% | $71,638,000 |
| 01--- | LANDS AND DAMAGES | $3,975,500 | $994,000 | 25% | $4,969,500 |
| 02--- | RELOCATIONS | $5,459,000 | $867,000 | 16% | $6,326,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $5,532,000 | $915,000 | 17% | $6,447,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $6,147,000 | $1,017,000 | 17% | $7,164,000 |
| | TOTAL PROJECT COSTS ==========> | $82,581,500 | $13,963,000 | 17% | $96,544,500 |

TABLE 32
**CONTRACT # 3 COST SUMMARY**
Rio Puerto Nuevo
November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 09--- | CHANNELS AND CANALS | $20,534,000 | $3,648,000 | 18% | $24,182,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $20,534,000 | $3,648,000 | 18% | $24,182,000 |
| 01--- | LANDS AND DAMAGES | $1,691,000 | $423,000 | 25% | $2,114,000 |
| 02--- | RELOCATIONS | $3,010,000 | $493,000 | 16% | $3,503,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $1,848,000 | $328,000 | 18% | $2,176,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $2,054,000 | $365,000 | 18% | $2,419,000 |
| | TOTAL PROJECT COSTS ==========> | $29,137,000 | $5,257,000 | 18% | $34,394,000 |

TABLE 33

**CONTRACT # 4 COST SUMMARY**

Rio Puerto Nuevo

November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 08--- | ROADS, RAILROADS & BRIDGES | $3,378,000 | $678,000 | 20% | $4,056,000 |
| 09--- | CHANNELS AND CANALS | $22,896,000 | $3,885,000 | 17% | $26,781,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $26,274,000 | $4,563,000 | 17% | $30,837,000 |
| 01--- | LANDS AND DAMAGES | $4,740,000 | $1,185,000 | 25% | $5,925,000 |
| 02--- | RELOCATIONS | $2,583,000 | $419,000 | 16% | $3,002,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $2,365,000 | $411,000 | 17% | $2,776,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $2,627,000 | $457,000 | 17% | $3,084,000 |
| | TOTAL PROJECT COSTS ==========> | $38,589,000 | $7,035,000 | 18% | $45,624,000 |

TABLE 34
**CONTRACT # 5 COST SUMMARY**
Rio Puerto Nuevo
November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 09--- | CHANNELS AND CANALS | $16,796,000 | $2,827,000 | 17% | $19,623,000 |
| 14--- | RECREATION FACILITIES | $328,000 | $62,000 | 19% | $390,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $17,124,000 | $2,889,000 | 17% | $20,013,000 |
| 01--- | LANDS AND DAMAGES | $557,000 | $139,000 | 25% | $696,000 |
| 02--- | RELOCATIONS | $2,786,000 | $439,000 | 16% | $3,225,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $1,541,000 | $260,000 | 17% | $1,801,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $1,712,000 | $289,000 | 17% | $2,001,000 |
| | TOTAL PROJECT COSTS ==========> | $23,720,000 | $4,016,000 | 17% | $27,736,000 |

TABLE 35

**CONTRACT # 6 COST SUMMARY**

Rio Puerto Nuevo

November 1990 Price Level

| ACCOUNT NUMBER | ITEM DESCRIPTION | ESTIMATED COST NOVEMBER 90* | CONTINGENCY AMOUNT($) | % | TOTAL EST COST NOVEMBER 90 |
|---|---|---|---|---|---|
| | | *EFFECTIVE PRICING DATE | | | |
| 08--- | ROADS, RAILROADS & BRIDGES | $260,000 | $51,000 | 20% | $311,000 |
| 09--- | CHANNELS AND CANALS | $25,565,000 | $4,299,000 | 17% | $29,864,000 |
| | TOTAL CONSTRUCTION COSTS =====> | $25,825,000 | $4,350,000 | 17% | $30,175,000 |
| 01--- | LANDS AND DAMAGES | $1,250,400 | $312,400 | 25% | $1,562,800 |
| 02--- | RELOCATIONS | $1,855,000 | $293,000 | 16% | $2,148,000 |
| 30--- | PLANNING, ENGINEERING AND DESIGN | $2,325,000 | $391,000 | 17% | $2,716,000 |
| 31--- | CONSTRUCTION MANAGEMENT | $2,582,000 | $435,000 | 17% | $3,017,000 |
| | TOTAL PROJECT COSTS ==========> | $33,837,400 | $5,781,400 | 17% | $39,618,800 |

TABLE 36

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 0+90 TO STA 74+32**
**CONTRACT 1 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $4,572,000 | $701,000 | $5,273,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $35,670,000 | $6,307,000 | $41,977,000 |
| | Subtotal, Construction Costs: | $40,242,000 | $7,008,000 | $47,250,000 |
| | Contingencies @ Average of 17.4 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 559,500 | 140,000 | 699,500 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | ROADS - CONSTRUCTION ACTIVITIES | 212,000 | 40,000 | 252,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,900,000 | 287,000 | 2,187,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 3,622,000 | 631,000 | 4,253,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 4,024,000 | 701,000 | 4,725,000 |
| | TOTAL PROJECT COSTS | $50,559,500 | $8,807,000 | $59,366,500 |

TABLE 36 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 0+90 TO STA 74+32**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | ROADS - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 14,000 | 25 | 4,000 | 1 |
| 02.1.1.- | Care of Traffic | | | | | | | |
| | Barriers and Markers | 1 | JOB | LS | 5,000 | 18 | 900 | 3,7 |
| 02.1.2.- | Construct Roads to Subgrade | | | | | | | |
| | Clearing and Grubbing | 1 | AC | 650.00 | 650 | 18 | 100 | 3,7 |
| | Random Fill | 32,000 | CY | 5.00 | 160,000 | 18 | 29,000 | 3,7 |
| 02.1.3.- | Road Surfacing | | | | | | | |
| | Asphaltic Concrete Pavement | 1,350 | SY | 24.00 | 32,400 | 18 | 6,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $212,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.9 % | | | | | | $40,000 | |
| 02.1.-.- | Roads - Construction Activities Total: | | | | | | $252,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 36 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 0+90 TO STA 74+32**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES, AND STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 50,000 | 15 | 8,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 1,200,000 | 15 | 180,000 | 2 |
| | Water Lines | 1 | JOB | LS | 550,000 | 15 | 83,000 | 2 |
| | Fuel Lines | 1 | JOB | LS | 50,000 | 15 | 8,000 | 2 |
| | Cable TV Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Subtotal, Construction Costs: | | | | $1,900,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.1 % | | | | | | $287,000 | |
| 02.3.-.- | Cemeteries, Utilities, And Structures - Construction Activities Total: | | | | | | $2,187,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 36 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 0+90 TO STA 74+32**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.-.- | ROADS (Including Bridges) | | | | | | | |
| 08.2.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 299,000 | 20 | 60,000 | 1 |
| 08.2.K.- | Bridges, Abutments & Piers | | | | | | | |
| | Kennedy Avenue Bridge Mod | | | | | | | |
| | Channel Excavation (Riprap Placement) | 19,630 | CY | 18.08 | 354,910 | 15 | 53,000 | 8 |
| | Structural Excavation | 1,080 | CY | 10.65 | 11,502 | 15 | 2,000 | 8 |
| | Structural Backfill | 1,164 | CY | 12.00 | 13,968 | 15 | 2,000 | 8 |
| | Steel Sheet Piling | 71,267 | SF | 38.36 | 2,733,802 | 15 | 410,000 | 8 |
| | Steel Tie Rods | 110 | EA | 282.00 | 31,020 | 15 | 5,000 | 8 |
| | Conc Sheet Pile Cap | 563 | CY | 690.00 | 388,470 | 15 | 58,000 | 8 |
| | Conc Cofferdam Slab | 365 | CY | 140.00 | 51,100 | 15 | 8,000 | 8 |
| | Reinforcing Steel | 352,640 | LBS | 0.53 | 186,899 | 15 | 28,000 | 8 |
| | Riprap | 9,276 | CY | 44.00 | 408,144 | 15 | 61,000 | 8 |
| | Stone Bedding | 1,630 | CY | 44.00 | 71,720 | 15 | 11,000 | 8 |
| | Filter Fabric | 7,572 | SY | 2.83 | 21,429 | 15 | 3,000 | 8 |
| | Subtotal, Construction Costs: | | | | $4,572,000 | | | |
| 08.2.Z.- | Contingencies @ Average of 15.3 % | | | | | | $701,000 | |
| 08.2.-.- | Roads (Including Bridges) Total: | | | | | | $5,273,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 36 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 0+90 TO STA 74+32**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 1,313,000 | 20 | 263,000 | 1 |
| 09.1.A.- | Mobilization, Demob & Prep Work (Dredging) | 1 | JOB | LS | 420,000 | 20 | 84,000 | 1 |
| 09.1.6.- | Mechanical Dredging | | | | | | | |
| | Mechanical Dredging (Ocean Disposal) | 2,837,150 | CY | 5.35 | 15,178,752 | 20 | 3,036,000 | 7 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing (Mangroves & Woods) | 72 | AC | 5,400 | 388,800 | 20 | 78,000 | 7 |
| | Riprap 12" | 24,500 | CY | 45.00 | 1,102,500 | 20 | 221,000 | 7 |
| | Borrow Fill | 3,030 | CY | 5.00 | 15,150 | 20 | 3,000 | 4,5 |
| | Mangrove Planting | 10 | AC | 8,700 | 87,000 | 20 | 17,000 | 7 |
| | Fencing for Mangroves 6' Chainlink | 2,980 | LF | 8.00 | 23,840 | 15 | 4,000 | 8 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 1,000 | 20 | 200 | 3,7 |
| | Fencing 6' Chainlink w/3 strands barb wire | 15,500 | LF | 10.00 | 155,000 | 15 | 23,000 | 8 |
| | Remove Existing King Pile Walls | | | | | | | |
| | Demolish Pile Caps | 470 | CY | 100.00 | 47,000 | 20 | 9,000 | 4,7 |
| | Remove Panels | 1,540 | EA | 100.00 | 154,000 | 20 | 31,000 | 4,7 |
| | Pull Vertical Piles | 20,020 | LF | 10.00 | 200,200 | 20 | 40,000 | 4,7 |
| | Pull Batter Piles | 20,020 | LF | 10.00 | 200,200 | 20 | 40,000 | 4,7 |
| | Steel Sheet Pile Walls | | | | | | | |
| | Steel Sheet Piling PZ-27 | 189,250 | SF | 29.00 | 5,488,250 | 15 | 823,000 | 8 |
| | Piling Furnished, Batter 18" | 61,500 | LF | 30.00 | 1,845,000 | 15 | 277,000 | 8 |
| | Piling Driven, Batter 18" | 61,500 | LF | 7.70 | 473,550 | 15 | 71,000 | 8 |
| | Concrete Facing 6" | 1,820 | CY | 170.00 | 309,400 | 15 | 46,000 | 8 |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 36 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 0+90 TO STA 74+32**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.T.- | Concrete | | | | | | | |
| | Construct King Pile Walls | | | | | | | |
| | Piling Furnished, Vertical 24" | 68,250 | LF | 40.00 | 2,730,000 | 15 | 410,000 | 8 |
| | Piling Furnished, Batter 18" | 68,250 | LF | 30.00 | 2,047,500 | 15 | 307,000 | 8 |
| | Piling Driven, Vertical | 68,250 | LF | 7.70 | 525,525 | 15 | 79,000 | 8 |
| | Piling Driven, Batter | 68,250 | LF | 7.70 | 525,525 | 15 | 79,000 | 8 |
| | Unloaded Test Piles, Vertical 24" | 6 | EA | 4,600 | 27,600 | 15 | 4,000 | 8 |
| | Unloaded Test Piles, Batter 18" | 6 | EA | 4,000 | 24,000 | 15 | 4,000 | 8 |
| | Pile Splices, Vertical | 10 | EA | 630.00 | 6,300 | 15 | 1,000 | 8 |
| | Pile Splices, Batter | 10 | EA | 630.00 | 6,300 | 15 | 1,000 | 8 |
| | Panels | 5,250 | EA | 300.00 | 1,575,000 | 15 | 236,000 | 8 |
| | Pile Caps | 1,600 | CY | 500.00 | 800,000 | 15 | 120,000 | 8 |
| | Subtotal, Construction Costs: | | | | $35,670,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 17.7 % | | | | | | $6,307,000 | |
| 09.1.-.- | Channels Total: | | | | | | $41,977,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 37

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL STA 74+32 TO STA 147+40**
**AND MARGARITA TRIBUTARY**
**CONTRACT 2 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $2,364,000 | $473,000 | $2,837,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $59,104,000 | $9,697,000 | $68,801,000 |
| | Subtotal, Construction Costs: | $61,468,000 | $10,170,000 | $71,638,000 |
| | Contingencies @ Average of 16.5 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 3,975,500 | 994,000 | 4,969,500 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 1,335,000 | 247,000 | 1,582,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 4,124,000 | 620,000 | 4,744,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 5,532,000 | 915,000 | 6,447,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 6,147,000 | 1,017,000 | 7,164,000 |
| | TOTAL PROJECT COSTS | $82,581,500 | $13,963,000 | $96,544,500 |

TABLE 37 (Cont)

NOVEMBER 1990 PRICE LEVEL

PUERTO NUEVO MAIN CHANNEL

STA 74+32 TO STA 147+40

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 500,000 | 15 | 75,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 1,750,000 | 15 | 263,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 550,000 | 15 | 83,000 | 2 |
| | Water Lines | 1 | JOB | LS | 600,000 | 15 | 90,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 27,000 | 15 | 4,000 | 2 |
| | Subtotal, Construction Costs: | | | | $3,427,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.0 % | | | | | | $515,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $3,942,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 37 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 74+32 TO STA 147+40**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.-.- | ROADS (Including Bridges) | | | | | | | |
| 08.2.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 132,000 | 20 | 26,000 | 1 |
| 08.2.k.- | Bridges, Abutments & Piers | | | | | | | |
| | Bridge Mod @ STA 93+58 (De Diego Exp) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 474,400 | 20 | 95,000 | 5,7 |
| | Soil Nailing | 52,500 | LF | 11.00 | 577,500 | 20 | 116,000 | 5,7 |
| | Shotcrete, Reinforced, 6" | 1,500 | SY | 40.00 | 60,000 | 20 | 12,000 | 5,7 |
| | Concrete | 4,300 | CY | 180.00 | 774,000 | 20 | 155,000 | 5,7 |
| | Subtotal, Construction Costs: | | | | $2,018,000 | | | |
| 08.2.Z.- | Contingencies @ Average of 20.0 % | | | | | | $404,000 | |
| 08.2.-.- | Roads (Including Bridges) Total: | | | | | | $2,422,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 37 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 74+32 TO STA 147+40**

**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $2,018,000 | $404,000 | $2,422,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $47,738,000 | $7,564,000 | $55,302,000 |
| | Subtotal, Construction Costs: | $49,756,000 | $7,968,000 | $57,724,000 |
| | Contingencies @ Average of 16.0 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 3,517,500 | 879,000 | 4,396,500 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 1,335,000 | 247,000 | 1,582,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 3,427,000 | 515,000 | 3,942,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 4,478,000 | 717,000 | 5,195,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 4,976,000 | 797,000 | 5,773,000 |
| | TOTAL PROJECT COSTS | $67,489,500 | $11,123,000 | $78,612,500 |

TABLE 37 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 74+32 TO STA 147+40**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 87,000 | 25 | 22,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | New Ped. Steel Bridge @ STA 110+06 | 1,080 | SF | 45.00 | 48,600 | 18 | 9,000 | 3,7 |
| | Conc Bridge Demol @Roosevelt Ave STA 119+00 | 10,450 | SF | 20.00 | 209,000 | 18 | 38,000 | 4,7 |
| | New Conc Bridge @Roosevelt Ave STA 119+00 | 18,000 | SF | 55.00 | 990,000 | 18 | 178,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $1,335,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.5 % | | | | | | $247,000 | |
| 02.1.-.- | Construction Activities Total: | | | | | | $1,582,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 37 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 74+32 TO STA 147+40**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 3,123,000 | 20 | 625,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 9 | AC | 4,000 | 36,000 | 20 | 7,000 | 7 |
| | Excavation | 884,570 | CY | 4.35 | 3,847,879 | 20 | 770,000 | 4,5 |
| | Borrow Fill | 15,000 | CY | 5.00 | 75,000 | 20 | 15,000 | 4,5 |
| | Granular Material | 61,250 | CY | 13.75 | 842,188 | 20 | 168,000 | 4,5 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 134,500 | 20 | 27,000 | 3,7 |
| | Fencing 6' chainlink w/3 strands barb wire | 11,800 | LF | 10.00 | 118,000 | 15 | 18,000 | 8 |
| | Steel Sheet Pile Walls | | | | | | | |
| | Steel Sheet Piling PZ-27 | 590,680 | SF | 23.00 | 13,585,640 | 15 | 2,038,000 | 8 |
| | Piling Furnished, Batter 18" | 133,200 | LF | 30.00 | 3,996,000 | 15 | 599,000 | 8 |
| | Piling Driven, Batter 18" | 133,200 | LF | 7.70 | 1,025,640 | 15 | 154,000 | 8 |
| | Concrete Facing 6" | 21,115 | CY | 170.00 | 3,589,550 | 15 | 538,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | 4' Tremie Concrete Bottom | 151,000 | CY | 115.00 | 17,365,000 | 15 | 2,605,000 | 8 |
| | Subtotal, Construction Costs: | | | | $47,738,000 | | | |
| | Contingencies @ Average of 15.8 % | | | | | | $7,564,000 | |
| 09.1.-.- | Channels Total: | | | | | | $55,302,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 38

NOVEMBER 1990 PRICE LEVEL

**MARGARITA TRIBUTARY**

**STA 0+00 to 89+60**

**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $346,000 | $69,000 | $415,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $11,366,000 | $2,133,000 | $13,499,000 |
| | Subtotal, Construction Costs: | $11,712,000 | $2,202,000 | $13,914,000 |
| | Contingencies @ Average of 18.8 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 458,000 | 115,000 | 573,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 697,000 | 105,000 | 802,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 1,054,000 | 198,000 | 1,252,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 1,171,000 | 220,000 | 1,391,000 |
| | TOTAL PROJECT COSTS | $15,092,000 | $2,840,000 | $17,932,000 |

TABLE 38 (Cont)

NOVEMBER 1990 PRICE LEVEL

**MARGARITA TRIBUTARY**

**STA 0+00 to 89+60**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES, AND STRUCTURES-CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 400,000 | 15 | 60,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 15,000 | 15 | 2,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 150,000 | 15 | 23,000 | 2 |
| | Water Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Cable TV Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 82,000 | 15 | 12,000 | 2 |
| | Subtotal, Construction Costs: | | | | $697,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.1 % | | | | | | $105,000 | |
| 02.3.-.- | Cemeteries, Utilities, And Structures- Total: Construction Activities | | | | | | $802,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 38 (Cont)

NOVEMBER 1990 PRICE LEVEL

**MARGARITA TRIBUTARY**
**STA 0+00 to 89+60**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.-.- | ROADS (Including Bridges) | | | | | | | |
| 08.2.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 23,000 | 20 | 5,000 | 1 |
| 08.2.K.- | Bridges, Abutments & Piers | | | | | | | |
| | Bridge Mod @ STA 60+00 (De Diego Exp) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 166,500 | 20 | 33,000 | 5,7 |
| | Concrete (Channel) | 870 | CY | 180.00 | 156,600 | 20 | 31,000 | 5,7 |
| | Subtotal, Construction Costs: | | | | $346,000 | | | |
| 08.2.Z.- | Contingencies @ Average of 19.9 % | | | | | | $69,000 | |
| 08.2.-.- | Roads (Including Bridges) Total: | | | | | | $415,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 38 (Cont)

NOVEMBER 1990 PRICE LEVEL

**MARGARITA TRIBUTARY**

**STA 0+00 to 89+60**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 457,000 | 20 | 91,000 | 1 |
| 09.1.A.- | Mobilization, Demob & Prep Work (Dredging) | 1 | JOB | LS | 420,000 | 20 | 84,000 | 1 |
| 09.1.6.- | Mechanical Dredging | | | | | | | |
| | Mechanical Dredging (ocean disposal) | 660,810 | CY | 6.00 | 3,964,860 | 20 | 793,000 | 7 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 73 | AC | 3,000 | 219,000 | 20 | 44,000 | 7 |
| | Dewatering | 1 | JOB | LS | 1,608,400 | 20 | 322,000 | 7 |
| | Excavation | 96,270 | CY | 2.80 | 269,556 | 20 | 54,000 | 4,5 |
| | Borrow Fill | 138,700 | CY | 5.00 | 693,500 | 20 | 139,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 537,200 | 20 | 107,000 | 4,5 |
| | Dike Fill | 60,800 | CY | 0.75 | 45,600 | 20 | 9,000 | 4,5 |
| | Riprap | 1,700 | CY | 45.00 | 76,500 | 20 | 15,000 | 7 |
| | Steel sheetpile Wing Walls | 5,400 | SF | 23.00 | 124,200 | 15 | 19,000 | 8 |
| | Mangrove Planting | 6 | AC | 8,700 | 52,200 | 20 | 10,000 | 8 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 211,000 | 20 | 42,000 | 3,7 |
| | Fencing 6' Chainlink | 17,920 | LF | 8.00 | 143,360 | 15 | 22,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 14,130 | CY | 180.00 | 2,543,400 | 15 | 382,000 | 8 |
| | Subtotal, Construction Costs: | | | | $11,366,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 18.8 % | | | | | | $2,133,000 | |
| 09.1.-.- | Channels Total: | | | | | | $13,499,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39

NOVEMBER 1990 PRICE LEVEL

**JOSEFINA TRIBUTARY STA 0+00 TO 77+29**
**AND DOÑA ANA TRIBUTARY STA 0+00 TO 32+80**
**CONTRACT 3 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $20,534,000 | $3,648,000 | $24,182,000 |
| | Subtotal, Construction Costs: | $20,534,000 | $3,648,000 | $24,182,000 |
| | Contingencies @ Average of 17.8 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 1,691,000 | 423,000 | 2,114,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 1,165,000 | 217,000 | 1,382,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,845,000 | 276,000 | 2,121,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 1,848,000 | 328,000 | 2,176,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 2,054,000 | 365,000 | 2,419,000 |
| | TOTAL PROJECT COSTS | $29,137,000 | $5,257,000 | $34,394,000 |

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**JOSEFINA TRIBUTARY**

**STA 0+00 to 77+29**

**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $14,877,000 | $2,680,000 | $17,557,000 |
| | Subtotal, Construction Costs: | $14,877,000 | $2,680,000 | $17,557,000 |
| | Contingencies @ Average of 18.0 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 960,000 | 240,000 | 1,200,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 847,000 | 158,000 | 1,005,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 933,000 | 140,000 | 1,073,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 1,339,000 | 241,000 | 1,580,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 1,488,000 | 268,000 | 1,756,000 |
| | TOTAL PROJECT COSTS | $20,444,000 | $3,727,000 | $24,171,000 |

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**JOSEFINA TRIBUTARY**
**STA 0+00 to 77+29**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 55,000 | 25 | 14,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | Exist Bridge Demol @ STA 24+67 (Pinero Ave) | 5,100 | SF | 20.00 | 102,000 | 18 | 18,000 | 4,7 |
| | New Conc Bridge @ STA 24+67 (Pinero Ave) | 3,825 | SF | 55.00 | 210,375 | 18 | 38,000 | 3,7 |
| | Exist Brdg Demol @ STA 31+10 (Analucia Ave) | 2,150 | SF | 20.00 | 43,000 | 18 | 8,000 | 4,7 |
| | New Conc Bridge @ STA 31+10 (Analucia Ave) | 2,700 | SF | 55.00 | 148,500 | 18 | 27,000 | 3,7 |
| | Exist Ped Bridge Demol @ STA 40+58 | 270 | SF | 20.00 | 5,400 | 18 | 1,000 | 4,7 |
| | New Ped Conc Bridge @ STA 40+58 | 220 | SF | 45.00 | 9,900 | 18 | 2,000 | 3,7 |
| | Exist Brdg Demol @ STA 47+30 (Americo Mir) | 1,750 | SF | 20.00 | 35,000 | 18 | 6,000 | 4,7 |
| | New Conc Bridge @ STA 47+30 (Americo Mir) | 1,100 | SF | 55.00 | 60,500 | 18 | 11,000 | 3,7 |
| | Exist Brdg Demol @ STA 52+24 (Calle 31 SE) | 540 | SF | 20.00 | 10,800 | 18 | 2,000 | 4,7 |
| | New Conc Bridge @ STA 52+24 (Calle 31 SE) | 880 | SF | 55.00 | 48,400 | 18 | 9,000 | 3,7 |
| | Exist Brdg Demol @ STA 63+40 (Calle 21 SE) | 800 | SF | 20.00 | 16,000 | 18 | 3,000 | 4,7 |
| | New Conc Bridge @ STA 63+40 (Calle 21 SE) | 880 | SF | 55.00 | 48,400 | 18 | 9,000 | 3,7 |
| | Exist Bridge Demol @ STA 74+50 (CAlle 9 SE) | 800 | SF | 20.00 | 16,000 | 18 | 3,000 | 4,7 |
| | New Conc Bridge @ STA 74+50 (CAlle 9 SE) | 680 | SF | 55.00 | 37,400 | 18 | 7,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $847,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.7 % | | | | | | $158,000 | |
| 02.1.-.- | Construction Activities Total: | | | | | | $1,005,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**JOSEFINA TRIBUTARY**

**STA 0+00 to 77+29**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES, AND STRUCTURES-CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 475,000 | 15 | 71,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 250,000 | 15 | 38,000 | 2 |
| | Water Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Gas Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Local Drainage | 1 | JOB | LS | 33,000 | 15 | 5,000 | 2 |
| | Subtotal, Construction Costs: | | | | $933,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.0 % | | | | | | $140,000 | |
| 02.3.-.- | Cemeteries, Utilities, And Structures- Total: | | | | | | $1,073,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**JOSEFINA TRIBUTARY**
**STA 0+00 to 77+29**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 973,000 | 20 | 195,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 11 | ACR | 2,000 | 22,000 | 20 | 4,000 | 7 |
| | Dewatering | 1 | JOB | LS | 2,049,000 | 20 | 410,000 | 7 |
| | Demolition Concrete Slab (8") | 2,500 | CY | 29.00 | 72,500 | 25 | 18,000 | 4,7 |
| | Excavation | 310,000 | CY | 4.00 | 1,240,000 | 25 | 310,000 | 4,5,6 |
| | Borrow Fill | 150,300 | CY | 5.00 | 751,500 | 25 | 188,000 | 4,5,6 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 435,900 | 20 | 87,000 | 4,5,6 |
| | Steel sht Pile Wall PZ-27 | 140,000 | SF | 34.00 | 4,760,000 | 15 | 714,000 | 8 |
| | Floodwall (Steel sheetpile) | 3,000 | SF | 23.00 | 69,000 | 15 | 10,000 | 8 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 141,000 | 20 | 28,000 | 3,7 |
| | Fencing 6' Chainlink | 15,458 | LF | 8.00 | 123,664 | 15 | 19,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 16,850 | CY | 180.00 | 3,033,000 | 15 | 455,000 | 8 |
| | Misc concrete (pile caps, facing, slab) | 6,800 | CY | 166.00 | 1,128,800 | 20 | 226,000 | 8 |
| | Concrete mud slab, 4" | 1,000 | CY | 78.00 | 78,000 | 20 | 16,000 | 8 |
| | Subtotal, Construction Costs: | | | | $14,877,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 18.0 % | | | | | | $2,680,000 | |
| 09.1.-.- | Channels Total: | | | | | | $17,557,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**DOÑA ANA TRIBUTARY**
**STA 0+00 to STA 32+80**
**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $5,657,000 | $968,000 | $6,625,000 |
| | Subtotal, Construction Costs: | $5,657,000 | $968,000 | $6,625,000 |
| | Contingencies @ Average of 17.1 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 731,000 | 183,000 | 914,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 318,000 | 59,000 | 377,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 912,000 | 136,000 | 1,048,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 509,000 | 87,000 | 596,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 566,000 | 97,000 | 663,000 |
| | TOTAL PROJECT COSTS | $8,693,000 | $1,530,000 | $10,223,000 |

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**DOÑA ANA TRIBUTARY**

**STA 0+00 to STA 32+80**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 21,000 | 25 | 5,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | Exist Bridge Demol @ STA 15+45 (Americo Miranda) | 3,150 | SF | 20.00 | 63,000 | 18 | 11,000 | 4,7 |
| | New Conc Brdg @ STA 15+45 (Americo Miranda) | 1,600 | SF | 55.00 | 88,000 | 18 | 16,000 | 3,7 |
| | Exist Brdg Demol @ STA 19+50 (Calle 29 SE) | 1,200 | SF | 20.00 | 24,000 | 18 | 4,000 | 4,7 |
| | New Conc Brdg @ STA 19+50 (Calle 29 SE) | 880 | SF | 55.00 | 48,400 | 18 | 9,000 | 3,7 |
| | Exist Brdg Demol @ STA 27+94 (Calle 21 SE) | 1,260 | SF | 20.00 | 25,200 | 18 | 5,000 | 4,7 |
| | New Conc Bridge @ STA 27+94 (CAlle 21 SE) | 880 | SF | 55.00 | 48,400 | 18 | 9,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $318,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.6 % | | | | | | $59,000 | |
| 02.1.-.- | Construction Activities Total: | | | | | | $377,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**DOÑA ANA TRIBUTARY**

**STA 0+00 to STA 32+80**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 500,000 | 15 | 75,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 15,000 | 15 | 2,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 300,000 | 15 | 45,000 | 2 |
| | Water Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 22,000 | 15 | 3,000 | 2 |
| | Subtotal, Construction Costs: | | | | $912,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 14.9 % | | | | | | $136,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $1,048,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 39 (Cont)

NOVEMBER 1990 PRICE LEVEL

**DOÑA ANA TRIBUTARY**
**STA 0+00 to STA 32+80**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 370,000 | 20 | 74,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 2 | ACR | 3,000 | 6,000 | 20 | 1,000 | 7 |
| | Dewatering | 1 | JOB | LS | 295,000 | 20 | 59,000 | 7 |
| | Demolition Concrete Slab (8") | 1,700 | CY | 29.00 | 49,300 | 25 | 12,000 | 4,7 |
| | Excavation | 44,400 | CY | 6.50 | 288,600 | 25 | 72,000 | 4,5,6 |
| | Borrow Fill | 13,000 | CY | 5.00 | 65,000 | 25 | 16,000 | 4,5,6 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 22,700 | 20 | 5,000 | 4,5,6 |
| | Steel sheetpile Wall PZ-27 | 96,200 | SF | 34.00 | 3,270,800 | 15 | 491,000 | 8 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 40,000 | 20 | 8,000 | 3,7 |
| | Fencing, 6' Chain Link | 6,560 | LF | 8.00 | 52,480 | 15 | 8,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 1,900 | CY | 180.00 | 342,000 | 15 | 51,000 | 8 |
| | Misc concrete (pile caps, facing, slab) | 4,800 | CY | 166.00 | 796,800 | 20 | 159,000 | 8 |
| | Concrete mud slab, 4" | 750 | CY | 78.00 | 58,500 | 20 | 12,000 | 8 |
| | Subtotal, Construction Costs: | | | | $5,657,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 17.1 % | | | | | | $968,000 | |
| 09.1.-.- | Channels Total: | | | | | | $6,625,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL STA 147+40 TO STA 205+85**
**AND BUENA VISTA DIVERSION**
**CONTRACT 4 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $3,378,000 | $678,000 | $4,056,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $22,896,000 | $3,885,000 | $26,781,000 |
| | Subtotal, Construction Costs: | $26,274,000 | $4,563,000 | $30,837,000 |
| | Contingencies @ Average of 17.4 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 4,740,000 | 1,185,000 | 5,925,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 884,000 | 164,000 | 1,048,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,699,000 | 255,000 | 1,954,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 2,365,000 | 411,000 | 2,776,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 2,627,000 | 457,000 | 3,084,000 |
| | TOTAL PROJECT COSTS | $38,589,000 | $7,035,000 | $45,624,000 |

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 147+40 to STA 205+85**
**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $3,378,000 | $678,000 | $4,056,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $15,662,000 | $2,630,000 | $18,292,000 |
| | Subtotal, Construction Costs: | $19,040,000 | $3,308,000 | $22,348,000 |
| | Contingencies @ Average of 17.4 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 1,152,000 | 288,000 | 1,440,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 365,000 | 67,000 | 432,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,172,000 | 175,000 | 1,347,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 1,714,000 | 298,000 | 2,012,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 1,904,000 | 331,000 | 2,235,000 |
| | TOTAL PROJECT COSTS | $25,347,000 | $4,467,000 | $29,814,000 |

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 147+40 to STA 205+85**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | $24,000 | 25 | 6,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | New Ped Steel Bridge @ STA 195+00 | 1,182 | SF | 45.00 | 53,190 | 18 | 10,000 | 3,7 |
| | Conc Bridge Demo @Notre Dame St. STA 196+38 | 2,880 | SF | 20.00 | 57,600 | 18 | 10,000 | 4,7 |
| | New Conc Bridge @Notre Dame St. STA 196+38 | 4,182 | SF | 55.00 | 230,010 | 18 | 41,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $365,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.4 % | | | | | | $67,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $432,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**

**STA 147+40 to STA 205+85**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 100,000 | 15 | 15,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 275,000 | 15 | 41,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 400,000 | 15 | 60,000 | 2 |
| | Water Lines | 1 | JOB | LS | 300,000 | 15 | 45,000 | 2 |
| | Gas Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 22,000 | 15 | 3,000 | 2 |
| | Subtotal, Construction Costs: | | | | $1,172,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 14.9 % | | | | | | $175,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $1,347,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 147+40 to STA 205+85**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.-.- | ROADS (Including Bridges) | | | | | | | |
| 08.2.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | $221,000 | 20 | 44,000 | 1 |
| 08.2.K.- | Bridges, Abutments & Piers | | | | | | | |
| | Bridge Mod @ STA 156+65 (Las Americas Bridge) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 282,840 | 20 | 57,000 | 7,8 |
| | Soil Nailing | 25,200 | LF | 11.00 | 277,200 | 20 | 55,000 | 7,8 |
| | Shotcrete, Reinforced, 6" | 796 | SY | 40.00 | 31,840 | 20 | 6,000 | 7,8 |
| | Concrete | 2,445 | CY | 180.00 | 440,100 | 20 | 88,000 | 7,8 |
| | Piles 14" SQ, Conc (for Pier Ext) | 1,440 | LF | 22.00 | 31,680 | 20 | 6,000 | 7,8 |
| | Concrete (for Pier Ext) | 450 | CY | 195.00 | 87,750 | 20 | 18,000 | 7,8 |
| | Bridge Mod @ STA 163+85 (NE Ramp) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 173,200 | 20 | 35,000 | 7,8 |
| | Soil Nailing | 11,200 | LF | 11.00 | 123,200 | 20 | 25,000 | 7,8 |
| | Shotcrete, Reinforced, 6" | 359 | SY | 40.00 | 14,360 | 20 | 3,000 | 7,8 |
| | Concrete | 1,100 | CY | 180.00 | 198,000 | 20 | 40,000 | 7,8 |
| | Piles 14" SQ, Conc (for Pier Ext) | 810 | LF | 22.00 | 17,820 | 20 | 4,000 | 7,8 |
| | Concrete (for Pier Ext) | 165 | CY | 195.00 | 32,175 | 20 | 6,000 | 7,8 |
| | Bridge Mod @ STA 169+22 (Piñero Bridge) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 227,720 | 20 | 46,000 | 7,8 |
| | Soil Nailing | 20,300 | LF | 11.00 | 223,300 | 20 | 45,000 | 7,8 |
| | Shotcrete, Reinforced, 6" | 640 | SY | 40.00 | 25,600 | 20 | 5,000 | 7,8 |
| | Concrete | 1,970 | CY | 180.00 | 354,600 | 20 | 71,000 | 7,8 |
| | Piles 14" SQ, Conc (for Pier Ext) | 720 | LF | 22.00 | 15,840 | 20 | 3,000 | 7,8 |
| | Concrete (for Pier Ext) | 210 | CY | 195.00 | 40,950 | 20 | 8,000 | 7,8 |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 147+40 to STA 205+85**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.K.- | Bridges, Abutments & Piers | | | | | | | |
| | Bridge Mod @ STA 174+50 (SE Ramp) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 173,200 | 20 | 35,000 | 7,8 |
| | Soil Nailing | 11,200 | LF | 11.00 | 123,200 | 20 | 25,000 | 7,8 |
| | Shotcrete, Reinforced, 6" | 359 | SY | 40.00 | 14,360 | 20 | 3,000 | 7,8 |
| | Concrete | 1,100 | CY | 180.00 | 198,000 | 20 | 40,000 | 7,8 |
| | Piles 14" SQ, Conc (for Pier Ext) | 810 | LF | 22.00 | 17,820 | 20 | 4,000 | 7,8 |
| | Concrete (for Pier Ext) | 165 | CY | 195.00 | 32,175 | 20 | 6,000 | 7,8 |
| | Subtotal, Construction Costs: | | | | $3,378,000 | | | |
| 08.2.Z.- | Contingencies @ Average of 20.1 % | | | | | | $678,000 | |
| 08.2.-.- | Roads (Including Bridges) Total: | | | | | | $4,056,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO MAIN CHANNEL**
**STA 147+40 to STA 205+85**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 1,025,000 | 20 | 205,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 22 | AC | 3,000 | 66,000 | 20 | 13,000 | 7 |
| | Dewatering | 1 | JOB | LS | 1,206,400 | 20 | 241,000 | 7 |
| | Excavation | 420,500 | CY | 4.60 | 1,934,300 | 20 | 387,000 | 4,5 |
| | Borrow Fill | 133,500 | CY | 5.00 | 667,500 | 20 | 134,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 464,100 | 20 | 93,000 | 4,5 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 244,000 | 20 | 49,000 | 3,7 |
| | Fencing 6' Chainlink w/3 Strands | 11,520 | LF | 10.00 | 115,200 | 15 | 17,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Canal Liner, Invert & Walls | 55,220 | CY | 180.00 | 9,939,600 | 15 | 1,491,000 | 8 |
| | Subtotal, Construction Costs: | | | | $15,662,000 | | | |
| | Contingencies @ Average of 16.8 % | | | | | | $2,630,000 | |
| 09.1.-.- | Channels Total: | | | | | | $18,292,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**BUENA VISTA DIVERSION**
**STA 0+00 to STA 42+38**
**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $7,234,000 | $1,255,000 | $8,489,000 |
| | Subtotal, Construction Costs: | $7,234,000 | $1,255,000 | $8,489,000 |
| | Contingencies @ Average of 17.3 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 3,588,000 | 897,000 | 4,485,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 519,000 | 97,000 | 616,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 527,000 | 80,000 | 607,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 651,000 | 113,000 | 764,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 723,000 | 126,000 | 849,000 |
| | TOTAL PROJECT COSTS | $13,242,000 | $2,568,000 | $15,810,000 |

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**BUENA VISTA DIVERSION**
**STA 0+00 to STA 42+38**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | ROADS (Including Bridges) | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 34,000 | 25 | 9,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | New Conc Bridge, STA 22+16 | 864 | SF | 55.00 | 47,520 | 18 | 9,000 | 3,7 |
| | New Conc Bridge, STA 36+76 | 864 | SF | 55.00 | 47,520 | 18 | 9,000 | 3,7 |
| | Exist Bridge Demol Sta 40+24 (Calle 4) | 880 | SF | 20.00 | 17,600 | 18 | 3,000 | 4,7 |
| | New Conc Bridge STA 40+24 (Calle 4) | 1,584 | SF | 55.00 | 87,120 | 18 | 16,000 | 3,7 |
| | Exist Bridge Demol STA 42+06 (P.R. 21) | 5,000 | SF | 20.00 | 100,000 | 18 | 18,000 | 4,7 |
| | New Conc Bridge STA 42+06 (P.R. 21) | 3,375 | SF | 55.00 | 185,625 | 18 | 33,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $519,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.7 % | | | | | | $97,000 | |
| 02.1.-.- | Roads (Including Bridges) Total: | | | | | | $616,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

NOVEMBER 1990 PRICE LEVEL

**BUENA VISTA DIVERSION**
**STA 0+00 to STA 42+38**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 50,000 | 15 | 8,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 350,000 | 15 | 53,000 | 2 |
| | Water Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 27,000 | 15 | 4,000 | 2 |
| | Subtotal, Construction Costs: | | | | $527,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.2 % | | | | | | $80,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $607,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 40 (Cont)

NOVEMBER 1990 PRICE LEVEL

**BUENA VISTA DIVERSION**
**STA 0+00 to STA 42+38**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 473,000 | 20 | 95,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 17 | ACR | 2,000 | 34,000 | 20 | 7,000 | 7 |
| | Dewatering | 1 | JOB | LS | 740,000 | 20 | 148,000 | 7 |
| | Excavation | 258,000 | CY | 4.10 | 1,057,800 | 20 | 212,000 | 4,5 |
| | Borrow Fill | 163,000 | CY | 5.00 | 815,000 | 20 | 163,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 266,600 | 20 | 53,000 | 4,5 |
| | Fencing 6' Chainlink | 8,476 | LF | 8.00 | 67,808 | 15 | 10,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 21,000 | CY | 180.00 | 3,780,000 | 15 | 567,000 | 8 |
| | Subtotal, Construction Costs: | | | | $7,234,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 17.3 % | | | | | | $1,255,000 | |
| 09.1.-.- | Channels Total: | | | | | | $8,489,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 41

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 205+85 to STA 270+65**
**CONTRACT 5 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $16,796,000 | $2,827,000 | $19,623,000 |
| 14.-.-.- | RECREATION FACILITIES | $328,000 | $62,000 | $390,000 |
| | Subtotal, Construction Costs: | $17,124,000 | $2,889,000 | $20,013,000 |
| | Contingencies @ Average of 16.9 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 557,000 | 139,000 | 696,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 593,000 | 110,000 | 703,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 2,193,000 | 329,000 | 2,522,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 1,541,000 | 260,000 | 1,801,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 1,712,000 | 289,000 | 2,001,000 |
| | TOTAL PROJECT COSTS | $23,720,000 | $4,016,000 | $27,736,000 |

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 205+85 to STA 270+65**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 39,000 | 25 | 10,000 | 1 |
| 02.1.N.- | Bridges, Complete | | | | | | | |
| | New Concrete Bridge @ STA 421+40 (PR 1) | 10,080 | SF | 55.00 | 554,400 | 18 | 100,000 | 3,7 |
| | Subtotal, Construction Costs: | | | | $593,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 18.5 % | | | | | | $110,000 | |
| 02.1.-.- | Construction Activities Total: | | | | | | $703,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 41 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**

**STA 205+85 to STA 270+65**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 400,000 | 15 | 60,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 1,560,000 | 15 | 234,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 100,000 | 15 | 15,000 | 2 |
| | Water Lines | 1 | JOB | LS | 100,000 | 15 | 15,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 33,000 | 15 | 5,000 | 2 |
| | Subtotal, Construction Costs: | | | | $2,193,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.0 % | | | | | | $329,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $2,522,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

## TABLE 41 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 205+85 to STA 270+65**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 1,099,000 | 20 | 220,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 45 | AC | 3,000 | 135,000 | 20 | 27,000 | 7 |
| | Dewatering | 1 | JOB | LS | 513,000 | 20 | 103,000 | 7 |
| | Excavation | 444,000 | CY | 4.10 | 1,820,400 | 20 | 364,000 | 4,5 |
| | Borrow Fill | 297,400 | CY | 5.00 | 1,487,000 | 20 | 297,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 564,900 | 20 | 113,000 | 4,5 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 515,000 | 20 | 103,000 | 3,7 |
| | Fencing 6' Chainlink w/3 Strands | 13,130 | LF | 10.00 | 131,300 | 15 | 20,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 58,500 | CY | 180.00 | 10,530,000 | 15 | 1,580,000 | 8 |
| | Subtotal, Construction Costs: | | | | $16,796,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 16.8 % | | | | | | $2,827,000 | |
| 09.1.-.- | Channels Total: | | | | | | $19,623,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 41 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**

**STA 205+85 to STA 270+65**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 14.0.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 14.-.-.- | RECREATION FACILITIES | | | | | | | |
| 14.0.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 30,000 | 12 | 3,600 | 6 |
| | Site Grading and Landscaping | | | | | | | |
| | Grassing of Berm | 2 | ACRE | 2,000 | 4,000 | 12 | 500 | 6 |
| | Landscaping, Shribs, etc | 2 | ACRE | 5,000 | 10,000 | 20 | 2,000 | 1,2 |
| | Flowering Trees | 24 | EA | 135.00 | 3,200 | 12 | 400 | 6 |
| | Earthwork for Screening Berms | 200 | CY | 4.00 | 800 | 12 | 100 | 6 |
| | Acitivity Guides and Controls | | | | | | | |
| | Laminated Wooden Bridge(6' w x 100' l) | 3 | EA | 13,000 | 39,000 | 20 | 7,800 | 1,2 |
| | Day Use Areas | | | | | | | |
| | Concrete and Steel Overpass for Pedes-trians and Bicycles (80' Span x 6' Wide) | 3 | EA | 22,000 | 66,000 | 20 | 13,200 | 1,2 |
| | Concrete Benches, Backless | 10 | EA | 670.00 | 6,700 | 12 | 800 | 6 |
| | Associated General Items | | | | | | | |
| | Planters, 4' Diameter | 6 | EA | 600.00 | 3,600 | 12 | 400 | 6 |
| | Trash Receptacles | 6 | EA | 400.00 | 2,400 | 12 | 300 | 6 |
| | Bicycle Rack, Galv. | 1 | EA | 400.00 | 400 | 12 | 50 | 6 |
| | Buildings - Public Use | | | | | | | |
| | Bicycle Path, 8' w x 6,000' L, Concrete | 48,000 | SF | 3.00 | 144,000 | 20 | 28,800 | 1,2 |
| | Pedestrian Walk, 6' w x 1000' l, Conc | 6,000 | SF | 3.00 | 18,000 | 20 | 3,600 | 1,2 |
| | Subtotal, Construction Costs: | | | | $328,000 | | | |
| 14.0.Z.- | Contingencies @ Average of 18.9 % | | | | | | $62,000 | |
| 14.-.-.- | Recreation Facilities Total: | | | | | | $390,000 | |

REASONS FOR CONTINGENCIES:

1. DATA TO ESTIMATE QUANTITIES IS INSUFFICIENT OR UNCERTAIN.
2. SUBSURFACE AND/OR SITE CONDITIONS ARE UNKNOWN OR UNCERTAIN.
3. HAUL PRICE IS UNKNOWN.
4. UNIT PRICE UNCERTAINTIES.
5. MATERIAL UNKNOWNS AND/OR UNINDENTIFIED MATERIAL SOURCES.
6. NONE OR MINIMUM LEVEL OF DESIGN.
7. DIMENSIONS, SIZE OR OR CONFIGURATION IS UNKNOWN OR UNCE

TABLE 42

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL STA 270+65 TO 338+92**
**AND GUARACANAL & DEBRIS BASIN**
**CONTRACT 6 - COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $260,000 | $51,000 | $311,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $25,565,000 | $4,299,000 | $29,864,000 |
| | Subtotal, Construction Costs: | $25,825,000 | $4,350,000 | $30,175,000 |
| | Contingencies @ Average of 16.8 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 1,250,400 | 312,400 | 1,562,800 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 437,000 | 80,000 | 517,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,418,000 | 213,000 | 1,631,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 2,325,000 | 391,000 | 2,716,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 2,582,000 | 435,000 | 3,017,000 |
| | TOTAL PROJECT COSTS | $33,837,400 | $5,781,400 | $39,618,800 |

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 270+65 TO 338+92**
**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 08.-.-.- | ROADS, RAILROADS & BRIDGES | | | |
| 08.2.-.- | ROADS (Including Bridges) | $260,000 | $51,000 | $311,000 |
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $22,792,000 | $3,820,000 | $26,612,000 |
| | Subtotal, Construction Costs: | $23,052,000 | $3,871,000 | $26,923,000 |
| | Contingencies @ Average of 16.8 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 993,000 | 248,000 | 1,241,000 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.1.-.- | CONSTRUCTION ACTIVITIES | 437,000 | 80,000 | 517,000 |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 1,047,000 | 157,000 | 1,204,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 2,075,000 | 348,000 | 2,423,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 2,305,000 | 387,000 | 2,692,000 |
| | TOTAL PROJECT COSTS | $29,909,000 | $5,091,000 | $35,000,000 |

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 270+65 TO 338+92**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.1.-.- | CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.1.A.- | Mobilization, Demob & Prep work | 1 | JOB | LS | 17,000 | 20 | 3,000 | 1 |
| 02.1.K.- | Bridges, Abutments & Piers | | | | | | | |
| | Bridge Mod @ STA 329+50 (P.R. 177) | | | | | | | |
| | Dewatering | 1 | JOB | LS | 81,200 | 20 | 16,000 | 7,8 |
| | Concrete (Channel) | 900 | CY | 180.00 | 162,000 | 20 | 32,000 | 7,8 |
| | Subtotal, Construction Costs: | | | | $260,000 | | | |
| 02.1.Z.- | Contingencies @ Average of 19.6 % | | | | | | $51,000 | |
| 02.1.-.- | Construction Activities Total: | | | | | | $311,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**

**STA 270+65 TO 338+92**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 175,000 | 15 | 26,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 370,000 | 15 | 56,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 400,000 | 15 | 60,000 | 2 |
| | Water Lines | 1 | JOB | LS | 75,000 | 15 | 11,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 27,000 | 15 | 4,000 | 2 |
| | Subtotal, Construction Costs: | | | | $1,047,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.0 % | | | | | | $157,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $1,204,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 270+65 TO 338+92**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 08.2.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 08.2.-.- | ROADS (Including Bridges) | | | | | | | |
| 08.2.A.- | Mobilization, Demob & Prep work | 1 | JOB | LS | 29,000 | 25 | 7,000 | 1 |
| 08.2.N.- | Bridges, Complete | | | | | | | |
| | New Conc Bridge @ STA 280+27 P.R. 76 | 3,780 | SF | 55.00 | 207,900 | 18 | 37,000 | 3,7 |
| | Conc Bridge Demol @ STA 280+27 P.R. 76 | 6,600 | SF | 20.00 | 132,000 | 18 | 24,000 | 4,7 |
| | New Pedestrian Steel Bridge @ STA 301+33 | 1,104 | SF | 45.00 | 49,680 | 18 | 9,000 | 3,7 |
| | Exist Pedestrian Bridge Demol @ STA 301+33 | 920 | SF | 20.00 | 18,400 | 18 | 3,000 | 4,7 |
| | Subtotal, Construction Costs: | | | | $437,000 | | | |
| 08.2.Z.- | Contingencies @ Average of 18.3 % | | | | | | $80,000 | |
| 08.2.-.- | Roads (Including Bridges) Total: | | | | | | $517,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**PUERTO NUEVO CHANNEL**
**STA 270+65 TO 338+92**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 1,491,000 | 20 | 298,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Clearing and Grubbing | 41 | AC | 3,000 | 123,000 | 20 | 25,000 | 7 |
| | Dewatering | 1 | JOB | LS | 1,048,200 | 20 | 210,000 | 7 |
| | Excavation | 405,000 | CY | 4.65 | 1,883,250 | 20 | 377,000 | 4,5 |
| | Borrow Fill | 507,000 | CY | 5.00 | 2,535,000 | 20 | 507,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 874,900 | 20 | 175,000 | 4,5 |
| | Piling Furnished 18" Square | 19,200 | LF | 30.00 | 576,000 | 15 | 86,000 | 8 |
| | Piling Driven 18" Square | 19,200 | LF | 7.70 | 147,840 | 15 | 22,000 | 8 |
| | Culverts, Flapgates, etc | 1 | JOB | LS | 64,000 | 20 | 13,000 | 3,7 |
| | Fencing 6' Chainlink w/3 Strands | 13,480 | LF | 10.00 | 134,800 | 15 | 20,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 77,300 | CY | 180.00 | 13,914,000 | 15 | 2,087,000 | 8 |
| | Subtotal, Construction Costs: | | | | $22,792,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 16.8 % | | | | | | $3,820,000 | |
| 09.1.-.- | Channels Total: | | | | | | $26,612,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**GUARACANAL CHANNEL & DEBRIS BASIN**
**STA 0+00 to STA 20+00**
**COST SUMMARY**

| | | Estimated Cost | Contingency | Total Cost |
|---|---|---|---|---|
| 09.-.-.- | CHANNELS AND CANALS | | | |
| 09.1.-.- | CHANNELS | $2,773,000 | $479,000 | $3,252,000 |
| | Subtotal, Construction Costs: | $2,773,000 | $479,000 | $3,252,000 |
| | Contingencies @ Average of 17.3 % | | | |
| | TOTAL CONSTRUCTION COST | | | |
| 01.-.-.- | LANDS AND DAMAGES | 257,400 | 64,400 | 321,800 |
| 02.-.-.- | RELOCATIONS | | | |
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | 371,000 | 56,000 | 427,000 |
| 30.-.-.- | PLANNING, ENGINEERING AND DESIGN (CESAJ-EN 9%) | 250,000 | 43,000 | 293,000 |
| 31.-.-.- | CONSTRUCTION MANAGEMENT (CESAJ-CO 10%) | 277,000 | 48,000 | 325,000 |
| | TOTAL PROJECT COSTS | $3,928,400 | $690,400 | $4,618,800 |

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

## GUARACANAL CHANNEL & DEBRIS BASIN
## STA 0+00 to STA 20+00

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 09.1.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 09.1.-.- | CHANNELS | | | | | | | |
| 09.1.A.- | Mobilization, Demob & Prep Work | 1 | JOB | LS | 181,000 | 20 | 36,000 | 1 |
| 09.1.S.- | Sitework | | | | | | | |
| | Dewatering | 1 | JOB | LS | 289,000 | 20 | 58,000 | 7 |
| | Excavation | 106,000 | CY | 4.10 | 434,600 | 20 | 87,000 | 4,5 |
| | Borrow Fill | 70,000 | CY | 3.70 | 259,000 | 20 | 52,000 | 4,5 |
| | Uplift Pressure Relief System | 1 | JOB | LS | 65,200 | 20 | 13,000 | 4,5 |
| | Dike Fill | 23,000 | CY | 0.75 | 17,250 | 20 | 3,000 | 4,5 |
| | Floodwalls (steel sheetpile) | 17,250 | SF | 23.00 | 396,750 | 15 | 60,000 | 8 |
| | Fencing 6' Chainlink | 4,000 | LF | 8.00 | 32,000 | 15 | 5,000 | 8 |
| 09.1.T.- | Concrete | | | | | | | |
| | Channel Liner, Invert & Walls | 6,100 | CY | 180.00 | 1,098,000 | 15 | 165,000 | 8 |
| | Subtotal, Construction Costs: | | | | $2,773,000 | | | |
| 09.1.Z.- | Contingencies @ Average of 17.3 % | | | | | | $479,000 | |
| 09.1.-.- | Channels Total: | | | | | | $3,252,000 | |

REASONS FOR CONTINGENCIES:

1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

TABLE 42 (Cont)

NOVEMBER 1990 PRICE LEVEL

**GUARACANAL CHANNEL & DEBRIS BASIN**

**STA 0+00 to STA 20+00**

| ACCOUNT CODE | ITEM | QUANTITY | UNIT | UNIT PRICE | AMOUNT | % | CONTINGENCY (In acct. 02.3.Z.-) | CONTINGENCY REASON |
|---|---|---|---|---|---|---|---|---|
| 02.3.-.- | CEMETERIES, UTILITIES & STRUCTURES - CONSTRUCTION ACTIVITIES | | | | | | | |
| 02.3.2.- | Utilities | | | | | | | |
| | Electrical Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Telephone Lines | 1 | JOB | LS | 15,000 | 15 | 2,000 | 2 |
| | Sewer Lines | 1 | JOB | LS | 300,000 | 15 | 45,000 | 2 |
| | Water Lines | 1 | JOB | LS | 25,000 | 15 | 4,000 | 2 |
| | Drainage Structures | 1 | JOB | LS | 5,500 | 15 | 1,000 | 2 |
| | Subtotal, Construction Costs: | | | | $371,000 | | | |
| 02.3.Z.- | Contingencies @ Average of 15.1 % | | | | | | $56,000 | |
| 02.3.-.- | Cemeteries, Utilities & Structures - Construction Activities Total: | | | | | | $427,000 | |

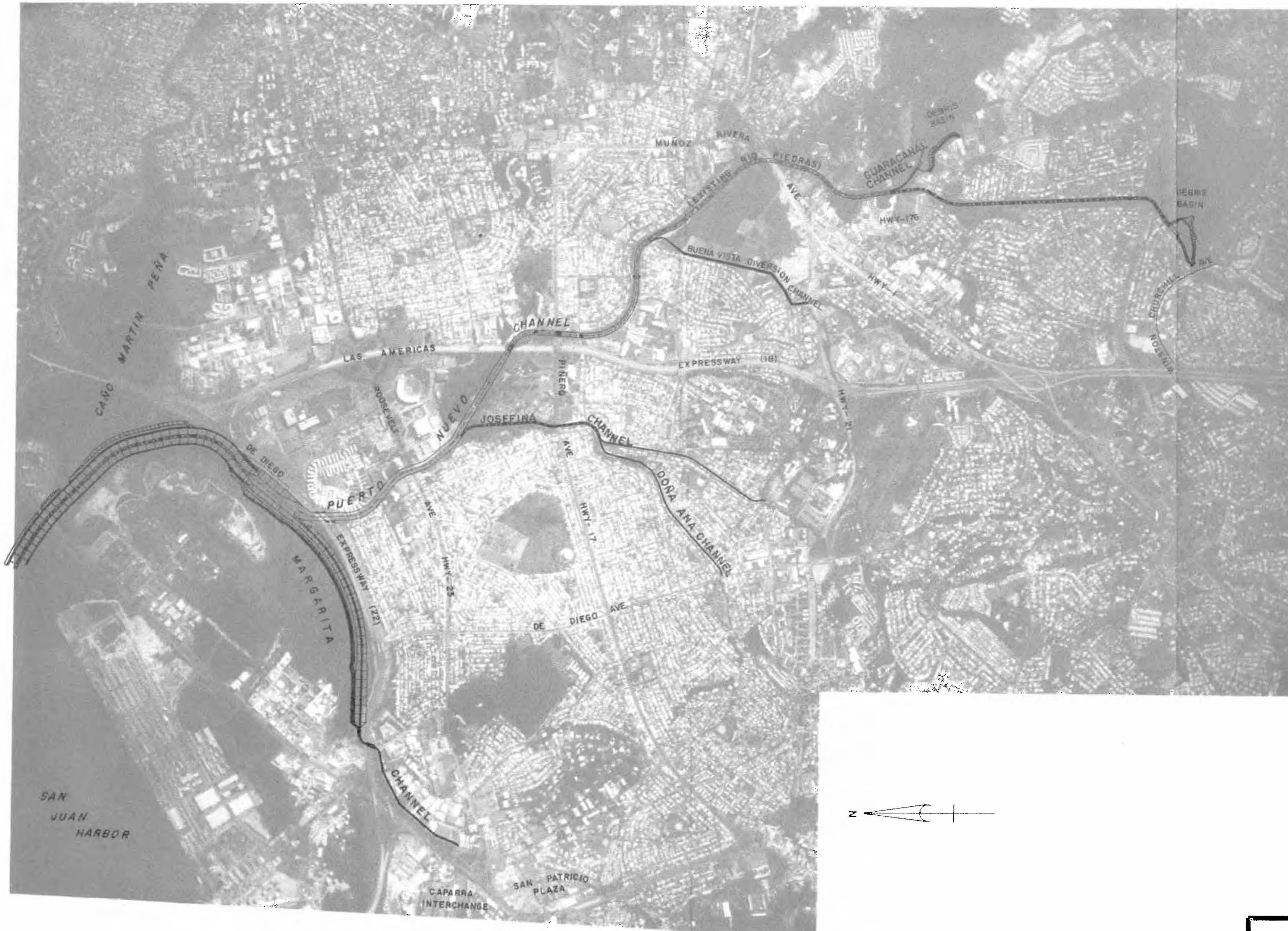
REASONS FOR CONTINGENCIES:

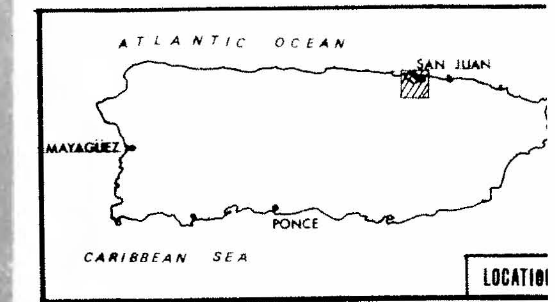
1. MOBILIZATION SOURCE UNKNOWN.
2. COST PROVIDED BY LOCAL GOVT, UNKNOWN METHOD OF CALCULATION
3. MINIMUM LEVEL OF DESIGN.
4. DIFFICULT HAULING CONDITIONS.
5. RESTRICTED CONST EQUIP MOVEMENT.
6. LIMITED ACCESS TO WORKSITE.
7. INSUFFICIENT OR UNCERTAIN DATA AVAILABLE.
8. SUFFICIENT DATA AVAILABLE.

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**HYDROLOGY AND HYDRAULICS**

PLATES




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO AND TRIBUTARY CHANNELS
PLAN OF IMPROVEMENT

HYDRAULICS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 199

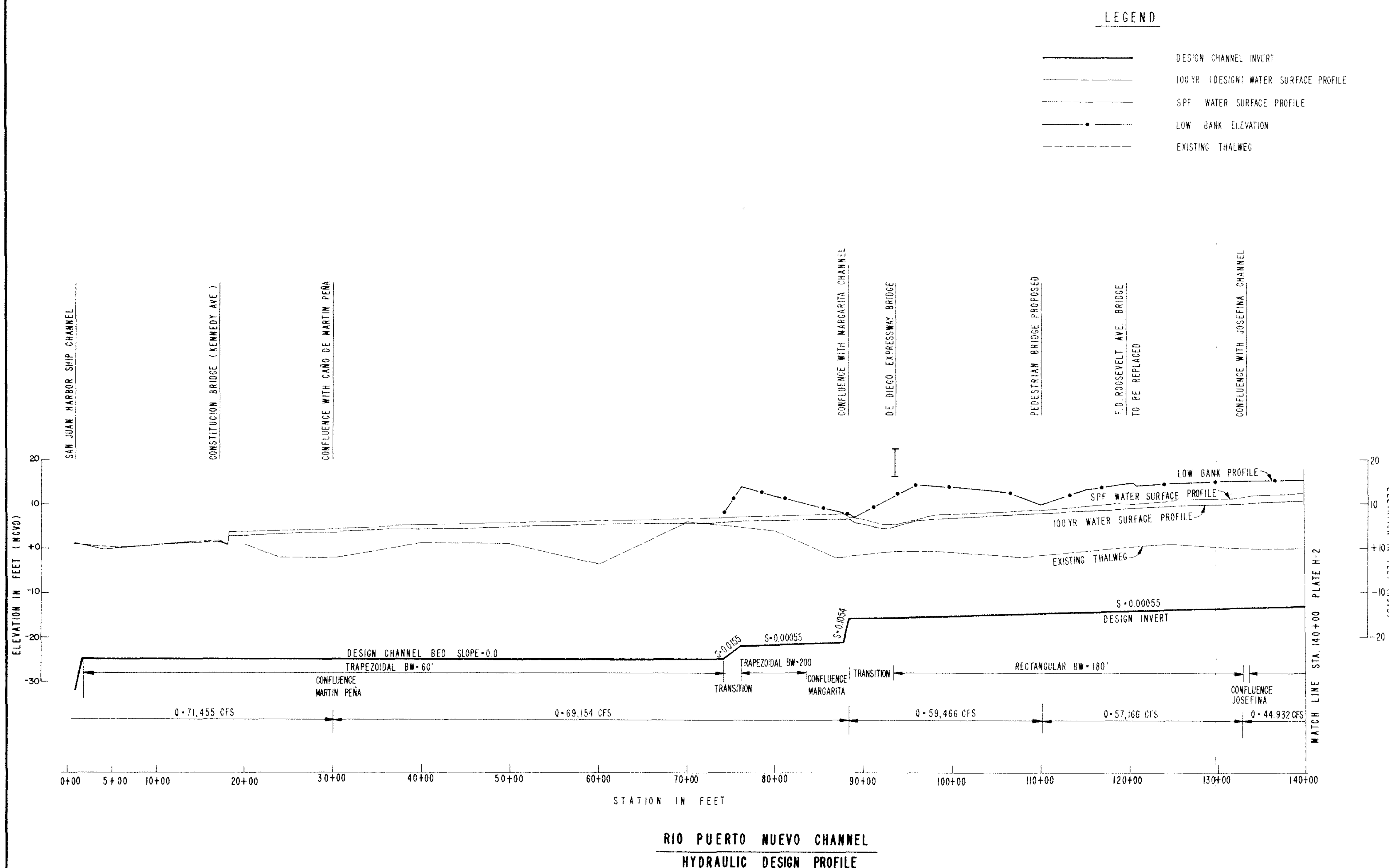

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO AND TRIBUTARY CHANNELS

BASIN MAP

HYDRAULICS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




**RIO PUERTO NUEVO CHANNEL**

**HYDRAULIC DESIGN PROFILE**

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL

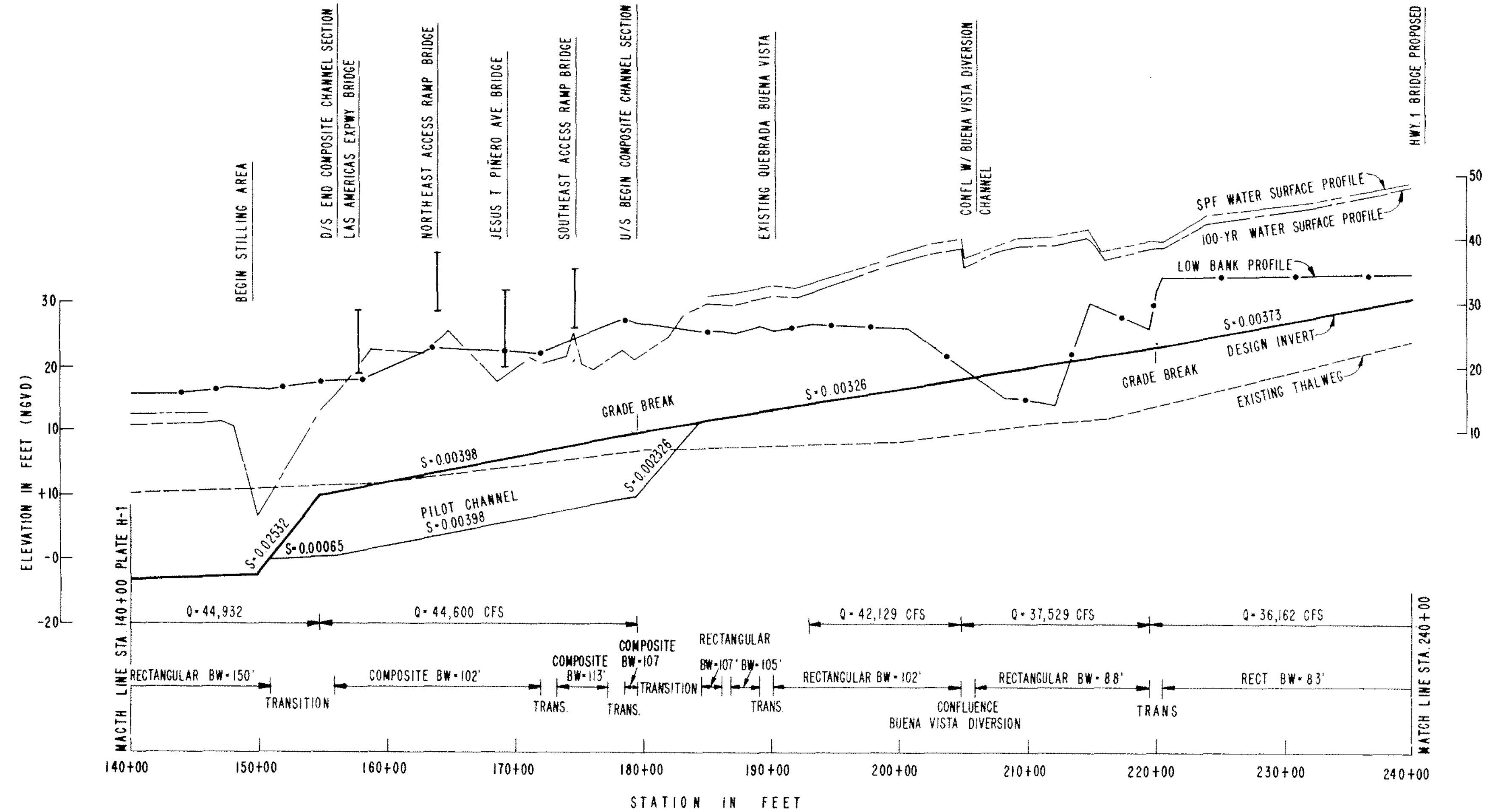
HYDRAULIC DESIGN PROFILES

HYDRAULICS

DEPARTMENT OF THE ARMY

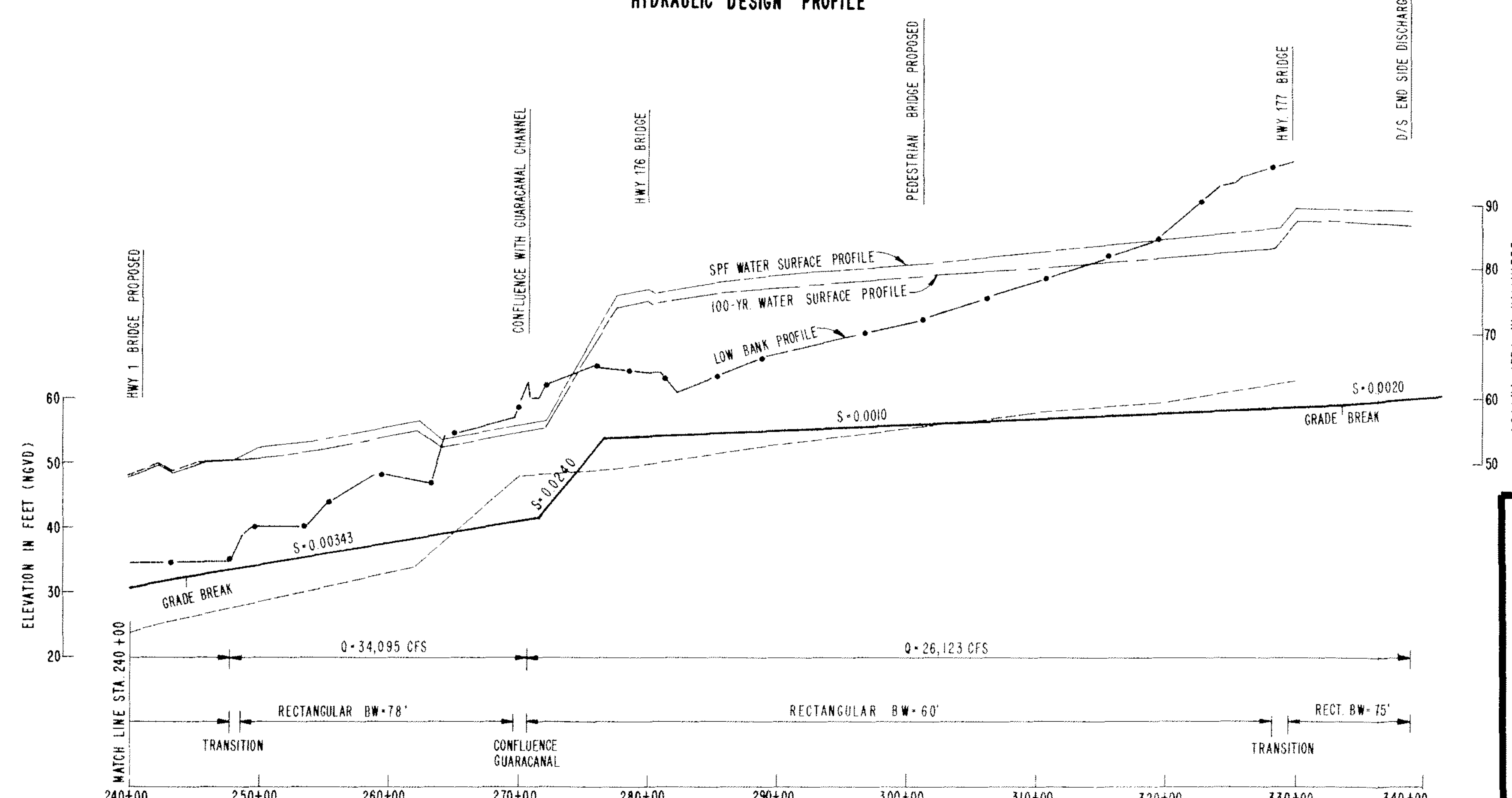
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199(




**RIO PUERTO NUEVO CHANNEL**

**HYDRAULIC DESIGN PROFILE**




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL

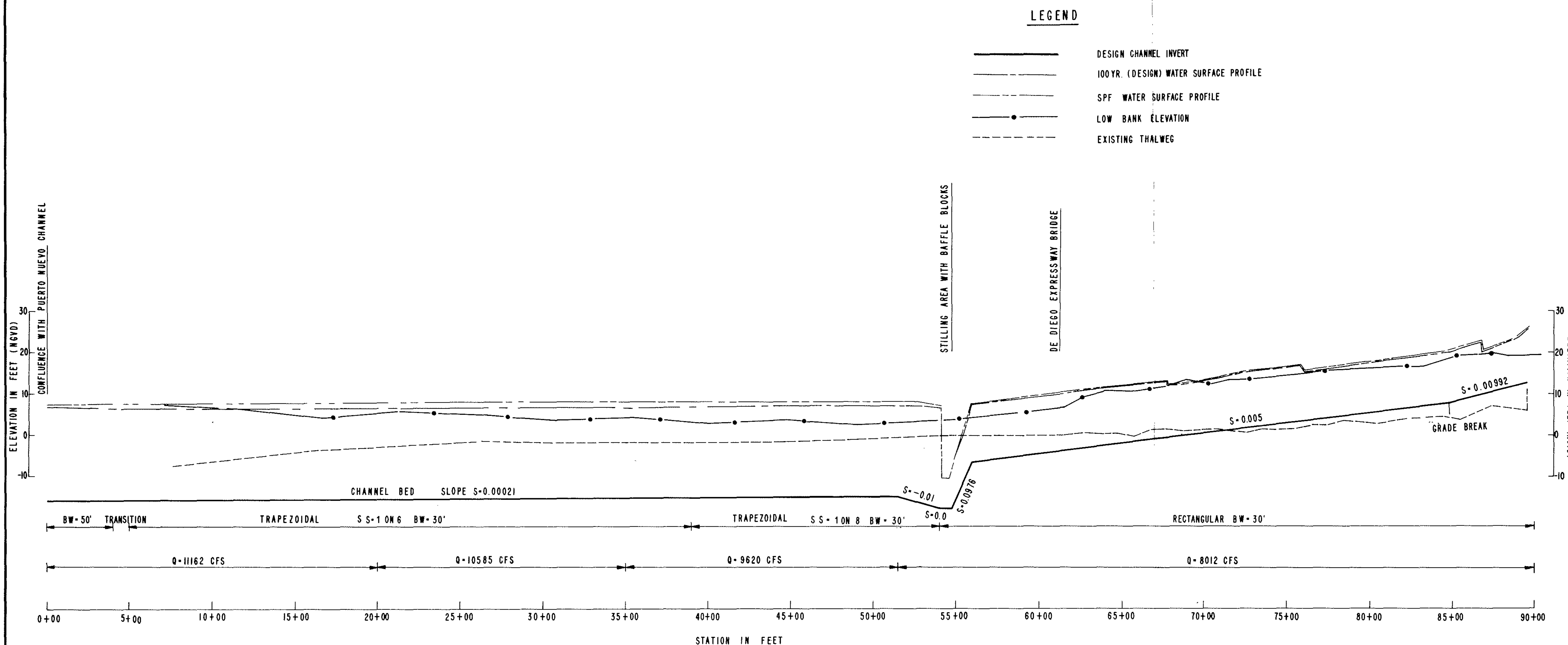
HYDRAULIC DESIGN PROFILES

HYDRAULICS

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199[illegible]




MARGARITA CHANNEL

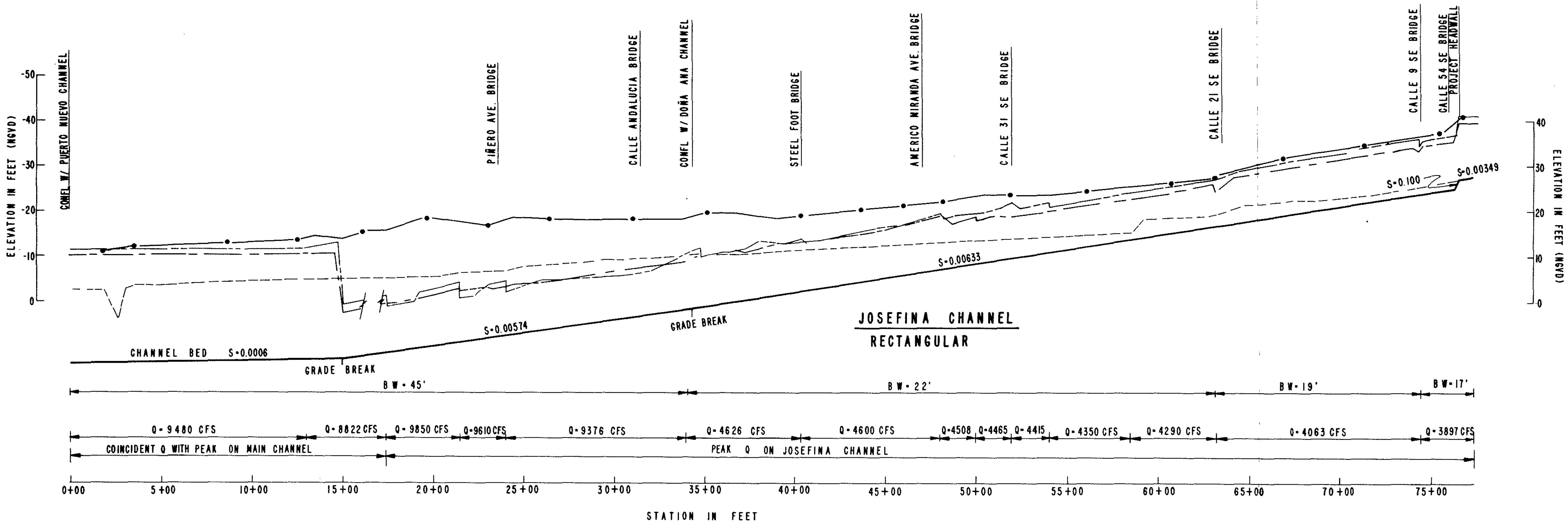
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA CHANNEL

HYDRAULIC DESIGN PROFILES

HYDRAULICS

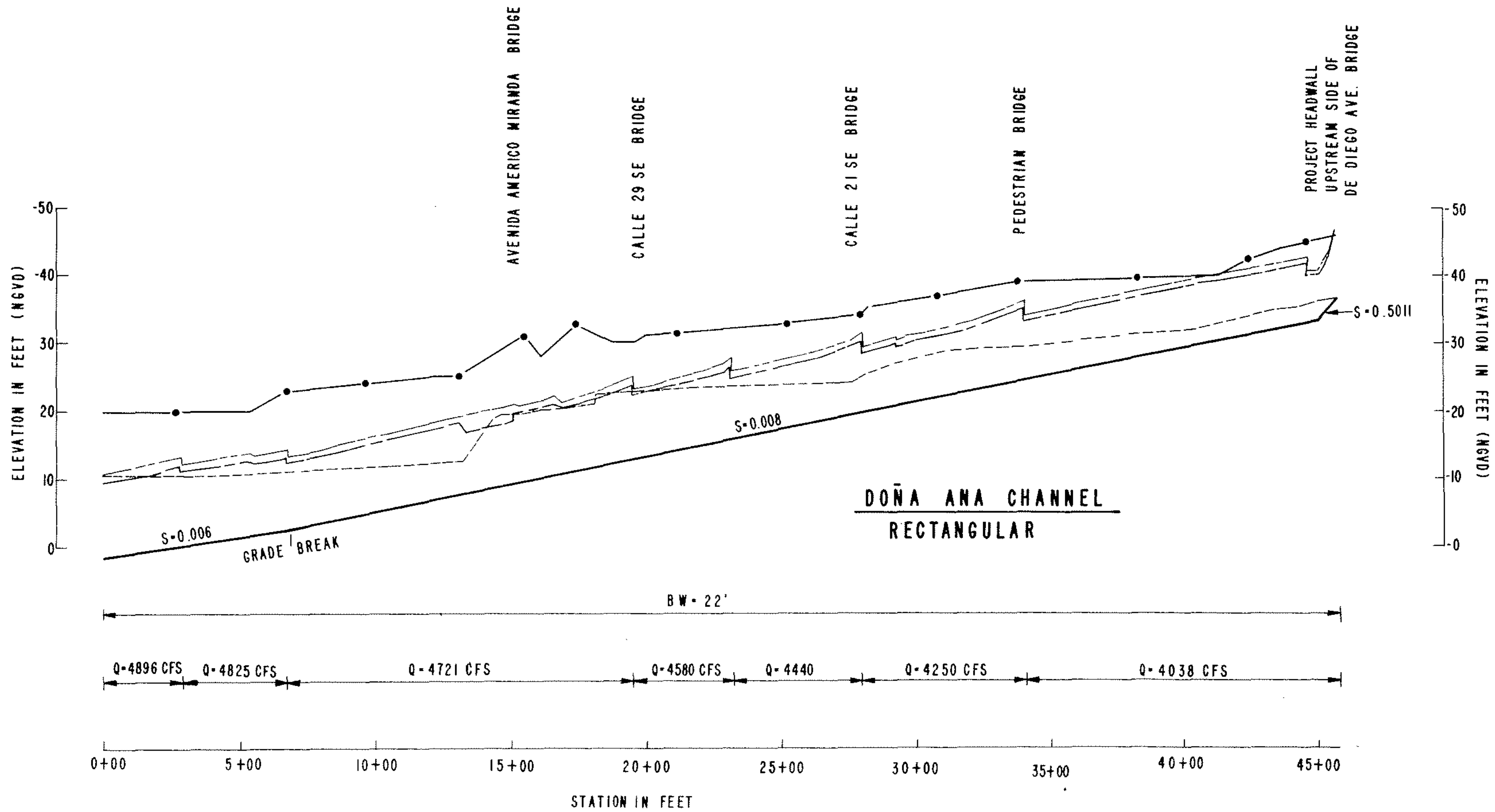
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO.102-35,578 DECEMBER 1990




## LEGEND

DESIGN CHANNEL INVERT
100 YR. (DESIGN) WATER SURFACE PROFILE
SPF WATER SURFACE PROFILE
LOW BANK ELEVATION
EXISTING THALWEG




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA & DOÑA ANA CHANNELS

HYDRAULIC DESIGN PROFILES

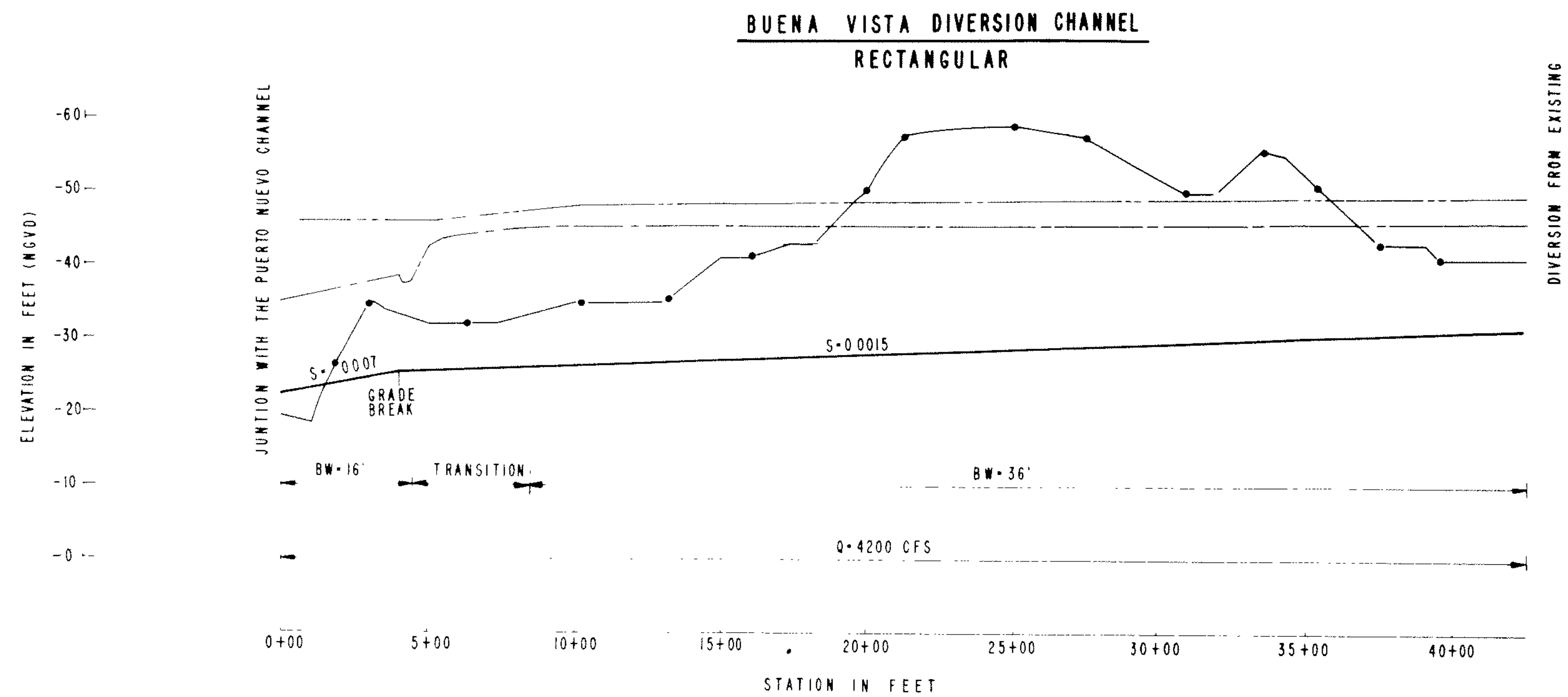
HYDRAULICS

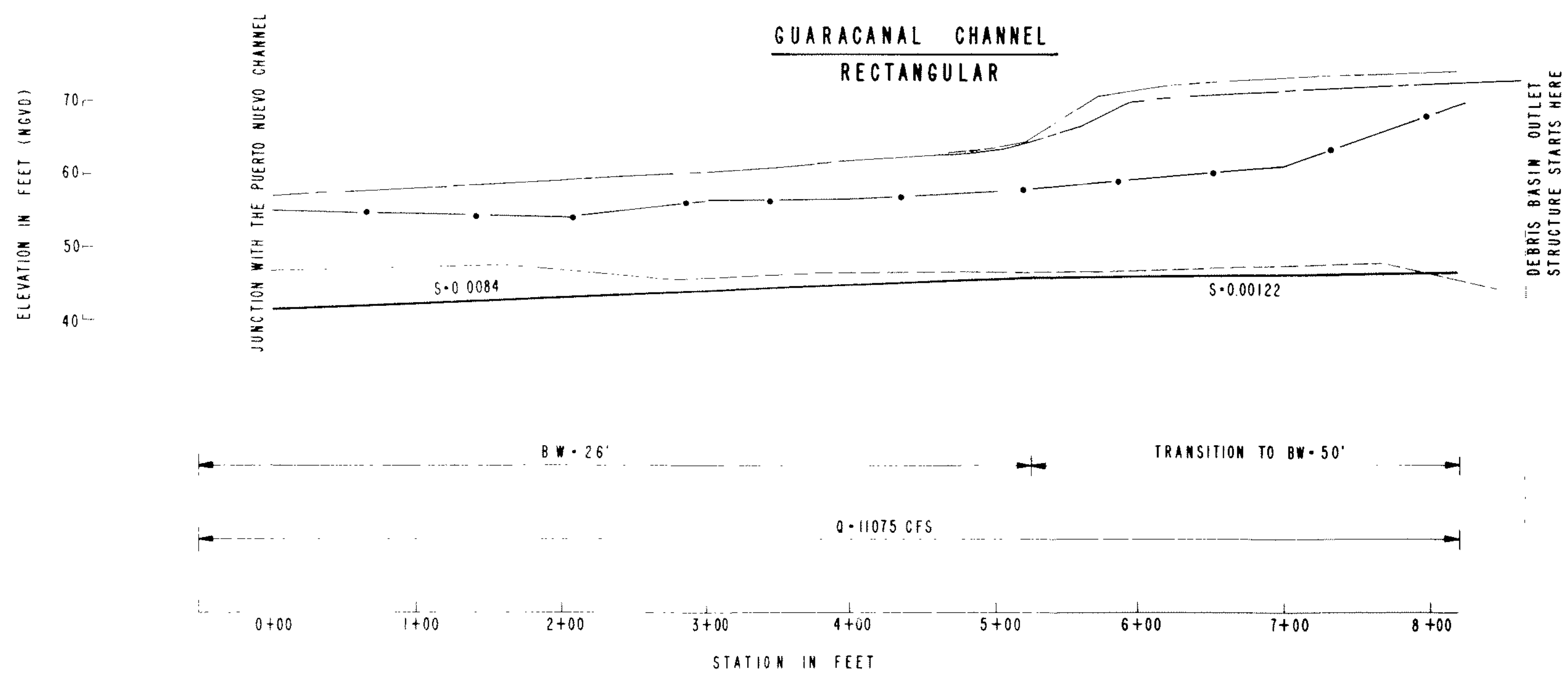
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO.102-35,578 DECEMBER 1990

## LEGEND

- DESIGN CHANNEL INVERT
- 100 YR (DESIGN WATER SURFACE PROFILE
- SPF WATER SURFACE PROFILE
- LOW BANK ELEVATION
- EXISTING THALWEG
- TOP OF CHANNEL




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

BUENA VISTA DIVERSION AND GUARACANAL CHANNELS

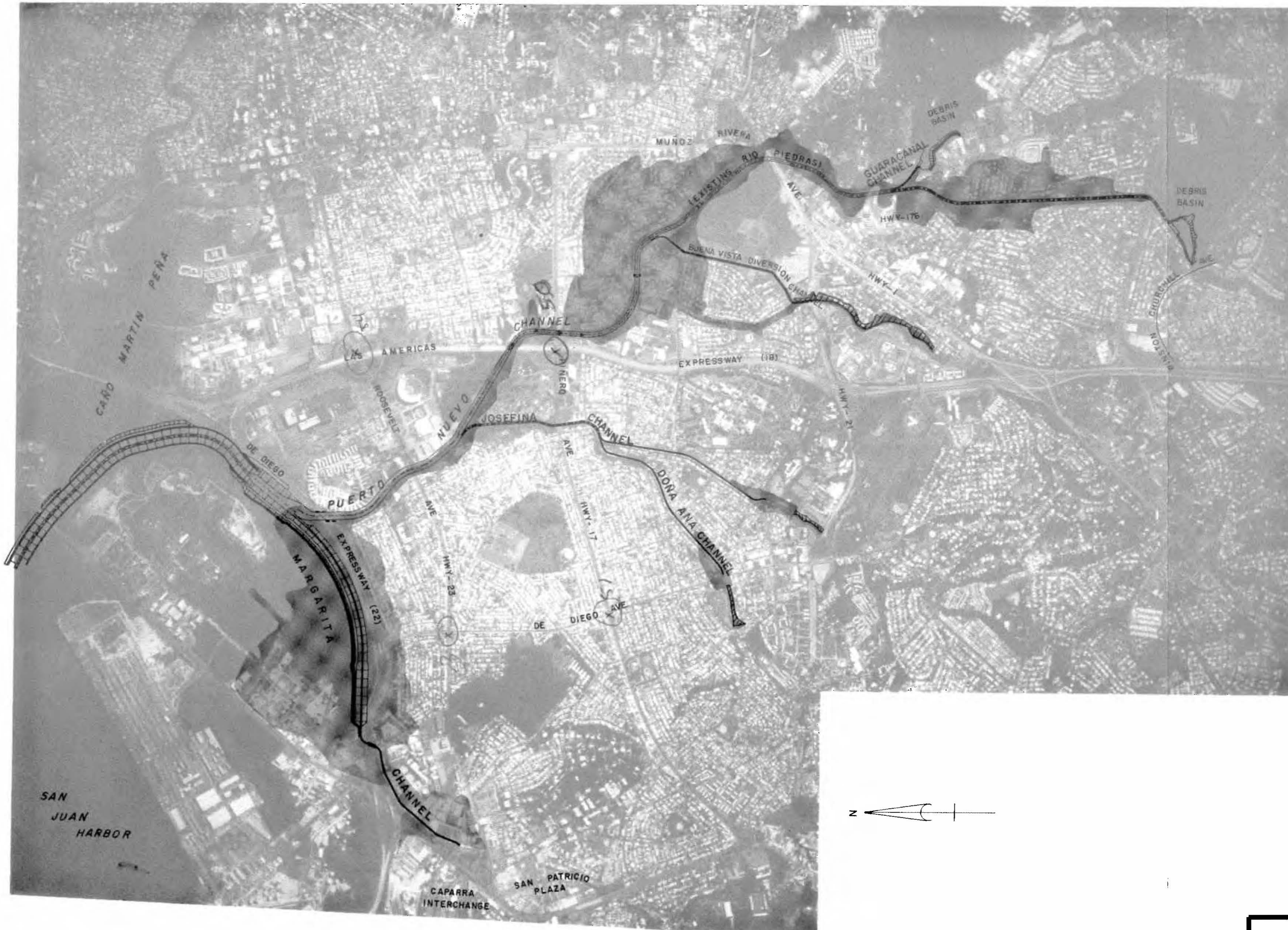
HYDRAULIC DESIGN PROFILES

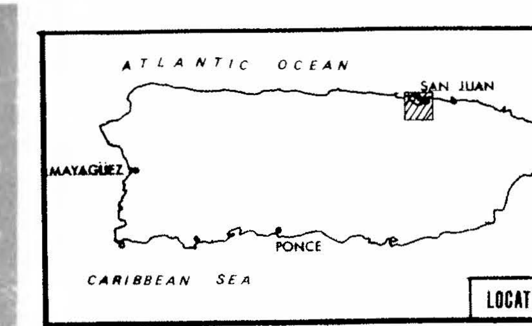
HYDRAULICS

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




100 YR. RESIDUAL FLOODING

SPF RESIDUAL FLOODING

N

GRAPHIC SCALE

1000' 0 1000' 2000'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO AND TRIBUTARY CHANNELS

PLAN OF IMPROVEMENT
RESIDUAL FLOODING

HYDRAULICS

DEPARTMENT OF THE ARMY

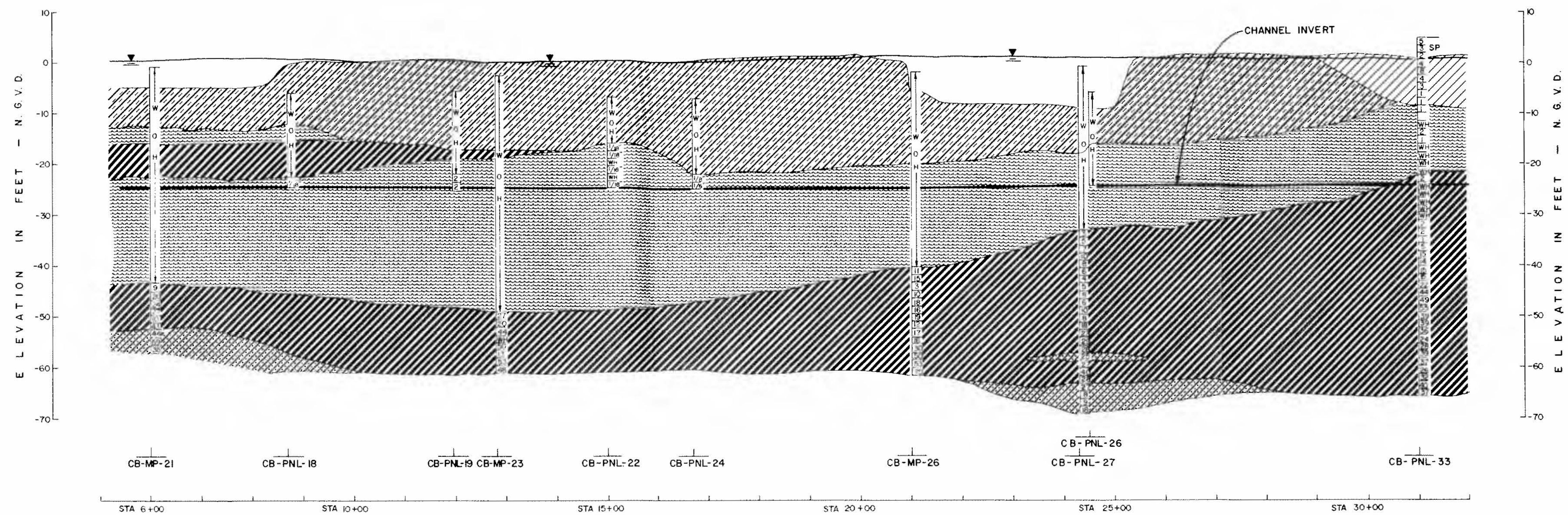
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,678 DECEMBER 19

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

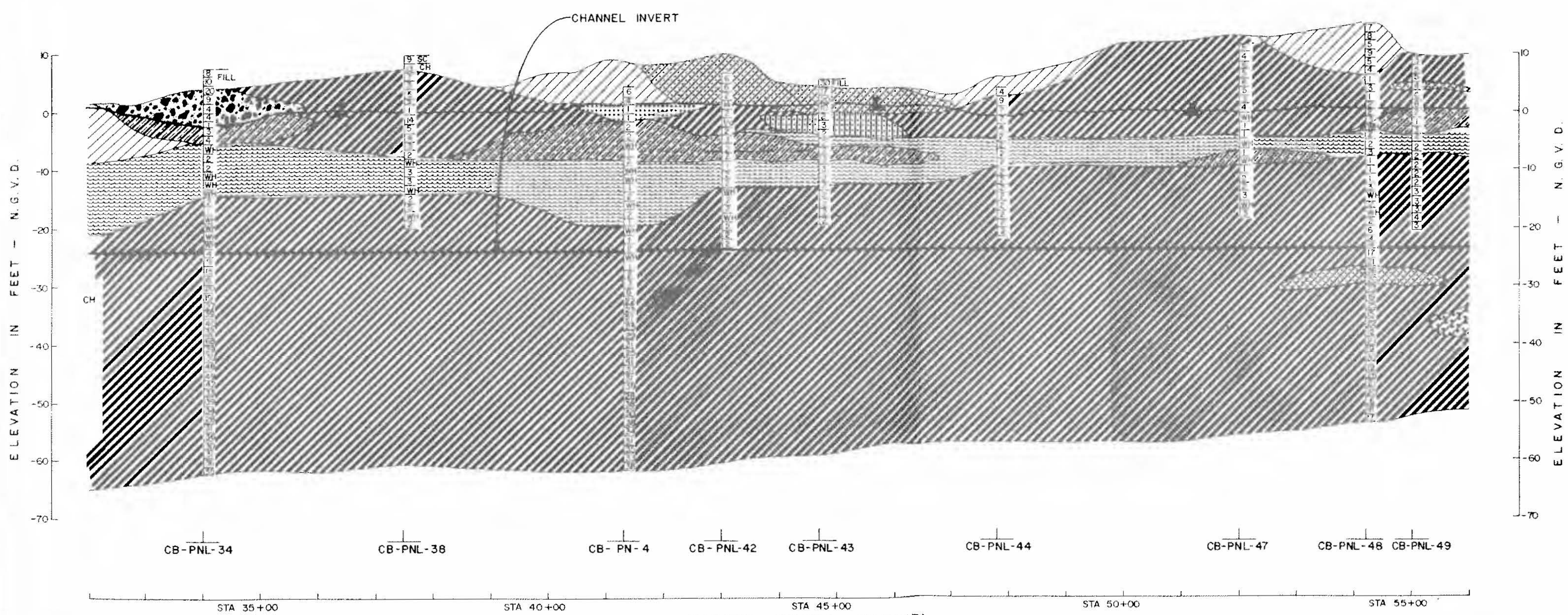
**GEOTECHNICAL**

PLATES




PUERTO NUEVO CHANNEL

LOWER CHANNEL




PUERTO NUEVO CHANNEL

LOWER CHANNEL

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-22 - S-24 FOR CORE BORING LOCATIONS
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

- (GP) GRAVEL, LITTLE SAND
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC HIGH PLASTICITY CLAY
- (PT) PEAT

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL
STA 5+00 TO STA 56+00

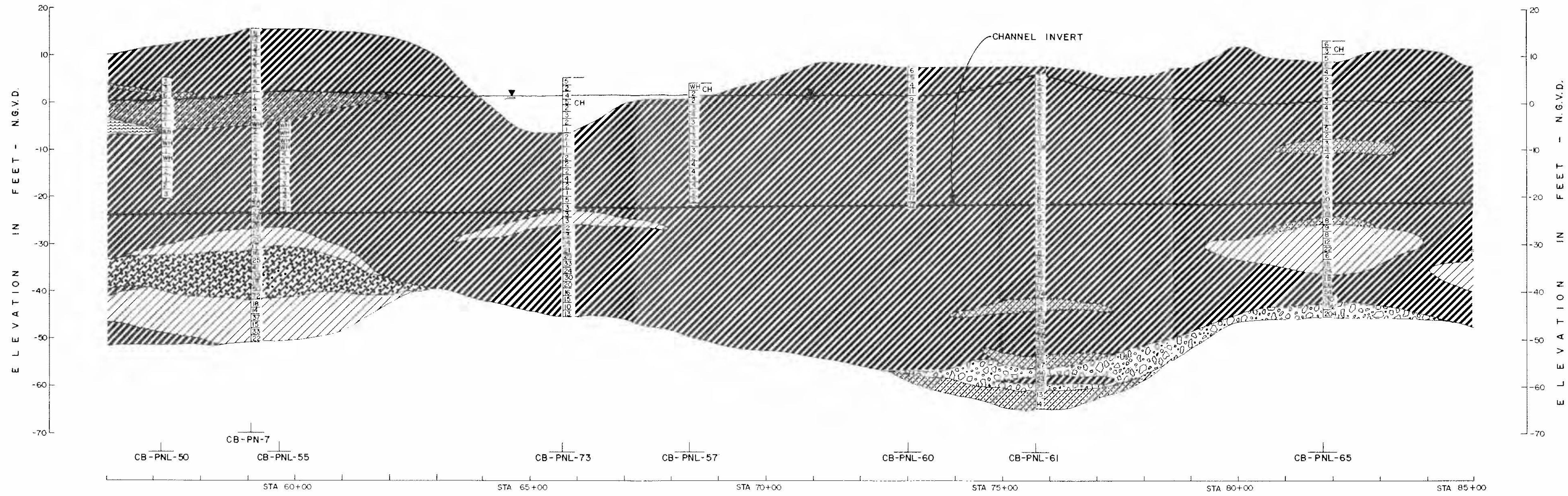
## GEOLOGIC SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

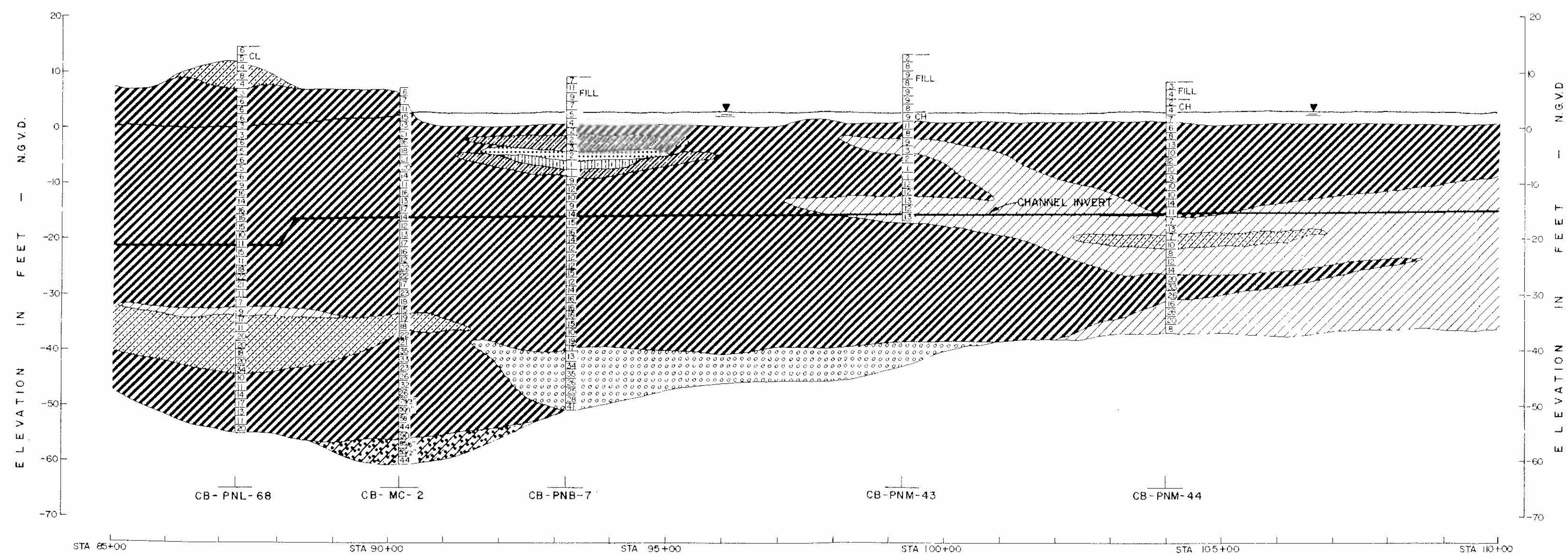
PLATE G-1




PUERTO NUEVO CHANNEL
LOWER CHANNEL (CONT.)

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-24-S-26 FOR CORE BORING LOCATIONS.
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.




PUERTO NUEVO CHANNEL
MIDDLE SECTION

LEGEND

- (GW) WELL GRADED GRAVEL
- (GC) CLAYEY GRAVEL
- (SW) WELL GRADED SAND
- (SP) POORLY GRADED SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (OL) ORGANIC, LOW PLASTICITY CLAY
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC, HIGH PLASTICITY CLAY

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL
STA 56+00 TO SAT 110+00

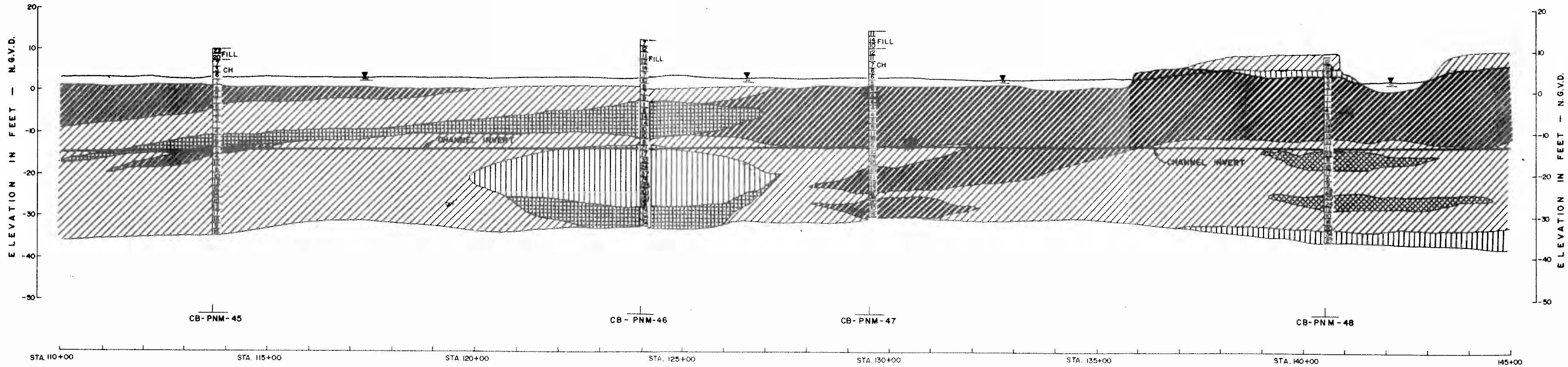
GEOLOGIC SECTIONS

GEOTECHNICAL

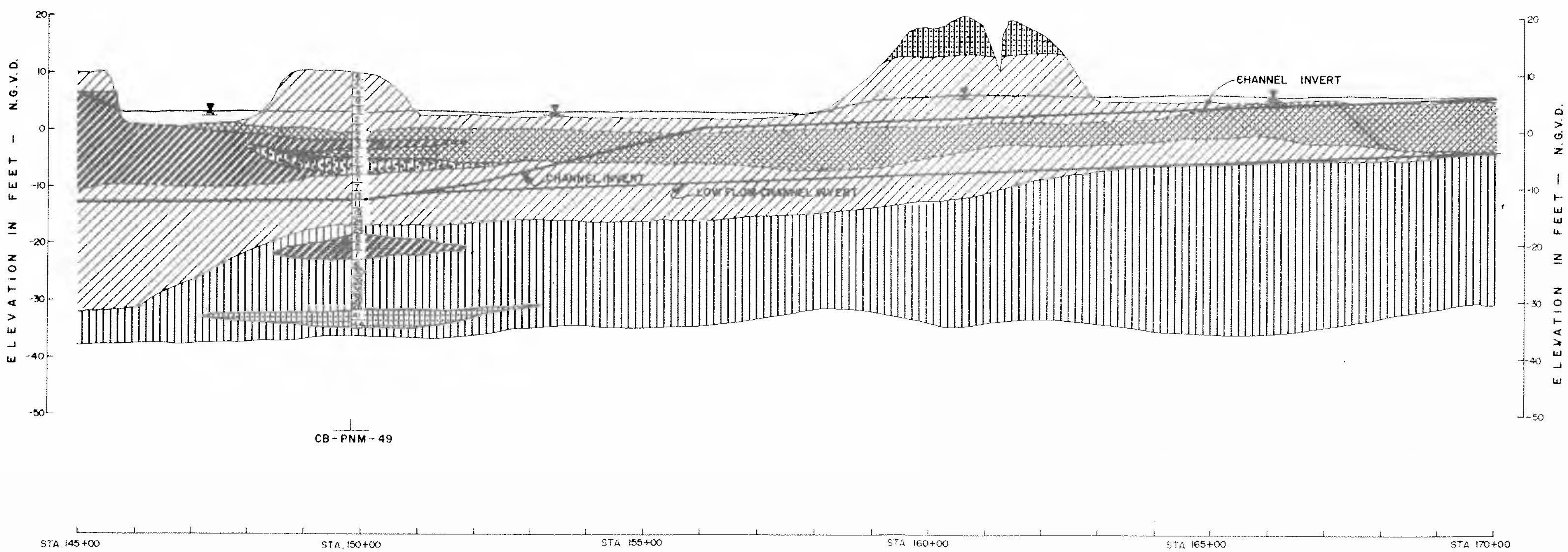
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE G-2




PUERTO NUEVO CHANNEL
MIDDLE SECTION



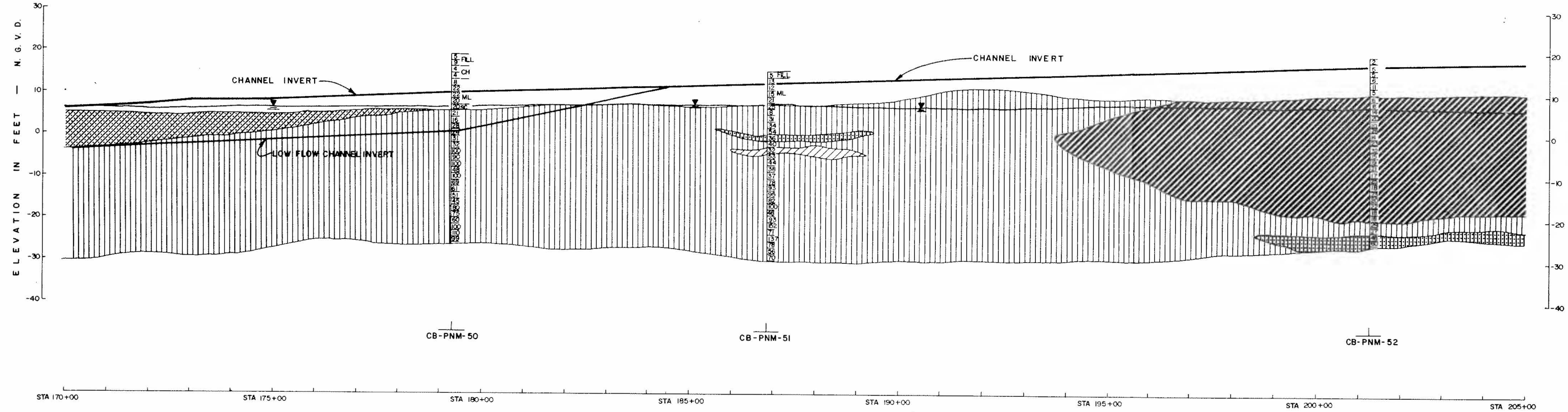

PUERTO NUEVO CHANNEL
MIDDLE SECTION

NOTES:
1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-26-S-29 FOR CORE BORING LOCATIONS.
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

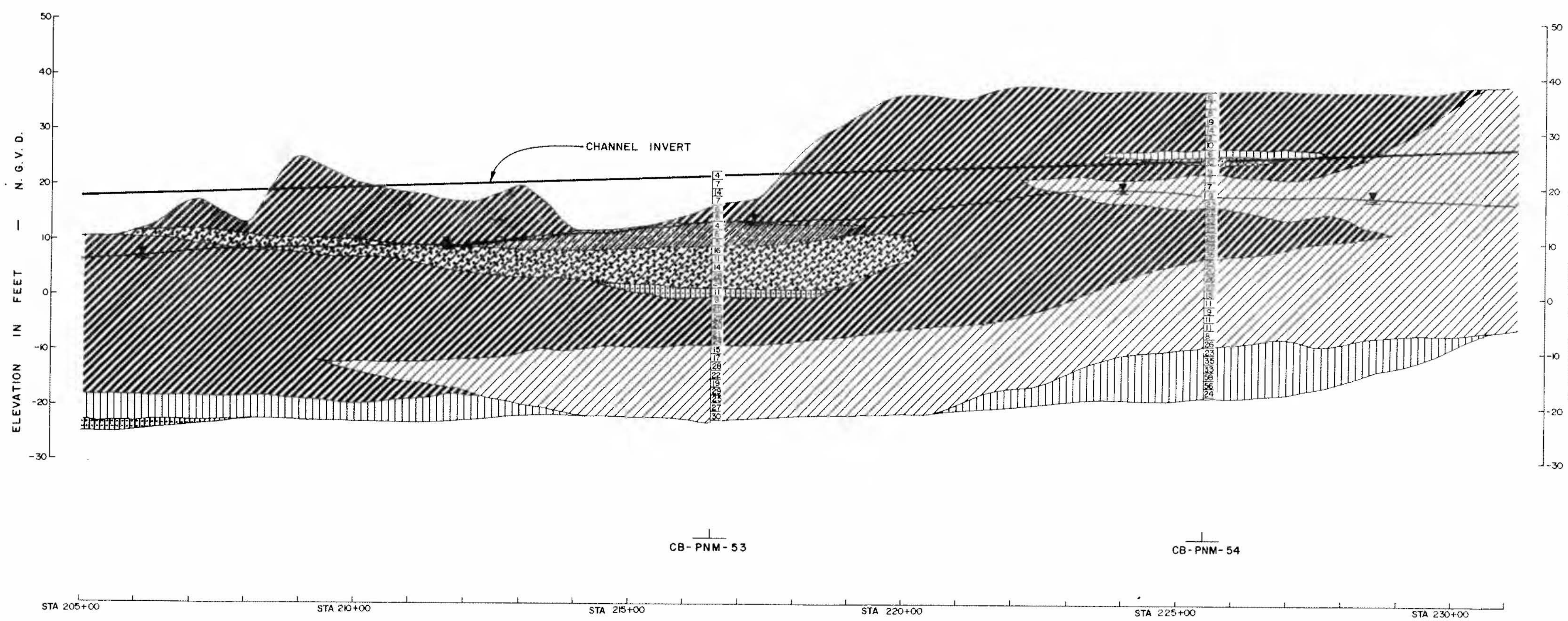
LEGEND
(GM) SILTY GRAVEL
(SM) SILTY SAND
(CL) LOW PLASTICITY CLAY
(SC) CLAYEY SAND
(ML) LOW PLASTICITY SILT
(CH) HIGH PLASTICITY CLAY

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
STA 110+00 TO STA 170+00
GEOLOGIC SECTIONS
GEOTECHNICAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE G-3




PUERTO NUEVO CHANNEL
MIDDLE SECTION




PUERTO NUEVO CHANNEL
MIDDLE SECTION (CONT.)

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-29-S-32 FOR CORE BORING LOCATIONS
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

- (GC) CLAYEY GRAVEL
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC, HIGH PLASTICITY CLAY

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL
STA 170+00 TO STA 230+00

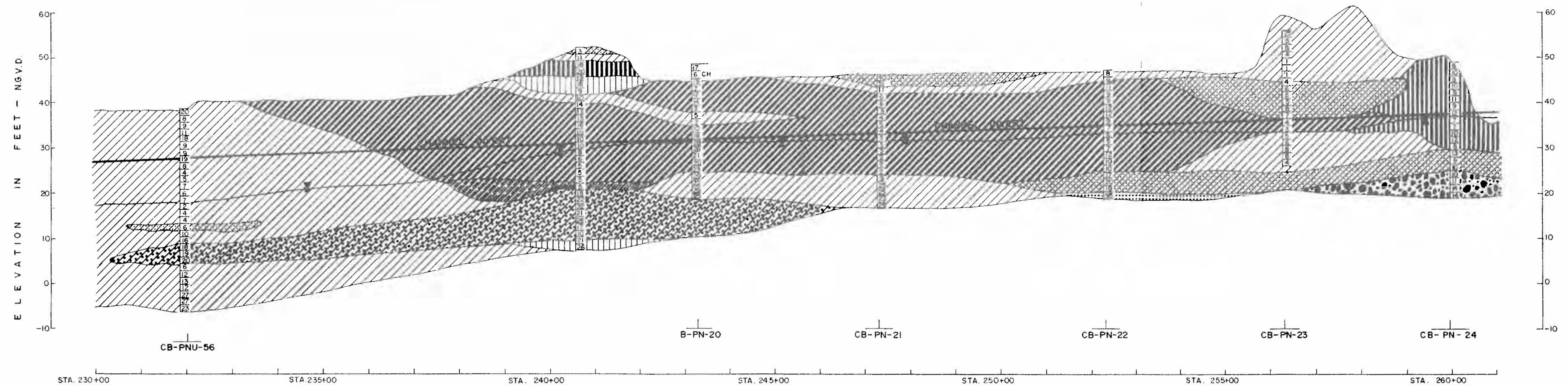
GEOLOGIC SECTIONS

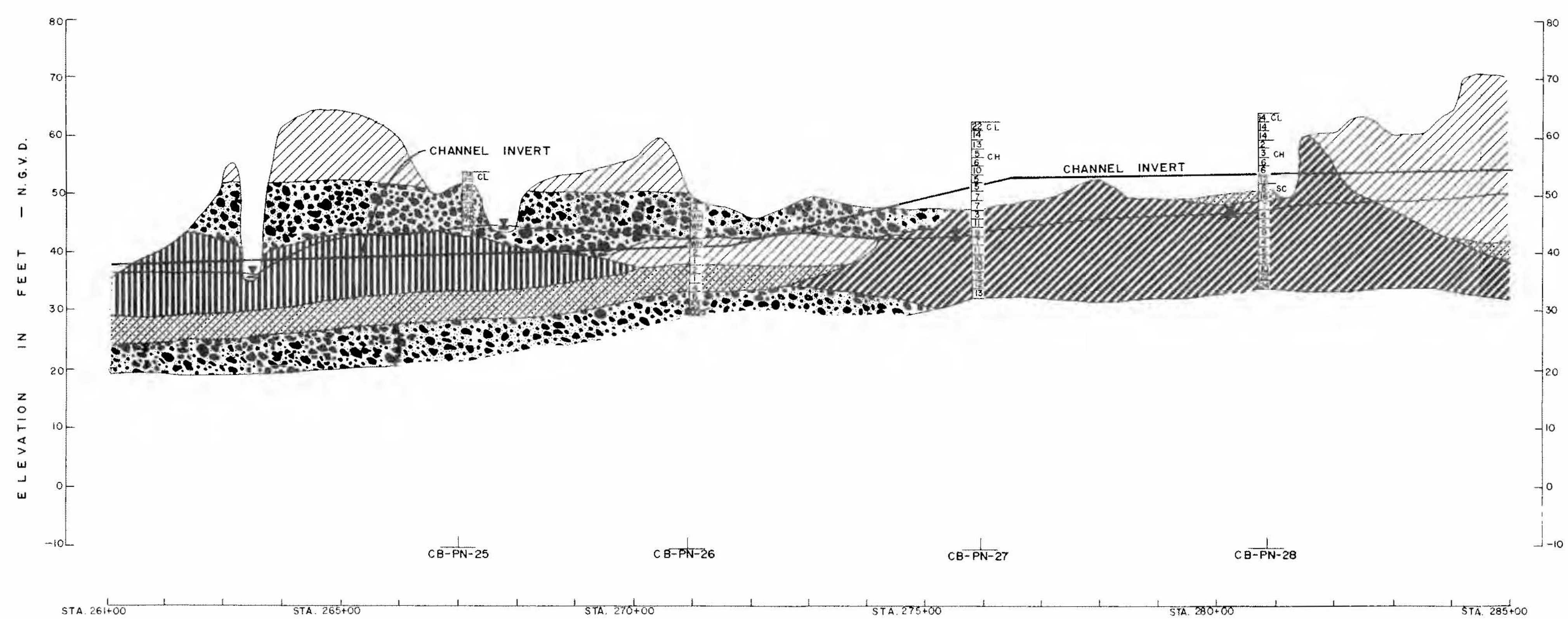
GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE G-4



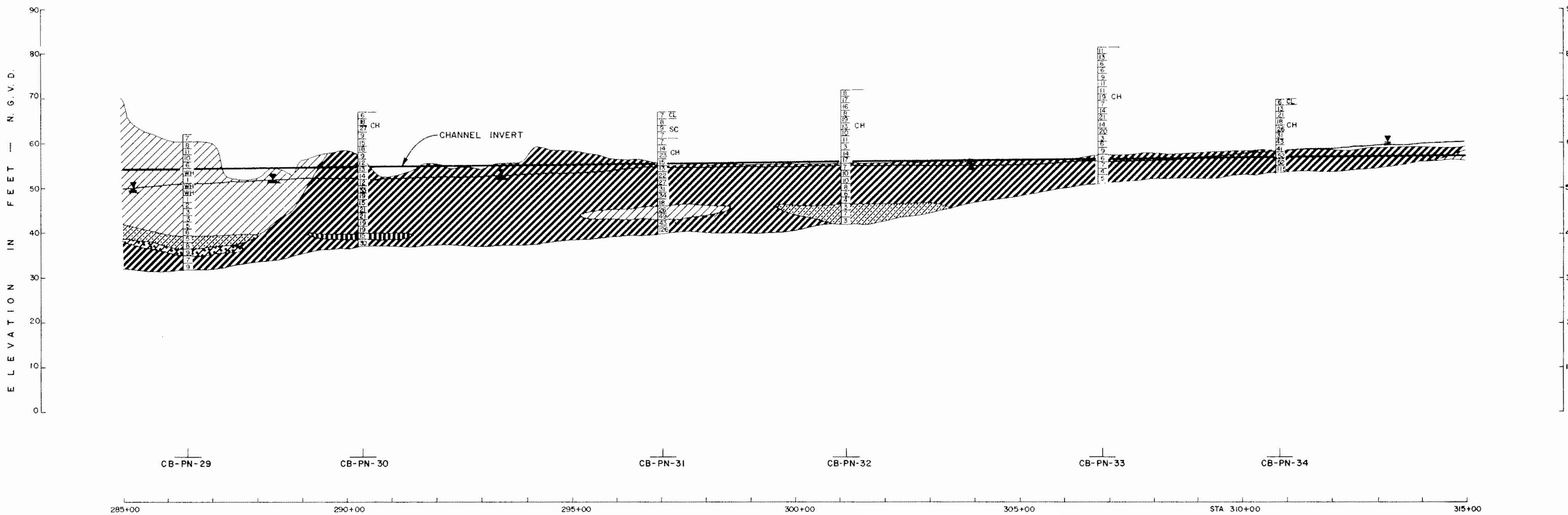

PUERTO NUEVO CHANNEL
UPPER SECTION

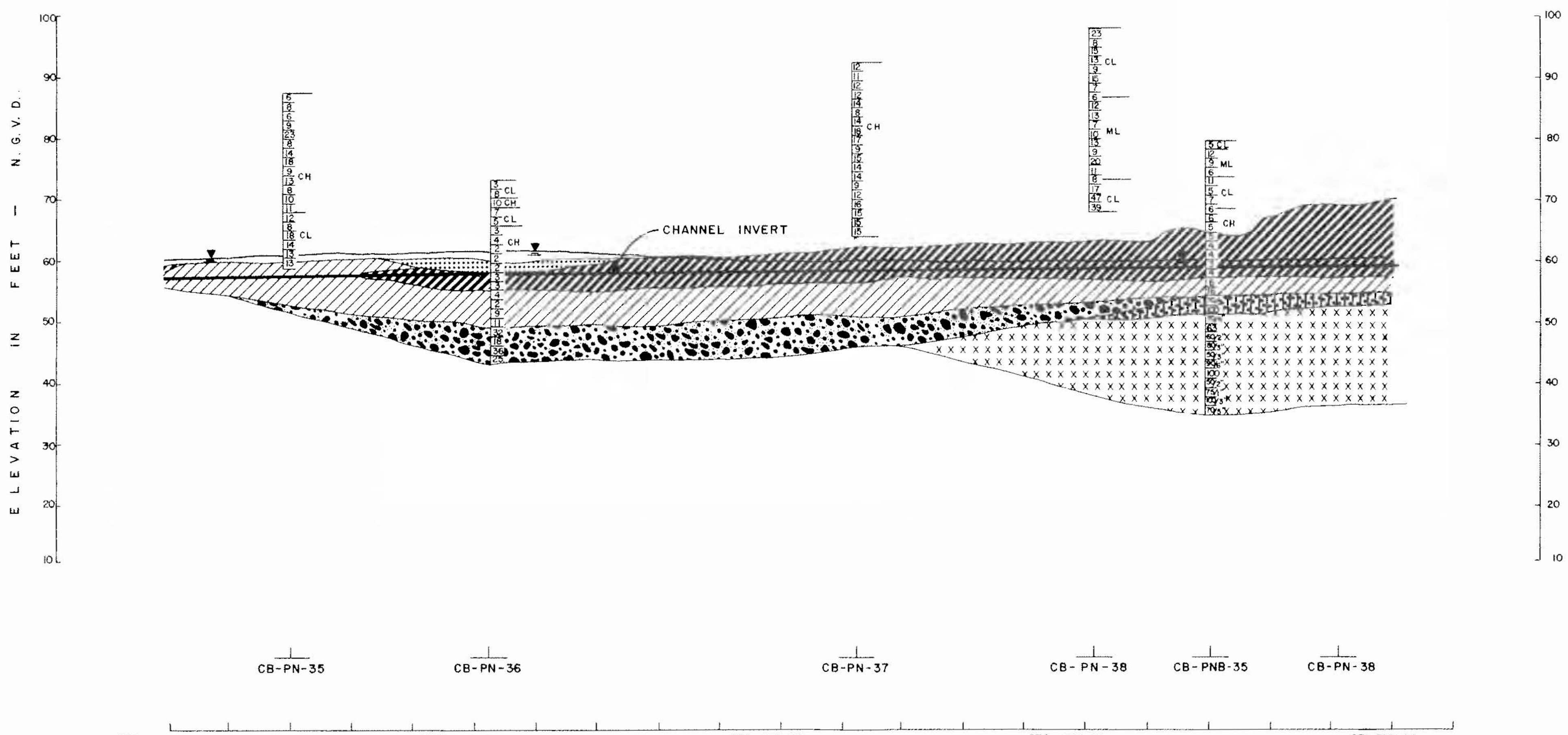
NOTES:
1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-32 - S-34 FOR CORE BORING LOCATIONS.
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

- (GP) GRAVEL, LITTLE SAND
- (GC) CLAYEY GRAVEL
- (SP) POORLY GRADED SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (MH) HIGH PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC, HIGH PLASTICITY CLAY

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
STA 230+00 TO STA 285+00
GEOLOGIC SECTIONS
GEOTECHNICAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




PUERTO NUEVO CHANNEL

UPPER SECTION

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-34 – S-36 FOR CORE BORING LOCATIONS
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

| | | |
|---|---|---|
| | (GP) | GRAVEL, LITTLE SAND |
| | (GM) | SILTY GRAVEL |
| | (GC) | CLAYEY GRAVEL |
| | (SP) | POORLY GRADED SAND |
| | (CL) | LOW PLASTICITY CLAY |
| | (SC) | CLAYEY SAND |
| | (MH) | HIGH PLASTICITY SILT |
| | (CH) | HIGH PLASTICITY CLAY |
| | | SILTSTONE |

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL

STA 285+00 TO STA 336+00

GEOLOGIC SECTIONS

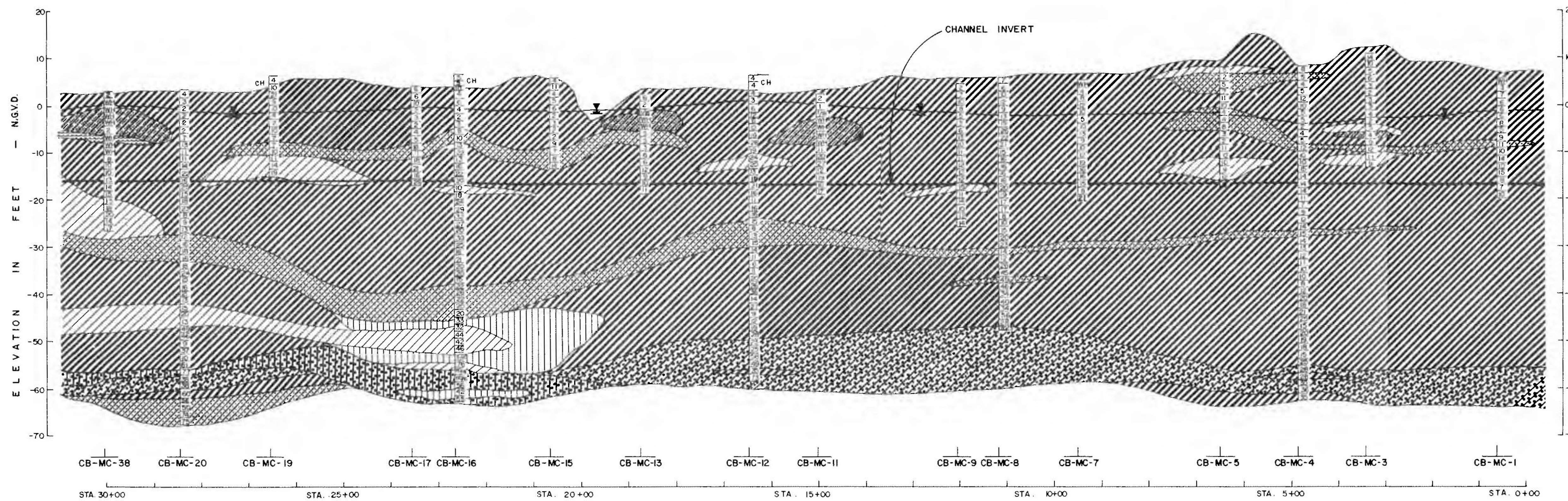
GEOTECHNICAL

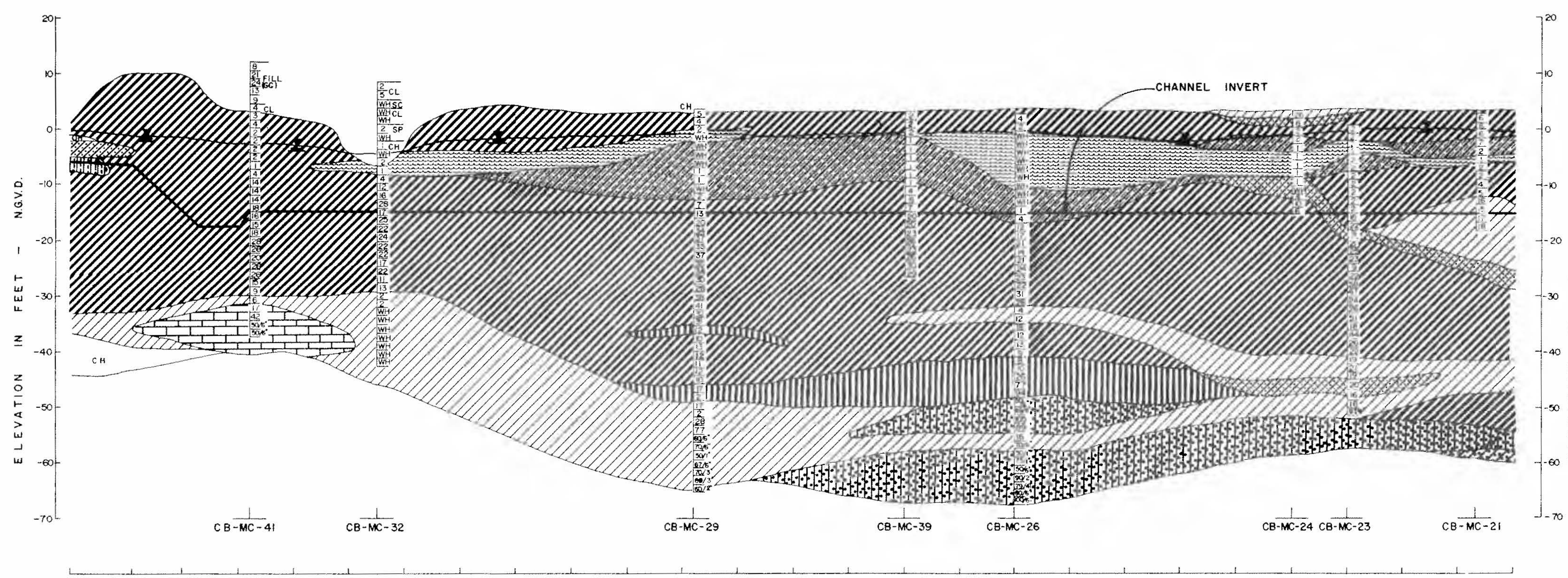
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578

DECEMBER 199




MARGARITA TRIBUTARY

LEGEND

- (GC) CLAYEY GRAVEL (WEATHERED) LIMESTONE)
- (GM) SILTY GRAVEL (WEATHERED LIMESTONE)
- (SP) SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (MH) HIGH PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY
- (PT) PEAT
- (LS) LIMESTONE FRAGMENTS

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-38-S-40 FOR CORE BORING LOCATIONS.
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

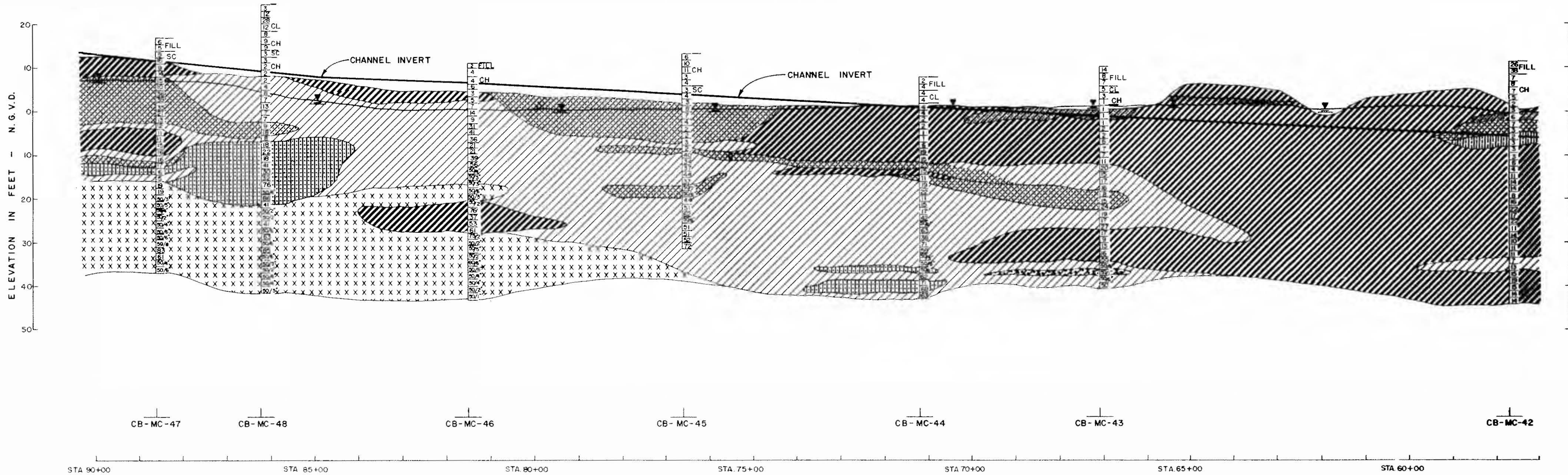
MARGARITA TRIBUTARY
STA 0+00 TO STA 57+00

## GEOLOGIC SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




MARGARITA TRIBUTARY (CONT.)

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-40-S-44 FOR CORE BORING LOCATIONS
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

- (GC) CLAYEY GRAVEL (WEATHERED LIMESTONE)
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (OL) ORGANIC SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY
- (MS) SILTSTONE

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY
STA 57+00 TO STA 90+00

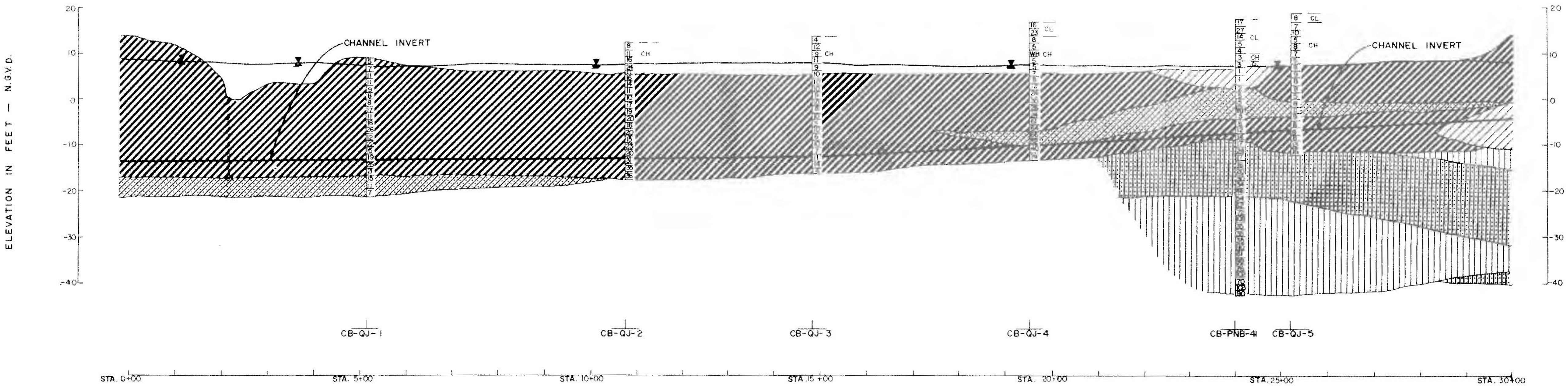
GEOLOGIC SECTIONS

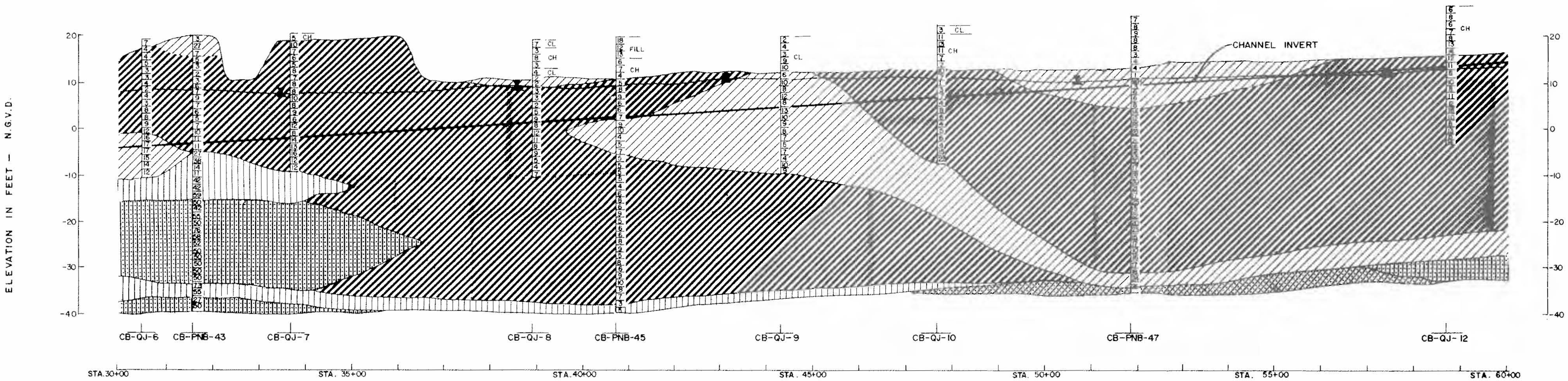
GEOTECHNICAL

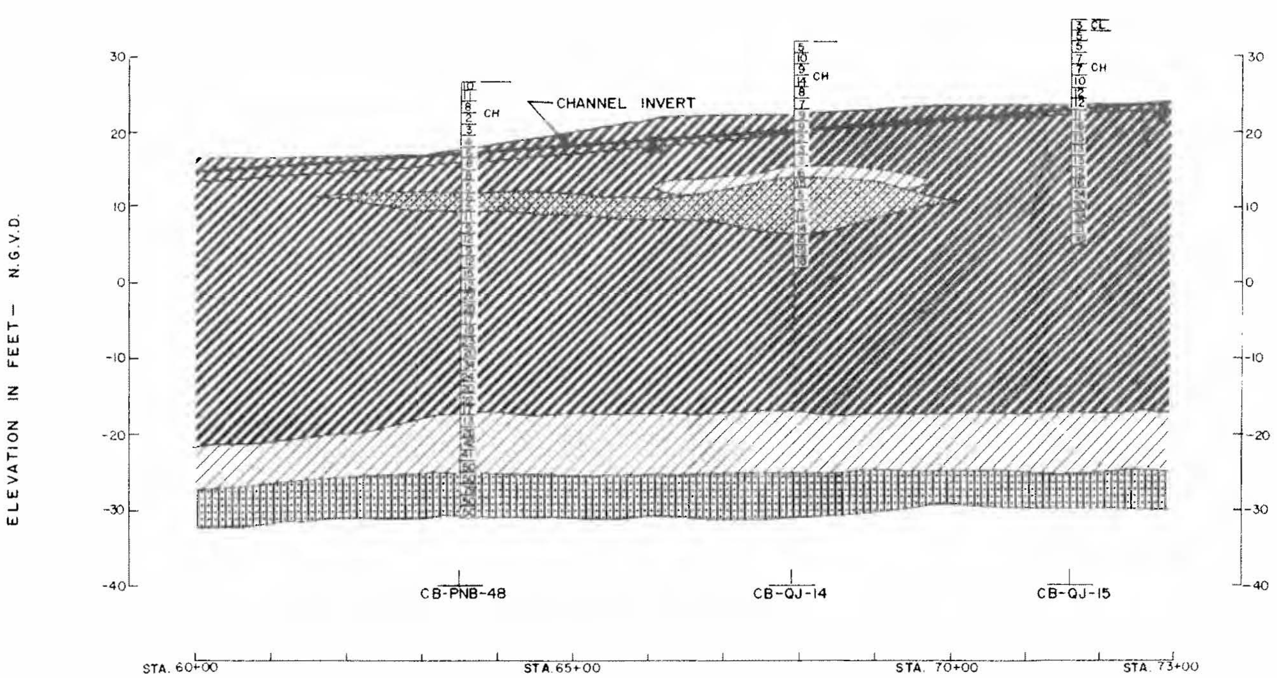
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199

PLATE G-8




## JOSEFINA TRIBUTARY

LEGEND

- (SM) SILTY SANDS
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SANDS
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-42-S-44 FOR CORE BORING LOCATIONS
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

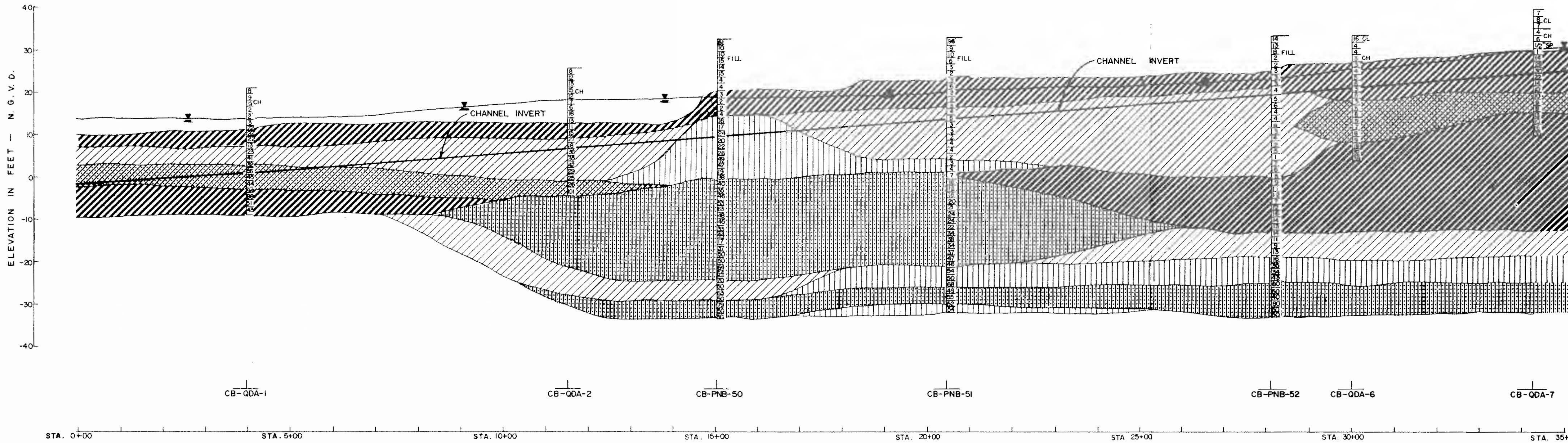
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY
STA 0+00 TO STA 73+00

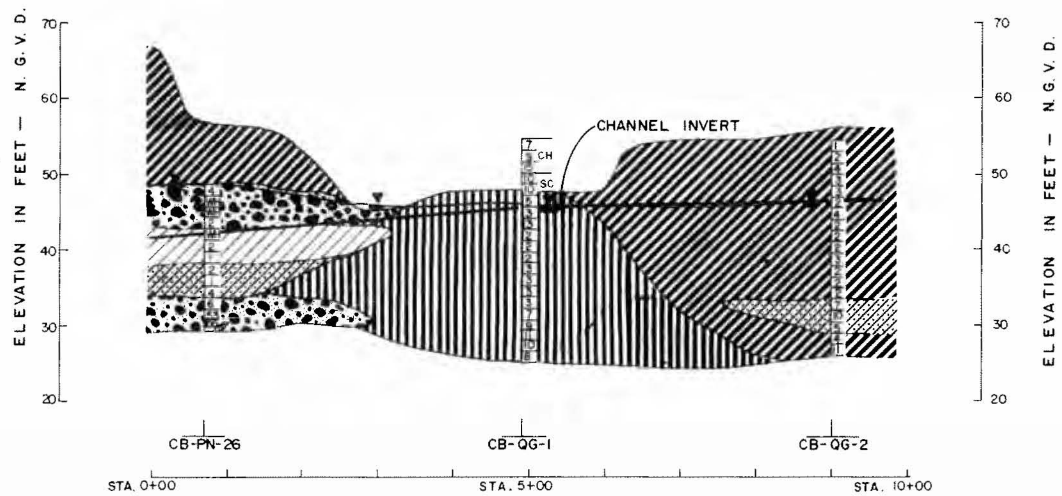
GEOLOGIC SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578
DECEMBER 199




DONA ANA TRIBUTARY




GUARACANAL TRIBUTARY

LEGEND

- (GP) POORLY-GRADED GRAVEL
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SANDS
- (ML) LOW PLASTICITY SILT
- (MH) HIGH PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-45, S-46 & S-49 FOR CORE BORING LOCATION
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

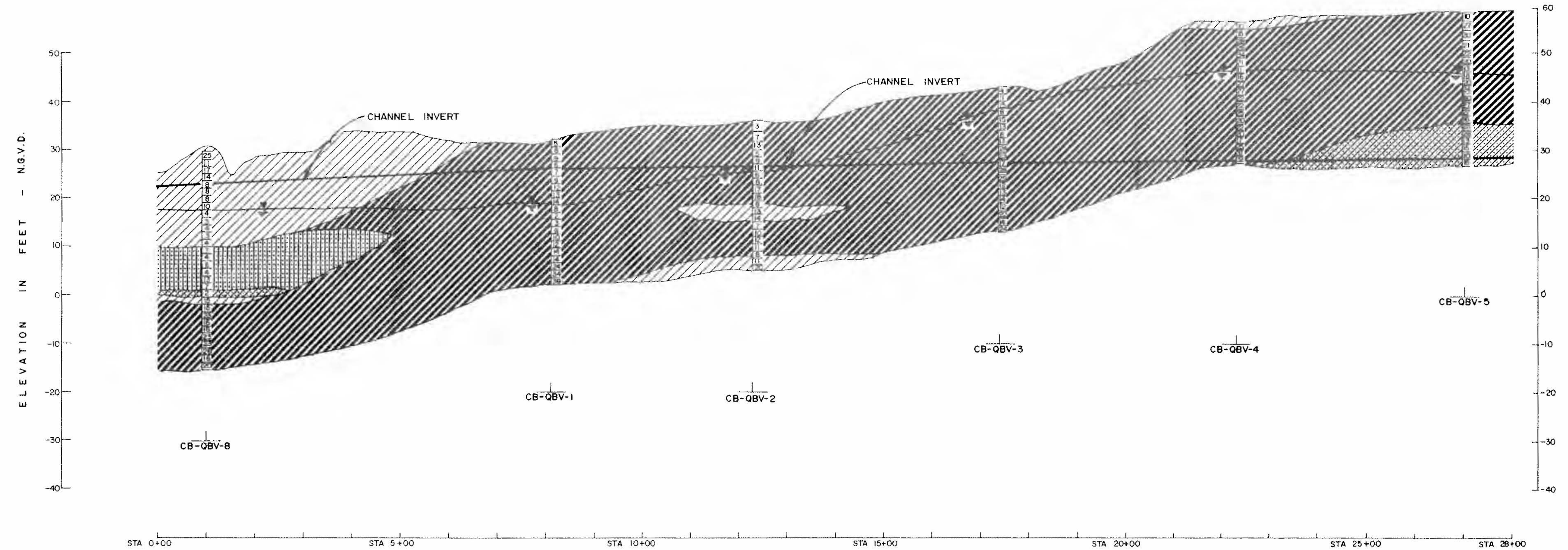
DONA ANA TRIBUTARY - STA 0+00 TO STA 35+00
GUARACANAL - STA 0+00 TO STA 10+00

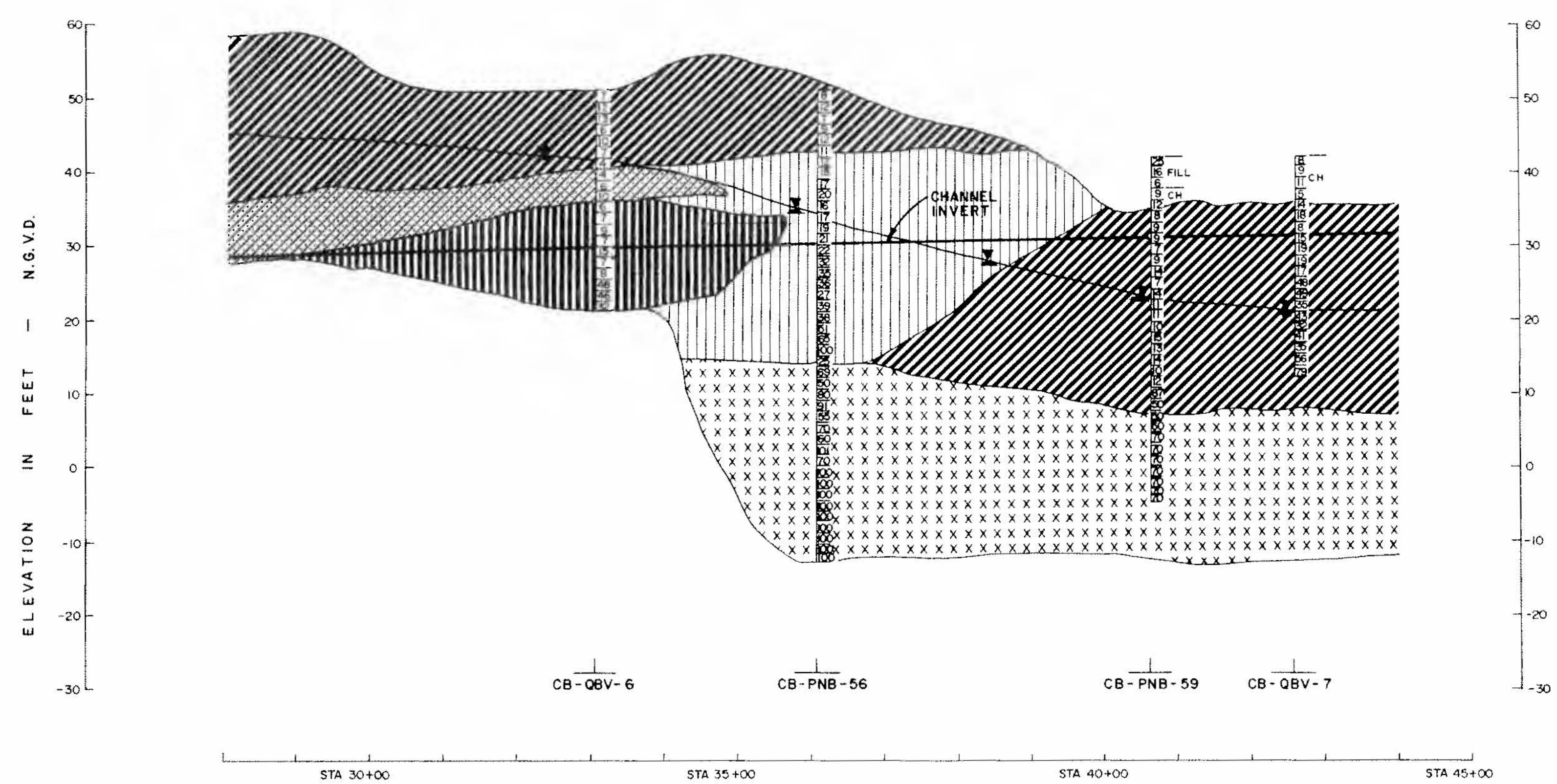
GEOLOGIC SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




BUENA VISTA CHANNEL

NOTES:

1. CORE BORINGS ARE PROJECTED ONTO THE CHANNEL CENTERLINE.
2. SEE PLATES S-47 & S-48 FOR CORE BORING LOCATIONS.
3. GROUNDWATER IS SUBJECT TO FLUCTUATION.

LEGEND

- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (MH) HIGH PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (MS) SILTSTONE

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

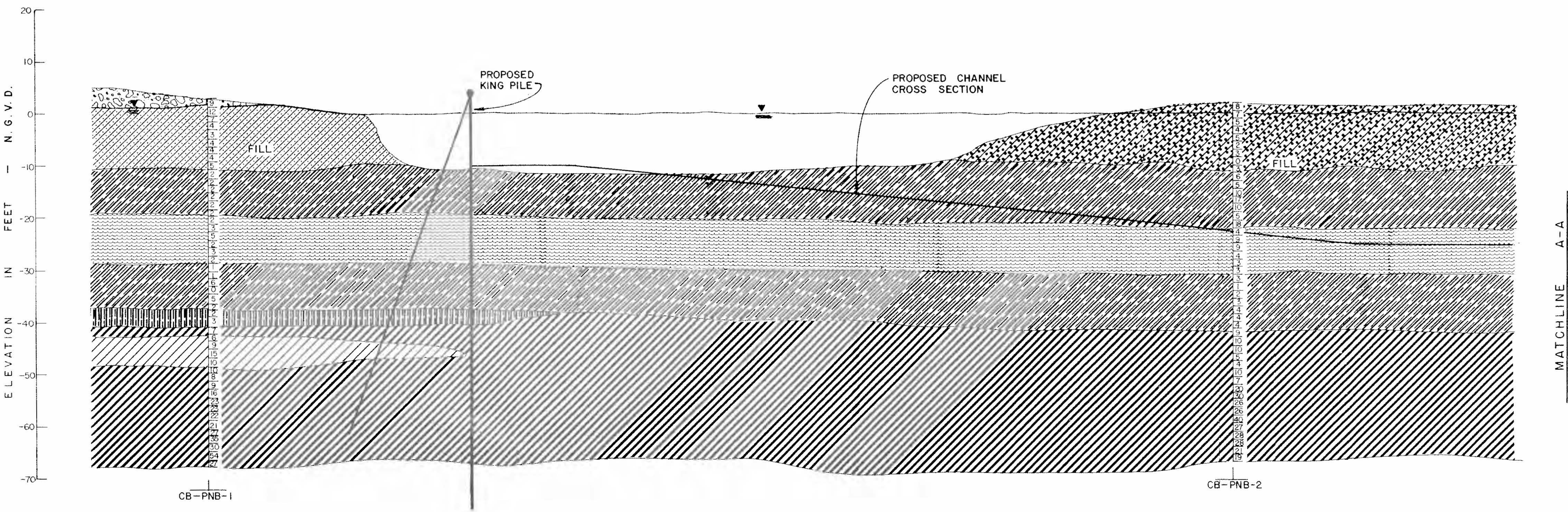
BUENA VISTA DIVERSION CHANNEL
STA 0+00 TO STA 45+00

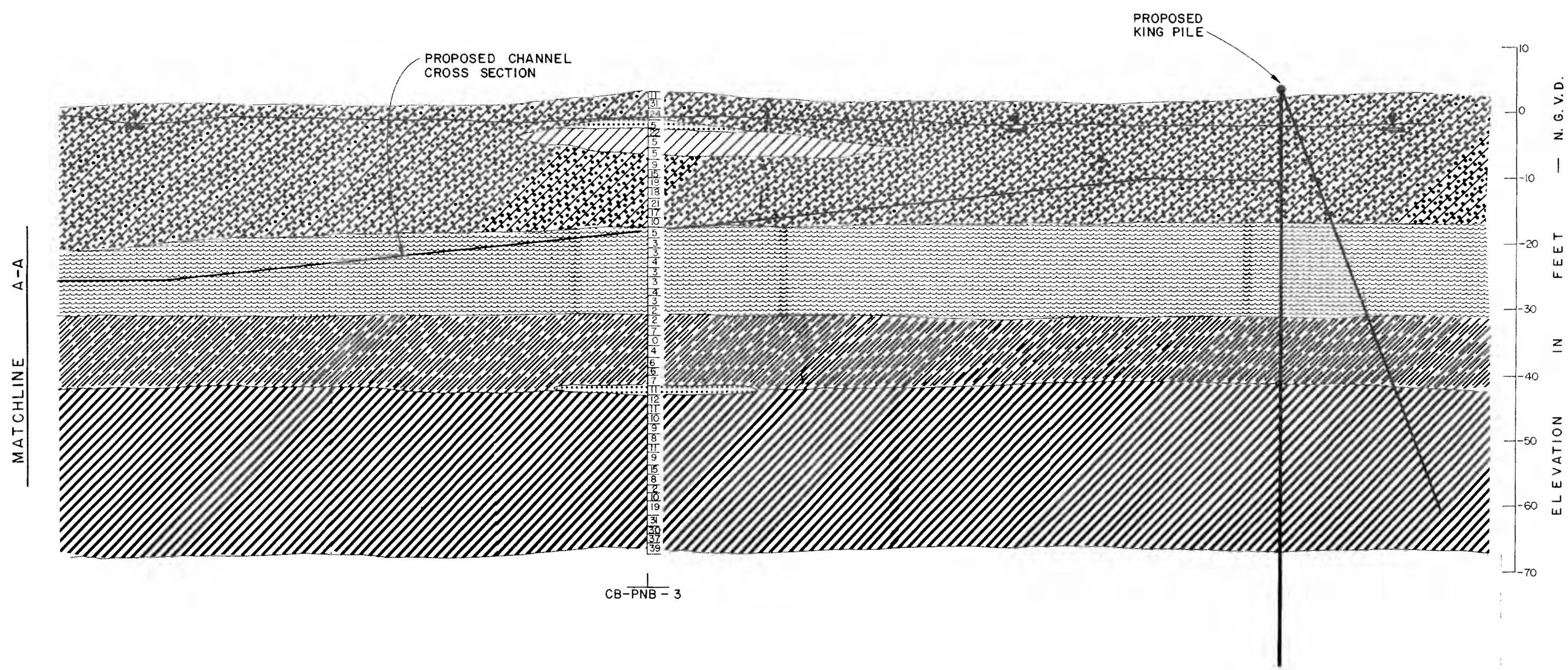
GEOLOGIC SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199




LEGEND

- (GW) WELL GRADED GRAVEL
- (GC) CLAYEY GRAVEL
- (SP) POORLY GRADED SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (OL) ORGANIC SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY
- (PT) PEAT

HORIZ. SCALE

0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 1

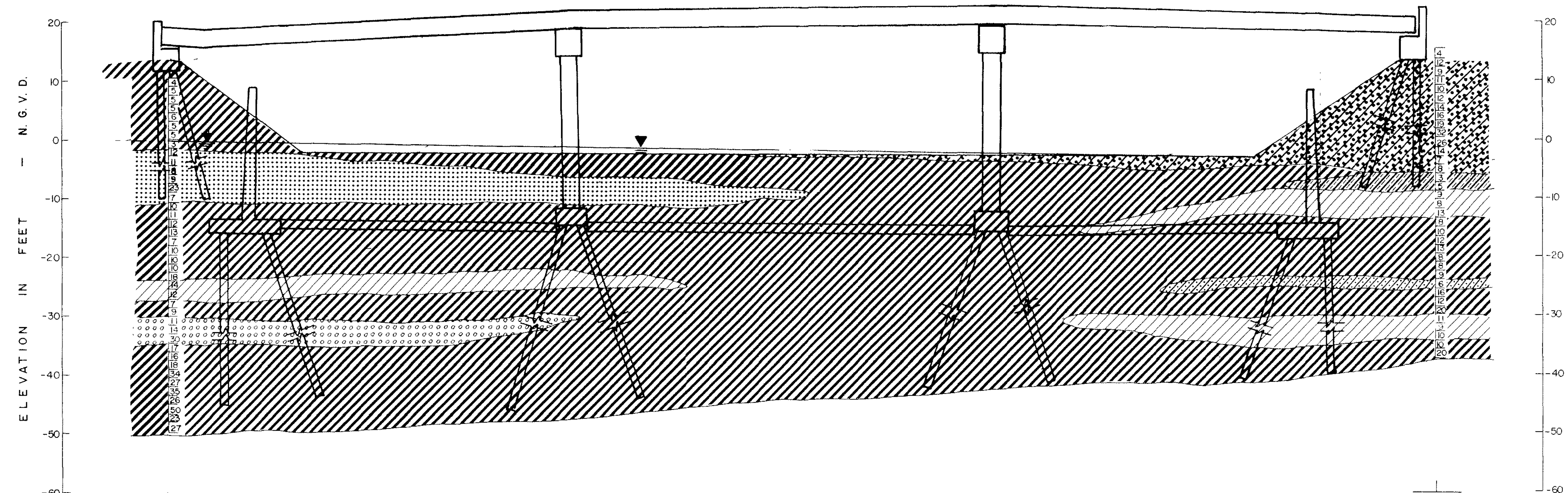
## BRIDGE CROSS SECTIONS

GEOTECHNICAL

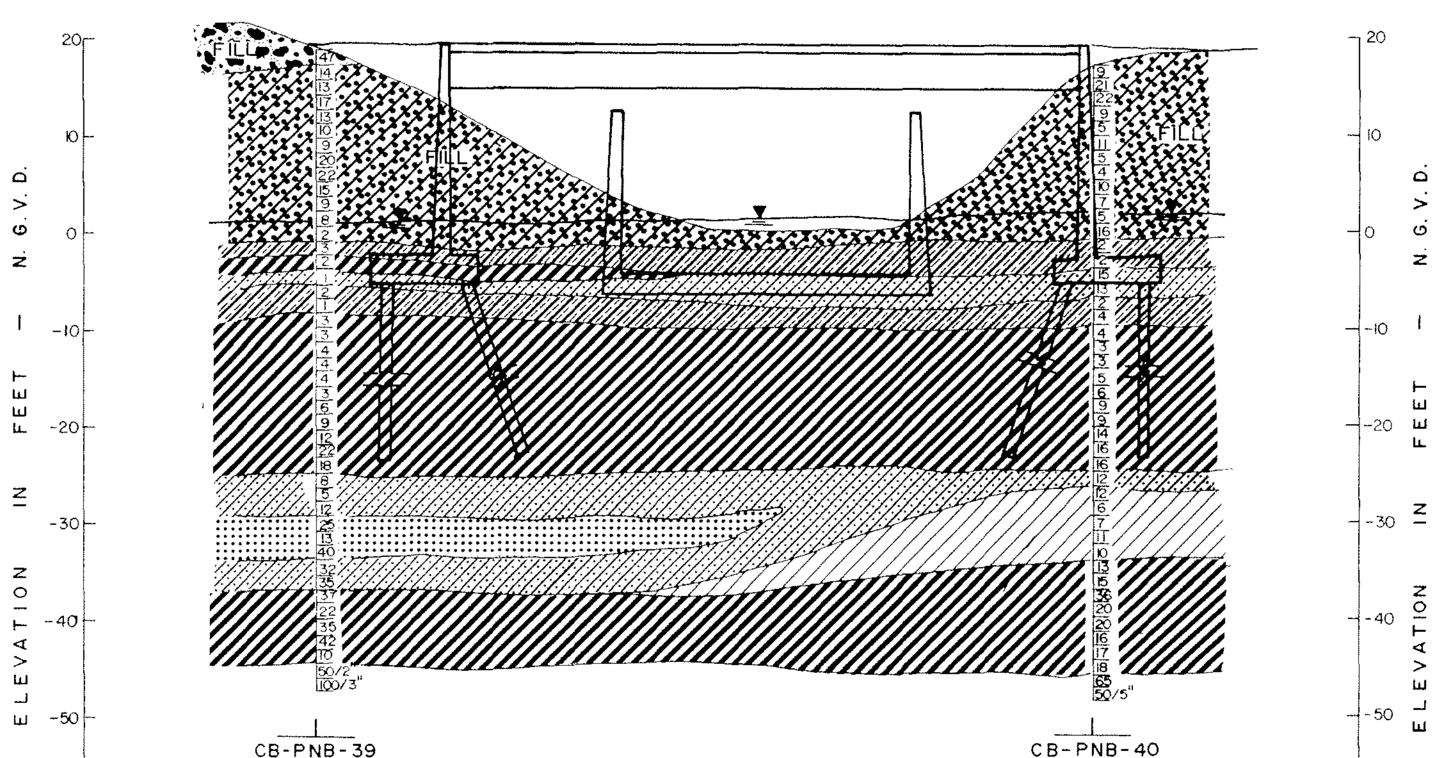
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990



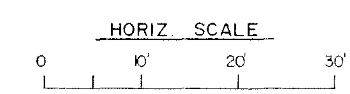

DE DIEGO EXPRESSWAY
STA. 95 + 00



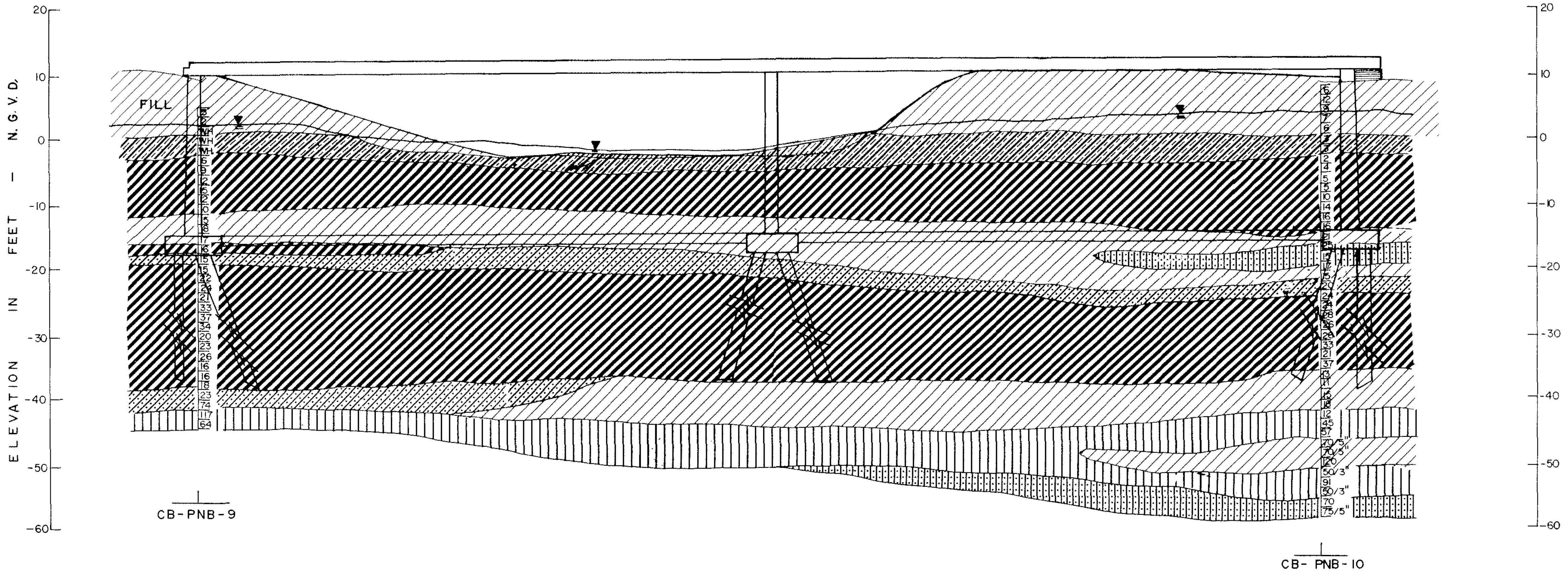

DE DIEGO EXPRESSWAY, MARGARITA
STA. 61 + 00

LEGEND

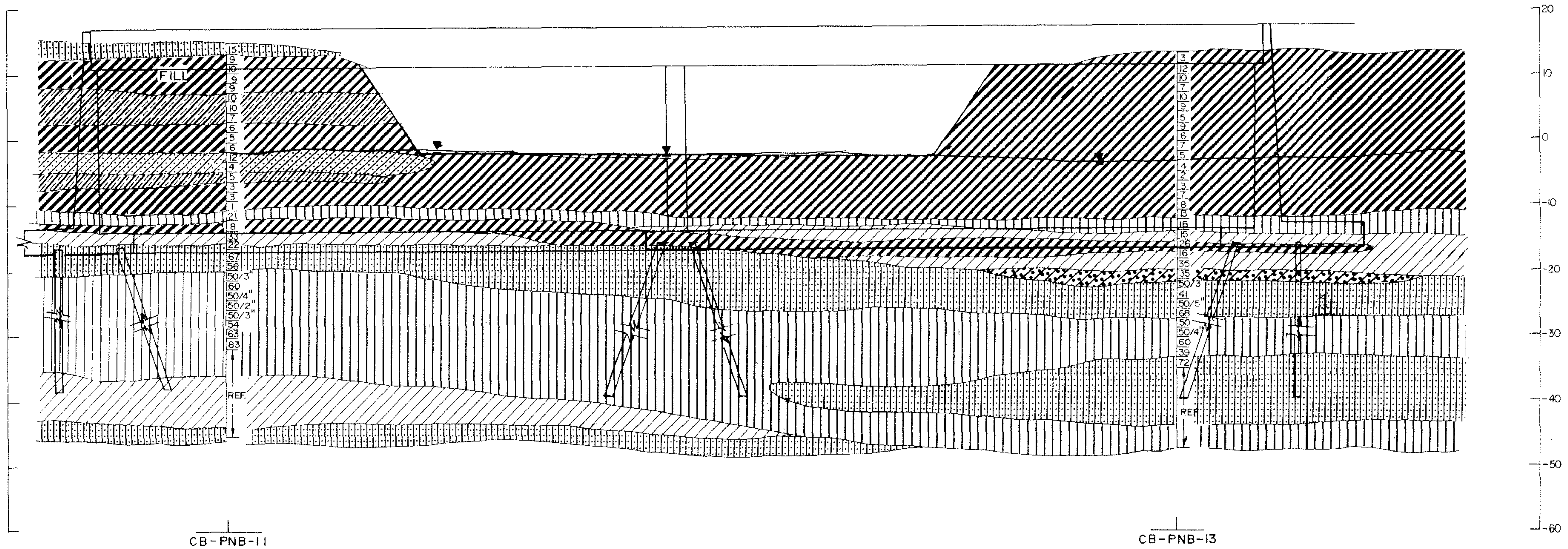
- (GP) POORLY GRADED GRAVEL
- (GC) CLAYEY GRAVEL
- (SW) WELL GRADED SAND
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 2
MARGARITA TRIBUTARY
BRIDGE CROSS SECTIONS
GEOTECHNICAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




PEDESTRIAN BRIDGE
STA. 110+00




ROOSEVELT AVENUE BRIDGE
STA. 120+50

LEGEND

- (GC) CLAYEY GRAVEL
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY

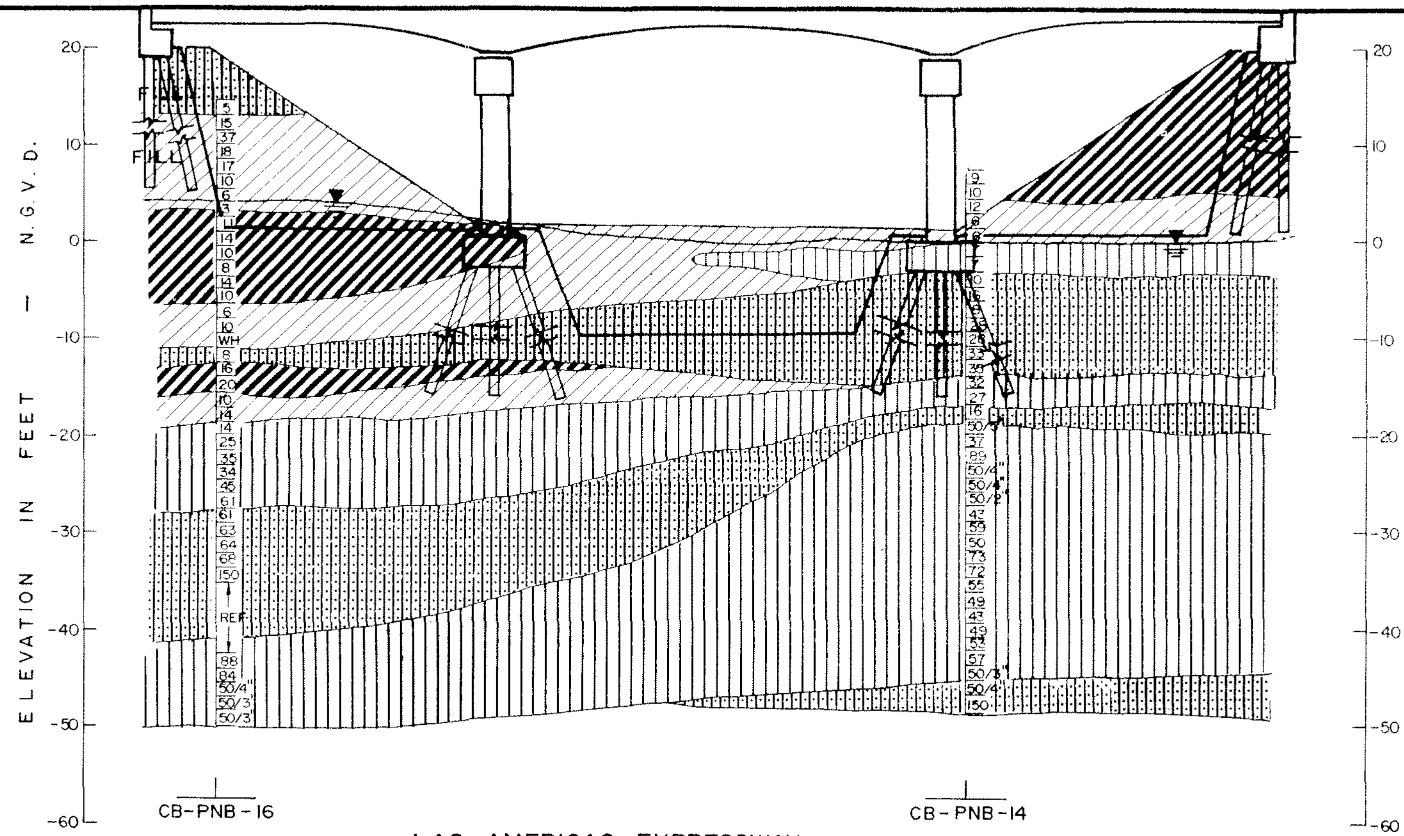
HORIZ SCALE
0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 2

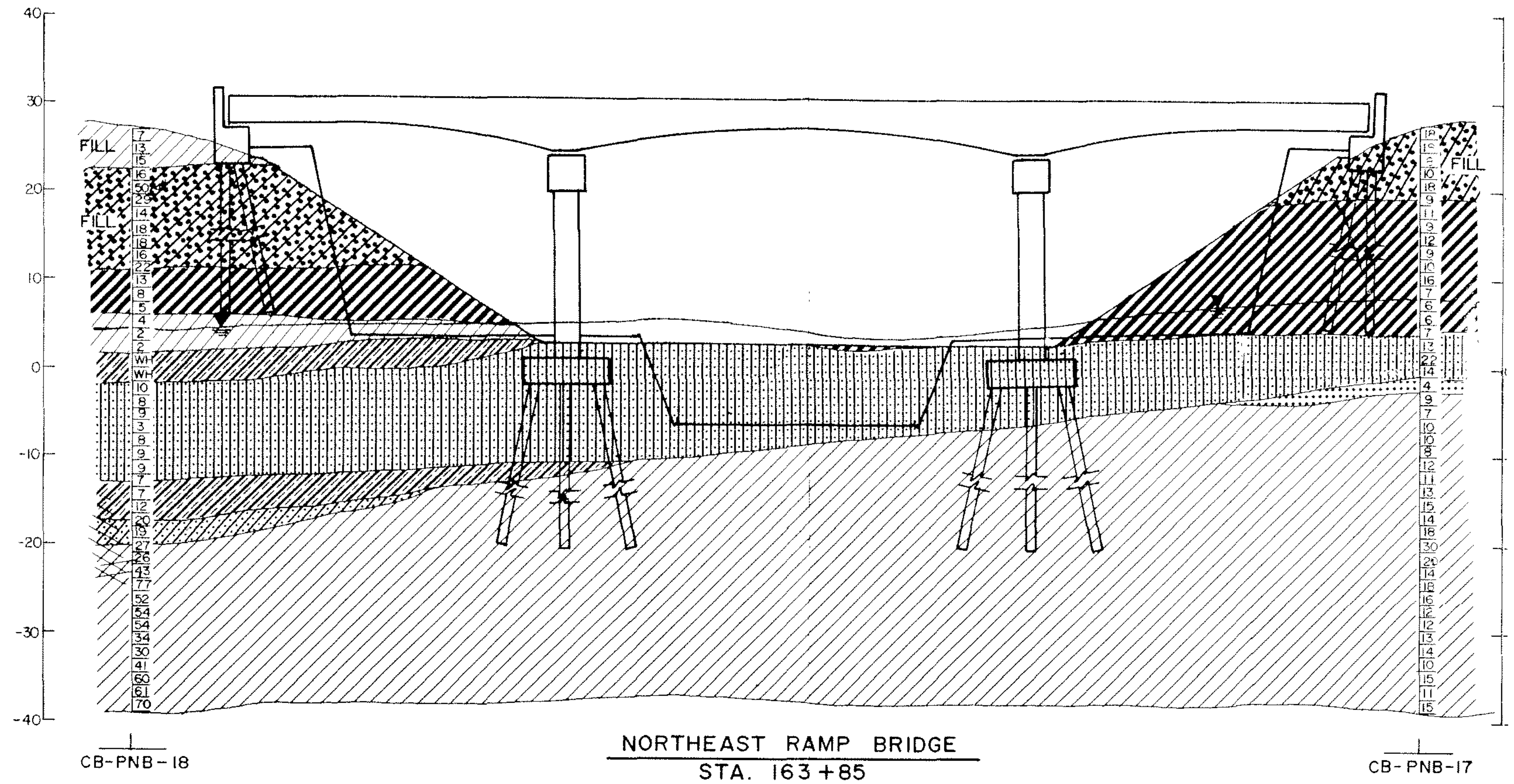
BRIDGE CROSS SECTIONS

GEOTECHNICAL

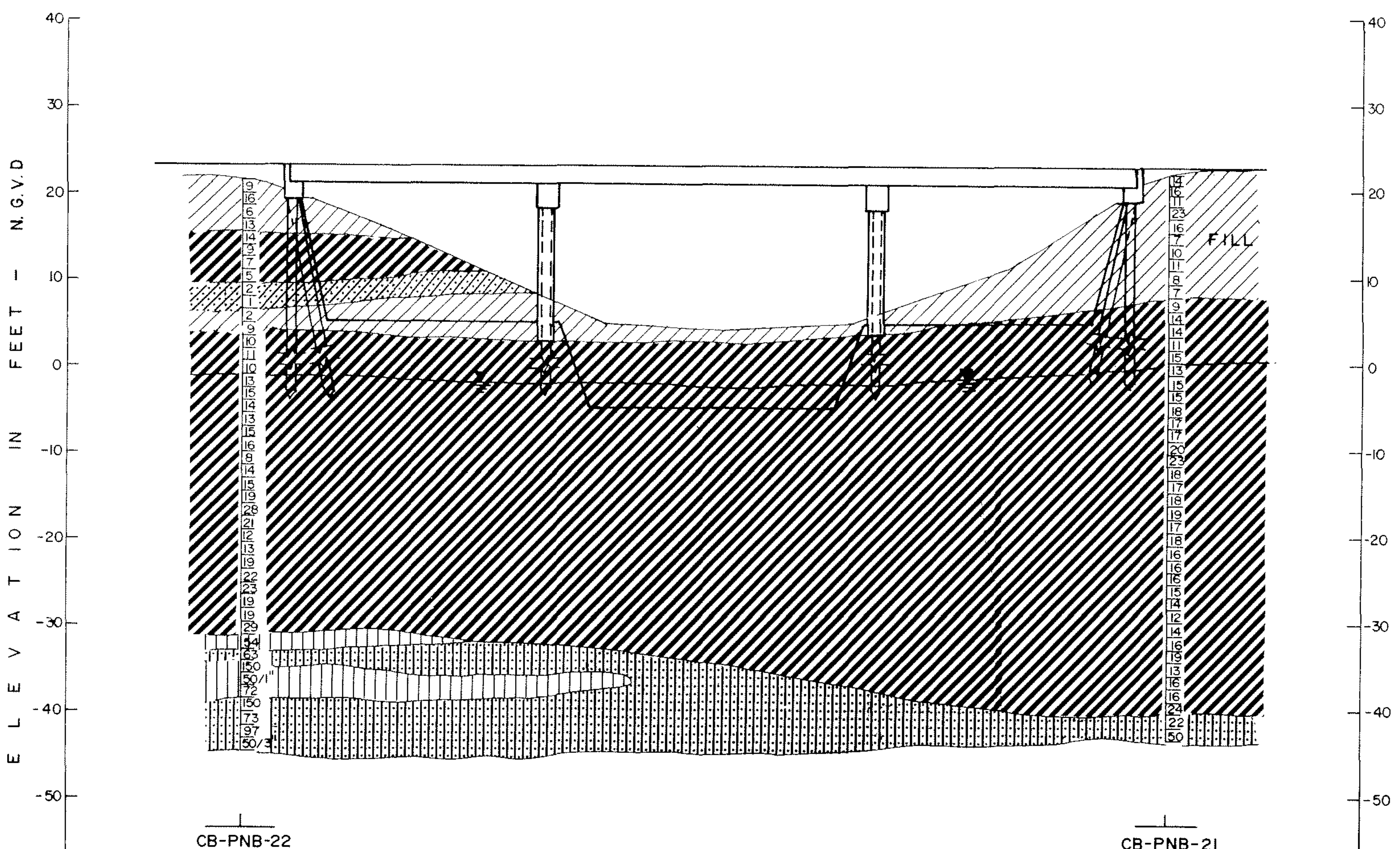
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




LAS AMERICAS EXPRESSWAY
STA 156+00




NORTHEAST RAMP BRIDGE
STA. 163+85




PINERO AVENUE BRIDGE
STA. 169+22

LEGEND

- (GC) CLAYEY GRAVEL
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (OL) ORGANIC SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY

HORIZ. SCALE
0 10' 20' 30'

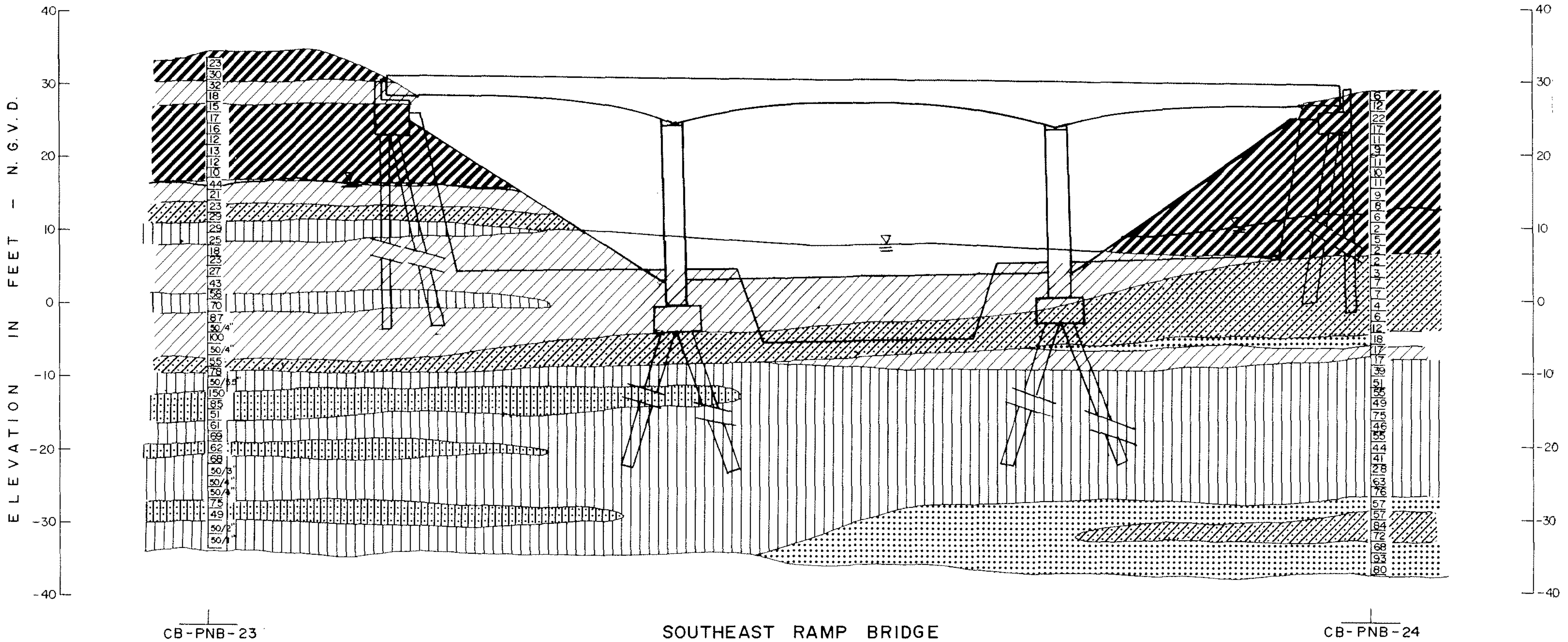
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 3

BRIDGE CROSS SECTIONS

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




SOUTHEAST RAMP BRIDGE
STA. 174+50


PEDESTRIAN BRIDGE
STA. 195+00

LEGEND

- (SW) WELL GRADED SAND
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY

HORIZ. SCALE
0 10' 20' 30'

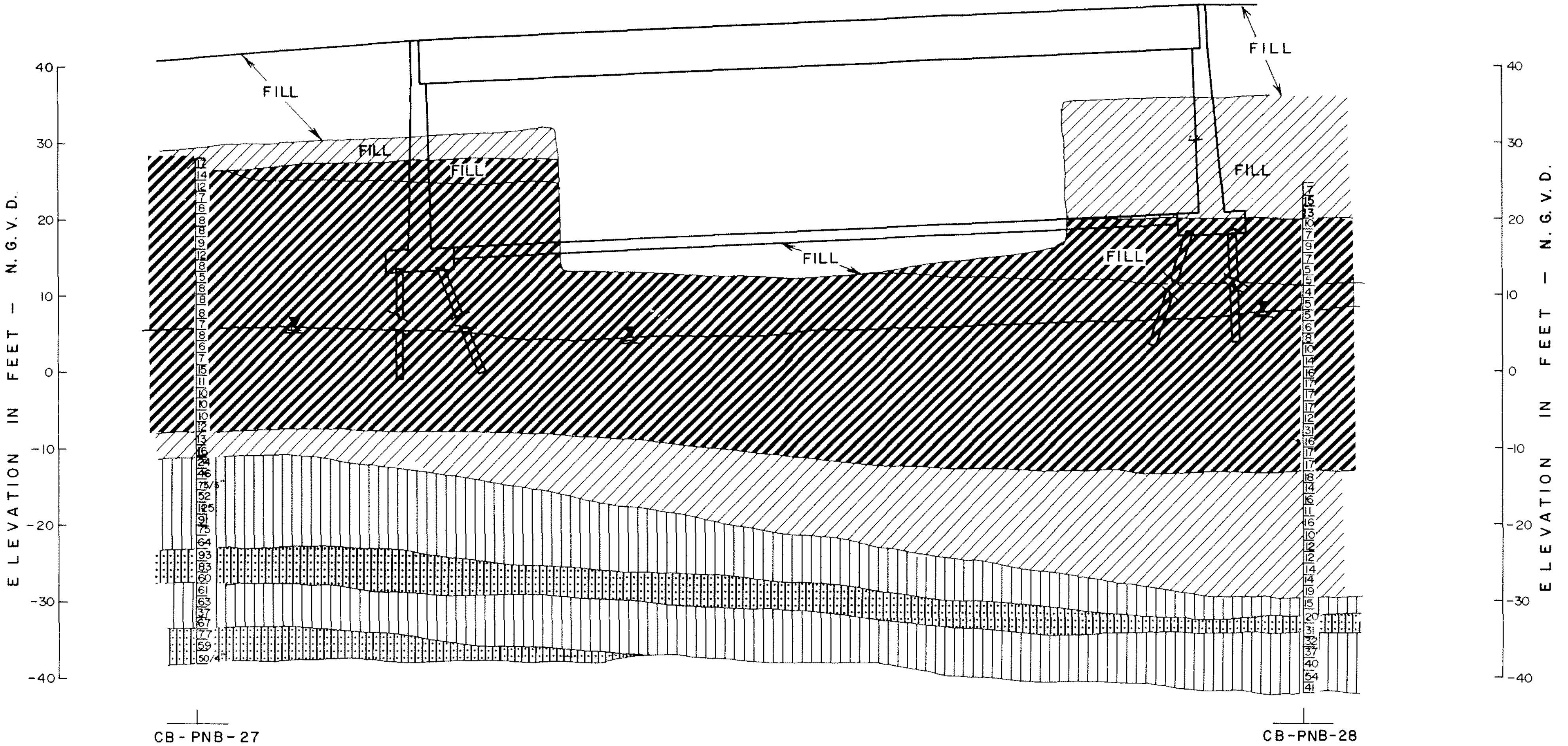
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 3

BRIDGE CROSS SECTIONS

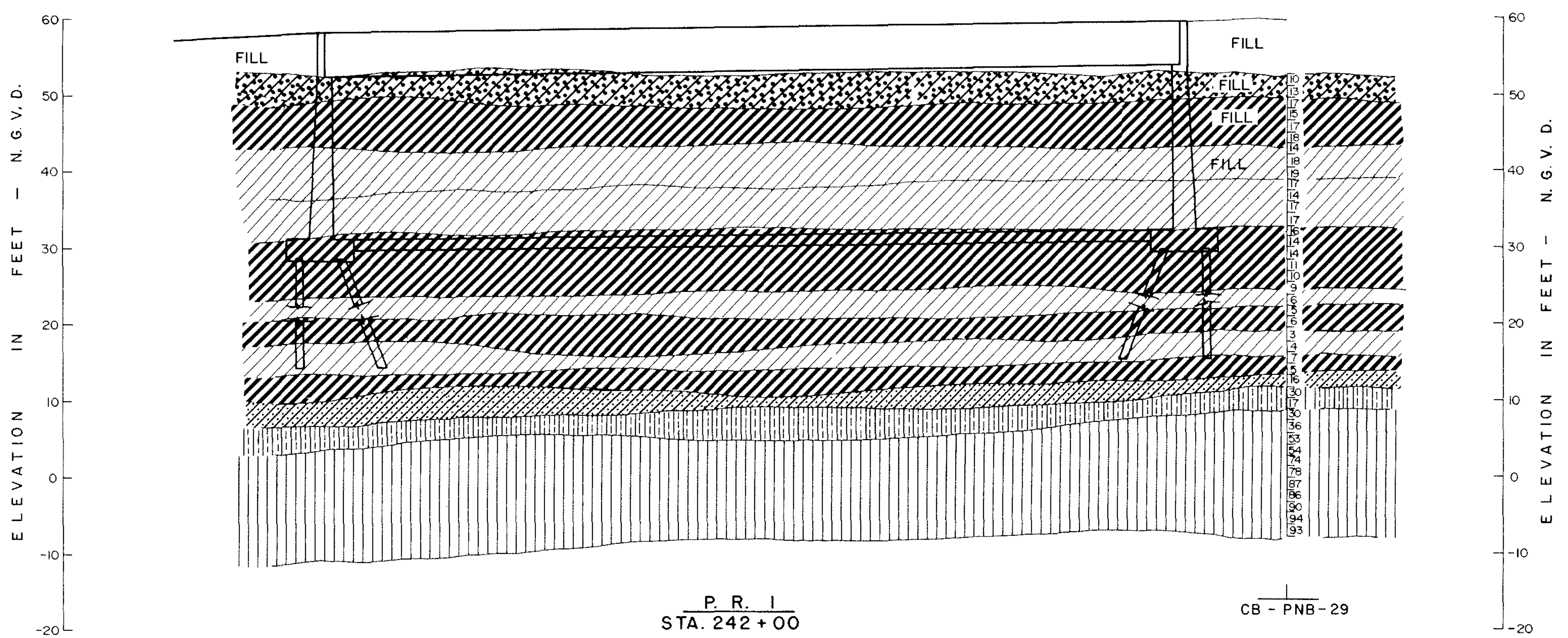
GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




NOTRE DAME BRIDGE
STA. 196 + 00




P. R. 1
STA. 242 + 00

LEGEND

| | |
|---|---|
| (GC) | CLAYEY GRAVEL |
| (SM) | SILTY SAND |
| (CL) | LOW PLASTICITY CLAY |
| (SC) | CLAYEY SAND |
| (ML) | LOW PLASTICITY SILT |
| (OL) | ORGANIC SILT |
| (CH) | HIGH PLASTICITY CLAY |

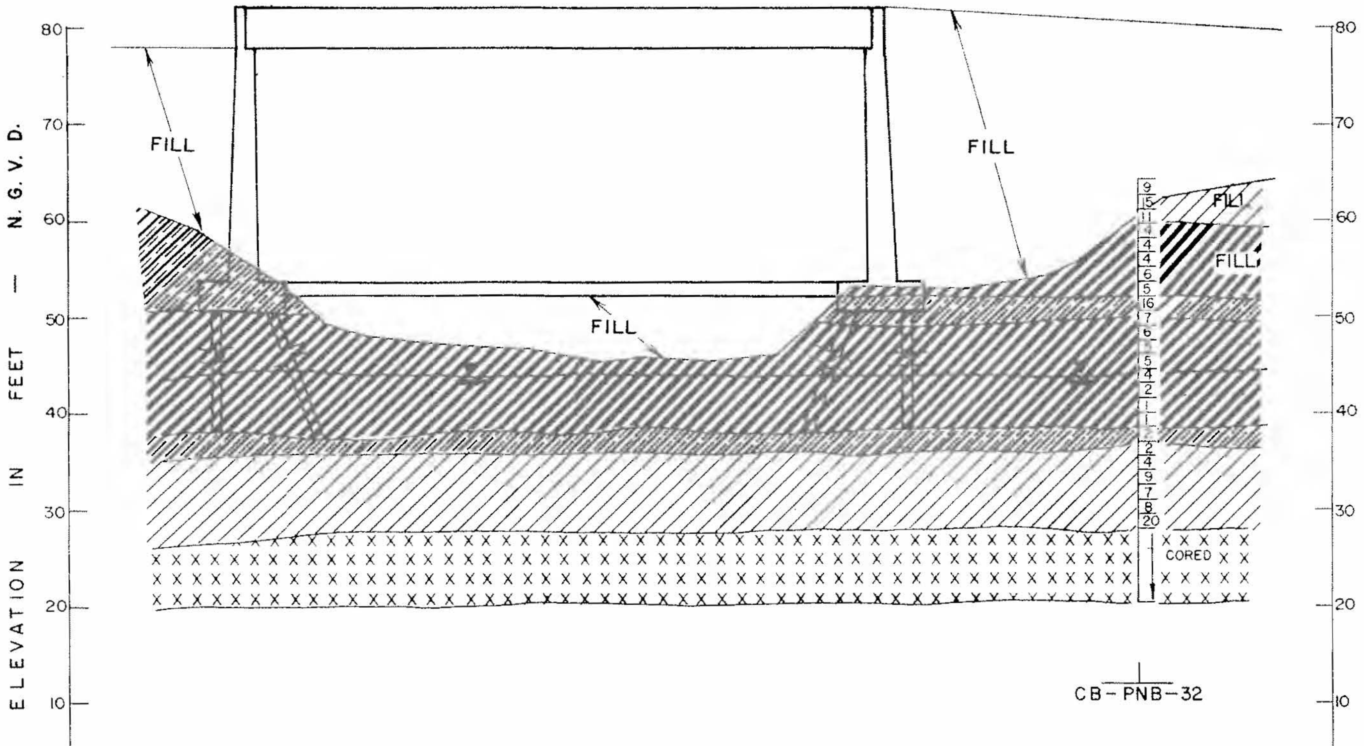
HORIZ. SCALE
0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACHES 3 & 4

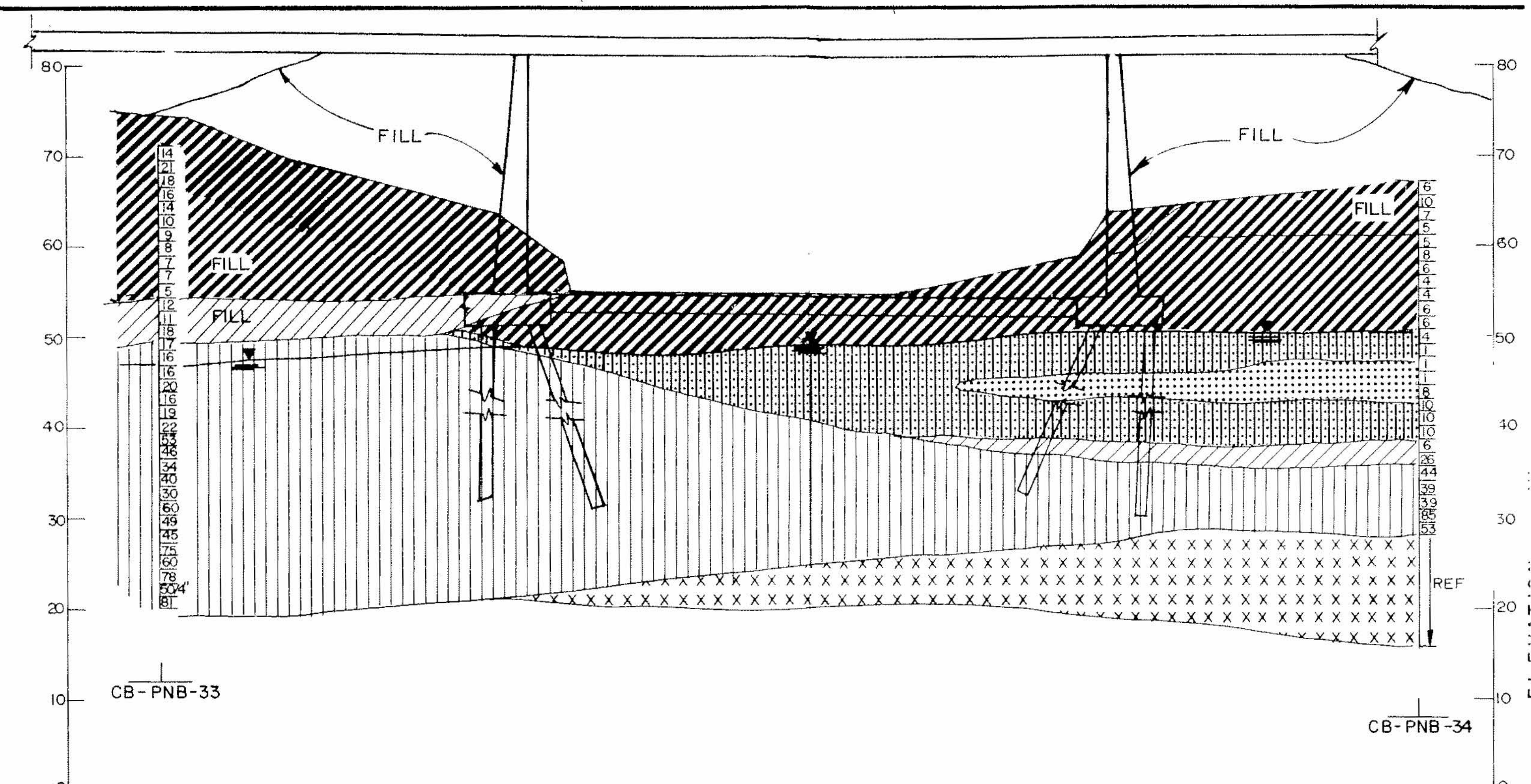
BRIDGE CROSS SECTIONS

GEOTECHNICAL

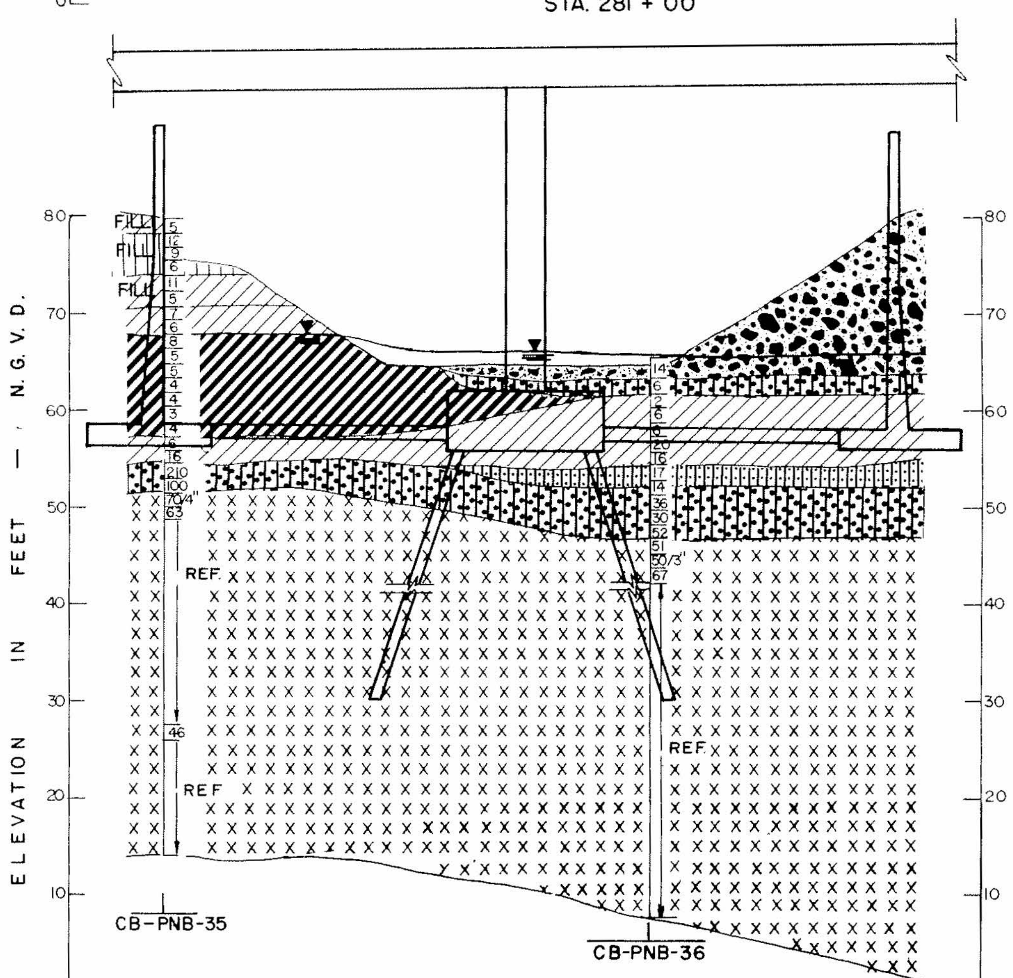
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



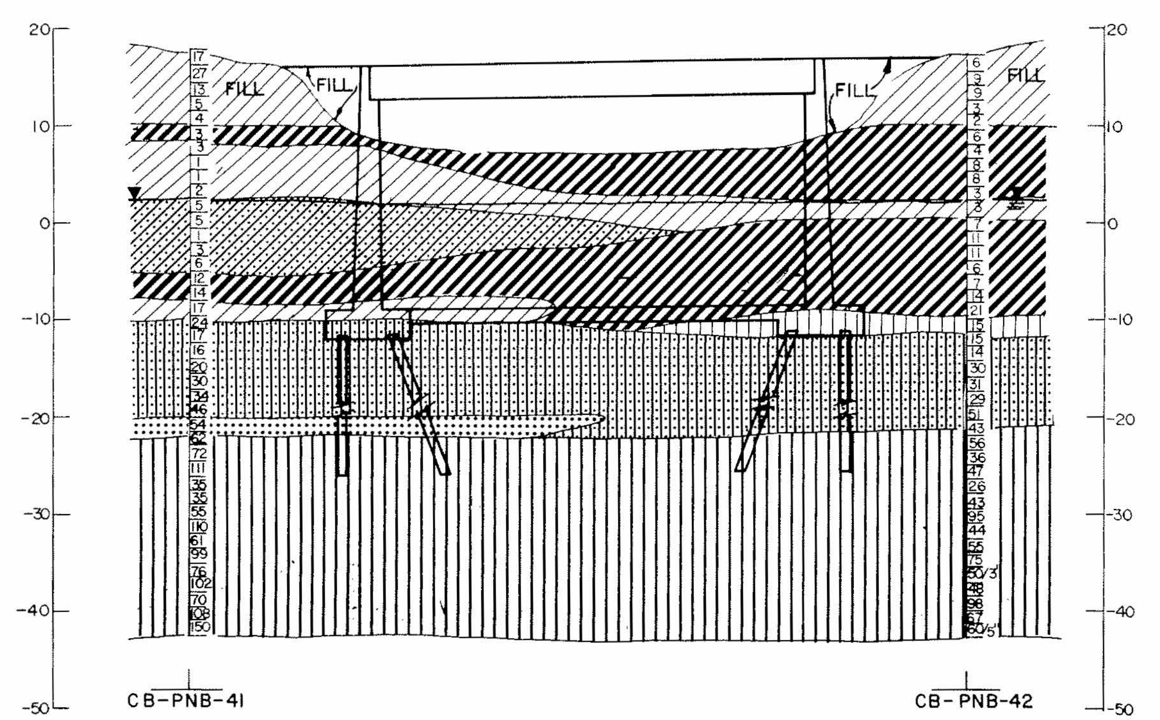

P.R. 176
STA. 281 + 00




PEDESTRIAN BRIDGE
STA. 302 + 30




P.R. 177
STA. 331 + 00




PINERO AVENUE JOSEFINA
STA. 24 + 00

HORIZ. SCALE
0 10' 20' 30'

LEGEND

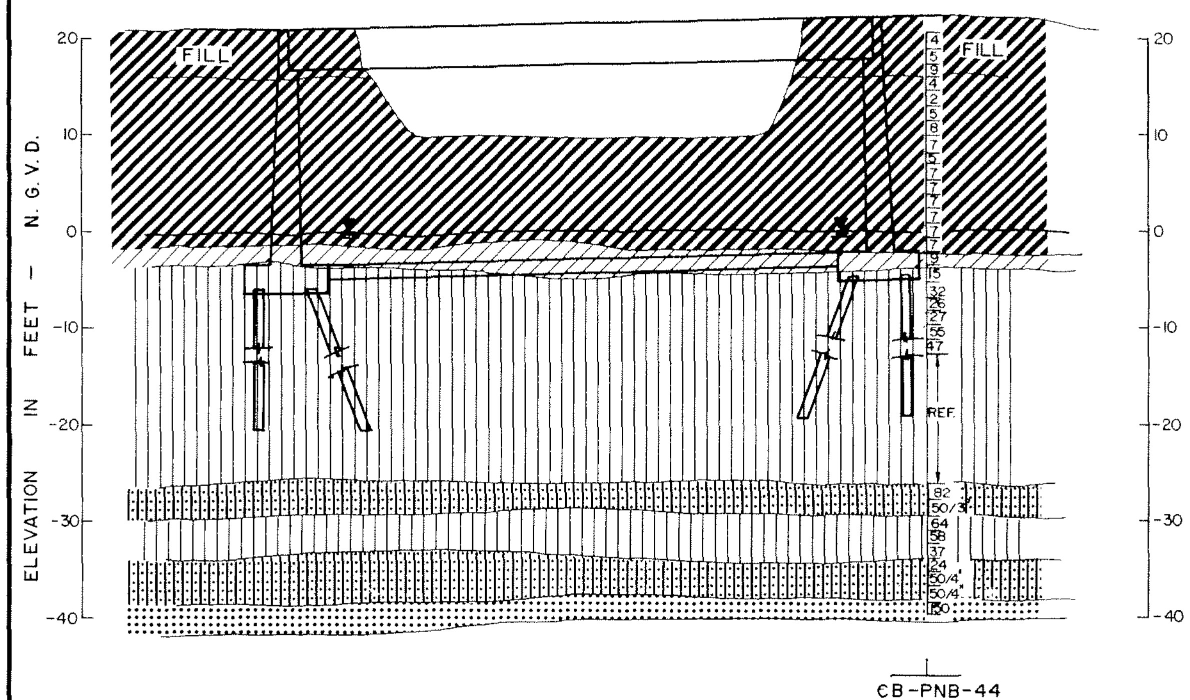
- (GP) GRAVEL, LITTLE SAND
- (GM) SILTY GRAVEL
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SAND
- (ML) LOW PLASTICITY SILT
- (OL) ORGANIC SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY
- (SS) SILTSTONE

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 5

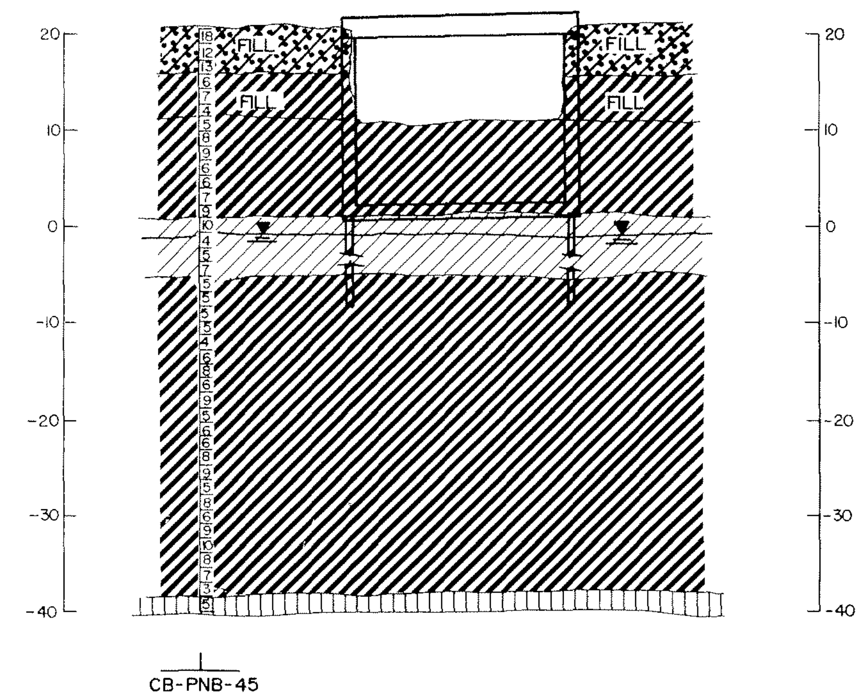
BRIDGE CROSS SECTIONS

GEOTECHNICAL

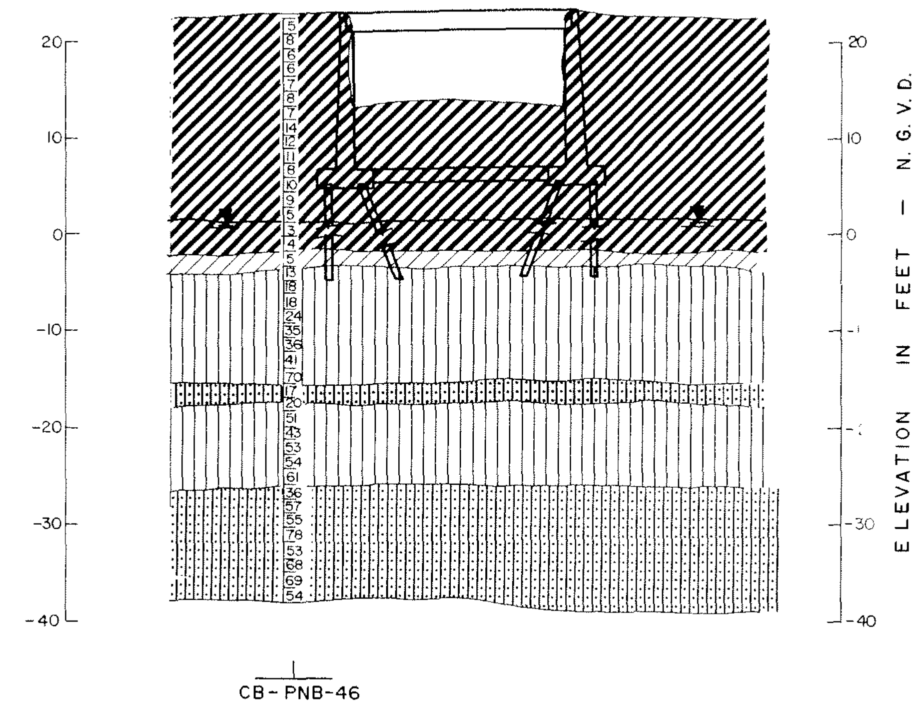
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



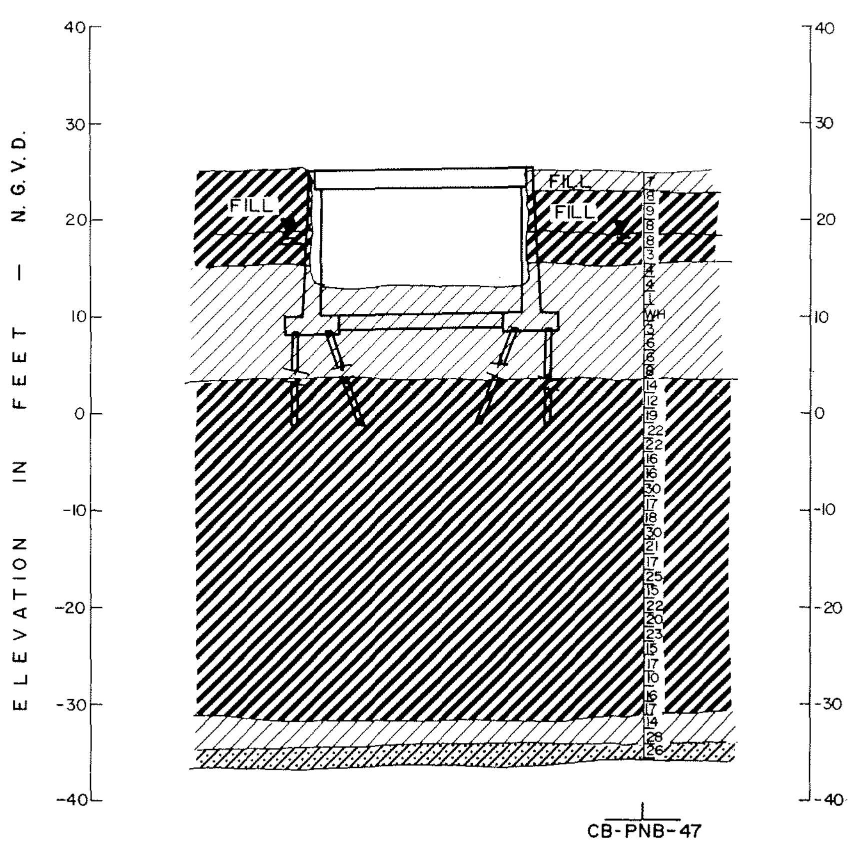

ANALUCIA AVENUE, JOSEFINA
STA. 31 + 10



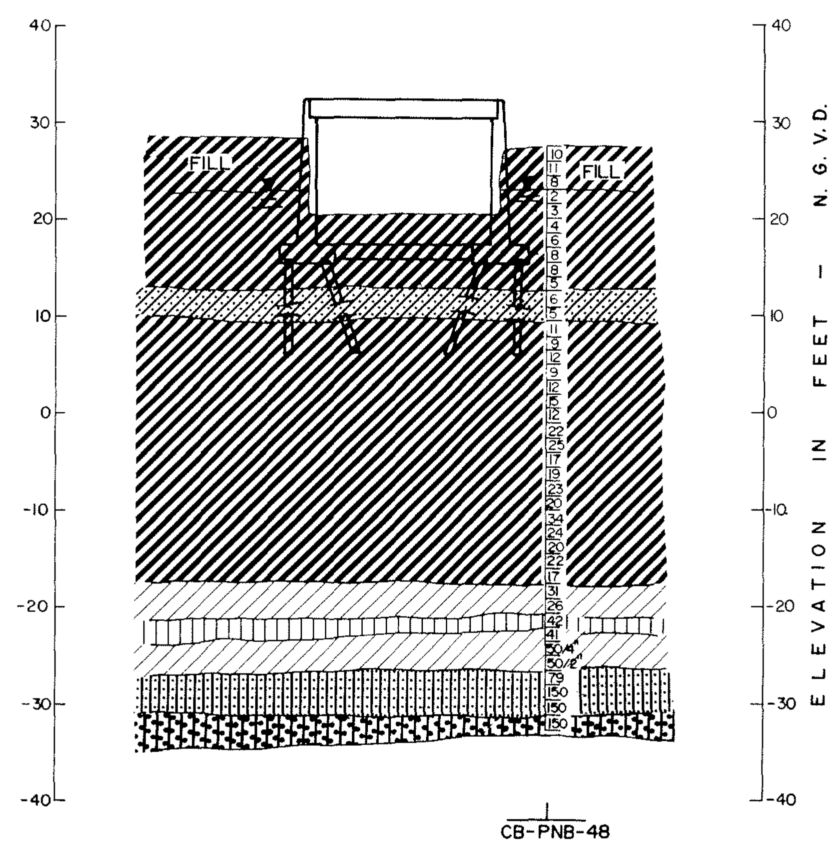

PEDESTRIAN BRIDGE, JOSEFINA
STA. 40 + 50




AMERICO MIRANDA, JOSEFINA
STA. 47 + 00




31st. SE STREET, JOSEFINA
STA. 51 + 50




21st. SE STREET, JOSEFINA
STA. 63 + 50

LEGEND

- (GM) SILTY GRAVEL
- (GC) CLAYEY GRAVEL
- (SP) POOR GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (SC) CLAYEY SANDS
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY

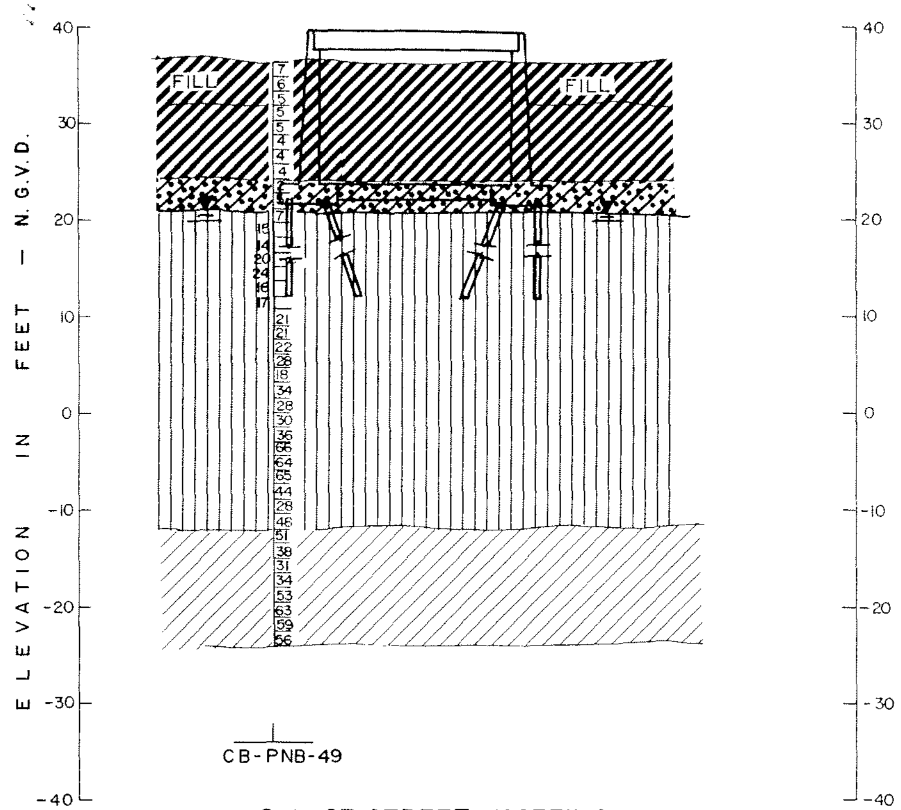
HORIZ. SCALE
0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY

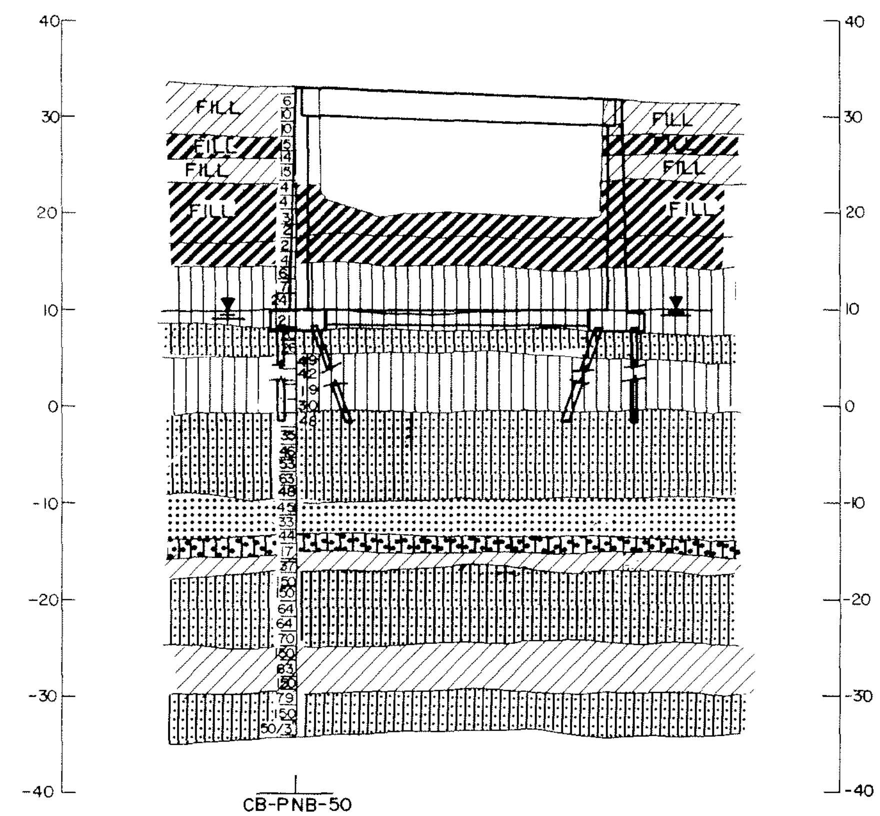
BRIDGE CROSS SECTIONS

GEOTECHNICAL

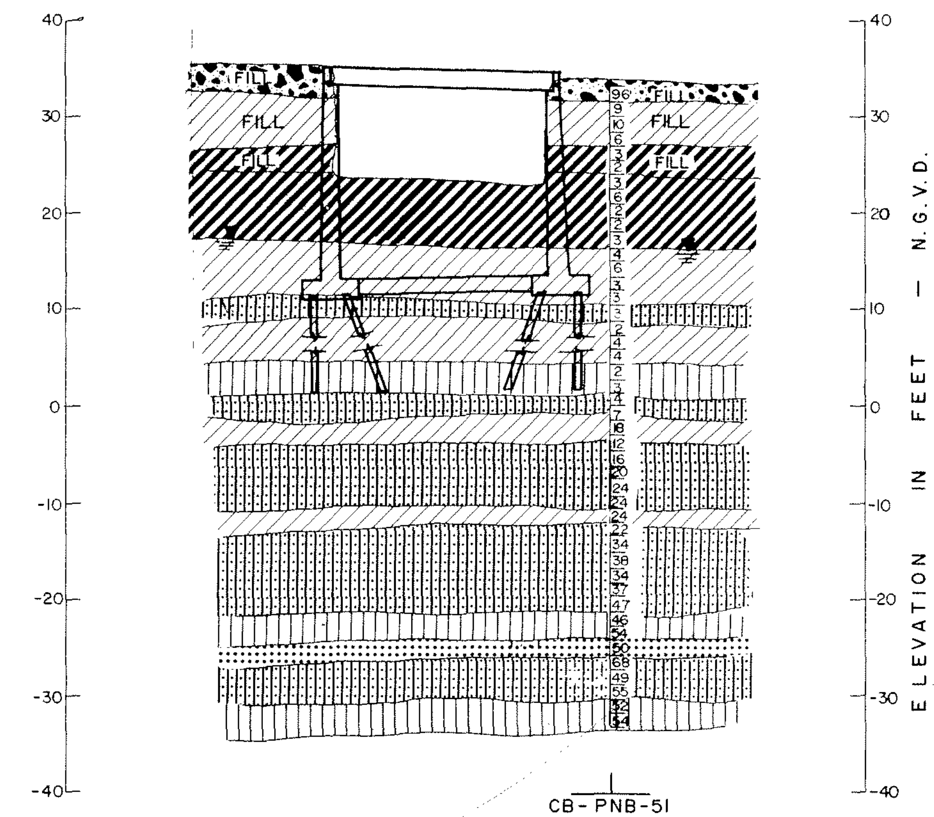
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



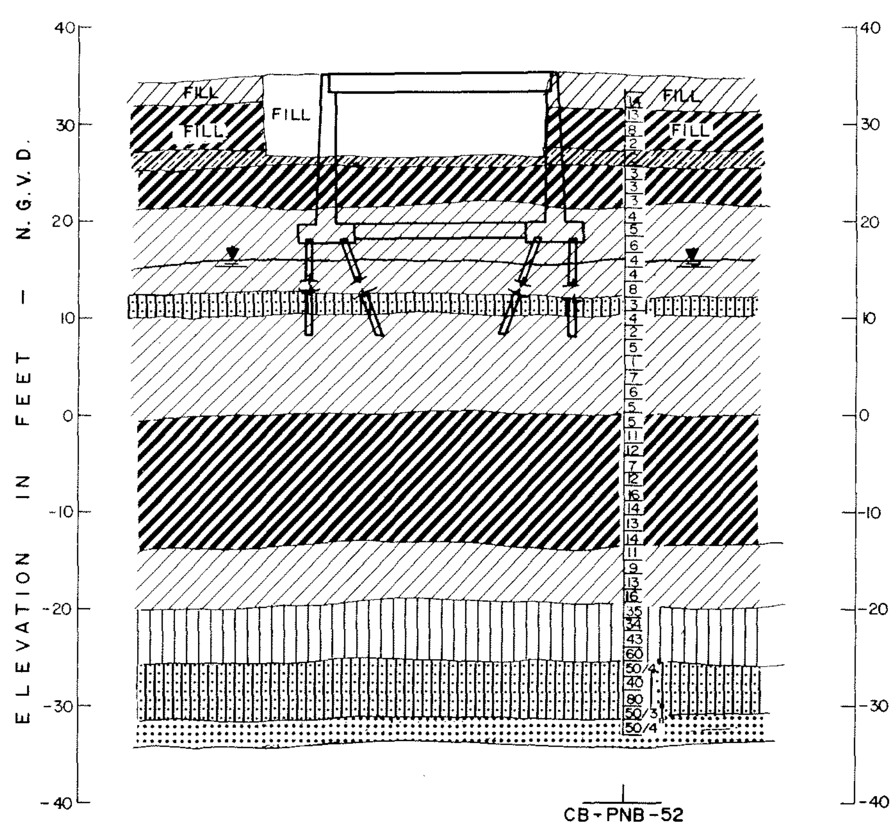

9th SE STREET, JOSEFINA
STA. 74+50



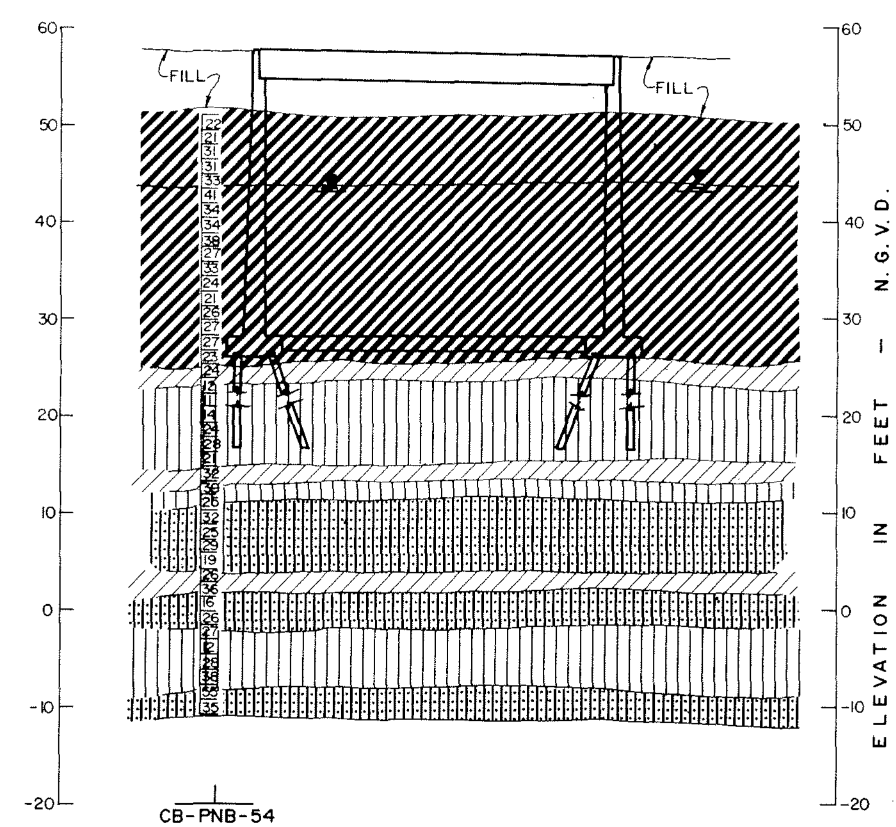

AMERICO MIRANDA, DONA ANA
STA. 15+00




29th SE STREET, DONA ANA
STA. 19+50




21st SE STREET, DONA ANA
STA. 28+00




SERVICE ROAD, BUENA VISTA
STA. 21+00

LEGEND

- (GP) POORLY GRADED GRAVEL
- (GM) SILTY GRAVEL
- (GC) CLAYEY GRAVEL
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (ML) LOW PLASTICITY SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) HIGH PLASTICITY ORGANIC CLAY

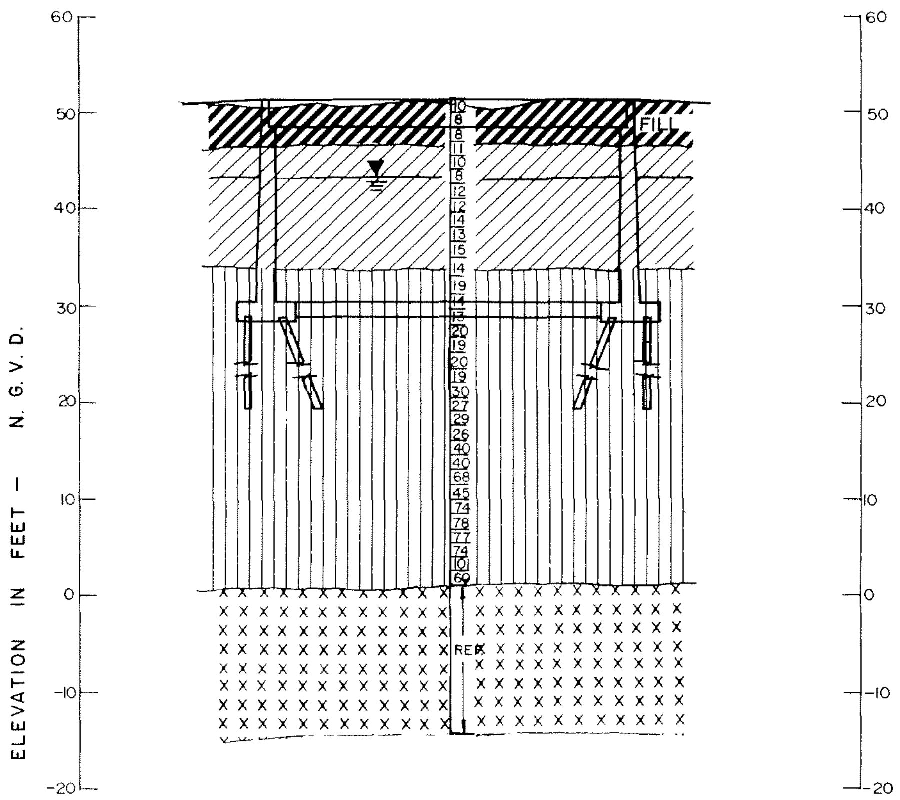
HORIZ. SCALE
0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA, DONA ANA & BUENA VISTA TRIBUTARIE

BRIDGE CROSS SECTIONS

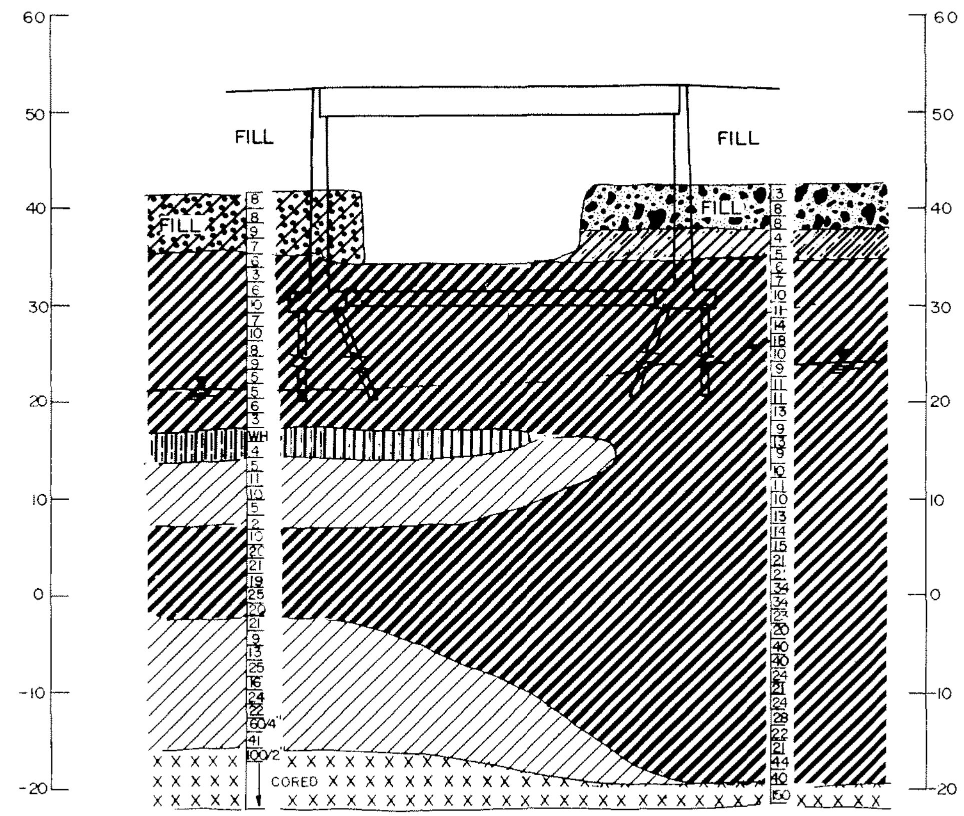
GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




CB-PNB-55

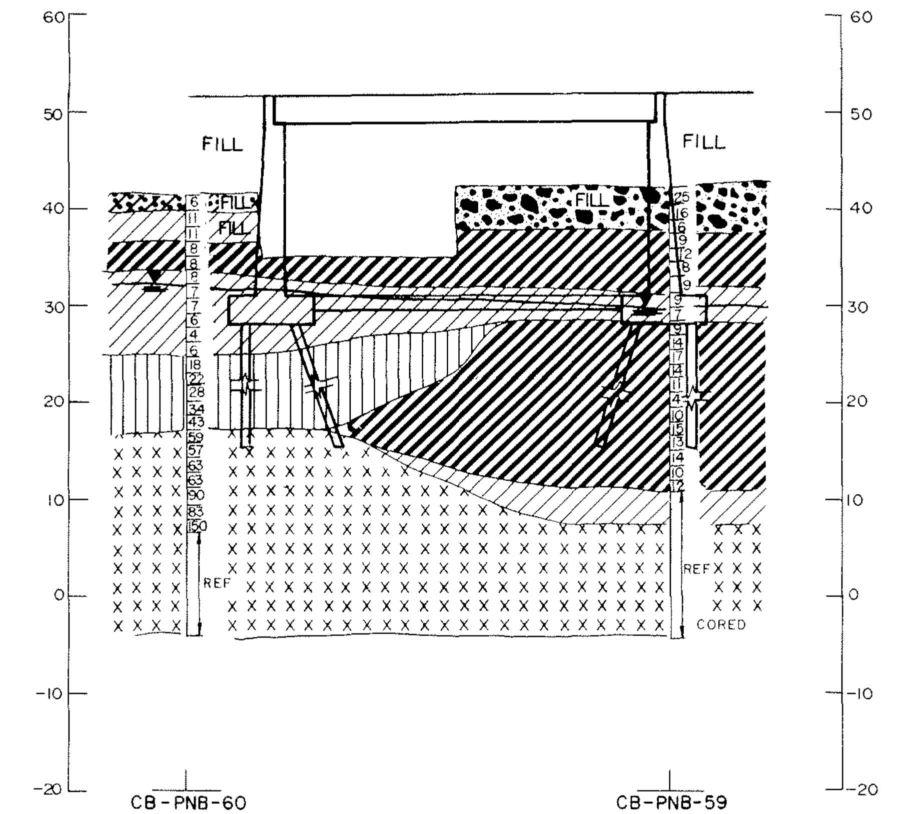
17th. STREET, BUENA VISTA
STA. 36 + 00




CB-PNB-57

CB-PNB-58

4th STREET, BUENA VISTA
STA. 38 + 50




P.R. 21, BUENA VISTA
STA. 40 + 50

LEGEND

- (GP) POORLY GRADED GRAVEL
- (GM) SILTY GRAVEL
- (GC) CLAYEY GRAVEL
- (SP) POORLY GRADED SAND
- (SM) SILTY SAND
- (CL) LOW PLASTICITY CLAY
- (ML) LOW PLASTICITY SILT
- (OL) ORGANIC SILT
- (CH) HIGH PLASTICITY CLAY
- (OH) ORGANIC CLAY
- (SS) SILT STONE

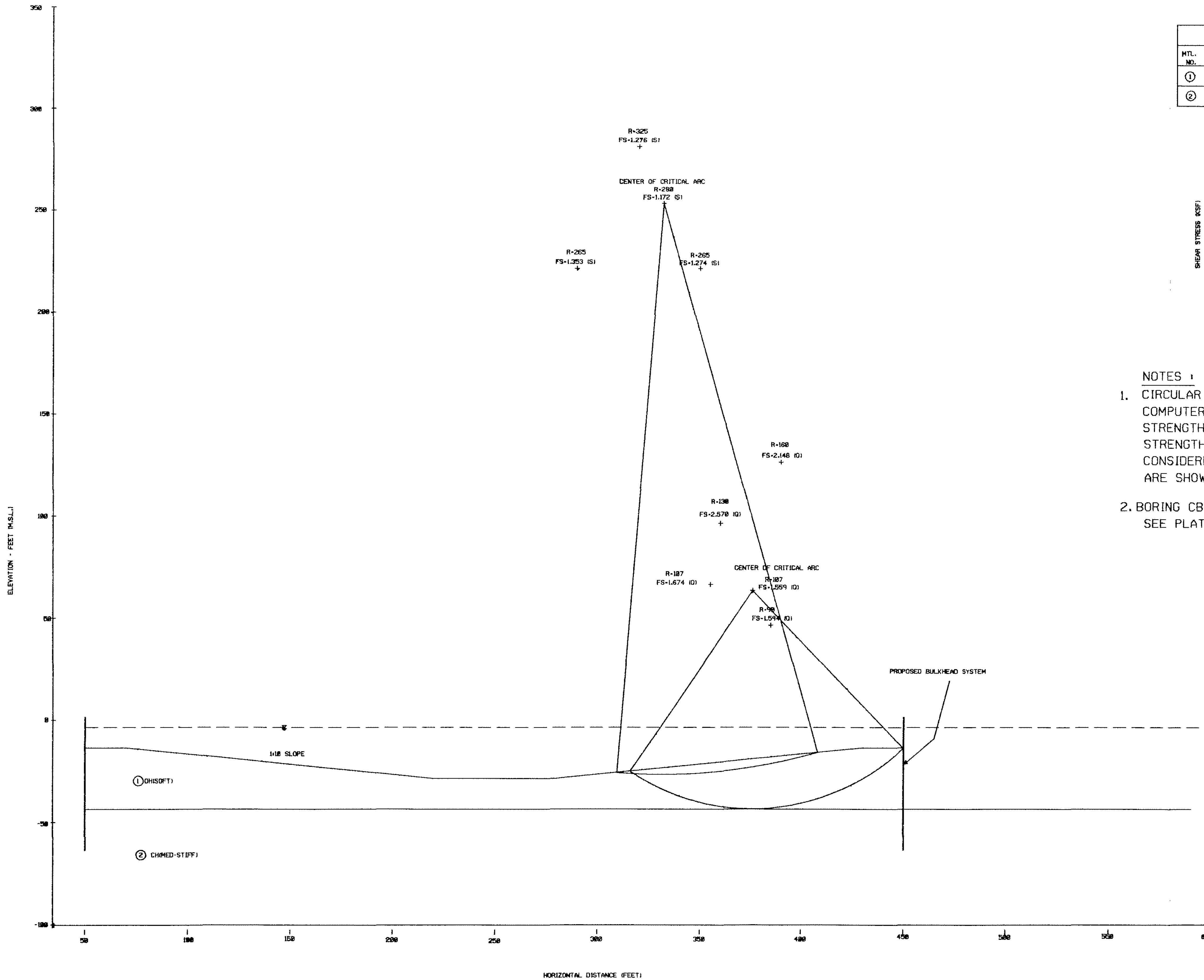
HORIZ. SCALE
0 10' 20' 30'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
BUENA VISTA TRIBUTARY

BRIDGE CROSS SECTIONS

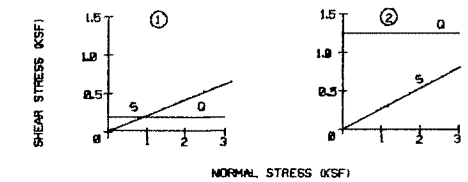
GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




STATION 7+00

| ASSUMED DESIGN DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| MTL. NO. | MTL. | UNIT WT.(PCF) | | S STRENGTH | | Q STRENGTH | |
| | | $\gamma_M$ | $\gamma_S$ | Ø (DEG) | C (KSF) | Ø (DEG) | C (KSF) |
| ① | (SOFT) OH | — | 94 | 26 | 0 | 0 | 0.18 |
| ② | (MED-STI) CH | — | 120 | 28 | 0 | 0 | 1.26 |




COMPOSITE STRENGTH ENVELOPES

NOTES :

1. CIRCULAR ANALYSIS WAS PERFORMED USING UTEXAS COMPUTER PROGRAM. END OF CONSTRUCTION USING Q STRENGTH AND LONG TERM CONDITION USING S STRENGTH WERE ANALYZED. EARTHQUAKE EFFECT WAS CONSIDERED. CRITICAL FAILURE SURFACE LOCATIONS ARE SHOWN WHICH PRODUCED THE LOWEST F.S.

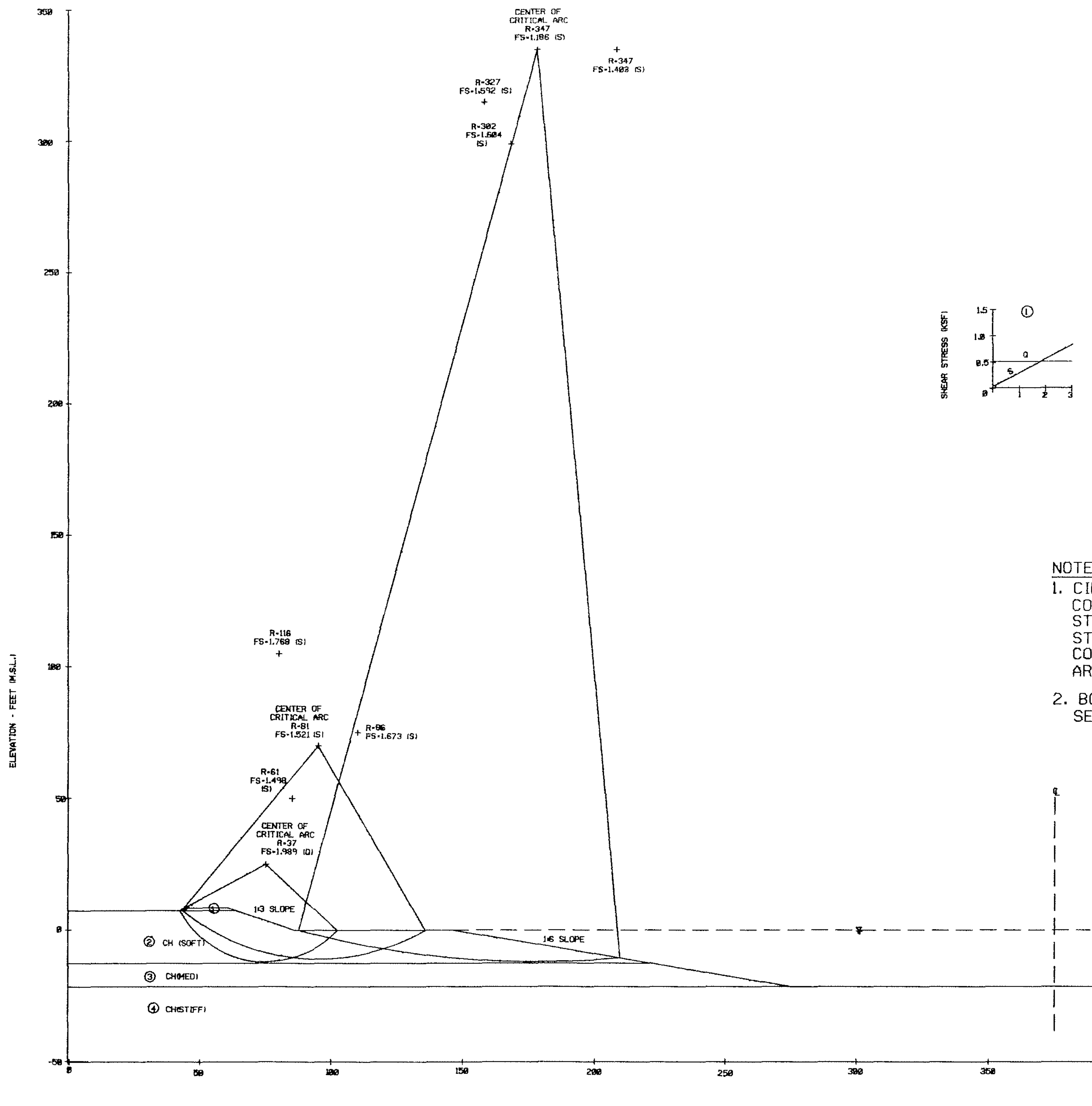
2. BORING CB-PNL-18 USED FOR SOIL SECTION INFORMATION. SEE PLATE S-22 FOR BORING LOCATION.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
STA 0+90 TO STA 74+32.5

SLOPE STABILITY

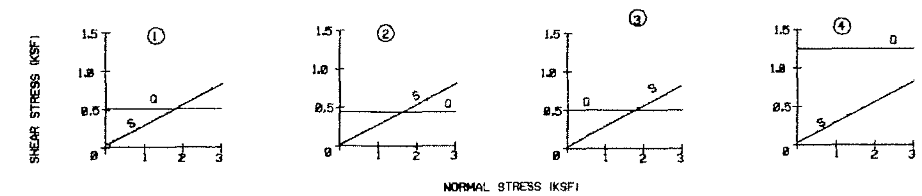
GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




STATION 82 + 50

| ASSUMED DESIGN DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| MTL. NO. | MTL. | UNIT WT.(PCF) | | S STRENGTH | | Q STRENGTH | |
| | | $\gamma_M$ | $\gamma_S$ | Ø (DEG) | C (KSF) | Ø (DEG) | C (KSF) |
| ① | FILL | 110 | --- | 28 | 0 | 0 | 0.5 |
| ② | (SOFT) CH | 100 | 105 | 28 | 0 | 0 | 0.44 |
| ③ | (MED) CH | — | 110 | 28 | 0 | 0 | 0.5 |
| ④ | (STIFF) CH | — | 120 | 28 | 0 | 0 | 1.26 |




COMPOSITE STRENGTH ENVELOPES

NOTES :

1. CIRCULAR ANALYSIS WAS PERFORMED USING UTEXAS COMPUTER PROGRAM. END OF CONSTRUCTION USING Q STRENGTH AND LONG TERM CONDITION USING S STRENGTH WERE ANALYZED. EARTHQUAKE EFFECT WAS CONSIDERED. CRITICAL FAILURE SURFACE LOCATIONS ARE SHOWN WHICH PROCEED THE LOWEST F.S.
2. BORING CB-PNL-75 USED FOR SOIL SECTION INFORMATION. SEE PLATE S-25 FOR BORING LOCATION.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
STA 76+32.5 TO STA 88+33.2

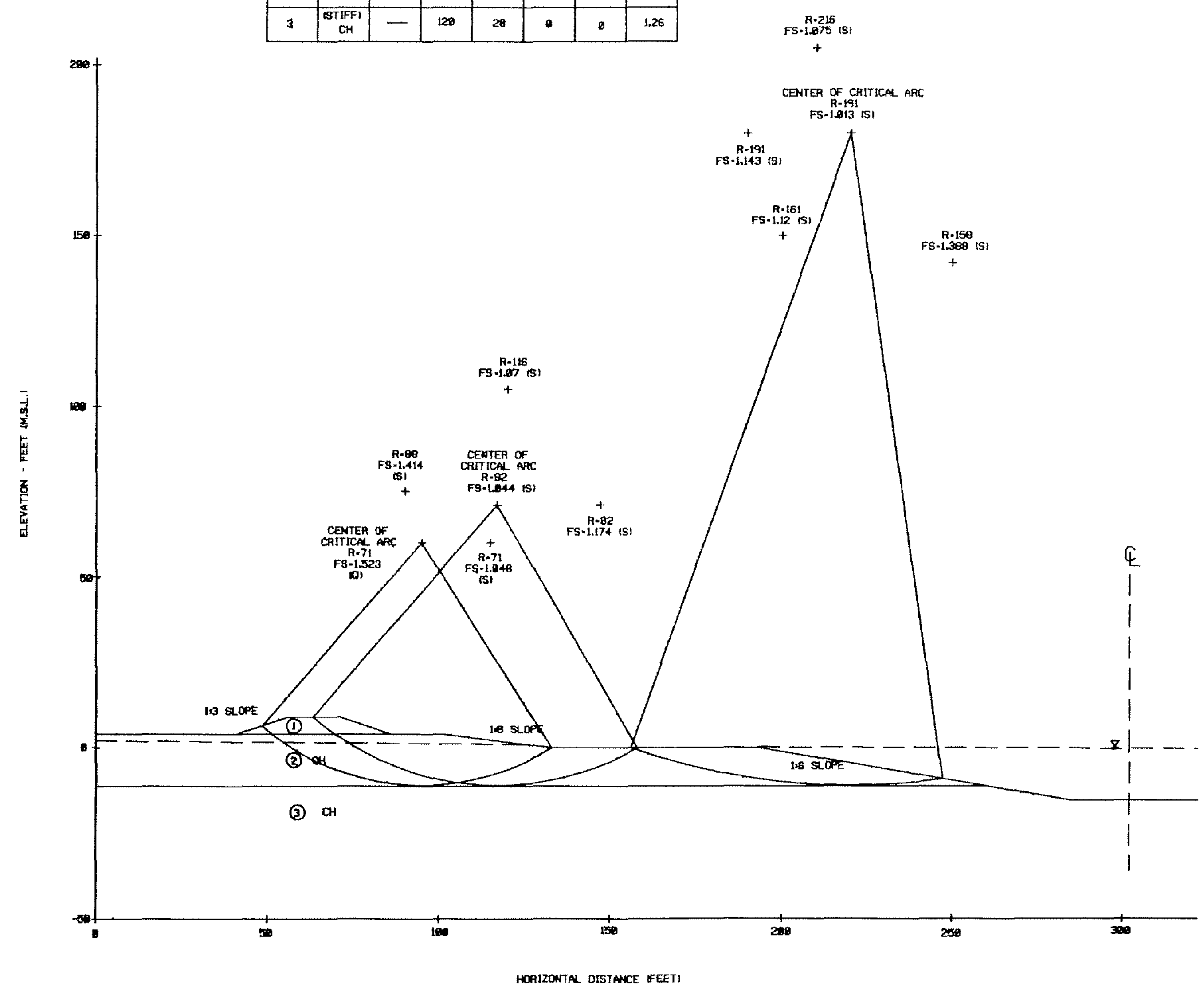
SLOPE STABILITY

GEOTECHNICAL

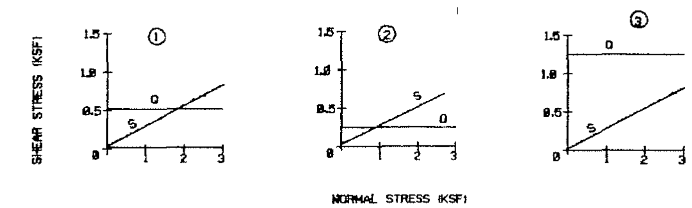
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

| ASSUMED DESIGN DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| MTL. NO. | MTL. | UNIT WT.(PCF) | | S STRENGTH | | Q STRENGTH | |
| | | $\gamma_M$ | $\gamma_S$ | Ø (DEG) | C (KSF) | Ø (DEG) | C (KSF) |
| 1 | FILL (CH) | 110 | — | 20 | 0 | 0 | 0.5 |
| 2 | (SOFT) OH | 80 | 85 | 26 | 0 | 0 | 0.20 |
| 3 | (STIFF) CH | — | 120 | 20 | 0 | 0 | 1.26 |




STA 27 + 80




COMPOSITE STRENGTH ENVELOPES

NOTES :

1. CIRCULAR ANALYSIS WAS PERFORMED USING UTEXAS COMPUTER PROGRAM. END OF CONSTRUCTION USING Q STRENGTH AND LONG TERM CONDITION USING S STRENGTH WERE ANALYZED. EARTHQUAKE EFFECT WAS CONSIDERED. CRITICAL FAILURE SURFACE LOCATIONS ARE SHOWN WHICH PRODUCED THE LOWEST F.S.
2. BORING CB-MC-38 USED FOR SOIL SECTION INFORMATION. SEE PLATE S-39 FOR BORING LOCATION.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY
STA 0+00 TO STA 39+00

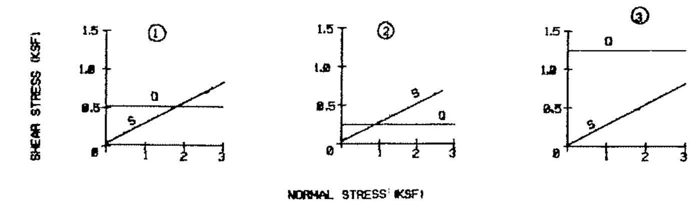
SLOPE STABILITY

GEOTECHNICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

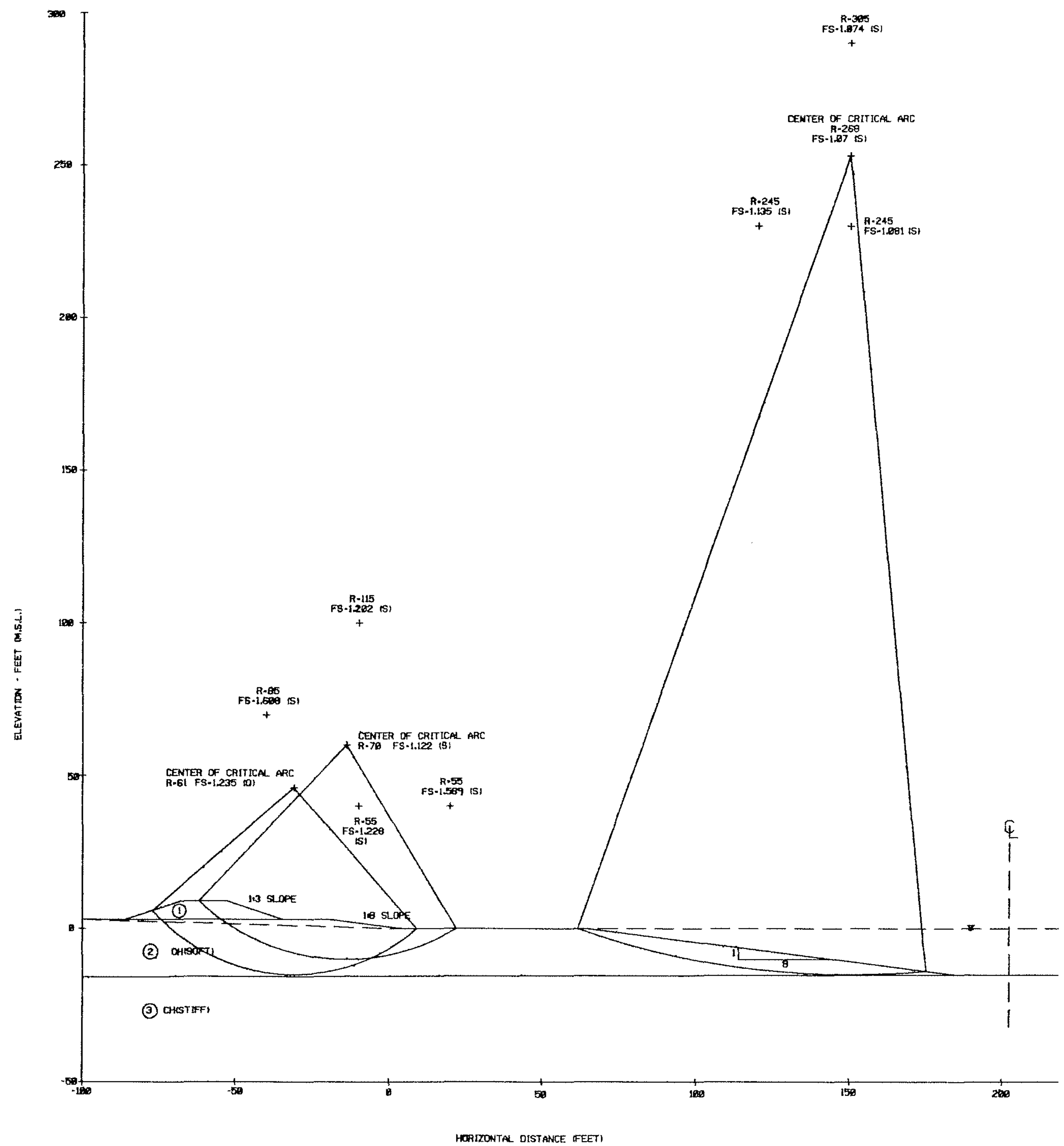
| ASSUMED DESIGN DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| MTL. NO. | MTL. | UNIT WT.(PCF) | | S STRENGTH | | Q STRENGTH | |
| | | $\gamma_M$ | $\gamma_S$ | Ø (DEG) | C (KSF) | Ø (DEG) | C (KSF) |
| ① | FILL | 110 | —— | 20 | 0 | 0 | 0.5 |
| ② | (SOFT) OH | 85 | 90 | 26 | 0 | 0 | 0.26 |
| ③ | (STIFF) CH | —— | 120 | 20 | 0 | 0 | 1.26 |




COMPOSITE STRENGTH ENVELOPES

NOTES :

1. CIRCULAR ANALYSIS WAS PERFORMED USING UTEXAS COMPUTER PROGRAM. END OF CONSTRUCTION USING Q STRENGTH AND LONG TERM CONDITION USING S STRENGTH WERE ANALYZED. EARTHQUAKE EFFECT WAS CONSIDERED. CRITICAL FAILURE SURFACE LOCATIONS ARE SHOWN WHICH PRODUCED THE LOWEST F.S.
2. BORING CB-MC-40 USED FOR SOIL SECTION INFORMATION SEE PLATE S-39 FOR BORING LOCATION.




STATION 43 + 00

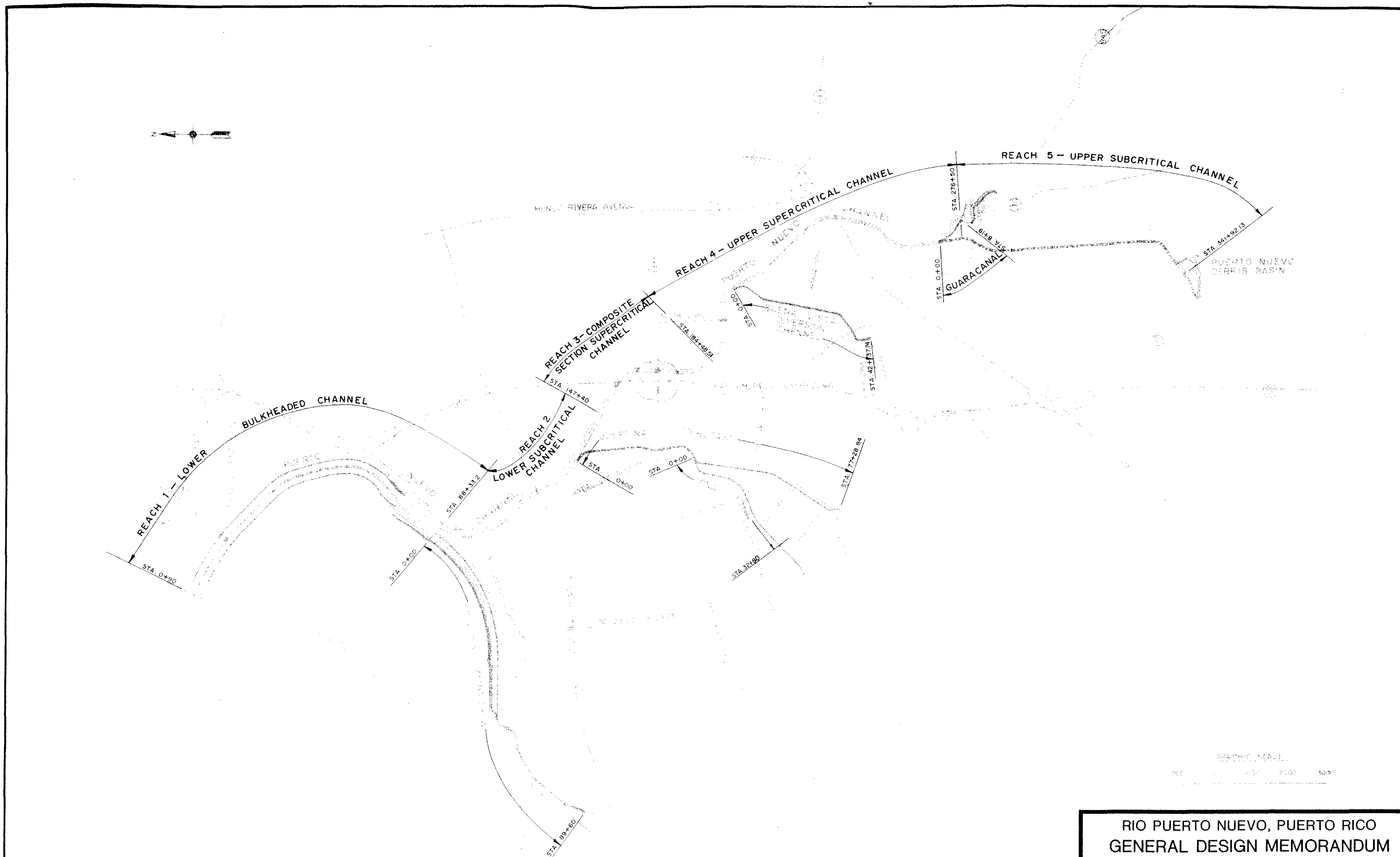
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY
STA 40+00 TO STA 54+10
SLOPE STABILITY
GEOTECHNICAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE G-2[illegible]

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**STRUCTURAL**

PLATES




RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL & TRIBUTARIES
REACHES

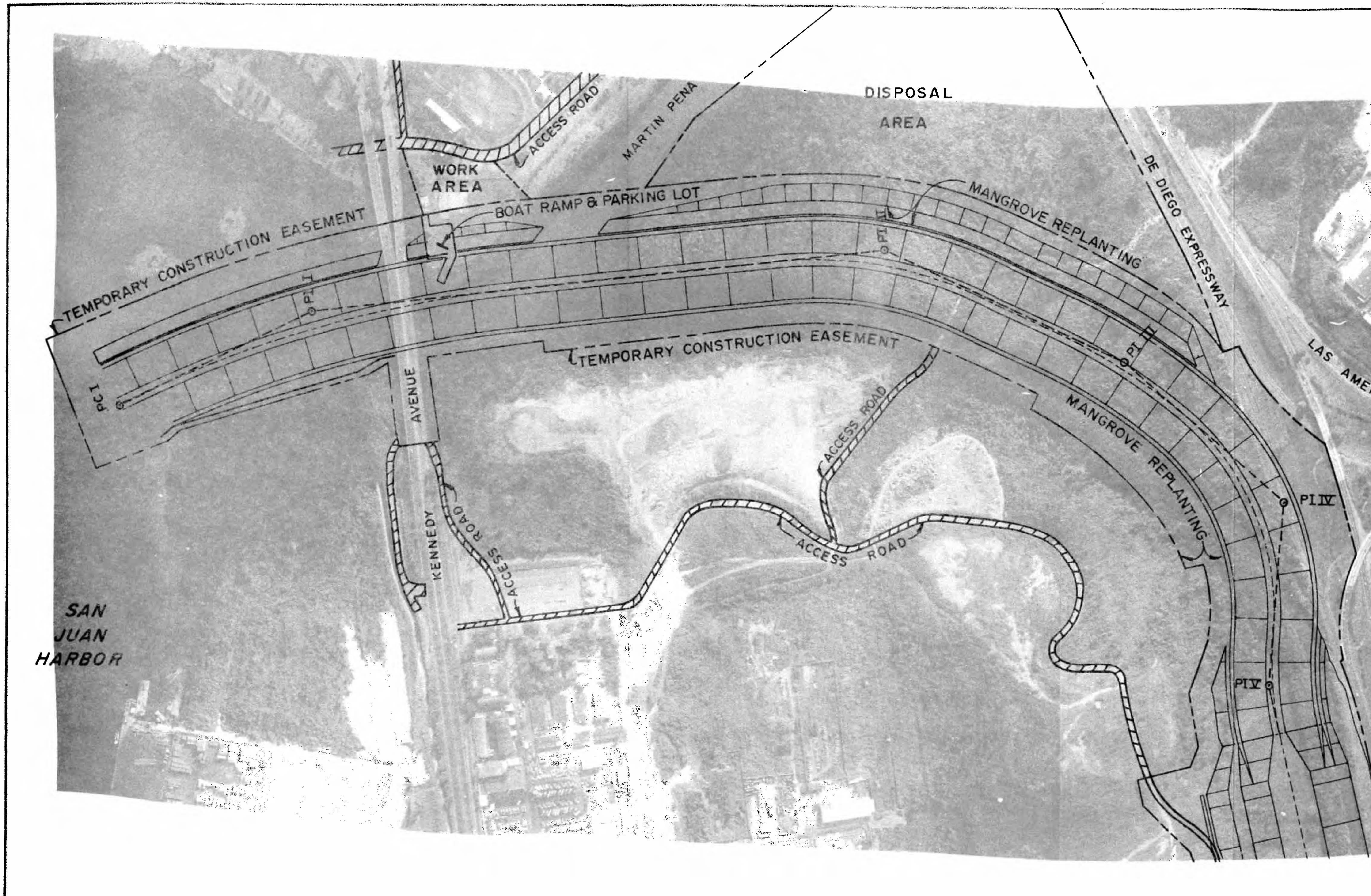
## KEY MAP

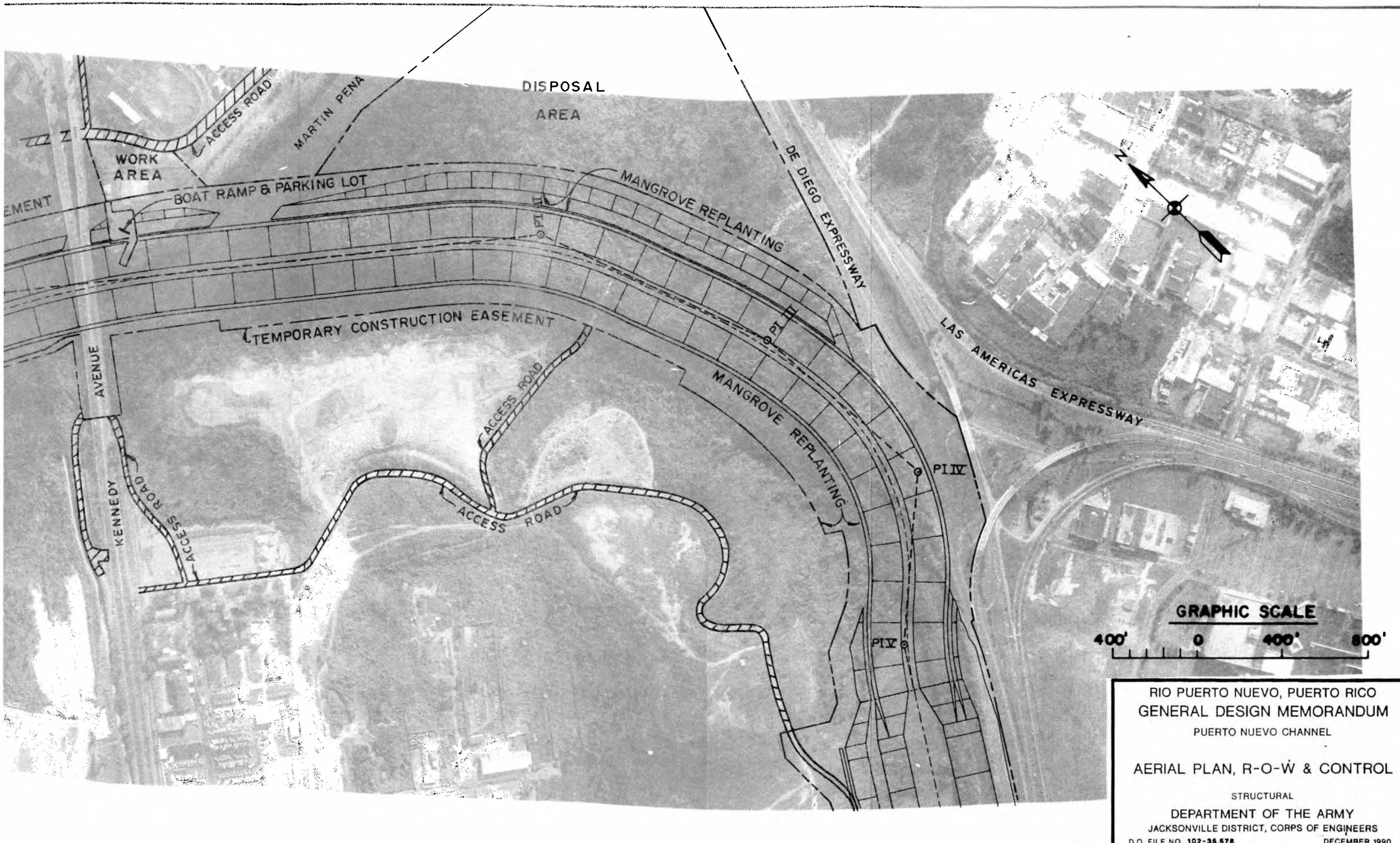
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-1


DISPOSAL
AREA
ACCESS ROAD
MARTIN PENA
WORK
AREA
BOAT RAMP & PARKING LOT
TEMPORARY CONSTRUCTION EASEMENT
MANGROVE REPLANTING
DE DIEGO EXPRESSWAY
LAS AMERI
PI I
PI II
PI III
PC I
TEMPORARY CONSTRUCTION EASEMENT
AVENUE
KENNEDY
ACCESS ROAD
ACCESS ROAD
ACCESS ROAD
MANGROVE REPLANTING
PI IV
PI V
SAN
JUAN
HARBOR



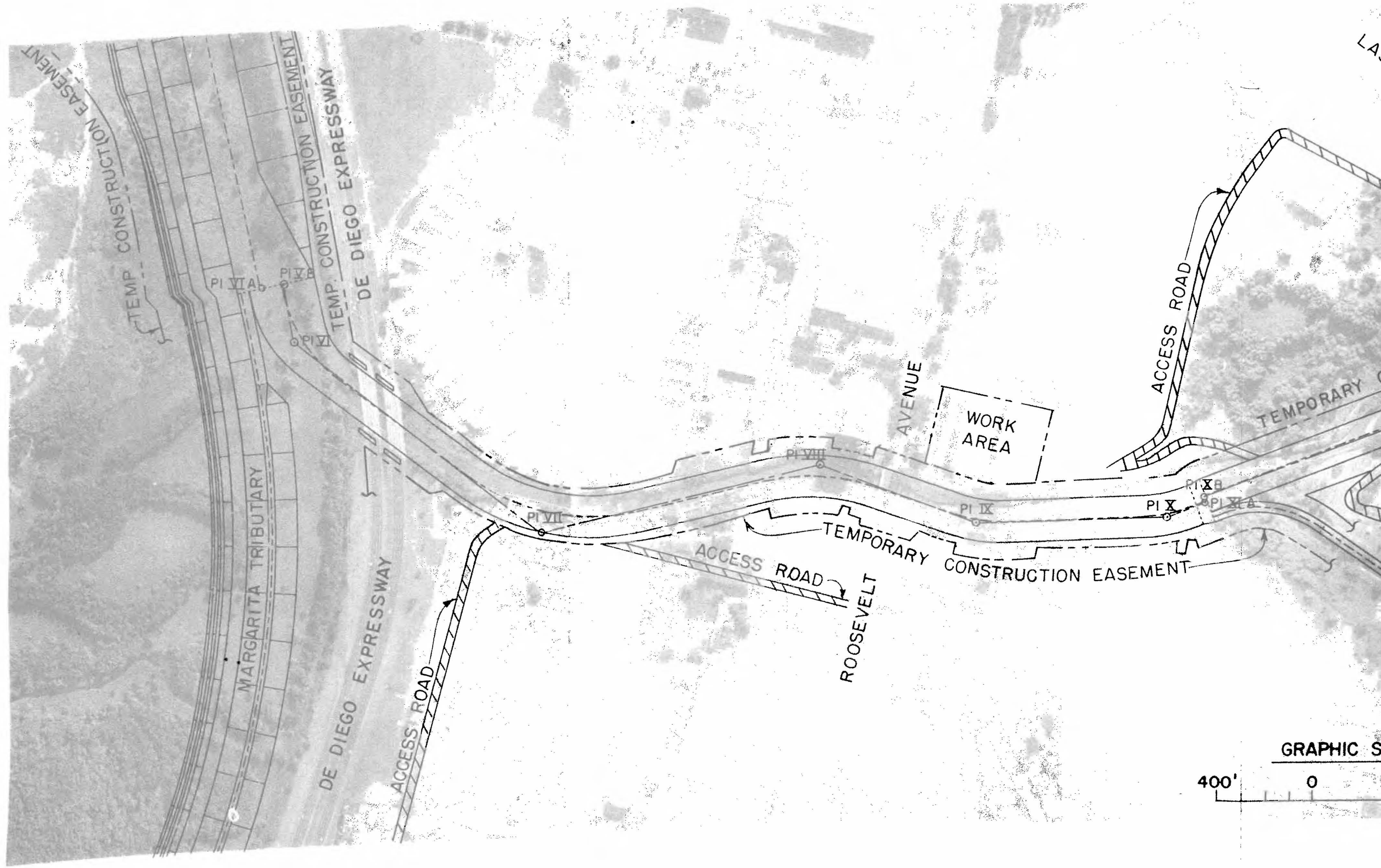

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

AERIAL PLAN, R-O-W & CONTROL

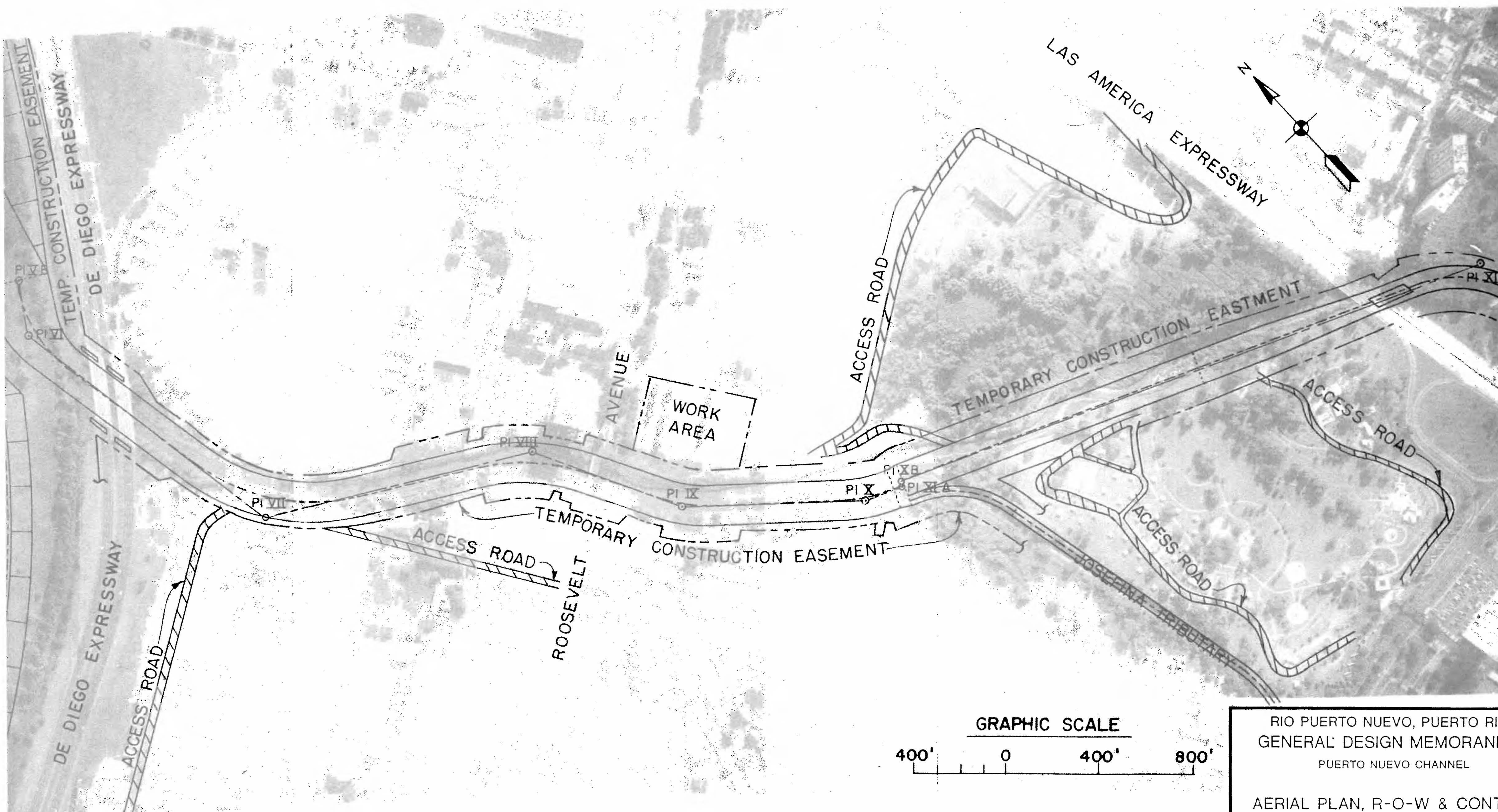
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35.578 DECEMBER 1990

PLATE S-2



TEMP. CONSTRUCTION EASEMENT
TEMP. CONSTRUCTION EASEMENT
DE DIEGO EXPRESSWAY
PI VI A
PI VI B
PI VI
MARGARITA TRIBUTARY
DE DIEGO EXPRESSWAY
ACCESS ROAD
PI VII
ACCESS ROAD
ROOSEVELT
AVENUE
PI VIII
WORK AREA
PI IX
TEMPORARY CONSTRUCTION EASEMENT
ACCESS ROAD
PI X
PI X B
PI X A
TEMPORARY CO
LAS
GRAPHIC SC
400'
0




Q=VA

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

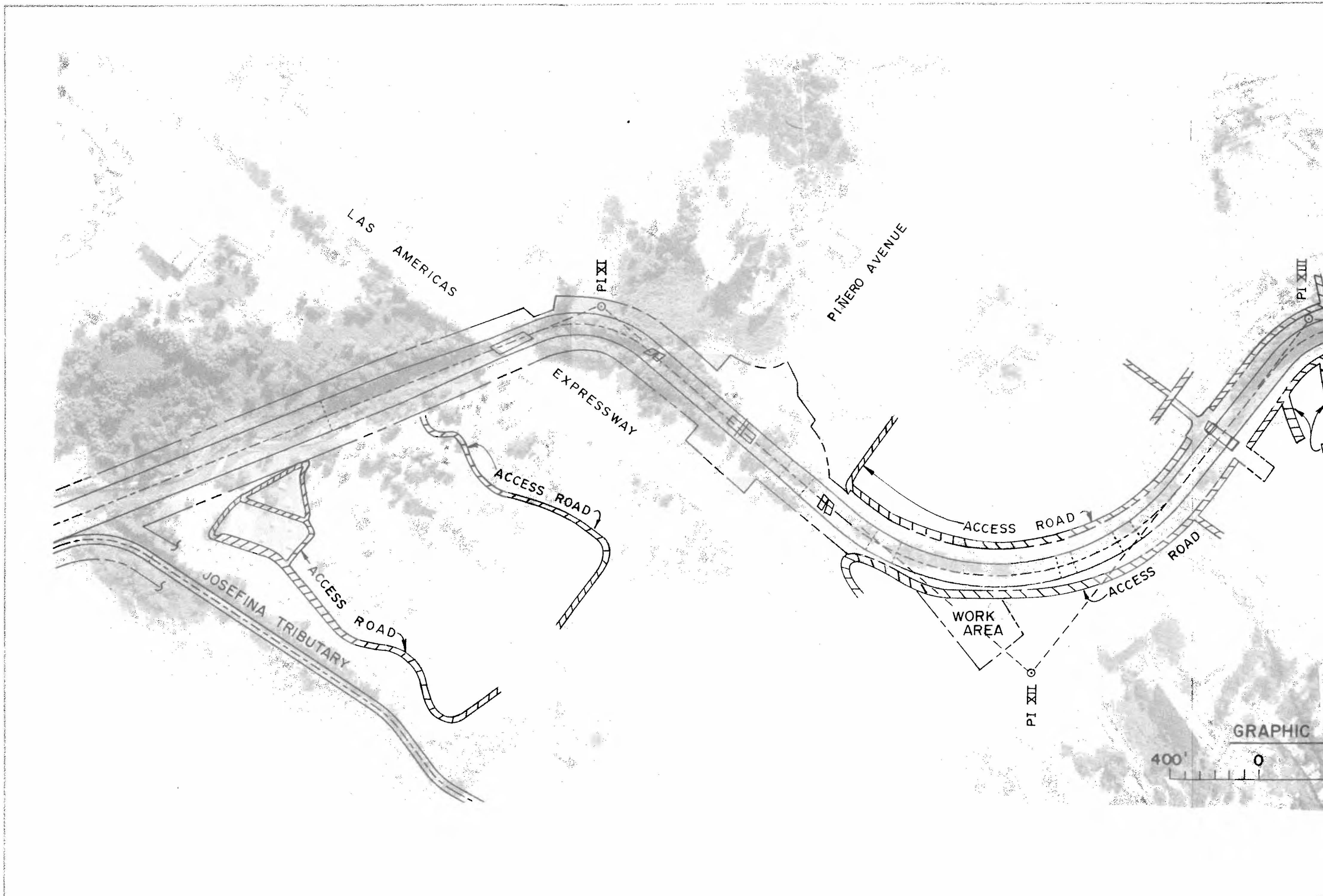
AERIAL PLAN, R-O-W & CONTROL

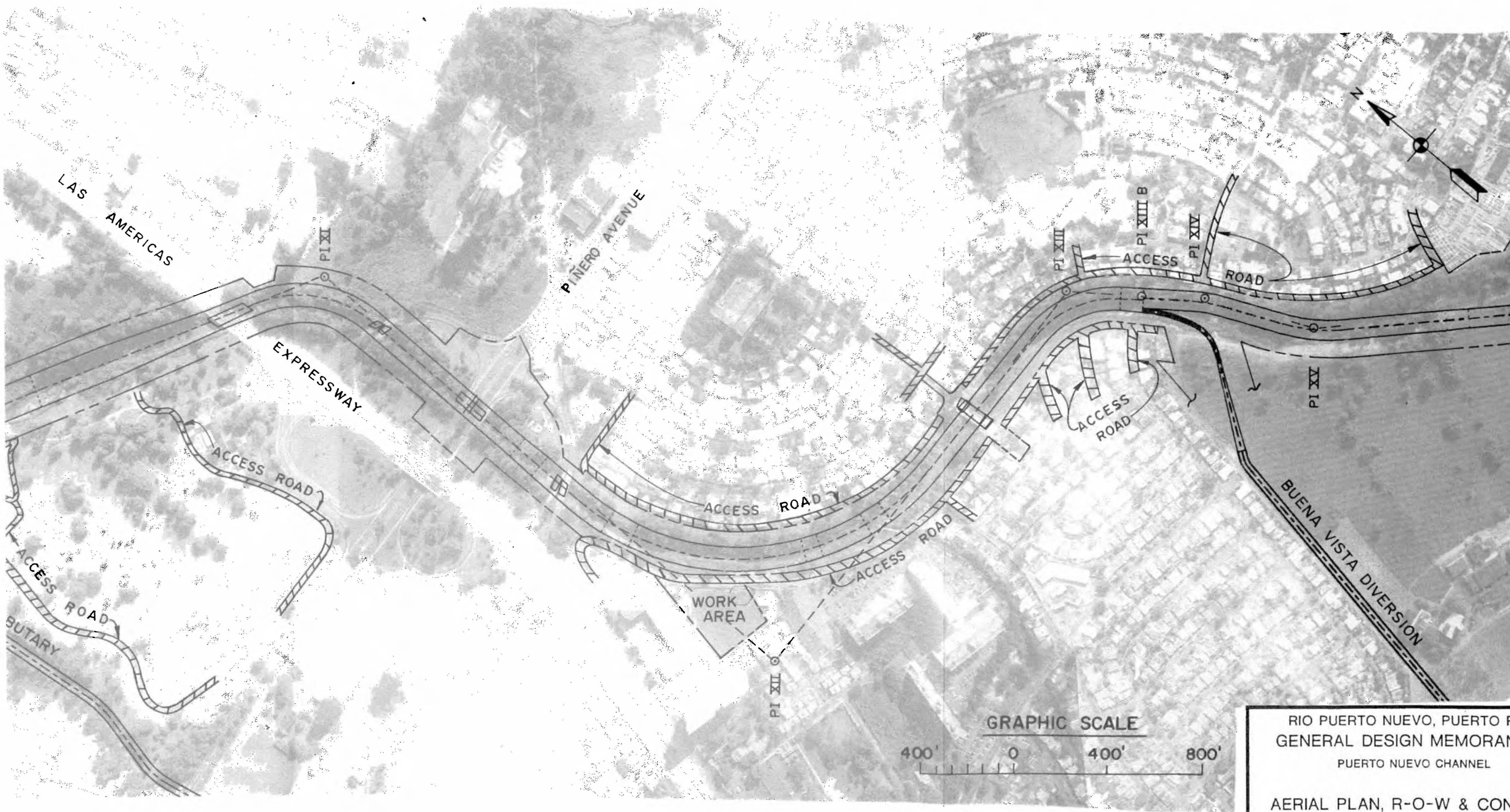
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-3


LAS AMERICAS
EXPRESSWAY
PI XI
PIÑERO AVENUE
PI XIII
ACCESS ROAD
ACCESS ROAD
ACCESS ROAD
ACCESS ROAD
ACCESS ROAD
JOSEFINA TRIBUTARY
WORK AREA
PI XII
GRAPHIC S
400'
0




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-4

ACCESS ROAD
P.I. XIV
ACCESS ROAD
TEMPORARY CONSTRUCTION EASEMENT
P.I. XV
P.I. XVI
TEMPORARY CONSTRUCTION EASEMENT
P.I. XVII
BUENA VISTA DIVERSION
P.I. XVIII
P.I. XIX A
ACCESS ROAD
P.I. XVIII B
GRAPHIC SCALE
400'
0
400'


RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

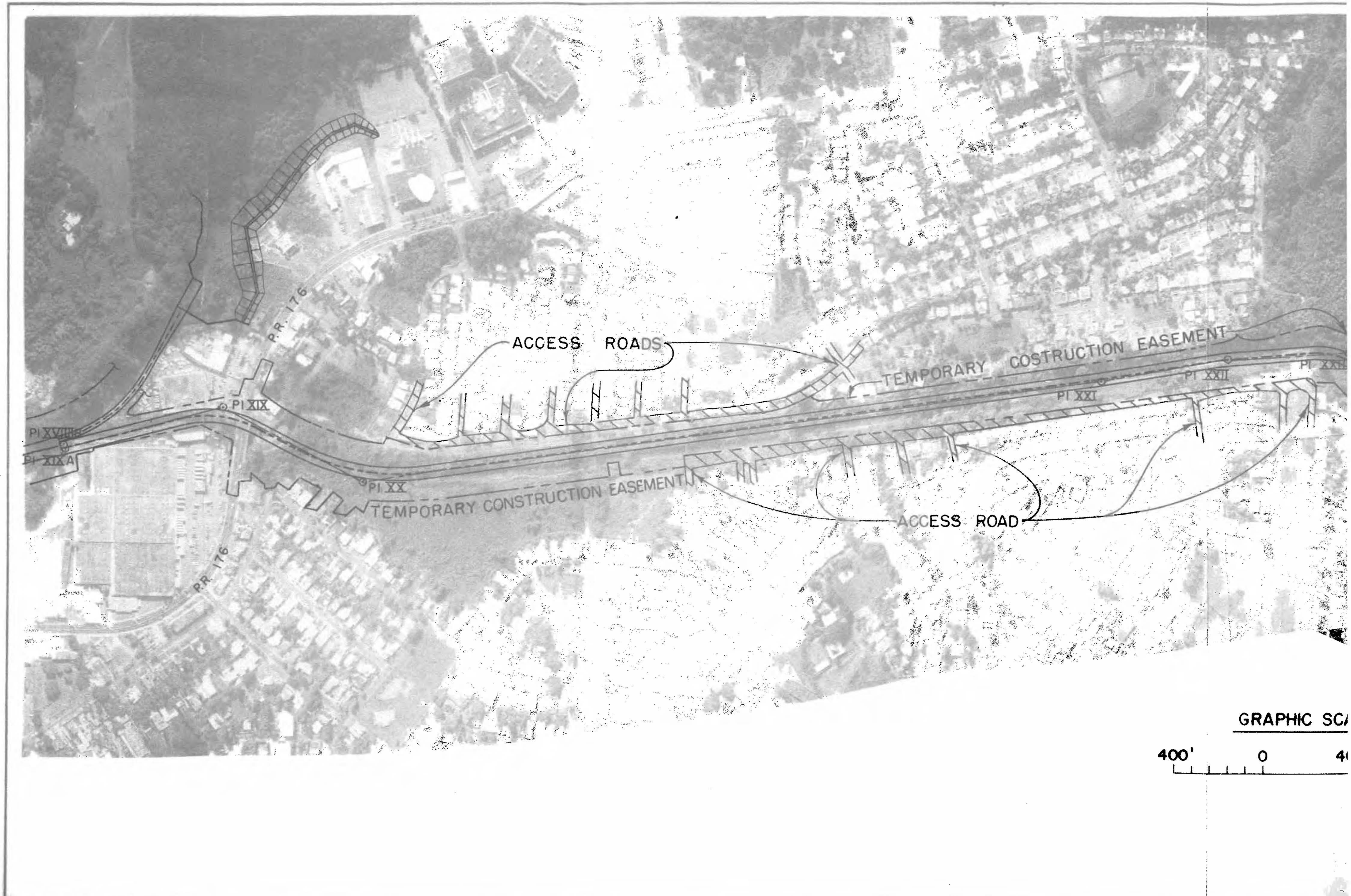
AERIAL PLAN, R-O-W & CONTROL

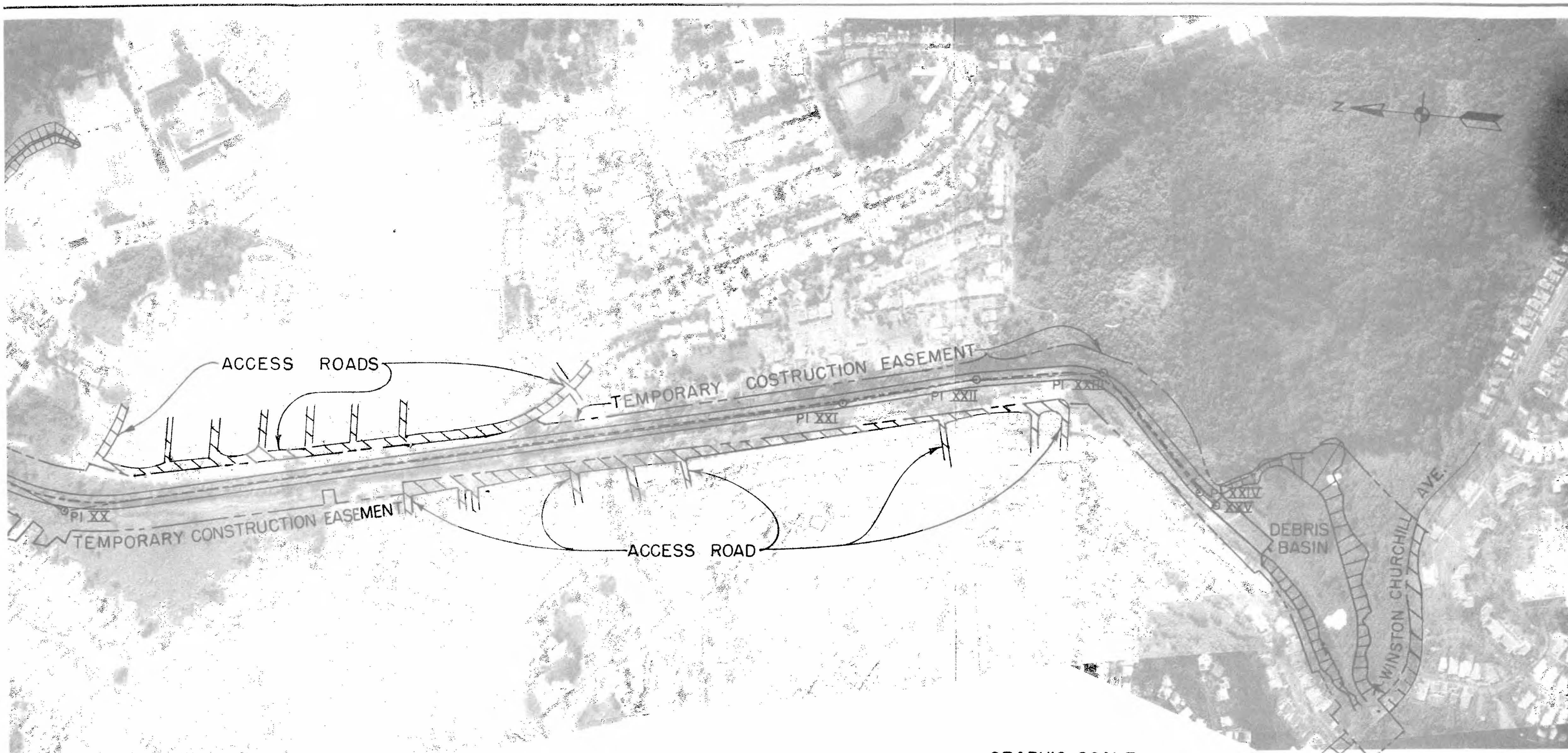
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-5


ACCESS ROADS
TEMPORARY COSTRUCTION EASEMENT
PI XXII
PI XXI
PI XIX
P.R. 176
PI XVIII
PI XIX A
PI XX
TEMPORARY CONSTRUCTION EASEMENT
ACCESS ROAD
P.R. 176
GRAPHIC SC
400'
0




GRAPHIC SCALE

400' 0 400' 800'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-36,578 DECEMBER 1990

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PC I | 620,346.66 | 221,666.56 | PC 1 | 3+84.21 | | | | | | |
| PI I | 621,245.78 | 221,271.32 | PC 1<br>PI 1 | 13+66.37<br>13+46.04 | 20°10'27.10" | 5521.02 | 1943.98 | 982.16 | 3+84.21 | 23+28.20 |
| PI II | 623,175.67 | 219,413.90 | PI 1<br>2 | 40+24.56<br>40+00.96 | 31°12'37.85" | 1700.00 | 926.03 | 474.82 | 35+49.74 | 44+75.78 |
| PI III | 623,550.88 | 218,002.34 | 2<br>3 | 54+61.54<br>54+57.12 | 15°25'38.76" | 2700.00 | 727.00 | 365.71 | 50+95.83 | 58+22.83 |
| PI IV | 623,541.52 | 217,012.41 | 3<br>4 | 64+47.10<br>63+49.83 | 54°58'07.91" | 1200.00 | 1157.27 | 624.27 | 58+22.83 | 69+74.10 |
| PI V | 622,836.58 | 216,528.11 | 4<br>5 | 72+05.10<br>72+01.50 | 17°30'35.07" | 1500.00 | 458.40 | 231.00 | 69+74.10 | 74+32.50 |
| PI VI A | 621,831.98 | 215,242.32 | 5<br>6A | 88+33.21 | | | | | | |
| PI V B | 621,906.84 | 215,183.83 | PI 5B | 88+33.21 | | | | | | |
| PI VI | 621,737.46 | 214,967.03 | 5B<br>6 | 91+08.33<br>90+88.83 | 41°07'51.06" | 600.00 | 430.72 | 225.11 | 88+83.22 | 93+13.94 |
| PI VII | 621,810.72 | 213,627.87 | 6<br>7 | 104+29.99<br>103+77.13 | 49°51'07.19" | 890.00 | 774.37 | 413.62 | 100+16.38 | 107+90.75 |
| PI VIII | 622,791.70 | 212,888.20 | 7<br>8 | 116+05.74<br>115+92.58 | 31°50'54.83" | 890.00 | 494.72 | 253.93 | 113+51.79 | 118+46.51 |
| PI IX | 623,052.89 | 212,212.53 | 8<br>9 | 123+16.98<br>123+14.60 | 20°37'57.54" | 600.00 | 216.06 | 109.22 | 122+07.76 | 124+23.82 |
| PI X | 623,596.98 | 211,603.31 | 9<br>10 | 131+31.42<br>131+29.70 | 18°34'53.49" | 600.00 | 194.59 | 98.15 | 130+33.27 | 132+27.85 |
| PI XI A | 623,755.79 | 211,512.91 | 10<br>11 A | 133+12.44 | | | | | | |
| PI X B | 623,767.41 | 211,533.33 | PI 10B | 133+12.44 | | | | | | |
| PI XI | 626,194.10 | 210,151.89 | 10B<br>11 | 161+04.79<br>160+43.92 | 62°20'04.77" | 500.00 | 543.97 | 302.42 | 158+02.37 | 163+46.34 |
| PI XII | 626,141.82 | 208,644.31 | 11<br>12 | 186+91.21<br>181+79.60 | 91°59'10.18" | 1100.00 | 1766.01 | 1138.81 | 175+52.40 | 193+18.41 |
| PI XIII | 628,211.76 | 207,506.19 | 12<br>13 | 202+89.00<br>202+53.40 | 54°33'22.02" | 450.00 | 428.48 | 232.04 | 200+56.96 | 204+85.44 |
| PI XIVA | 628,404.31 | 207,235.68 | 13<br>14A | 205+85.45 | | | | | | |

| PI | PLANE COORDINATES | | CUT | PI/PI |
|---|---|---|---|---|
| | X | Y | | |
| PI XIIIB | 628,409.37 | 207,239.28 | PI13B | 205+85.4 |
| PI XIV | 628,573.54 | 207,008.63 | 13B<br>14 | 208+68.5<br>208+68.0 |
| PI XV | 628,762.82 | 206,560.85 | 14<br>15 | 213+54.17<br>213+51.0 |
| PI XVI | 630,438.15 | 204,819.96 | 15<br>16 | 237+67.1<br>236+75.8 |
| PI XVII | 630,089.25 | 203,324.63 | 16<br>17 | 252+11.38<br>251+86.3 |
| PI XVIII | 629,480.14 | 202,828.39 | 17<br>18 | 259+72.0<br>258+87.3 |
| PI XIXA | 629,686.01 | 201,668.91 | 18<br>19A | 270+65.0 |
| PI XVIIIB | 629,673.21 | 201,666.64 | PI 18B | 270+65.0 |
| PI XIX | 629,806.25 | 200,917.41 | 18B<br>19 | 278+25.95<br>278+09.5 |
| PI XX | 629,429.72 | 200,294.73 | 19<br>20 | 285+37.2<br>285+17.2 |
| PI XXI | 629,669.10 | 196,857.32 | 20<br>21 | 319+63.0<br>319+63.00 |
| PI XXII | 629,724.76 | 196,236.11 | 21<br>22 | 325+86.7<br>325+86.64 |
| PI XXIII | 629,728.97 | 195,670.00 | 22<br>23 | 331+52.77<br>331+26.19 |
| PI XXIV | 629,197.96 | 195,294.00 | 23<br>24 | 337+76.84<br>337+76.71 |
| PI XXV | 629,117.02 | 195,214.00 | 24<br>25 | 338+90.52 |

| CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|
| | | | RADIUS | L | T | PC | PT |
| PC 1 | 3+84.21 | | | | | | |
| PC 1<br>PI 1 | 13+66.37<br>13+46.04 | 20°10'27.10" | 5521.02 | 1943.98 | 982.16 | 3+84.21 | 23+28.20 |
| PI 1<br>2 | 40+24.56<br>40+00.96 | 31°12'37.85" | 1700.00 | 926.03 | 474.82 | 35+49.74 | 44+75.78 |
| 2<br>3 | 54+61.54<br>54+57.12 | 15°25'38.76" | 2700.00 | 727.00 | 365.71 | 50+95.83 | 58+22.83 |
| 3<br>4 | 64+47.10<br>63+49.83 | 54°58'07.91" | 1200.00 | 1157.27 | 624.27 | 58+22.83 | 69+74.10 |
| 4<br>5 | 72+05.10<br>72+01.50 | 17°30'35.07" | 1500.00 | 458.40 | 231.00 | 69+74.10 | 74+32.50 |
| 5<br>6A | 88+33.21 | | | | | | |
| PI 5B | 88+33.21 | | | | | | |
| 5B<br>6 | 91+08.33<br>90+88.83 | 41°07'51.06" | 600.00 | 430.72 | 225.11 | 88+83.22 | 93+13.94 |
| 6<br>7 | 104+29.99<br>103+77.13 | 49°51'07.19" | 890.00 | 774.37 | 413.62 | 100+16.38 | 107+90.75 |
| 7<br>8 | 116+05.74<br>115+92.58 | 31°50'54.83" | 890.00 | 494.72 | 253.93 | 113+51.79 | 118+46.51 |
| 8<br>9 | 123+16.98<br>123+14.60 | 20°37'57.54" | 600.00 | 216.06 | 109.22 | 122+07.76 | 124+23.82 |
| 9<br>10 | 131+31.42<br>131+29.70 | 18°34'53.49" | 600.00 | 194.59 | 98.15 | 130+33.27 | 132+27.85 |
| 10<br>11 A | 133+12.44 | | | | | | |
| PI 10B | 133+12.44 | | | | | | |
| 10B<br>11 | 161+04.79<br>160+43.92 | 62°20'04.77" | 500.00 | 543.97 | 302.42 | 158+02.37 | 163+46.34 |
| 11<br>12 | 186+91.21<br>181+79.60 | 91°59'10.18" | 1100.00 | 1766.01 | 1138.81 | 175+52.40 | 193+18.41 |
| 12<br>13 | 202+89.00<br>202+53.40 | 54°33'22.02" | 450.00 | 428.48 | 232.04 | 200+56.96 | 204+85.44 |
| 13<br>14A | 205+85.45 | | | | | | |

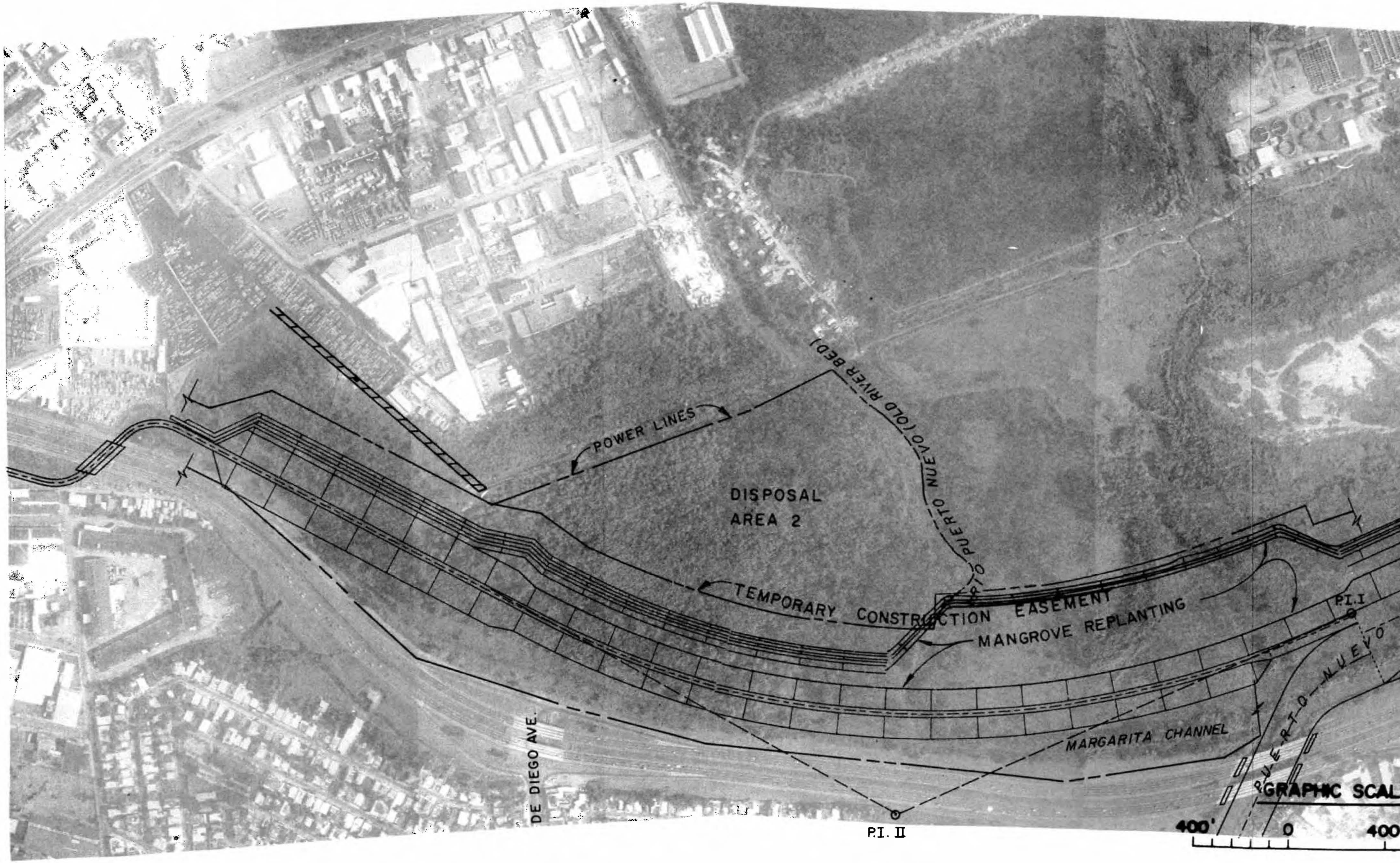
| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PI XIIIB | 628,409.37 | 207,239.28 | PI13B | 205+85.45 | | | | | | |
| PI XIV | 628,573.54 | 207,008.63 | 13B<br>14 | 208+68.56<br>208+68.03 | 12°31'42.96" | 600.00 | 131.20 | 65.86 | 208+02.69 | 209+33.89 |
| PI XV | 628,762.82 | 206,560.85 | 14<br>15 | 213+54.17<br>213+51.06 | 20°59'11.16" | 750.00 | 274.71 | 138.91 | 212+15.26 | 214+89.97 |
| PI XVI | 630,438.15 | 204,819.96 | 15<br>16 | 237+67.14<br>236+75.89 | 57°02'03.23" | 1000.00 | 995.44 | 543.34 | 232+23.79 | 242+19.23 |
| PI XVII | 630,089.25 | 203,324.63 | 16<br>17 | 252+11.38<br>251+86.33 | 37°41'48.33" | 1010.00 | 664.51 | 344.78 | 248+66.60 | 255+31.11 |
| PI XVIII | 629,480.14 | 202,828.39 | 17<br>18 | 259+72.01<br>258+87.39 | 60°53'55.25" | 750.00 | 797.16 | 440.89 | 255+31.12 | 263+28.28 |
| PI XIXA | 629,686.01 | 201,668.91 | 18<br>19A | 270+65.00 | | | | | | |
| PI XVIIIB | 629,673.21 | 201,666.64 | PI 18B | 270+65.00 | | | | | | |
| PI XIX | 629,806.25 | 200,917.41 | 18B<br>19 | 278+25.95<br>278+09.57 | 41°13'47.76" | 500.00 | 359.80 | 188.09 | 276+37.86 | 279+97.66 |
| PI XX | 629,429.72 | 200,294.73 | 19<br>20 | 285+37.25<br>285+17.26 | 35°08'40.14" | 1000.00 | 613.39 | 316.69 | 282+20.56 | 288+33.95 |
| PI XXI | 629,669.10 | 196,857.32 | 20<br>21 | 319+63.00<br>319+63.00 | 01°08'11.38" | 1200.00 | 23.80 | 11.90 | 319+51.10 | 319+74.90 |
| PI XXII | 629,724.76 | 196,236.11 | 21<br>22 | 325+86.70<br>325+86.64 | 04°41'36.93" | 1200.00 | 98.30 | 49.18 | 325+37.52 | 326+35.82 |
| PI XXIII | 629,728.97 | 195,670.00 | 22<br>23 | 331+52.77<br>331+26.19 | 55°07'28.39" | 325.00 | 312.68 | 169.63 | 329+83.13 | 332+95.82 |
| PI XXIV | 629,197.96 | 195,294.00 | 23<br>24 | 337+76.84<br>337+76.71 | 09°21'32.96" | 337.50 | 55.13 | 27.63 | 337+76.84 | 338+04.34 |
| PI XXV | 629,117.02 | 195,214.00 | 24<br>25 | 338+90.52 | | | | | | |

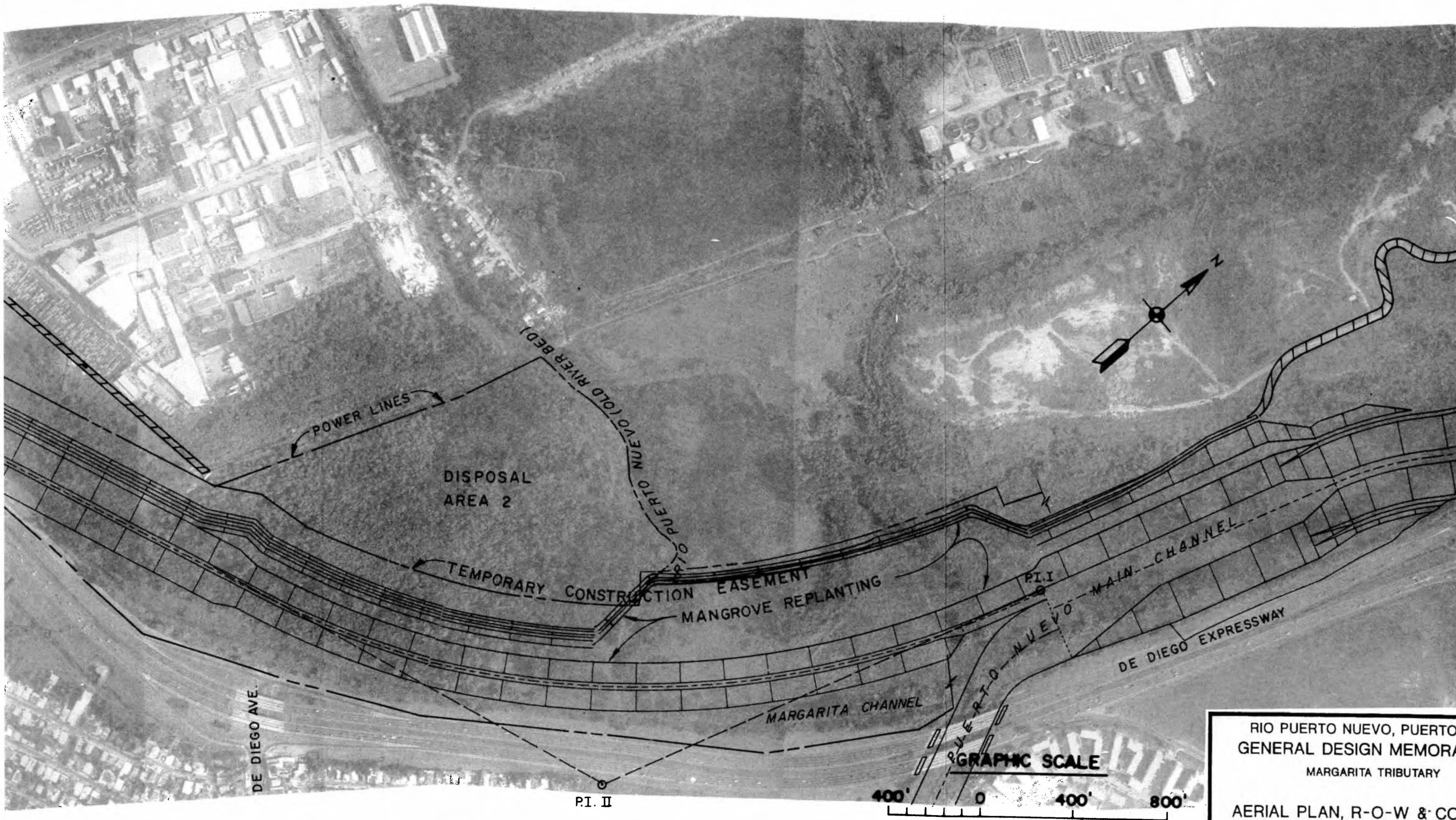
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

CONTROL DATA

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990


POWER LINES
DISPOSAL AREA 2
PUERTO NUEVO (OLD RIVER BED)
TEMPORARY CONSTRUCTION EASEMENT
MANGROVE REPLANTING
P.I. I
PUERTO NUEVO
MARGARITA CHANNEL
DE DIEGO AVE.
P.I. II
GRAPHIC SCALE
400'
0
400'




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

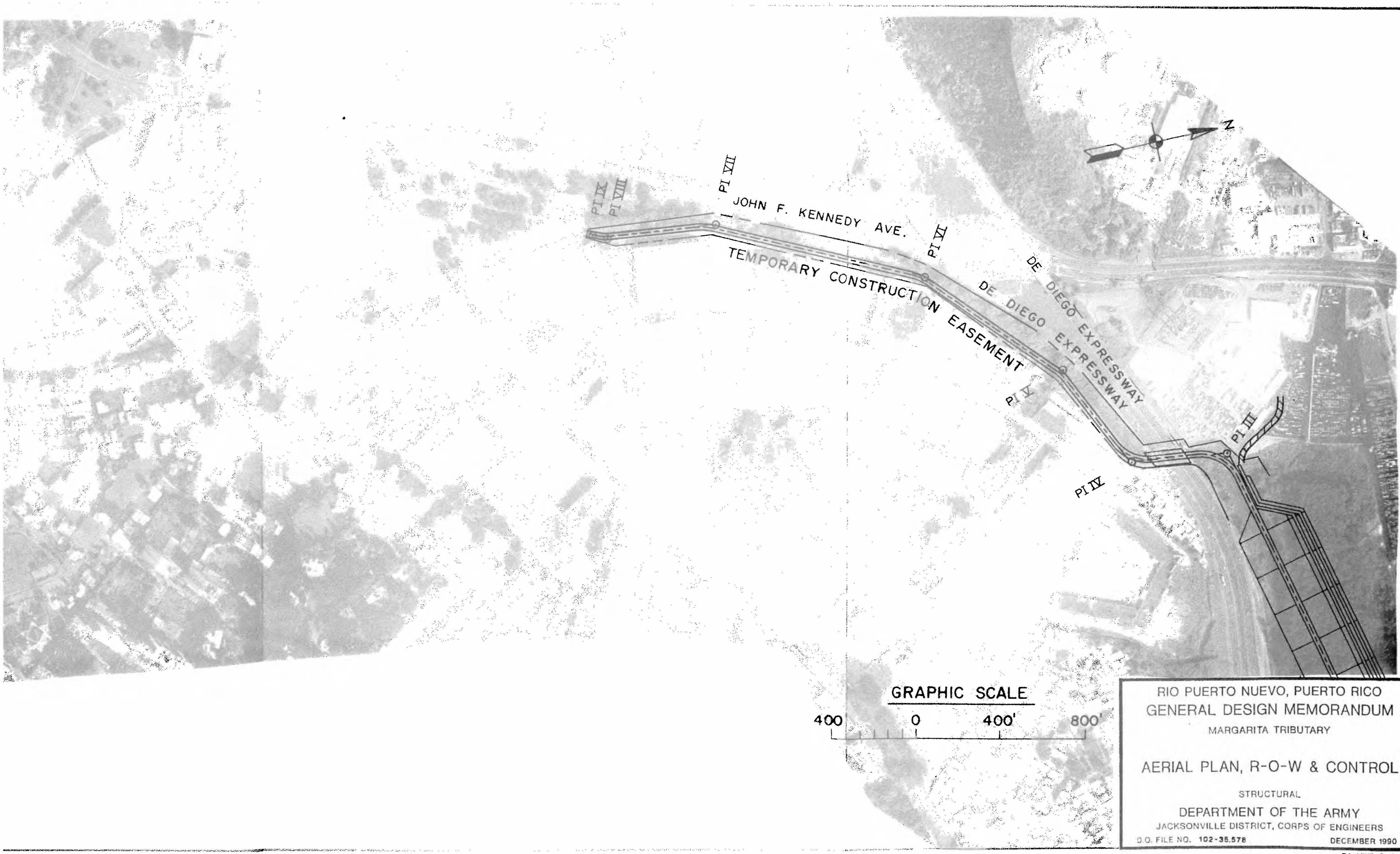
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-8


PI IX
PI VIII
PI VII
JOHN F. KENNEDY AVE.
PI VI
TEMPORARY CONSTRUCTION
GRAPHIC
400
0




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35.578 DECEMBER 1990

PLATE S-9

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PI I | 621,765.00 | 215,294.65 | PI 1 | 0+00.00 | | | | | | |
| PI II | 620,437.26 | 213,595.26 | PI 1<br>PI 2 | 21+56.58<br>18+86.89 | 51°49'28.74" | 4015.00 | 3631.61 | 1950.65 | 2+05.93 | 38+37.54 |
| PI III | 616,593.50 | 213,583.54 | 2<br>3 | 57+30.67<br>56+94.89 | 70°01'37.40" | 200.00 | 244.44 | 140.11 | 55+90.56 | 58+35.00 |
| PI IV | 616,431.70 | 213,134.08 | 3<br>4 | 61+72.58<br>61+53.04 | 58°15'04.26" | 200.00 | 203.33 | 111.44 | 60+61.15 | 62+64.48 |
| PI V | 615,900.60 | 213,021.67 | 4<br>5 | 66+95.91<br>66+95.43 | 17°37'44.33" | 200.00 | 61.54 | 31.01 | 66+64.90 | 67+26.44 |
| PI VI | 615,169.02 | 212,606.42 | 5<br>6 | 75+36.64<br>75+35.74 | 21°12'43.63" | 210.00 | 77.75 | 39.32 | 74+97.31 | 75+75.06 |
| PI VII | 614,473.14 | 211,753.44 | 6<br>7 | 86+36.57<br>86+35.68 | 19°34'12.06" | 265.00 | 90.51 | 45.70 | 85+90.86 | 86+81.38 |
| PI VIII | 614,304.47 | 211,280.76 | 7<br>8 | 91+37.55<br>91+37.19 | 17°30'47.07" | 150.00 | 45.85 | 23.10 | 91+14.44 | 91+60.29 |
| PI IX | 614,251.12 | 211,210.35 | 8 | 92+25.53 | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY

CONTROL DATA

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 199

PLATE S-1

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PI I | 621,765.00 | 215,294.65 | PI 1 | 0+00.00 | | | | | | |
| PI II | 620,437.26 | 213,595.26 | PI 1<br>PI 2 | 21+56.58<br>18+86.89 | 51°49'28.74" | 4015.00 | 3631.61 | 1950.65 | 2+05.93 | 38+37.54 |
| PI III | 616,593.50 | 213,583.54 | 2<br>3 | 57+30.67<br>56+94.89 | 70°01'37.40" | 200.00 | 244.44 | 140.11 | 55+90.56 | 58+35.00 |
| PI IV | 616,431.70 | 213,134.08 | 3<br>4 | 61+72.58<br>61+53.04 | 58°15'04.26" | 200.00 | 203.33 | 111.44 | 60+61.15 | 62+64.48 |
| PI V | 615,900.60 | 213,021.67 | 4<br>5 | 66+95.91<br>66+95.43 | 17°37'44.33" | 200.00 | 61.54 | 31.01 | 66+64.90 | 67+26.44 |
| PI VI | 615,169.02 | 212,606.42 | 5<br>6 | 75+36.64<br>75+35.74 | 21°12'43.63" | 210.00 | 77.75 | 39.32 | 74+97.31 | 75+75.06 |
| PI VII | 614,473.14 | 211,753.44 | 6<br>7 | 86+36.57<br>86+35.68 | 19°34'12.06" | 265.00 | 90.51 | 45.70 | 85+90.86 | 86+81.38 |
| PI VIII | 614,304.47 | 211,280.76 | 7<br>8 | 91+37.55<br>91+37.19 | 17°30'47.07" | 150.00 | 45.85 | 23.10 | 91+14.44 | 91+60.29 |
| PI IX | 614,251.12 | 211,210.35 | 8 | 92+25.53 | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY

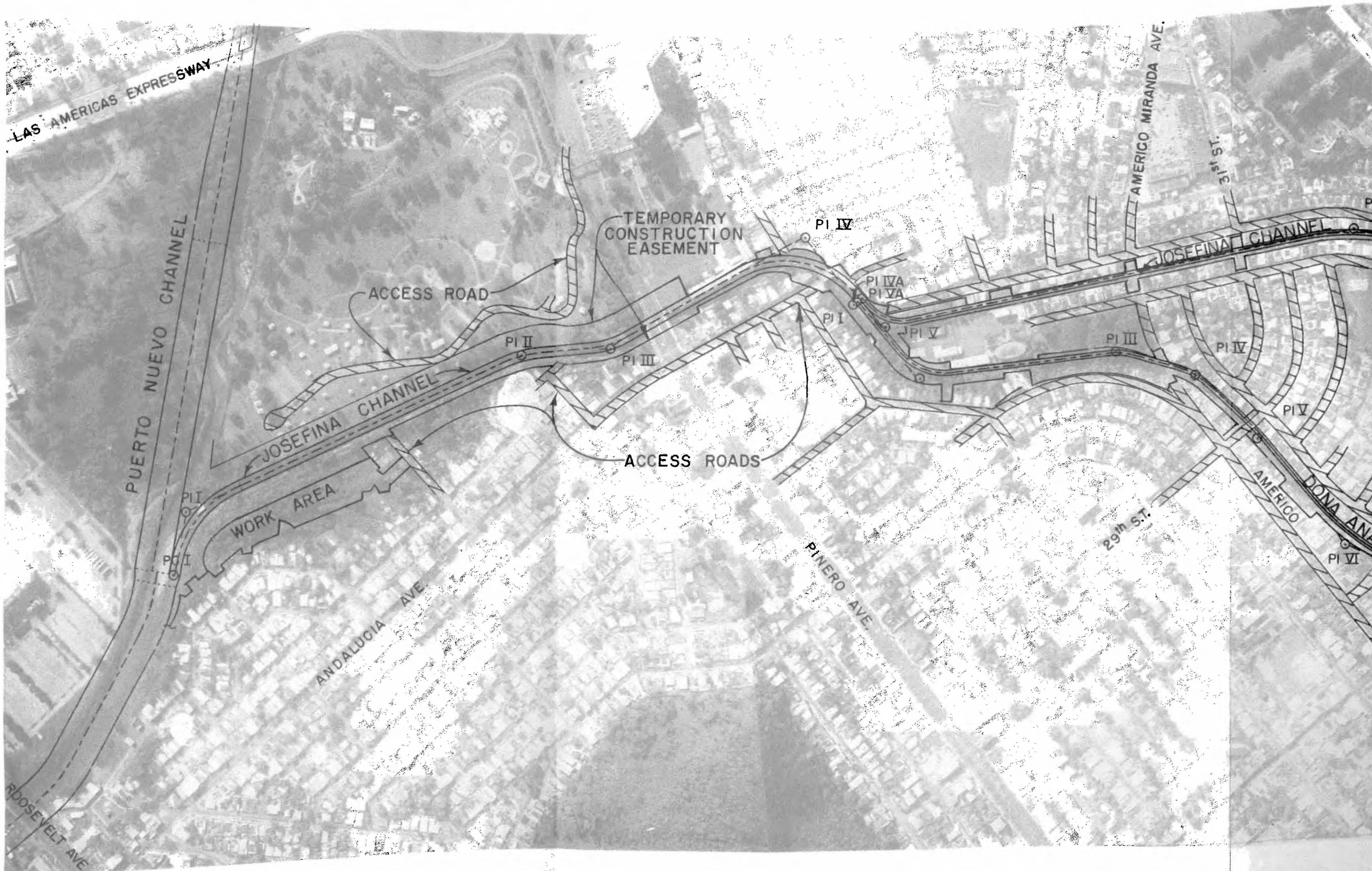
CONTROL DATA

STRUCTURAL

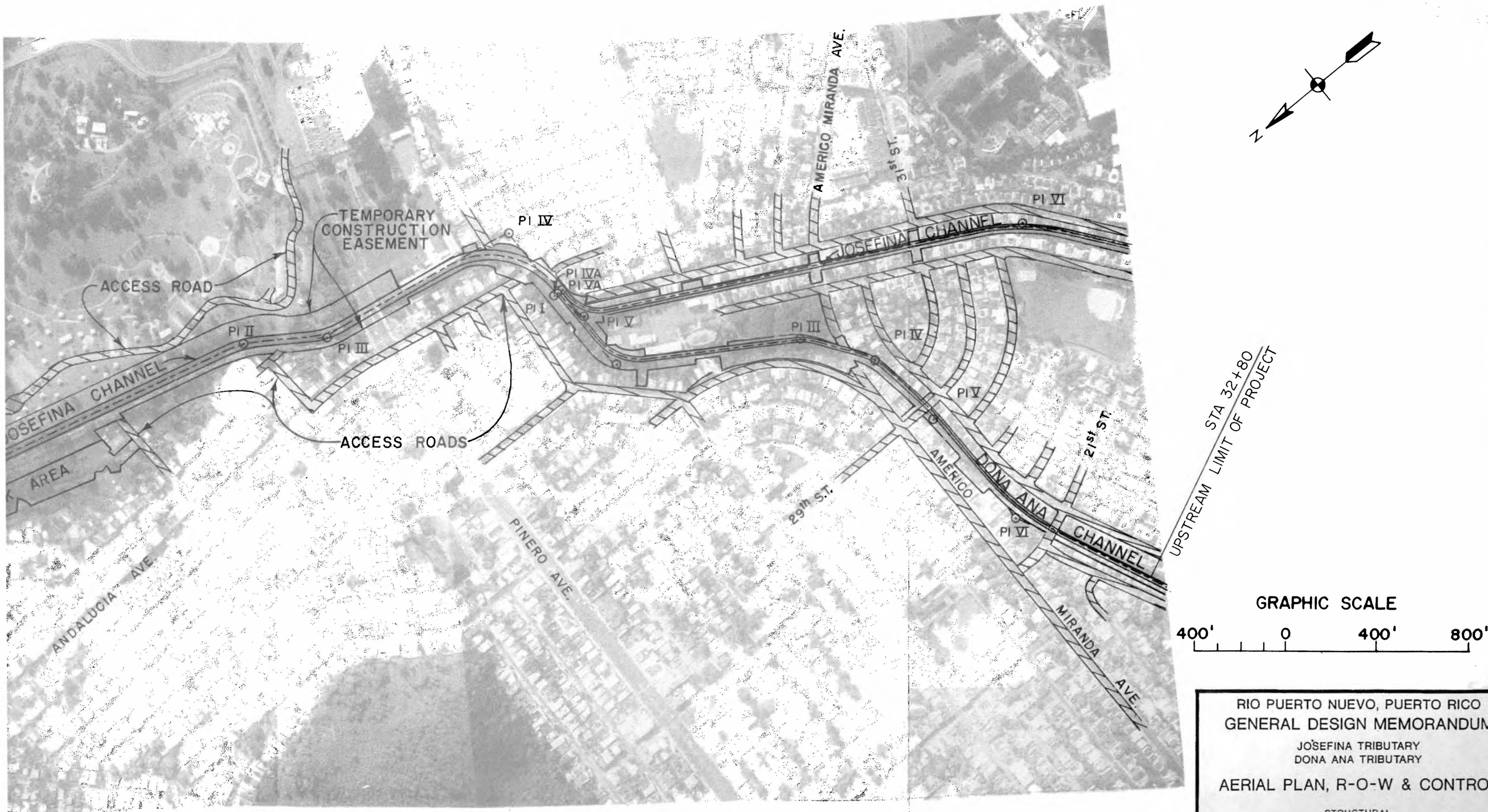
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990



LAS AMERICAS EXPRESSWAY
PUERTO NUEVO CHANNEL
TEMPORARY CONSTRUCTION EASEMENT
ACCESS ROAD
ACCESS ROADS
JOSEFINA CHANNEL
WORK AREA
PI I
PC I
PI II
PI III
PI IV
PI IVA
PI VA
PI I
PI V
PI III
PI IV
PI V
PI VI
PI
AMERICO MIRANDA AVE.
31st ST.
29th ST.
AMERICO
DONA ANA
ANDALUCIA AVE.
PINERO AVE.
ROOSEVELT AVE.




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY
DONA ANA TRIBUTARY

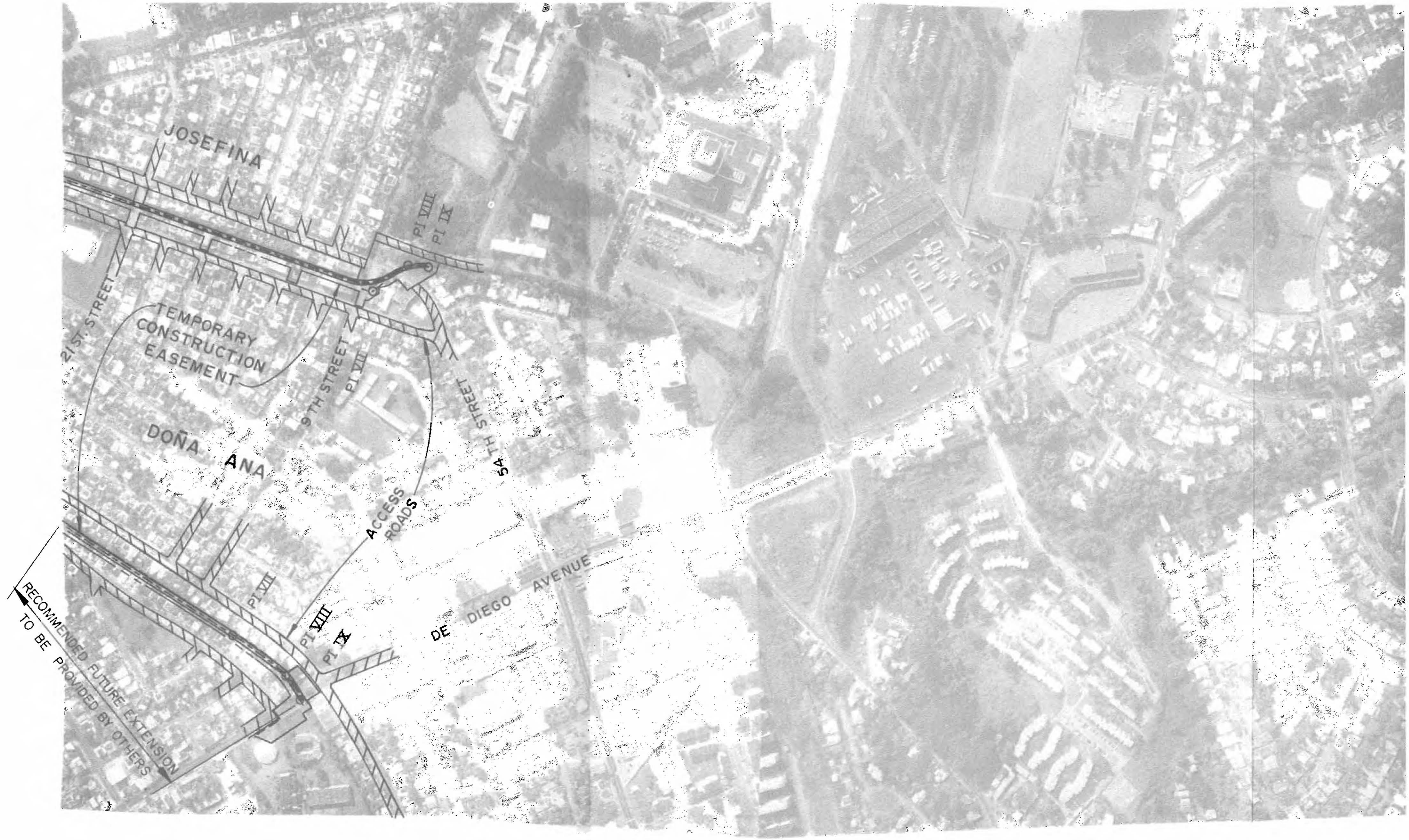
AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35.578 DECEMBER 1990

PLATE S-11



JOSEFINA
PI VIII
PI IX
21 ST. STREET
TEMPORARY CONSTRUCTION EASEMENT
9 TH STREET
PI VII
54 TH STREET
DOÑA ANA
ACCESS ROADS
DE DIEGO AVENUE
PI VII
PI VIII
PI IX
RECOMMENDED FUTURE EXTENSION TO BE PROVIDED BY OTHERS


GRAPHIC SCALE

400' 0 400' 800'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY
DONA ANA TRIBUTARY

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-12

# JOSEFINA TRIBUTARY

| PI | PLANE COORDINATES X | PLANE COORDINATES Y | CUT | PI/PI | I | CURVE DATA RADIUS | CURVE DATA L | CURVE DATA T | CURVE DATA PC | CURVE DATA PT |
|---|---|---|---|---|---|---|---|---|---|---|
| PC I | 623,718.18 | 211,446.86 | PC 1 | 0+00.00 | | | | | | |
| PI I | 623,959.76 | 211,309.34 | PC 1<br>PI 1 | 2+77.97<br>2+42.50 | 54°58'28.95" | 437.500 | 419.78 | 227.63 | 0+50.35 | 4+70.13 |
| PI II | 624,108.44 | 209,728.96 | 1<br>2 | 18+29.86<br>18+27.86 | 20°10'50.92" | 540.00 | 190.20 | 96.10 | 17+33.76 | 19+23.96 |
| PI III | 624,007.81 | 209,348.26 | 2<br>3 | 22+21.64<br>22+19.09 | 24°41'51.60" | 375.00 | 161.65 | 82.10 | 21+39.55 | 23+01.19 |
| PI IV | 624,174.12 | 208,394.52 | 3<br>4 | 31+87.22<br>30+75.77 | 79°43'50.59" | 400.00 | 556.637 | 334.04 | 28+53.18 | 34+09.81 |
| PI V A | 623,835.28 | 208,270.12 | 4<br>5 | 34+36.72 | | | | | | |
| PI IV B | 623,839.41 | 208,258.85 | 4B | 34+36.72 | | | | | | |
| PI V | 623,696.19 | 208,206.27 | 4B<br>5 | 35+89.30<br>35+66.95 | 62°11'19.09" | 185.00 | 200.80 | 111.57 | 34+77.72 | 36+78.53 |
| PI VI | 623,421.69 | 206,162.88 | 5<br>6 | 56+28.69<br>56+21.30 | 25°23'13.40" | 1000.00 | 443.09 | 225.24 | 54+03.45 | 58+46.54 |
| PI VII | 622,409.62 | 204,606.70 | 6<br>7 | 74+77.63<br>74+62.29 | 52°26'00.70" | 220.00 | 201.33 | 108.33 | 73+69.29 | 75+70.62 |
| PI VIII | 622,472.98 | 204,426.73 | 7<br>8 | 76+53.09<br>76+47.03 | 37°55'27.84" | 240.00 | 158.86 | 82.46 | 75+70.63 | 77+29.49 |
| PI IX | 622,446.78 | 204,348.54 | 8<br>9 | 77+29.49 | | | | | | |

# DONA ANA TRIB

| PI | PLANE COORDINATES X | PLANE COORDINATES Y | CUT | PI/PI | |
|---|---|---|---|---|---|
| PI I | 623,831.14 | 208,281.38 | PI 1 | 0+00 | |
| PI II | 623,439.27 | 208,137.50 | PI 1<br>PI 2 | 4+17.45<br>3+94.33 | 57°1 |
| PI III | 623,248.59 | 207,282.19 | PI 2<br>3 | 12+70.64<br>12+69.39 | 22°1 |
| PI IV | 623,064.07 | 207,017.62 | 3<br>4 | 15+91.94<br>15+89.02 | 27°0 |
| PI V | 622,751.14 | 206,850.99 | 4<br>5 | 19+43.55<br>19+43.37 | 7°16' |
| PI VI | 622,173.54 | 206,632.03 | 5<br>6 | 25+61.09<br>25+54.65 | 22°4 |
| PI VII | 621,035.66 | 205,540.47 | 6<br>7 | 41+31.48<br>41+31.48 | 3°02 |
| PI VIII | 620,826.28 | 205,357.62 | 7<br>8 | 44+09.45<br>44+08.30 | 21°4 |
| PI IX | 620,677.64 | 205,305.36 | 8 | 45+65.86 | |
| | | | | | |
| | | | | | |
| | | | | | |

NOTE: STA. 32+80 UPSTREAM LIMIT OF PR
STA. 32+80 TO STA. 45+65.86 RECOMMENDE
FUTURE EXTENSION TO BE PROVIDED BY C

## ·INA TRIBUTARY

| ·IT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|
| | | | RADIUS | L | T | PC | PT |
| 1 | 0+00.00 | | | | | | |
| 1<br>1 | 2+77.97<br>2+42.50 | 54°58'28.95" | 437.500 | 419.78 | 227.63 | 0+50.35 | 4+70.13 |
| 1<br>2 | 18+29.86<br>18+27.86 | 20°10'50.92" | 540.00 | 190.20 | 96.10 | 17+33.76 | 19+23.96 |
| 2<br>3 | 22+21.64<br>22+19.09 | 24°41'51.60" | 375.00 | 161.65 | 82.10 | 21+39.55 | 23+01.19 |
| 3<br>4 | 31+87.22<br>30+75.77 | 79°43'50.59" | 400.00 | 556.637 | 334.04 | 28+53.18 | 34+09.81 |
| 4<br>5 | 34+36.72 | | | | | | |
| 4B | 34+36.72 | | | | | | |
| 4B<br>5 | 35+89.30<br>35+66.95 | 62°11'19.09" | 185.00 | 200.80 | 111.57 | 34+77.72 | 36+78.53 |
| 5<br>6 | 56+28.69<br>56+21.30 | 25°23'13.40" | 1000.00 | 443.09 | 225.24 | 54+03.45 | 58+46.54 |
| 6<br>7 | 74+77.63<br>74+62.29 | 52°26'00.70" | 220.00 | 201.33 | 108.33 | 73+69.29 | 75+70.62 |
| 7<br>8 | 76+53.09<br>76+47.03 | 37°55'27.84" | 240.00 | 158.86 | 82.46 | 75+70.63 | 77+29.49 |
| 8<br>9 | 77+29.49 | | | | | | |

## DONA ANA TRIBUTARY

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PI I | 623,831.14 | 208,281.38 | PI 1 | 0+00 | | | | | | |
| PI II | 623,439.27 | 208,137.50 | PI 1<br>PI 2 | 4+17.45<br>3+94.33 | 57°16'10.67" | 250.00 | 249.89 | 136.50 | 2+80.95 | 5+30.83 |
| PI III | 623,248.59 | 207,282.19 | PI 2<br>3 | 12+70.64<br>12+69.39 | 22°19'30.50" | 250.00 | 97.41 | 49.33 | 12+21.30 | 13+18.72 |
| PI IV | 623,064.07 | 207,017.62 | 3<br>4 | 15+91.94<br>15+89.02 | 27°04'19.97" | 325.00 | 153.56 | 78.24 | 15+13.70 | 16+67.26 |
| PI V | 622,751.14 | 206,850.99 | 4<br>5 | 19+43.55<br>19+43.37 | 7°16'24.76" | 1000.00 | 126.95 | 63.56 | 18+79.99 | 20+06.93 |
| PI VI | 622,173.54 | 206,632.03 | 5<br>6 | 25+61.09<br>25+54.65 | 22°45'27.82" | 1212.00 | 481.40 | 243.92 | 23+17.17 | 27+98.57 |
| PI VII | 621,035.66 | 205,540.47 | 6<br>7 | 41+31.48<br>41+31.48 | 3°02'52.10" | 100.00 | 5.32 | 2.66 | 41+28.82 | 41+34.14 |
| PI VIII | 620,826.28 | 205,357.62 | 7<br>8 | 44+09.45<br>44+08.30 | 21°45'39.89" | 250.00 | 94.95 | 48.05 | 43+61.40 | 44+56.35 |
| PI IX | 620,677.64 | 205,305.36 | 8 | 45+65.86 | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

NOTE: STA. 32+80 UPSTREAM LIMIT OF PROJECT, STA. 32+80 TO STA. 45+65.86 RECOMMENDED FUTURE EXTENSION TO BE PROVIDED BY OTHERS.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
DONA ANA TRIBUTARY
CONTROL DATA
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PC I | 628,365.38 | 207,207.96 | PC 1 | 0+00 | | | | | | |
| PI I | 628,394.47 | 207,167.08 | PC 1<br>PI 1 | 1+06.28<br>0+49.84 | 11°36'00.49" | 494.00 | 100.02 | 50.18 | 0+00.00 | 1+00.02 |
| SPIRAL | | | | | | | | | (C.S.)<br>1+00.030 | (S.T.)<br>2+25.49 |
| PI II | 628,483.13 | 206,911.87 | PI 2 | 3+20.81<br>3+06.87 | 53°17'04.72" | 190.00 | 176.70 | 95.32 | 2+25.49 | 4+02.19 |
| PI III | 628,125.41 | 206,429.55 | 2<br>3 | 9+07.36<br>9+06.60 | 25°26'44.05" | 102.00 | 45.30 | 23.03 | 8+84.33 | 9+29.63 |
| PI IV | 627,719.07 | 204,361.77 | 3<br>4 | 30+13.93<br>30+09.37 | 40°13'50.14" | 150.00 | 105.32 | 54.94 | 29+58.99 | 30+64.31 |
| PI V | 627,331.37 | 204,051.70 | 4<br>5 | 35+05.82<br>35+05.73 | 10°45'34.86" | 150.00 | 28.17 | 14.13 | 34+91.70 | 35+19.86 |
| PI VI | 627,006.63 | 203,879.81 | 5<br>6 | 38+73.16<br>38+50.28 | 71°22'11.68" | 120.00 | 149.48 | 86.18 | 37+86.98 | 39+36.46 |
| PI VII | 627,067.08 | 203,496.90 | 6 | | | | | | | |
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RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

BUENA VISTA DIVERSION CHANNEL

CONTROL DATA

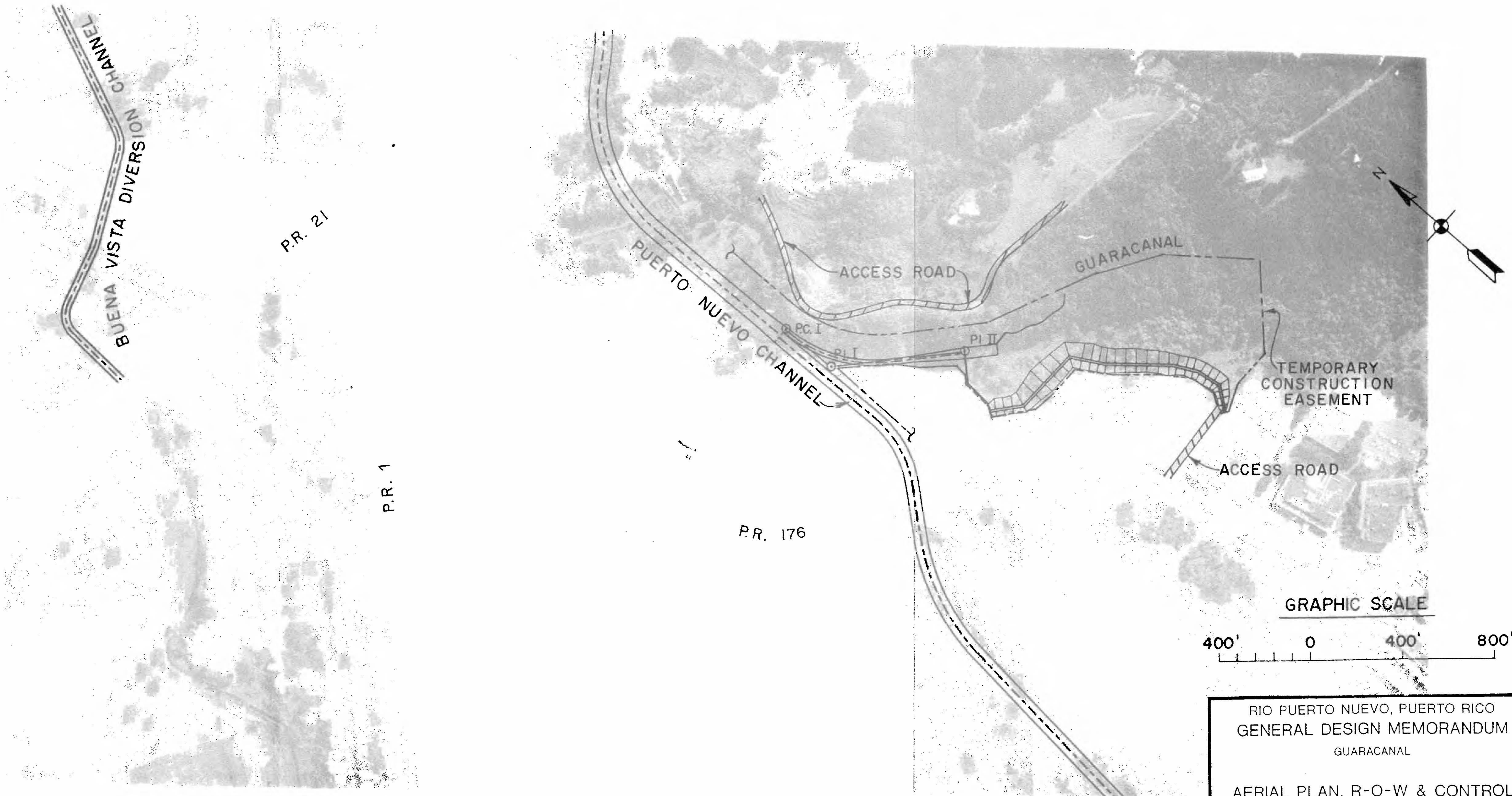
STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

BUENA VISTA DIVERSION CHANNEL
P.R. 21
P.R. 1
PUERTO NUEVO CHANNEL
ACCESS ROAD
PC. I
PI I
PI II
P.R. 176




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
GUARACANAL

AERIAL PLAN, R-O-W & CONTROL

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-16

| PI | PLANE COORDINATES | | CUT | PI/PI | I | CURVE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | | | | RADIUS | L | T | PC | PT |
| PC I | 629,717.52 | 201,674.51 | PC 1 | 0+00 | | | | | | |
| PI I | 629,766.29 | 201,399.72 | PC 1<br>PI 1 | 2+79.08<br>2+48.53 | 46°30'57.09" | 640.00 | 519.59 | 275.07 | 0+04.01 | 5+23.60 |
| PI II | 630,277.80 | 201,062.19 | PI 1 | 8+61.37 | | | | | | |
| | | | | | | | | | | |
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RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
GUARACANAL

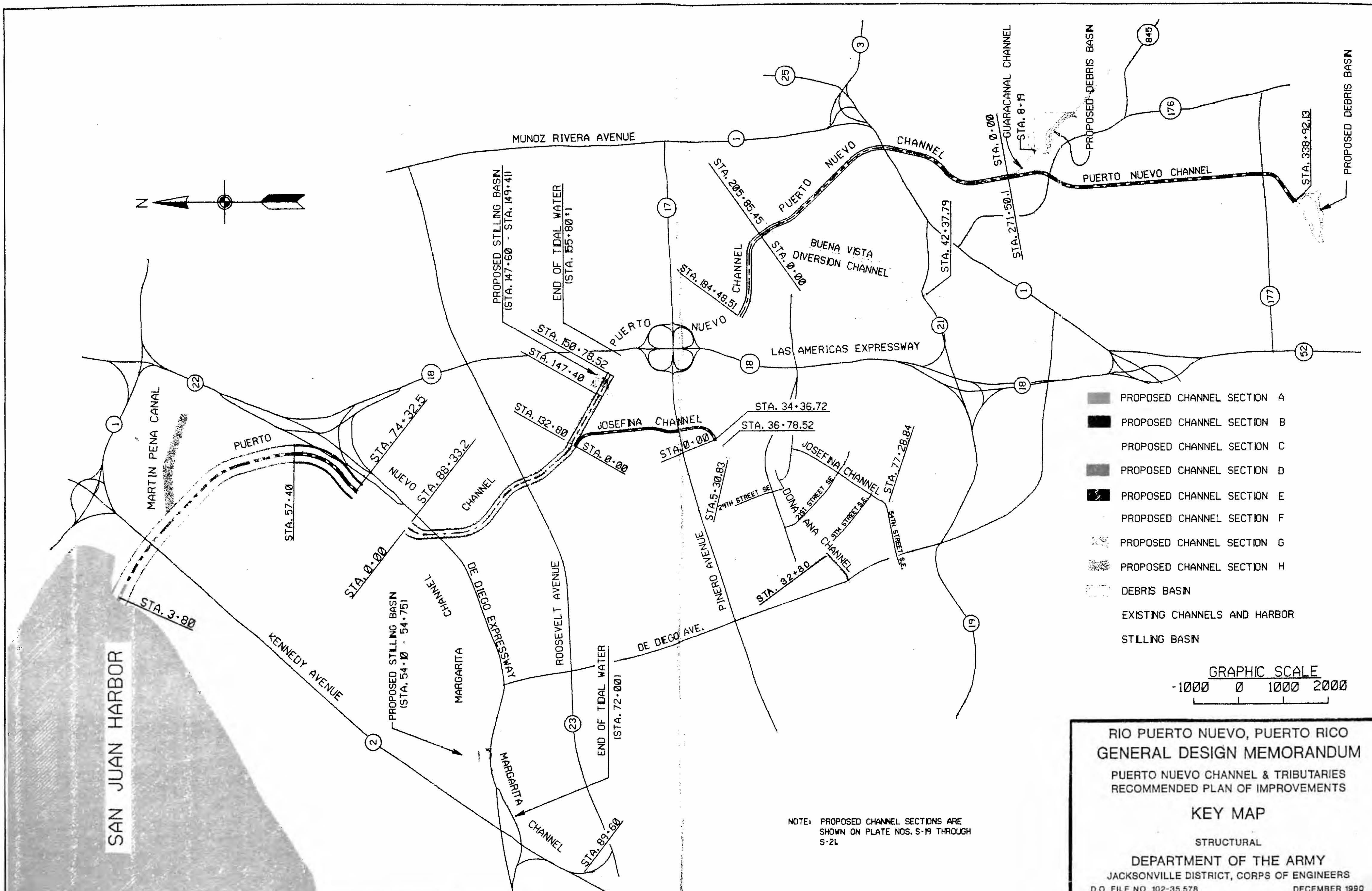
CONTROL DATA

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-17




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL & TRIBUTARIES
RECOMMENDED PLAN OF IMPROVEMENTS

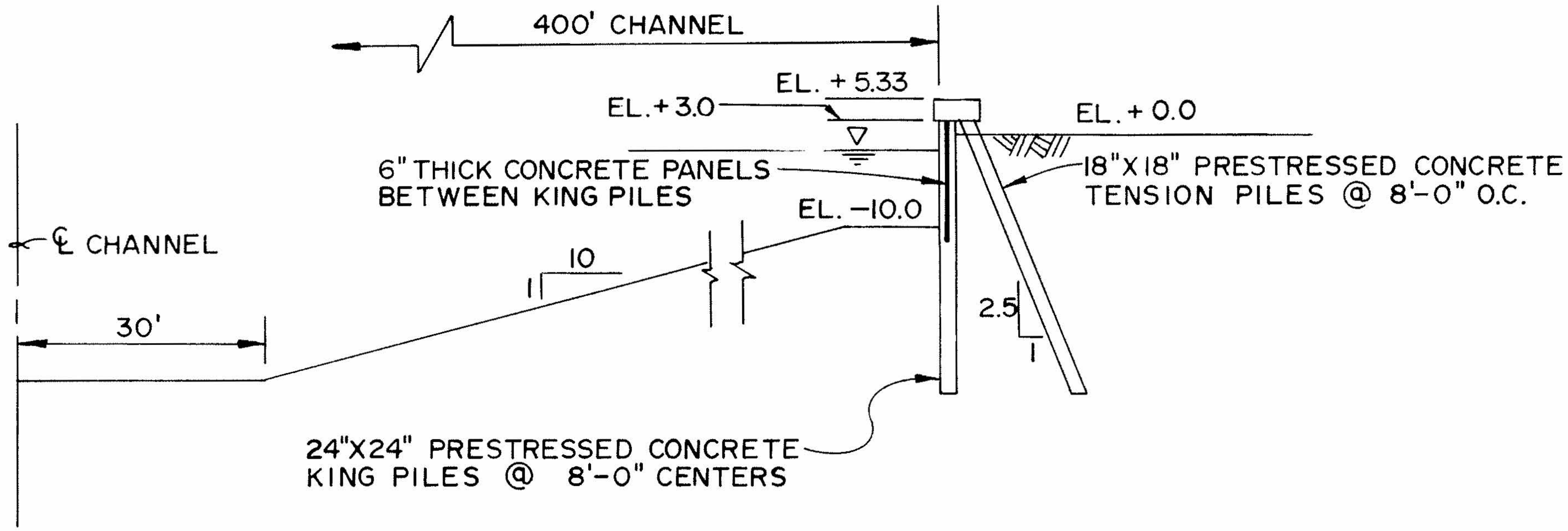
KEY MAP

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

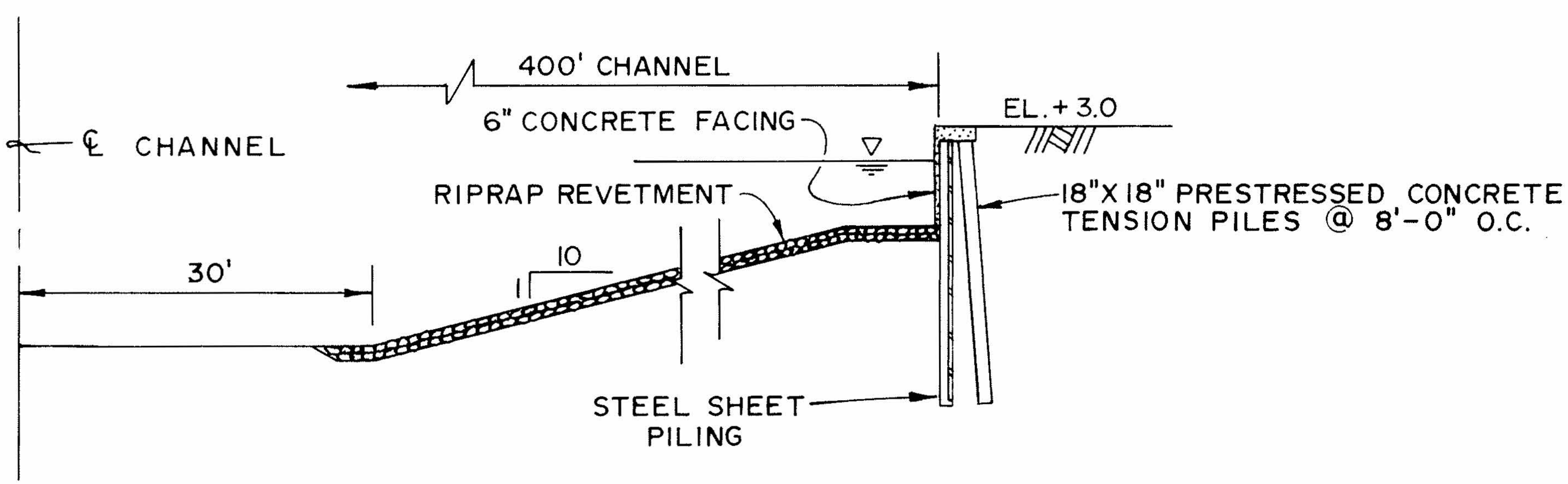
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-18



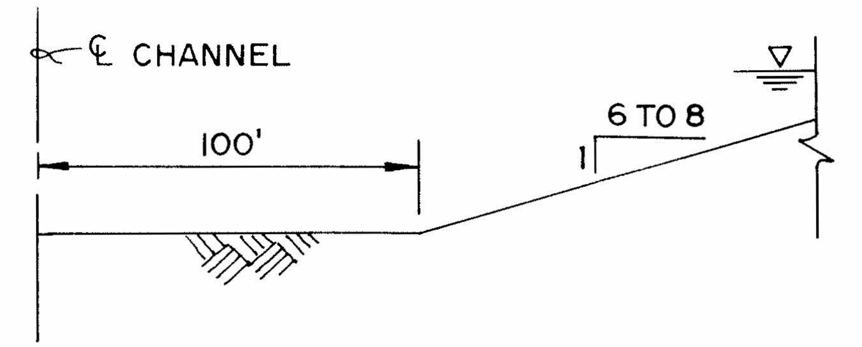

(A) KING PILE CHANNEL WALL

PUERTO NUEVO STA. 3+80 TO STA. 57+40




(B) SHEET PILE CHANNEL WALL

PUERTO NUEVO STA. 57+40 TO STA. 74+32.5




(C) EARTH TRAPEZOIDAL

PUERTO NUEVO STA. 74+32.5

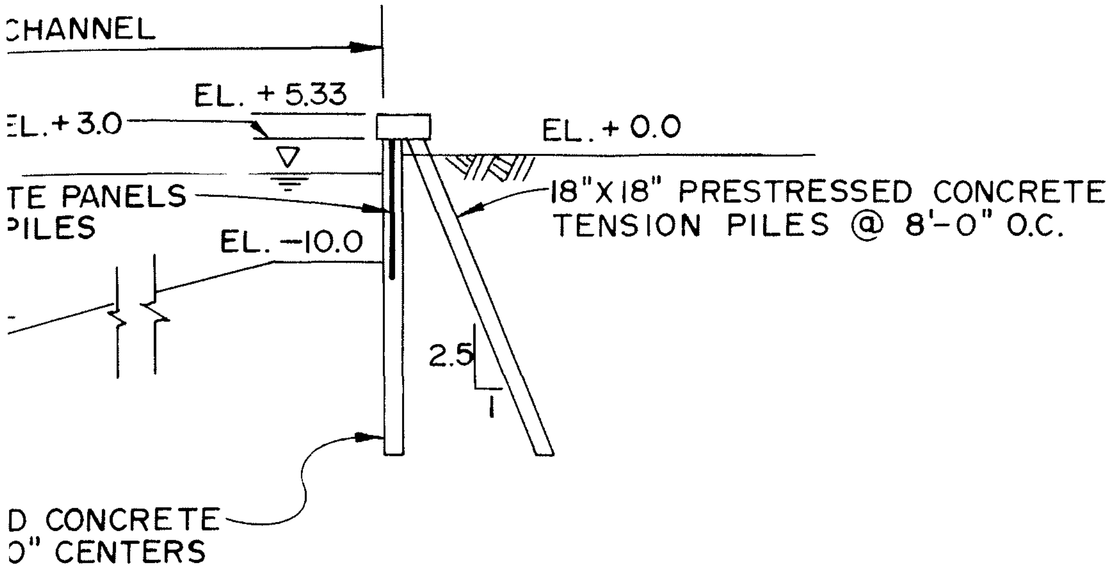
MARGARITA STA. 0+00 TO

NOTES:

1. RIPRAP IS REQUIRED FOR

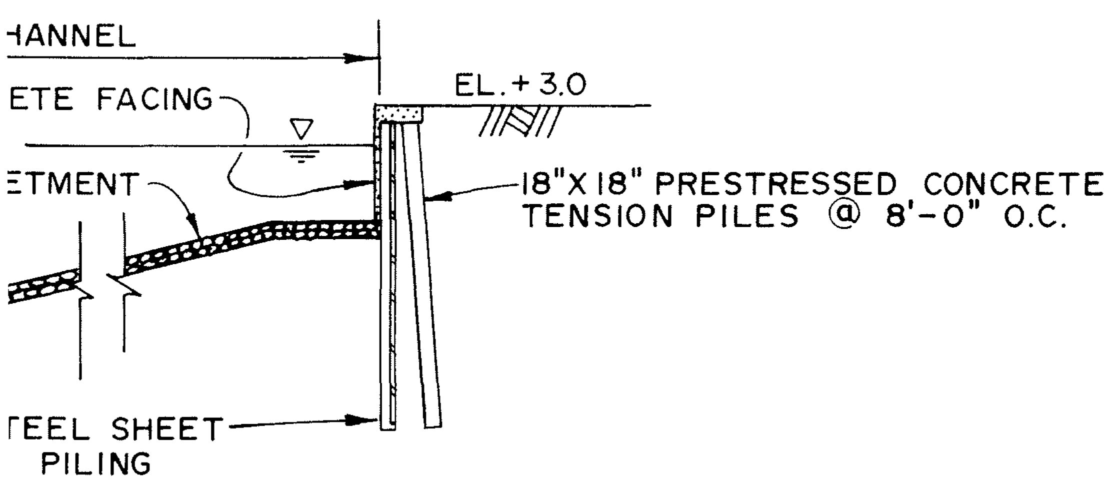
| STATION |
| --- |
| STA. 51+85 TO S |
| STA. 54+00 TO S |

2. SIDE SLOPES FOR MARGAR
1V:8H FROM STA. 40+00



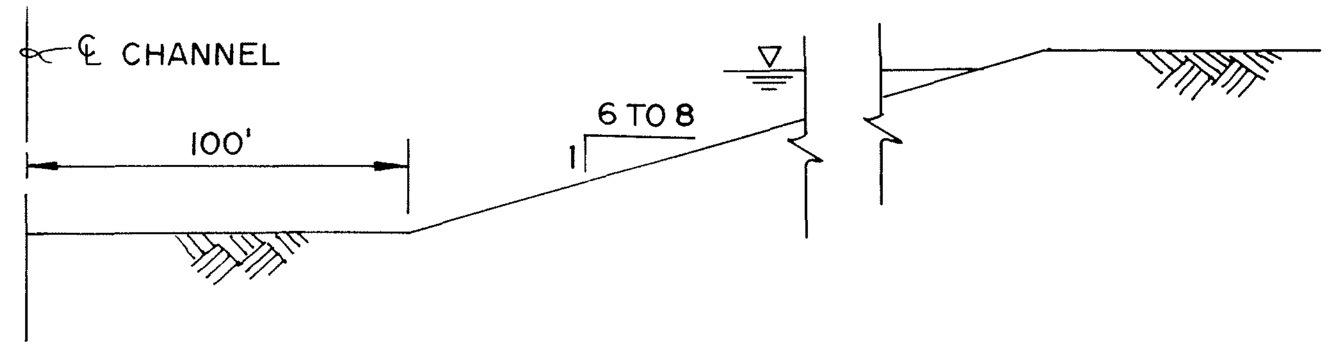

HANNEL WALL

3+80 TO STA. 57+40




CHANNEL WALL

57+40 TO STA. 74+32.5




(C) EARTH TRAPEZOIDAL CHANNEL

PUERTO NUEVO STA. 74+32.5 TO STA. 88+33.2
MARGARITA STA. 0+00 TO STA. 54+10

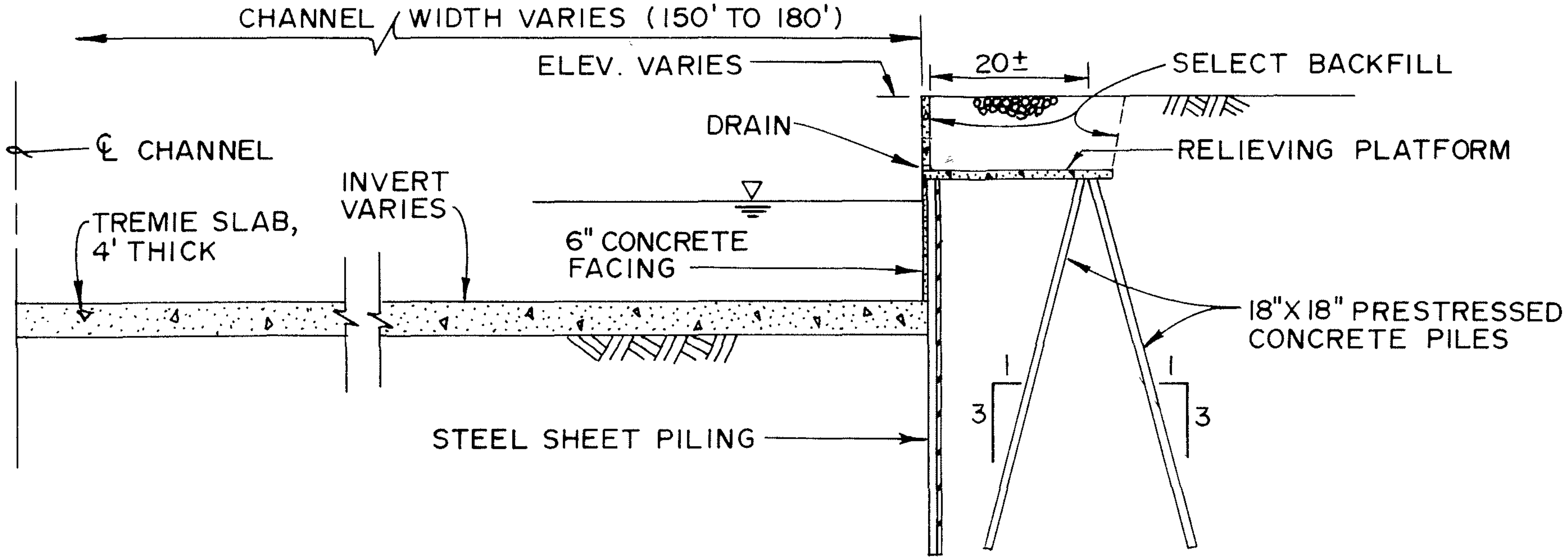
NOTES:

1. RIPRAP IS REQUIRED FOR MARGARITA TRIBUTARY AS FOLLOWS:

| STATION | THICKNESS | |
|---|---|---|
| | BOTTOM | SIDES |
| STA. 51+85 TO STA. 54+00 | 12" | 12" |
| STA. 54+00 TO STA. 54+10 | 24" | 27" |

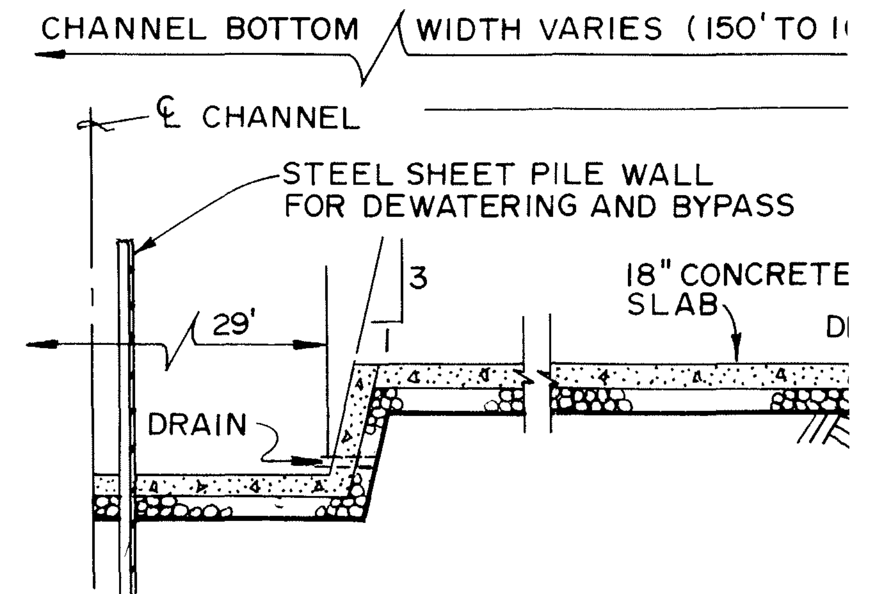
2. SIDE SLOPES FOR MARGARITA TRIBUTARY ARE 1V:8H FROM STA. 40+00 TO STA. 54+10.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL & TRIBUTARIES
RECOMMENDED PLAN OF IMPROVEMENTS
PROPOSED CHANNEL SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35.578 DECEMBER 1990




(D) RELIEVING PLATFORM CHANNEL WALL

PUERTO NUEVO STA. 88+33.2 TO STA. 147+40



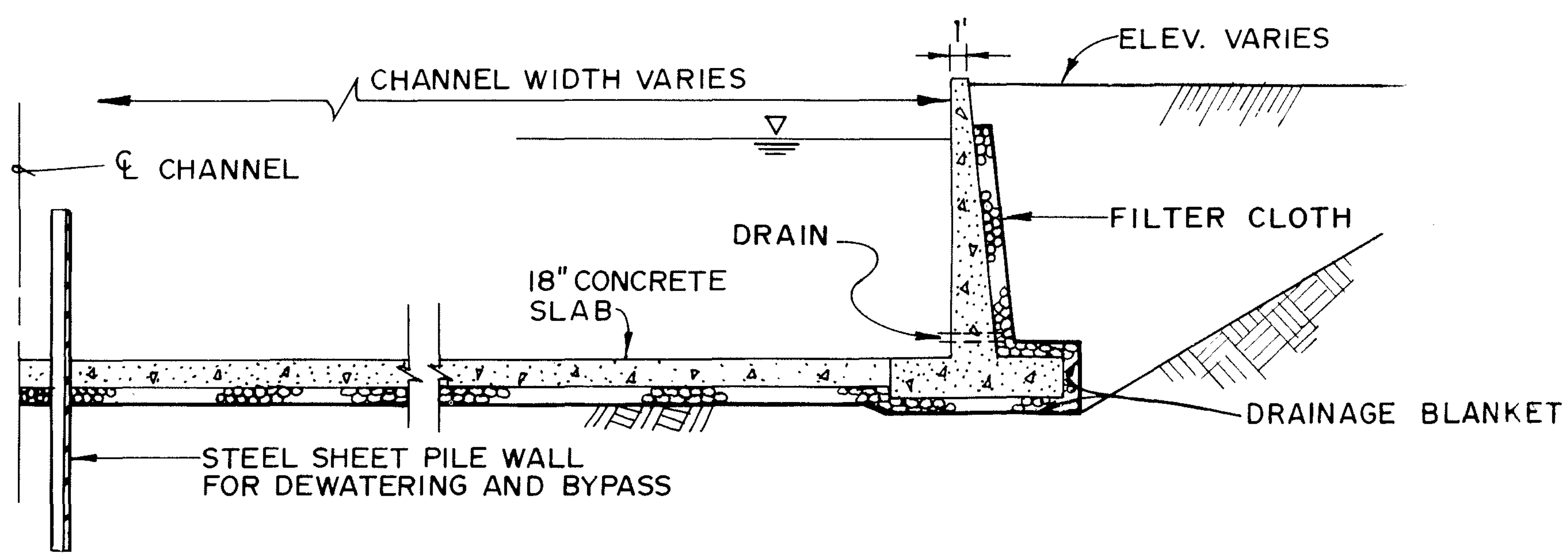

(F) TRAPEZOIDAL CHANNEL WITH

PUERTO NUEVO STA. 150+7

(EXCLUDING

NOTE:

FOUNDATION IMPROVEMENTS MA
FOR PORTIONS OF PROPOSED C
REFER TO TEXT SECTION "GEO

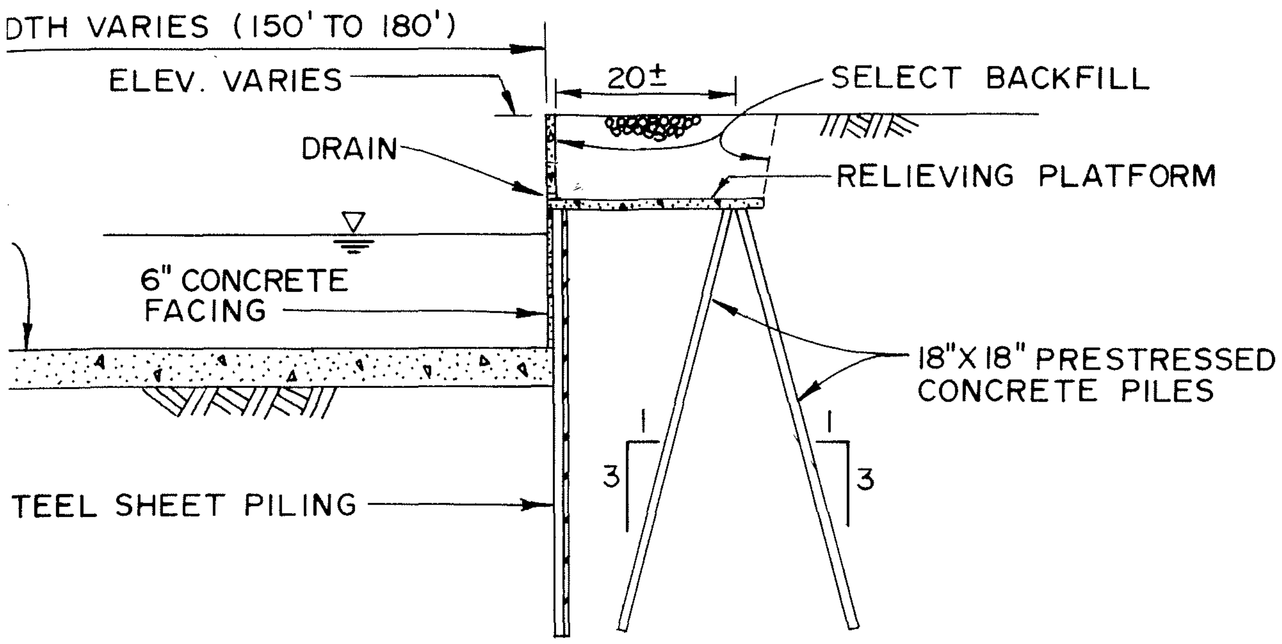



(E) INVERTED TEE CHANNEL WALL

PUERTO NUEVO STA. 147+40 TO STA. 150+78.52

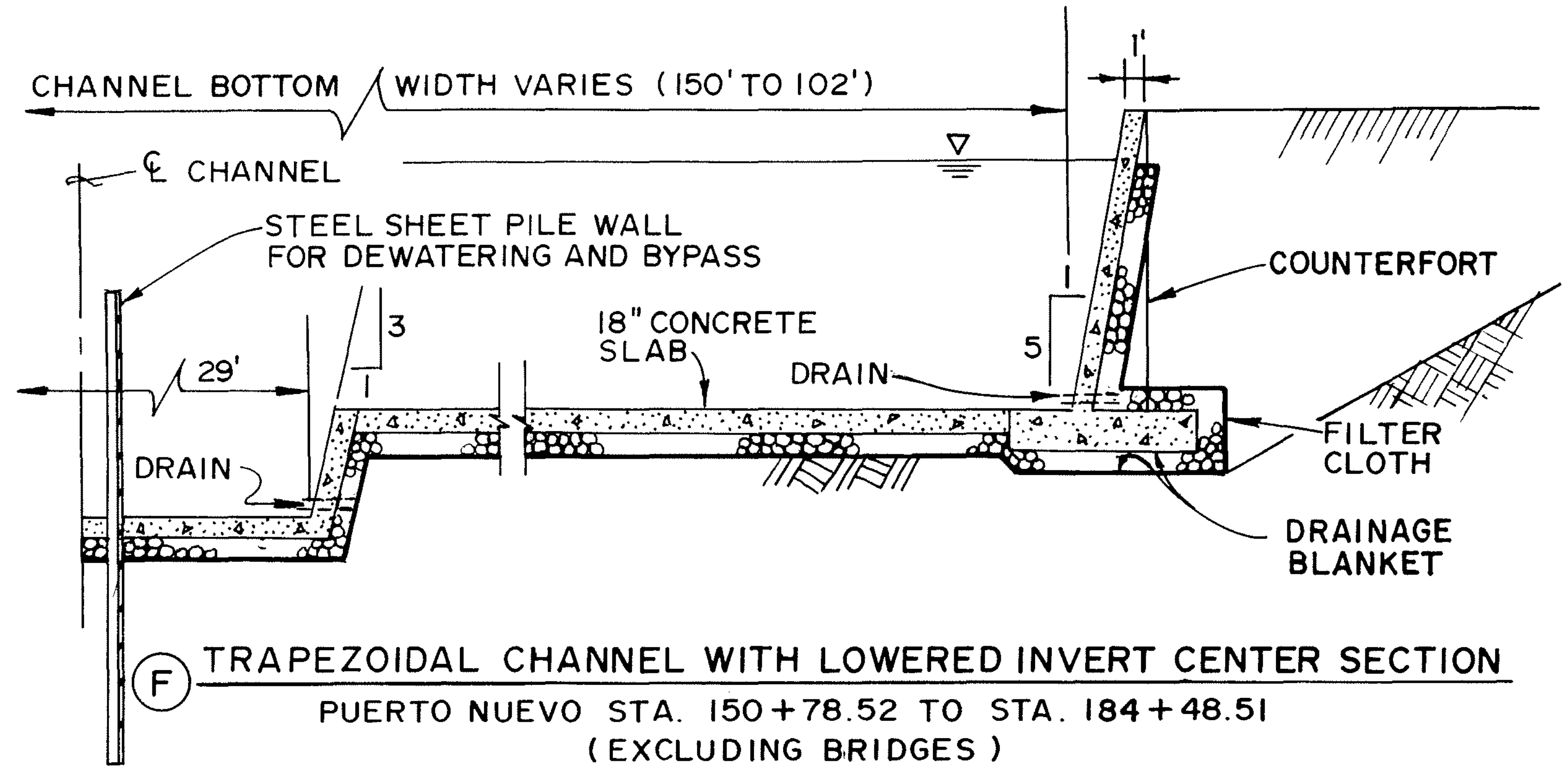
PUERTO NUEVO STA. 184+48.51 TO STA. 338+92.13

JOSEFINA STA. 0+00 TO 34+36.72




NG PLATFORM CHANNEL WALL

VO STA. 88+33.2 TO STA. 147+40

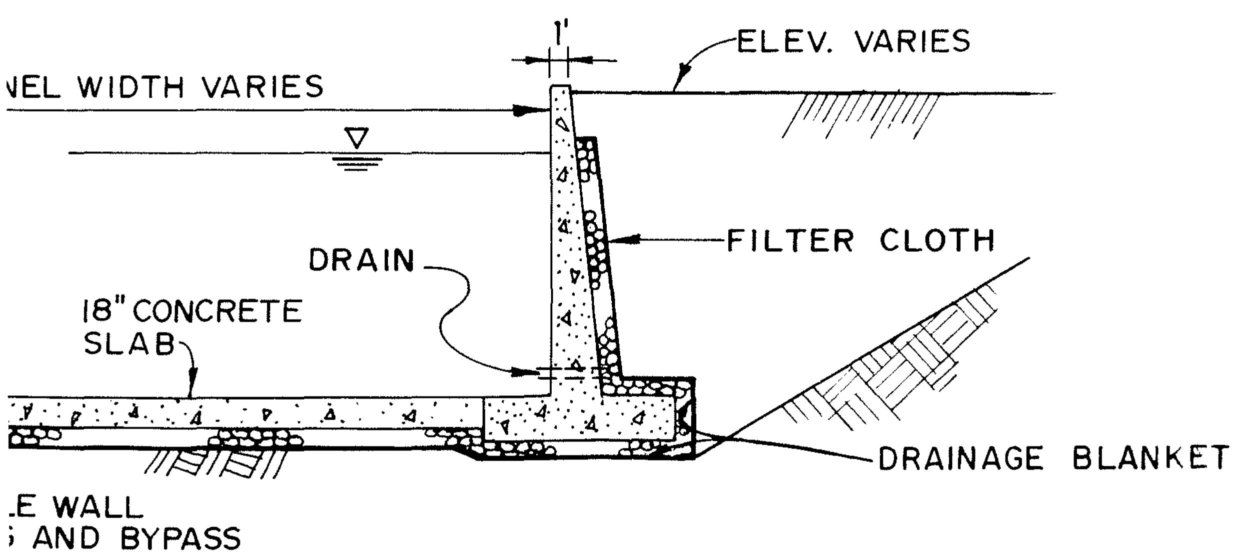



(F) TRAPEZOIDAL CHANNEL WITH LOWERED INVERT CENTER SECTION

PUERTO NUEVO STA. 150+78.52 TO STA. 184+48.51
(EXCLUDING BRIDGES)

NOTE:

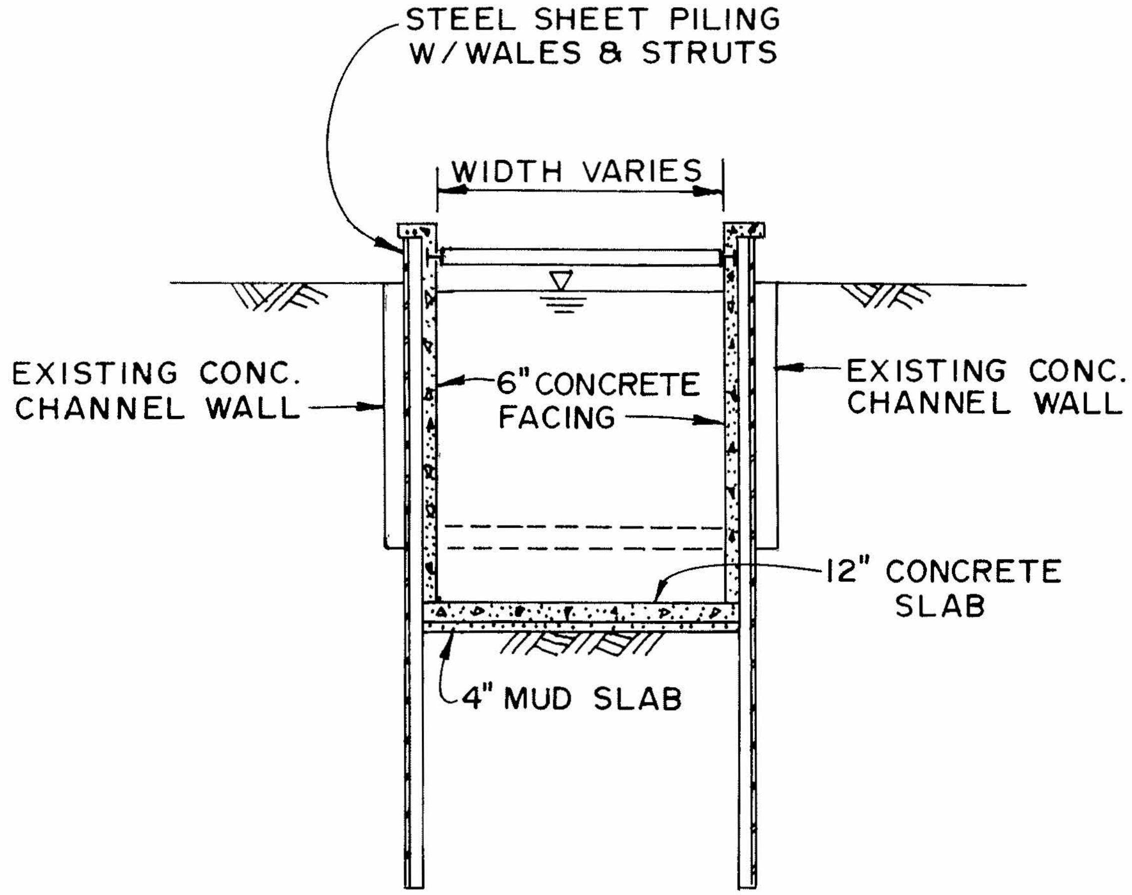
FOUNDATION IMPROVEMENTS MAY BE REQUIRED FOR PORTIONS OF PROPOSED CHANNEL SECTION (E) AND (F). REFER TO TEXT SECTION "GEOLOGY AND SOILS".

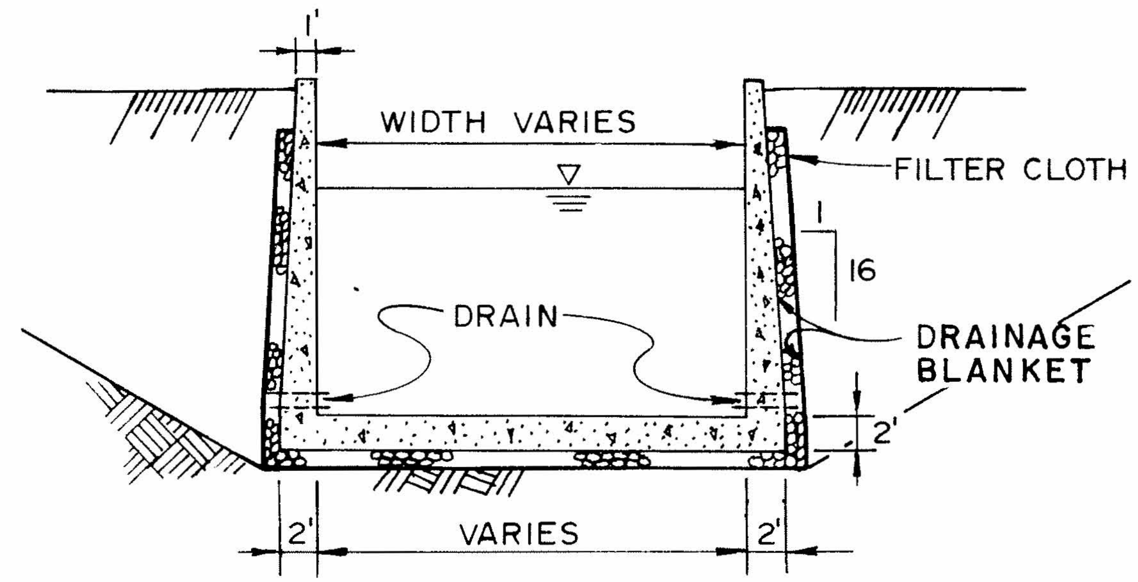



TEE CHANNEL WALL

TA. 147+40 TO STA. 150+78.52
A. 184+48.51 TO STA. 338+92.13
TA. 0+00 TO 34+36.72

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL & TRIBUTARIES
RECOMMENDED PLAN OF IMPROVEMENTS
PROPOSED CHANNEL SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,678 DECEMBER 1990




NOTE:

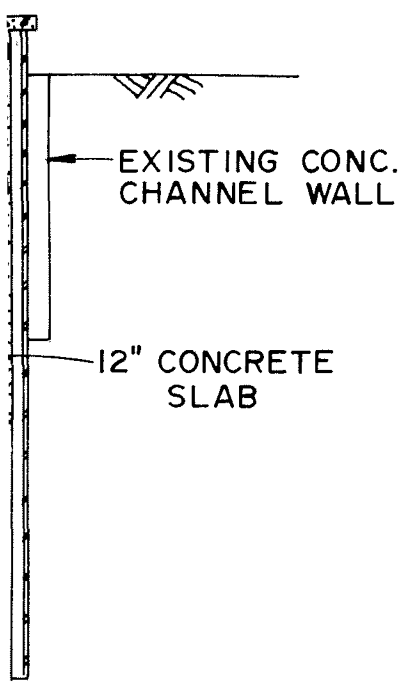
FOUNDATION

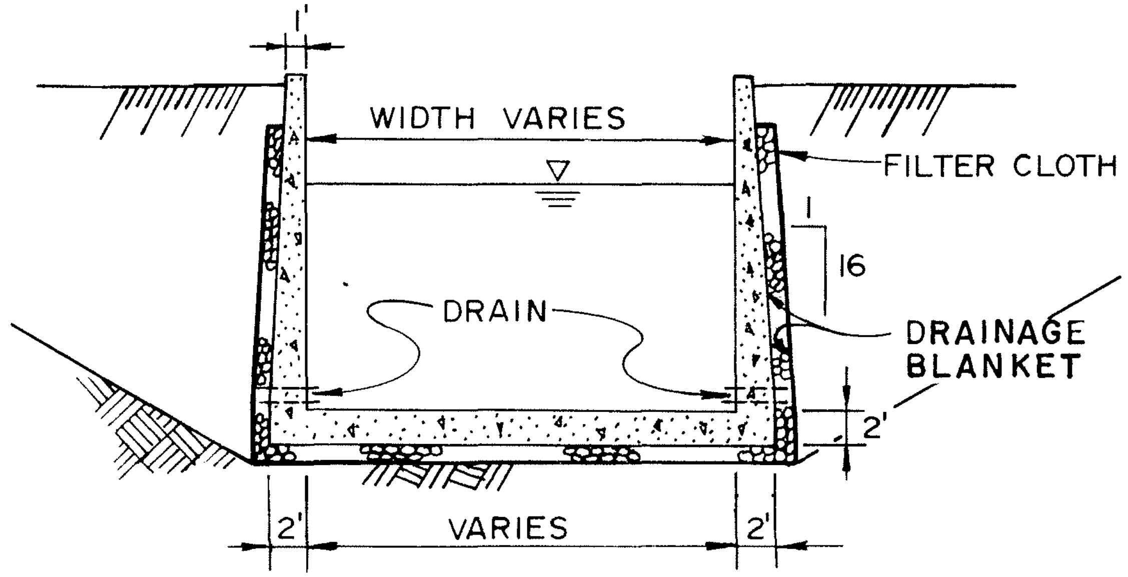
FOR PORTIC

REFER TO

| (H) SHEET PILE WALL CHANNEL | WIDTH | (G) CONCRETE U-FRAME CHANNEL | WIDTH | CHANNEL |
|---|---|---|---|---|
| STA. 36+78.52— 77+28.84 | VARIES 17'—22' | STA. 34+36.72—36+78.52 | 22' | JOSEFINA |
| STA. 5+30.83— 32+80 | 22' | STA. 0+00— 5+30.83 | 22' | DONA ANA |
| | | STA. 0+00— 8+19 | 26' | GUARA CANAL |
| | | STA. 0+00— 4+50 | 16' | BUENA VISTA |
| | | STA. 4+50— 42+37.79 | VARIES 16'-36' | |
| | | STA. 54+10— 89+60 | 30' | MARGARITA |

NG
TS



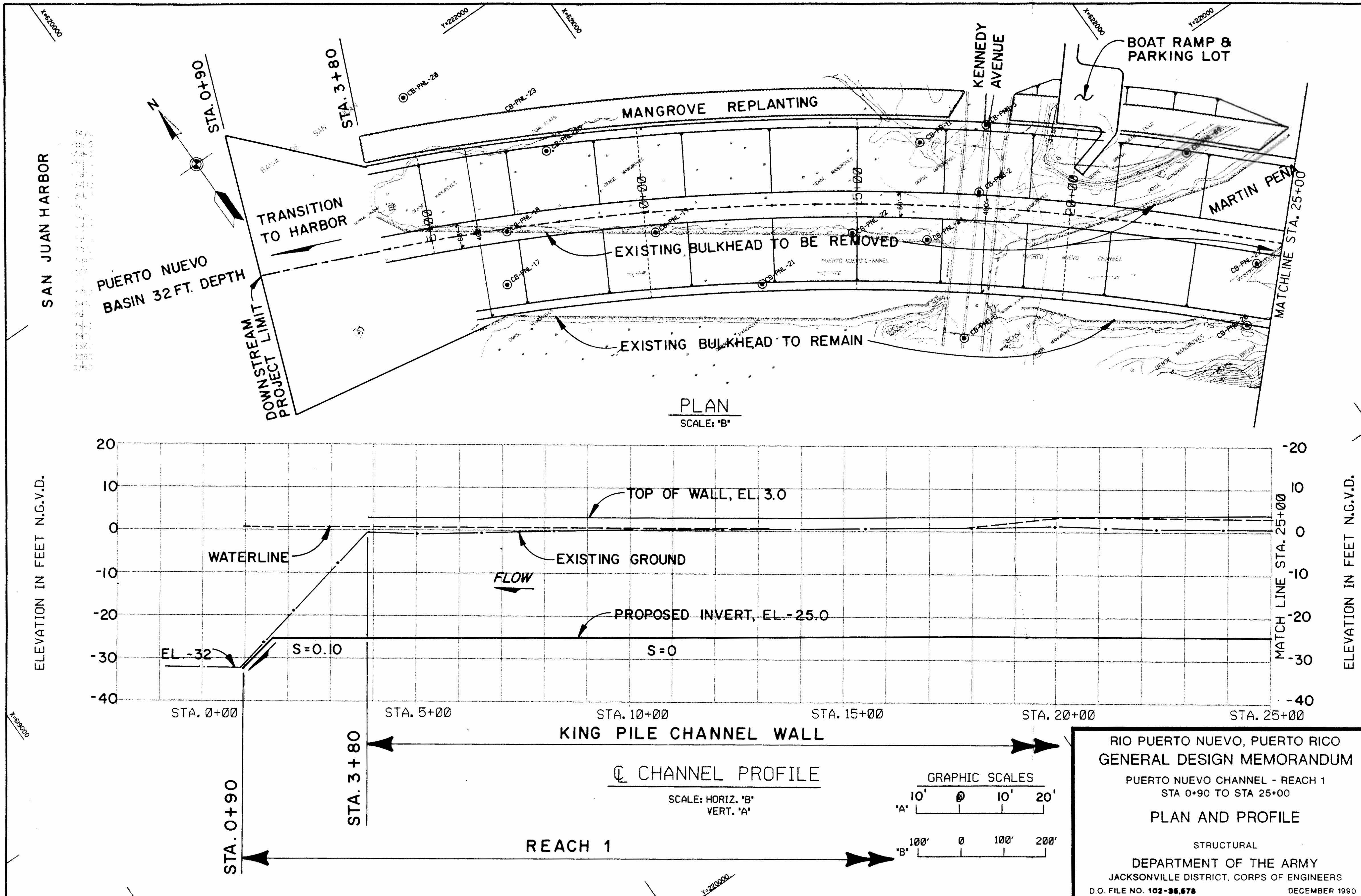




NOTE:

FOUNDATION IMPROVEMENTS MAY BE REQUIRED FOR PORTIONS OF PROPOSED CHANNEL SECTION (G). REFER TO TEXT SECTION "GEOLOGY AND SOILS".

| L | WIDTH | (G) CONCRETE U-FRAME CHANNEL | WIDTH | CHANNEL |
|---|---|---|---|---|
| | VARIES 17'—22' | STA. 34+36.72—36+78.52 | 22' | JOSEFINA |
| | 22' | STA. 0+00 — 5+30.83 | 22' | DONA ANA |
| | | STA. 0+00 — 8+19 | 26' | GUARA CANAL |
| | | STA. 0+00 — 4+50 | 16' | BUENA VISTA |
| | | STA. 4+50 — 42+37.79 | VARIES 16'—36' | |
| | | STA. 54+10 — 89+60 | 30' | MARGARITA |

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL & TRIBUTARIES
RECOMMENDED PLAN OF IMPROVEMENTS
PROPOSED CHANNEL SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 1
STA 0+90 TO STA 25+00

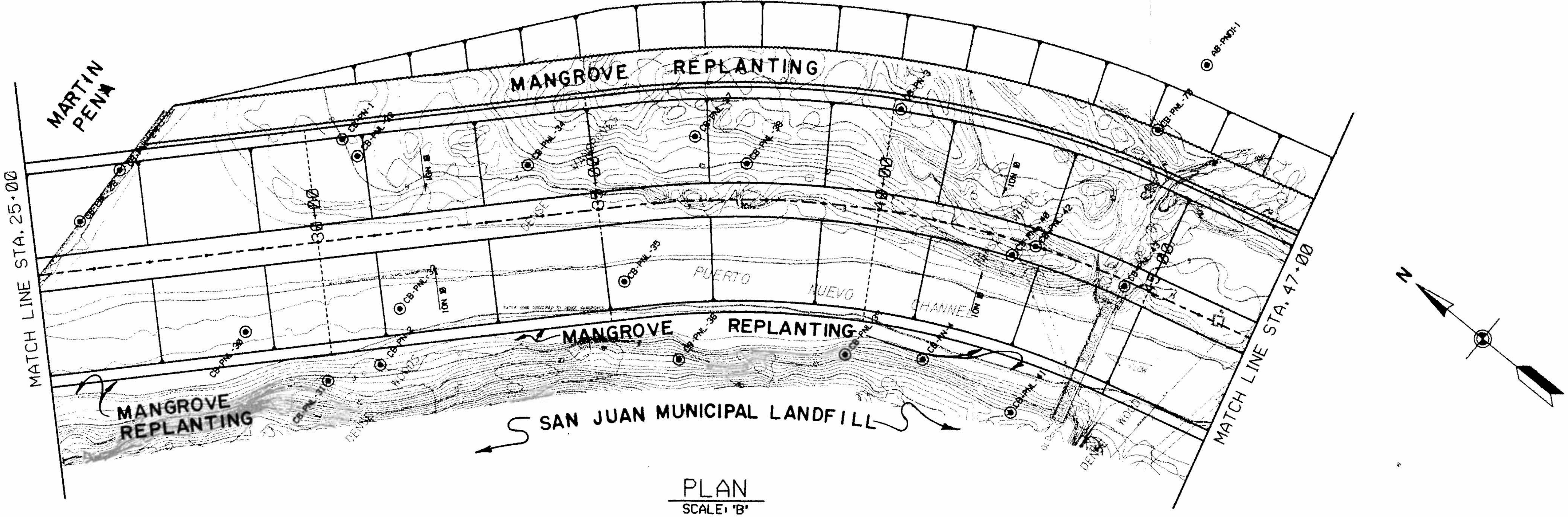
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

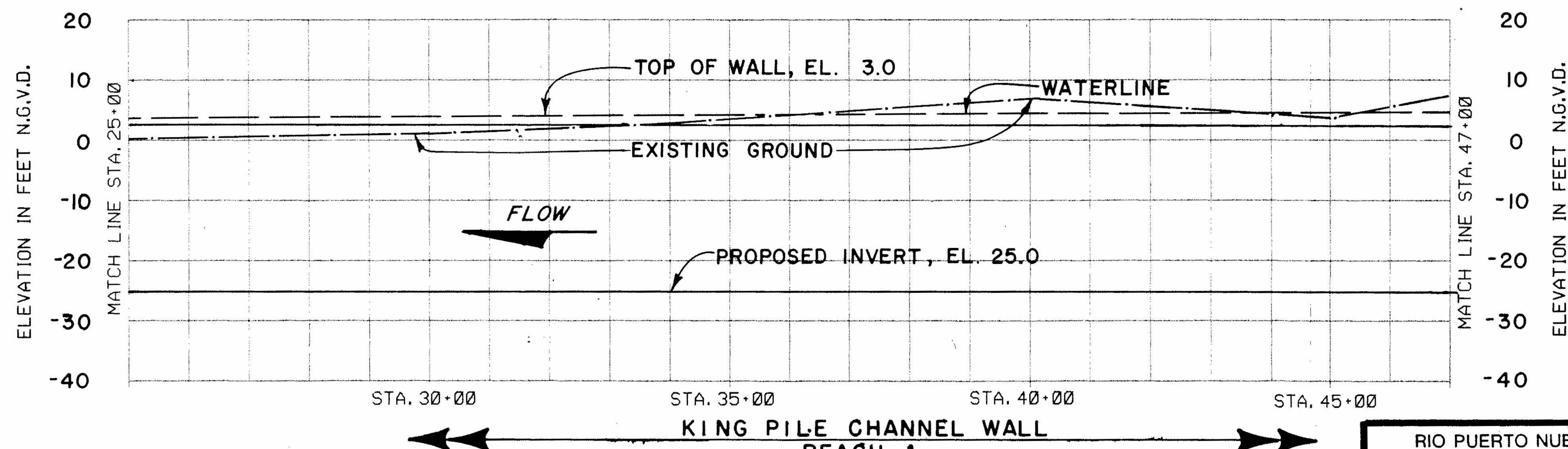
D.O. FILE NO. 102-36,678 DECEMBER 1990

PLATE S-22




## PLAN

SCALE: 'B'




## ℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

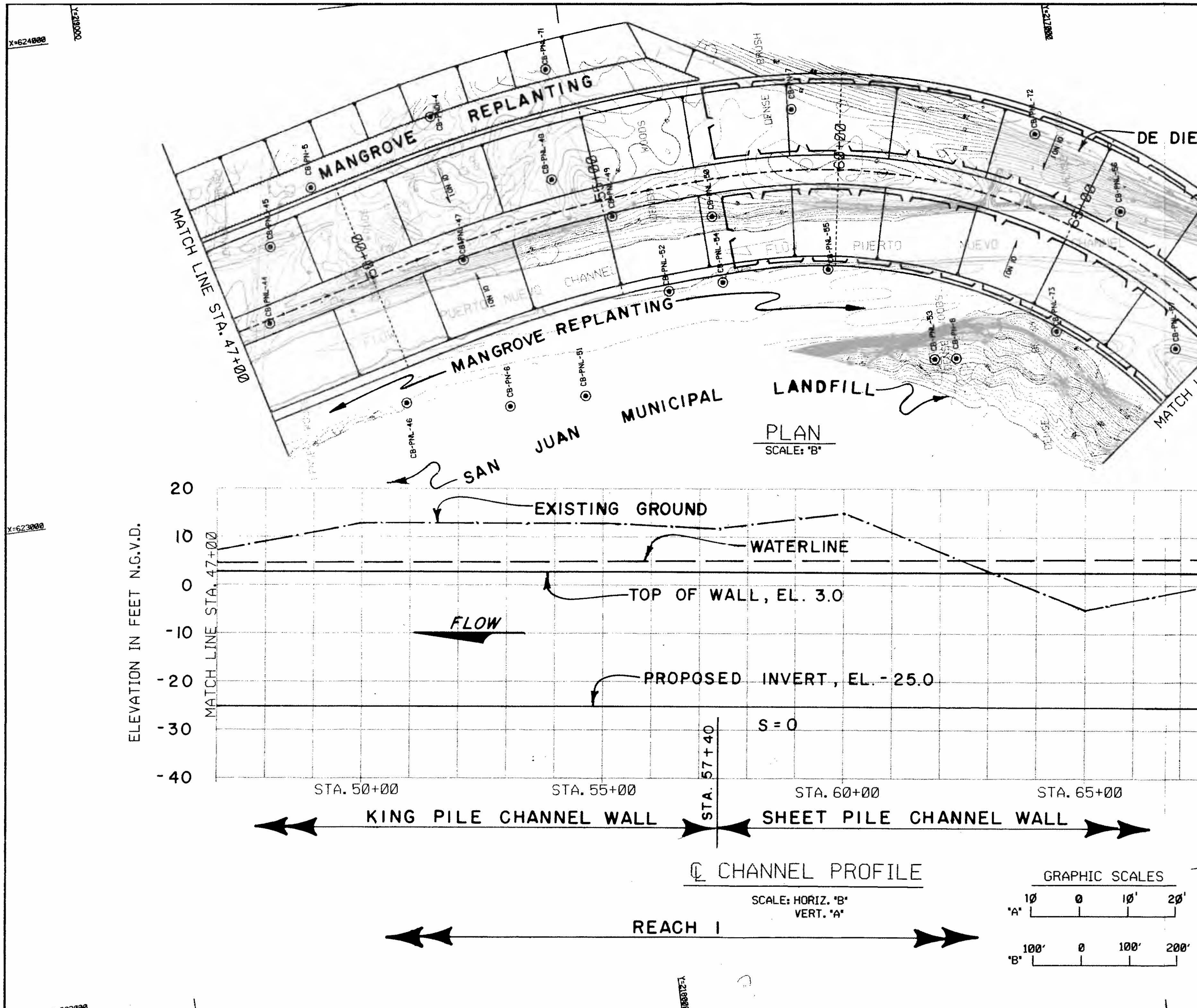
PUERTO NUEVO CHANNEL - REACH 1
STA 25+00 TO STA 47+00

PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-26,678 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 1
STA 47+00 TO STA 69+00

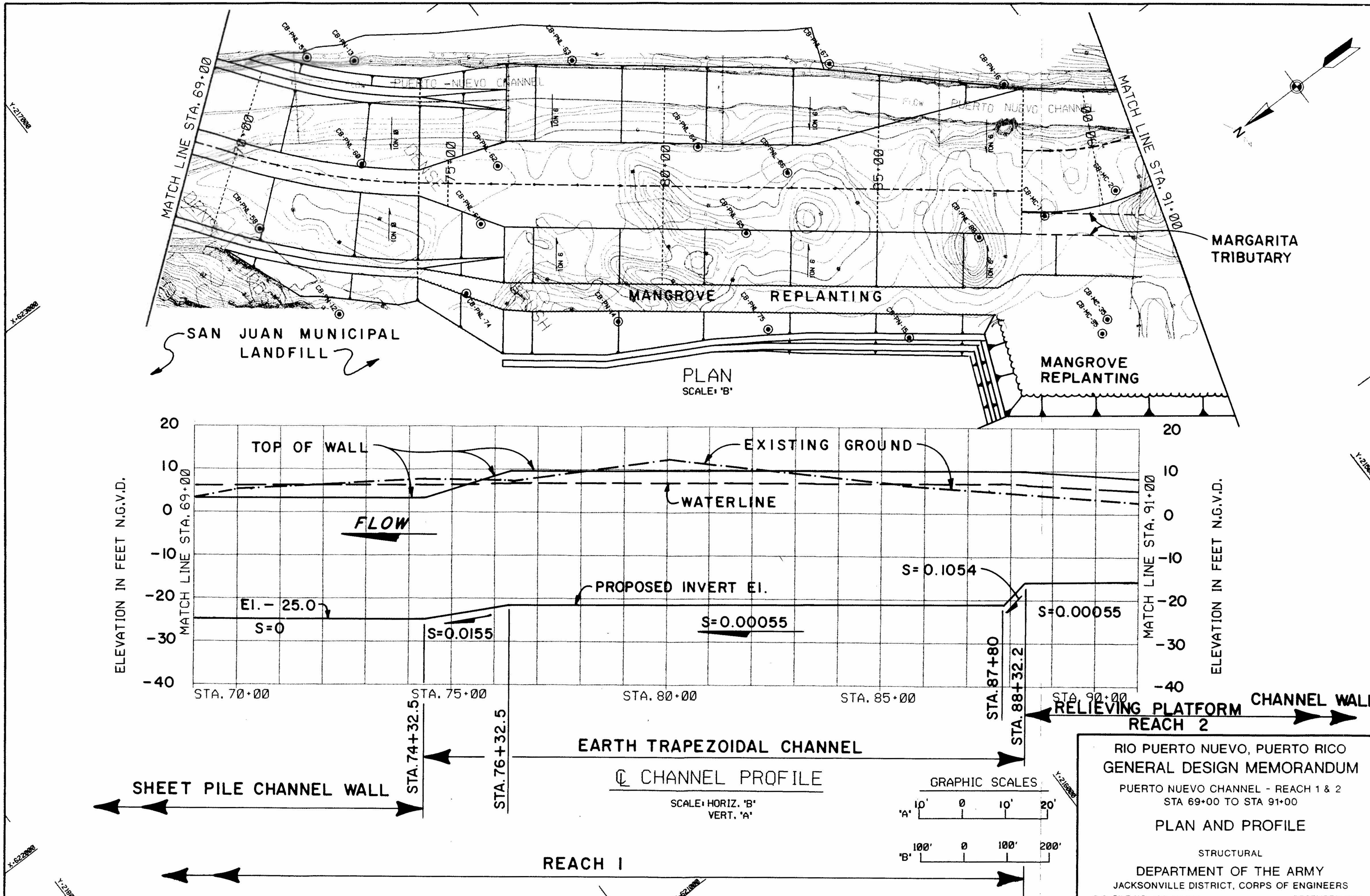
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-24




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 1 & 2

STA 69+00 TO STA 91+00

PLAN AND PROFILE

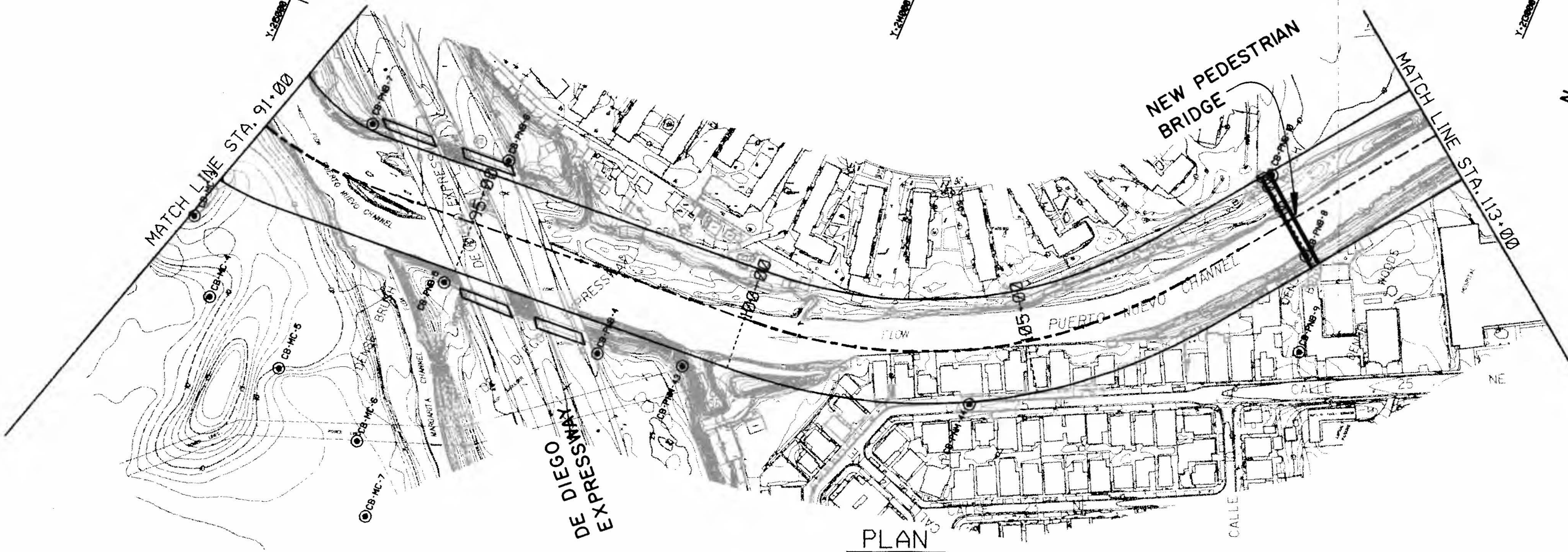
STRUCTURAL

DEPARTMENT OF THE ARMY

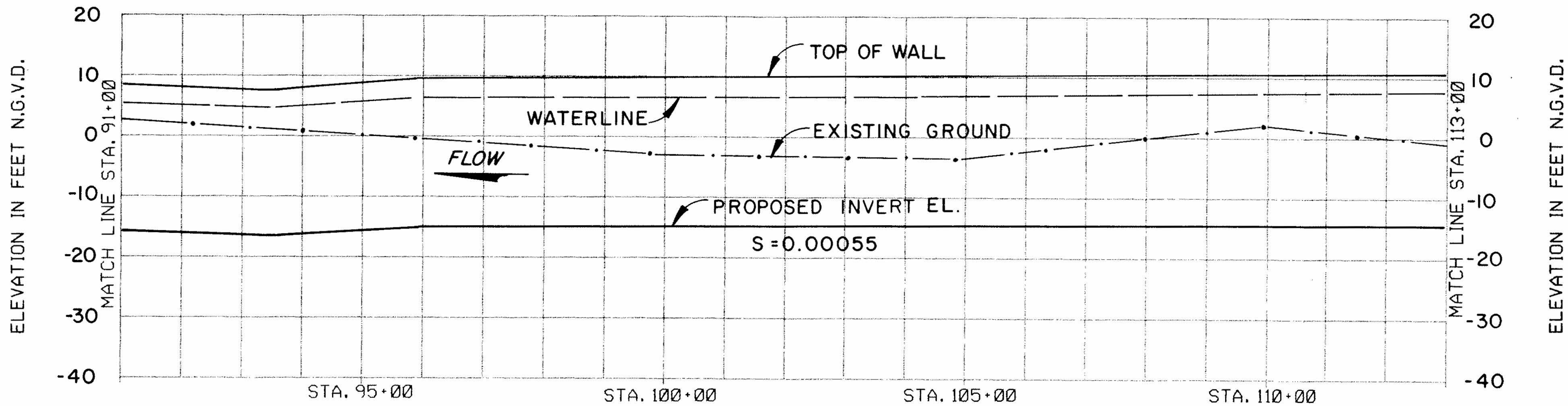
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-25




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

RELIEVING PLATFORM CHANNEL WALL

REACH 2

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 2
STA 91+00 TO STA 113+00

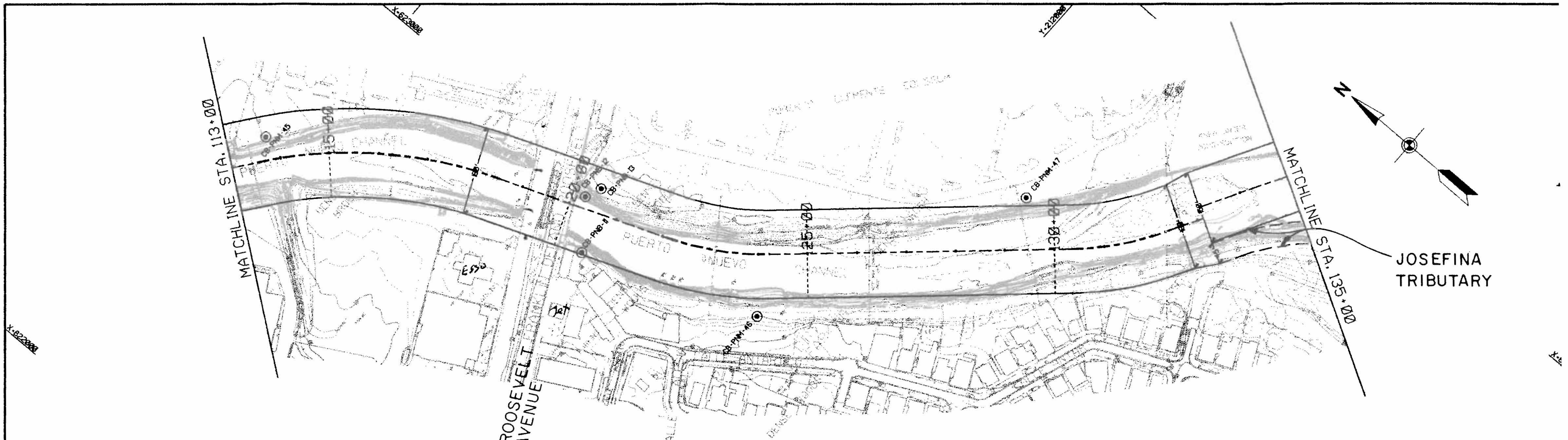
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

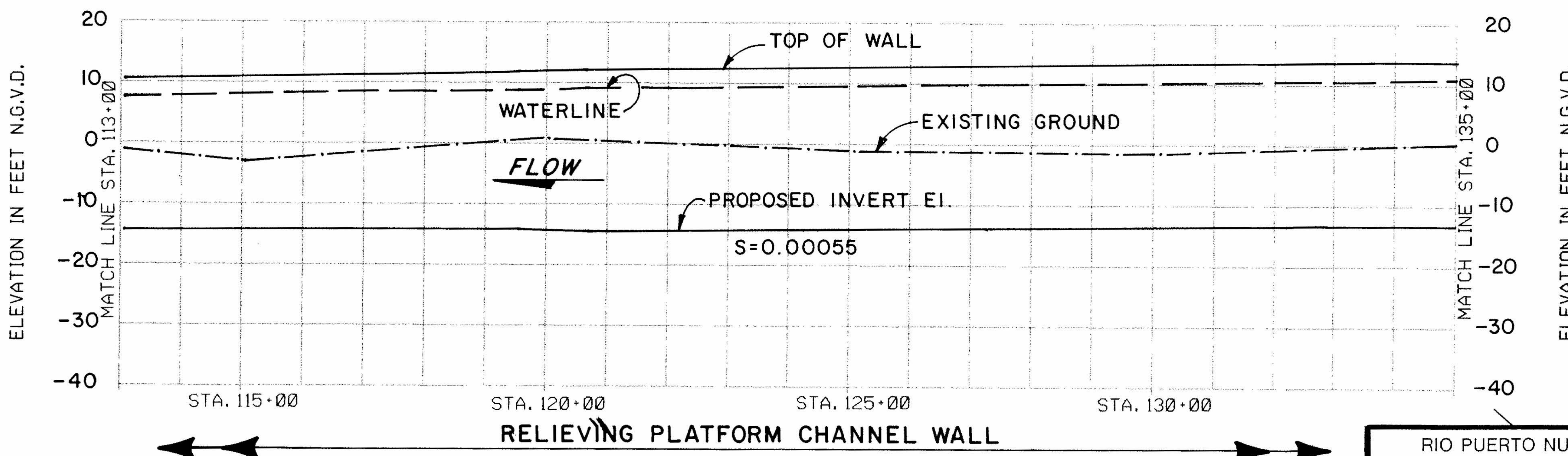
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-26




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

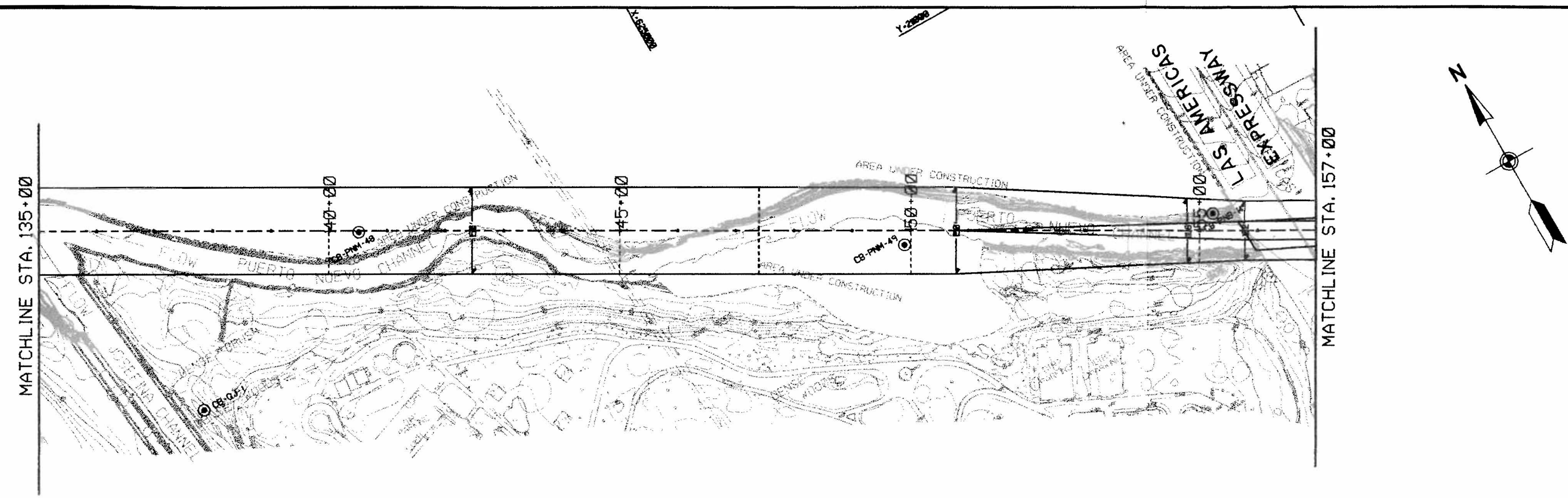
PUERTO NUEVO CHANNEL - REACH 2
STA 113+00 TO STA 135+00

PLAN AND PROFILE

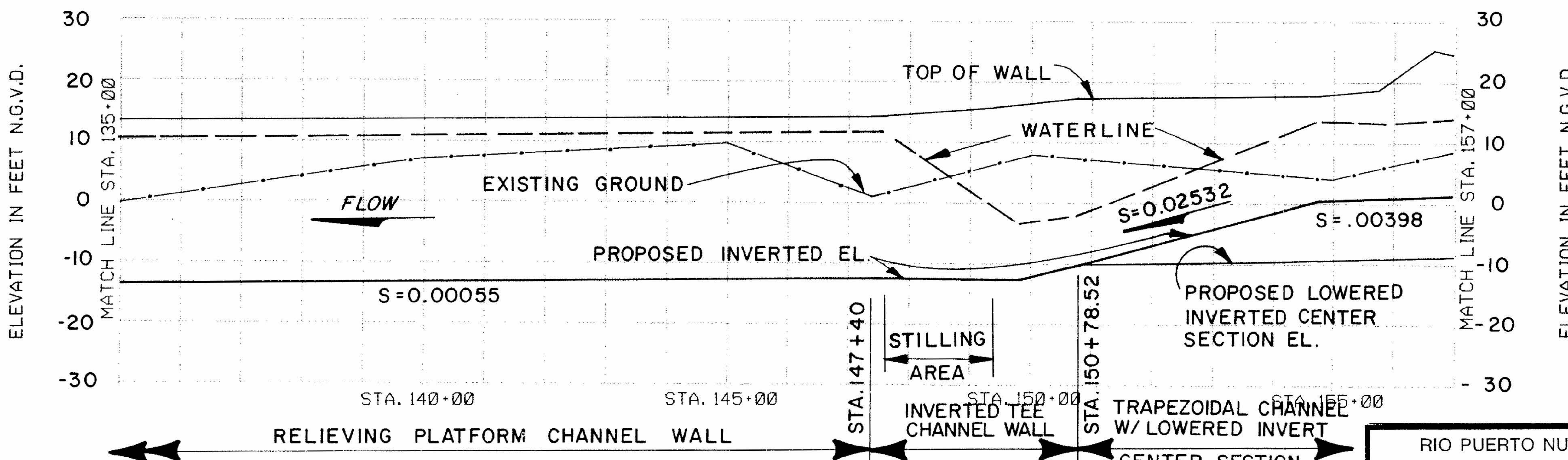
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

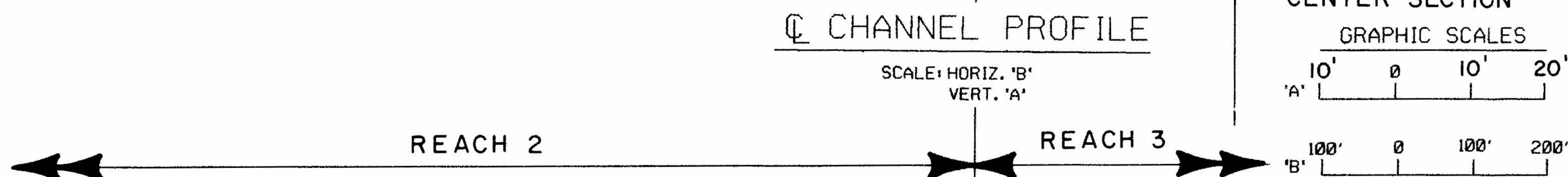
D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE
SCALE: HORIZ. 'B'
VERT. 'A'




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

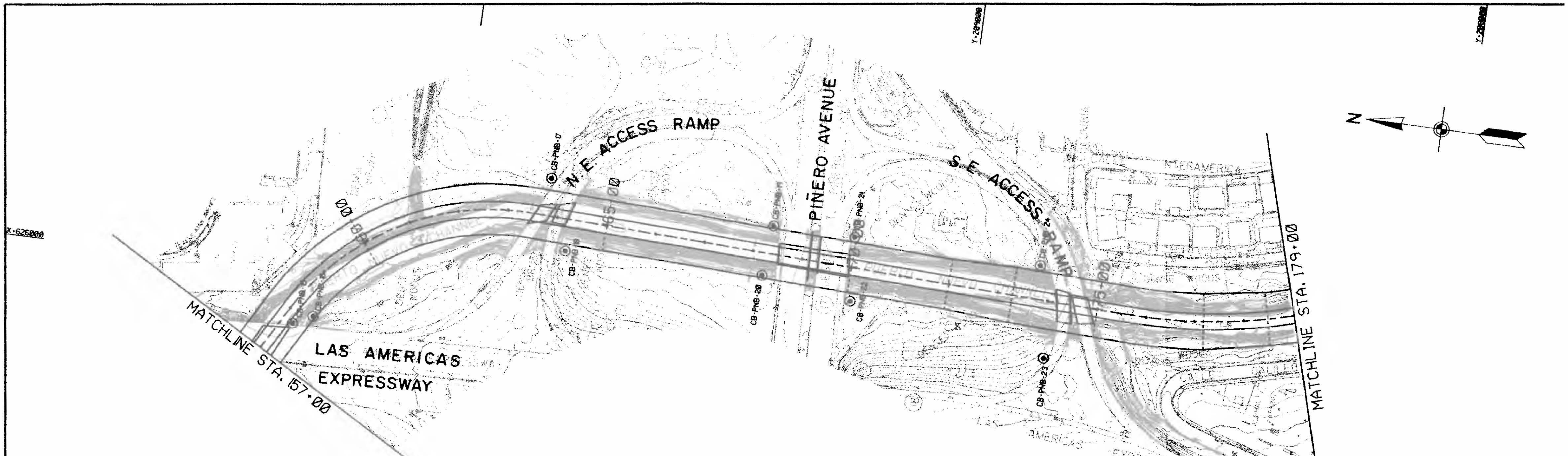
PUERTO NUEVO CHANNEL - REACH 2 & 3
STA 135+00 TO STA 157+00

PLAN AND PROFILE

STRUCTURAL

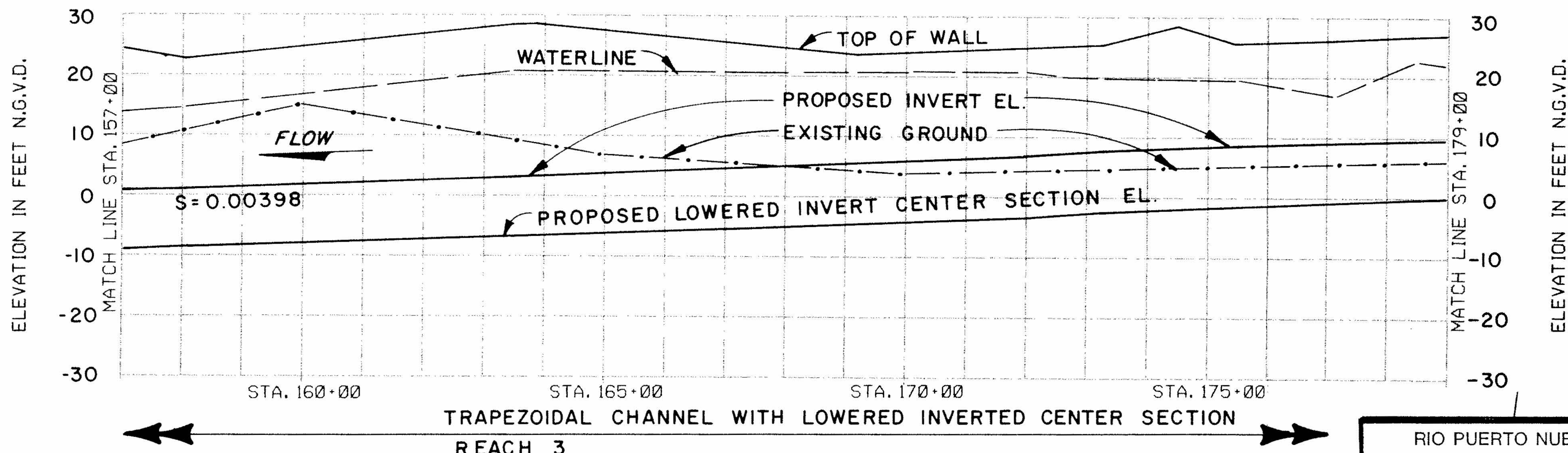
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35.578 DECEMBER 1990

PLATE S-




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

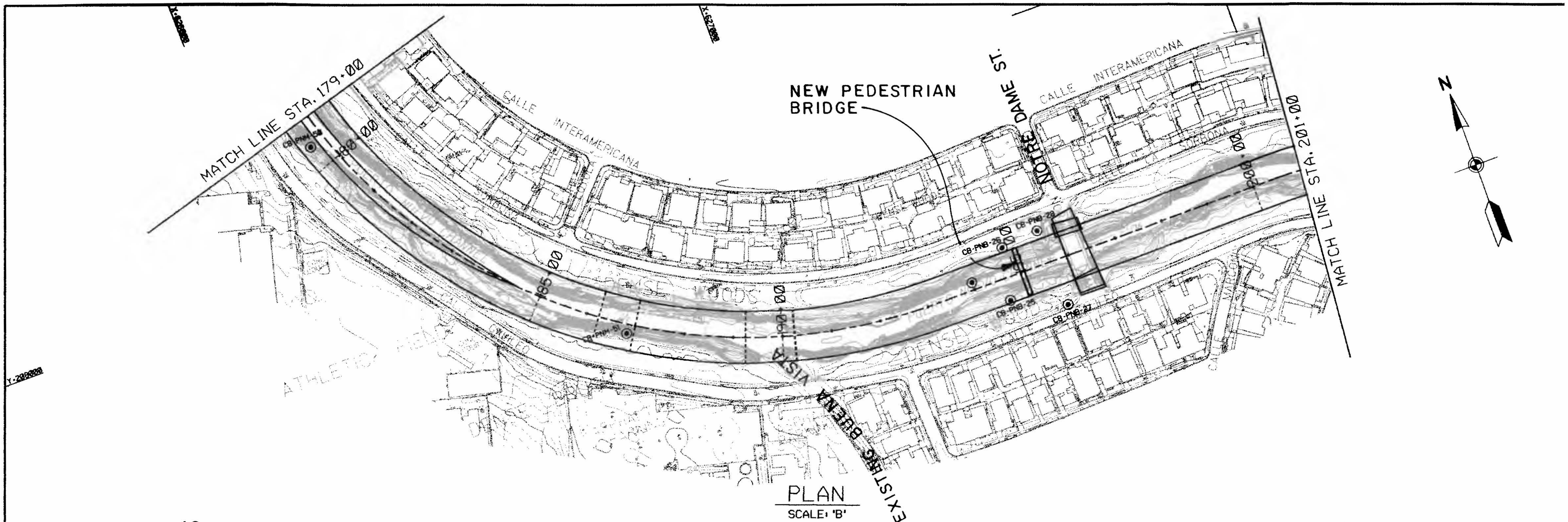
PUERTO NUEVO CHANNEL - REACH 3
STA 157+00 TO STA 179+00

PLAN AND PROFILE

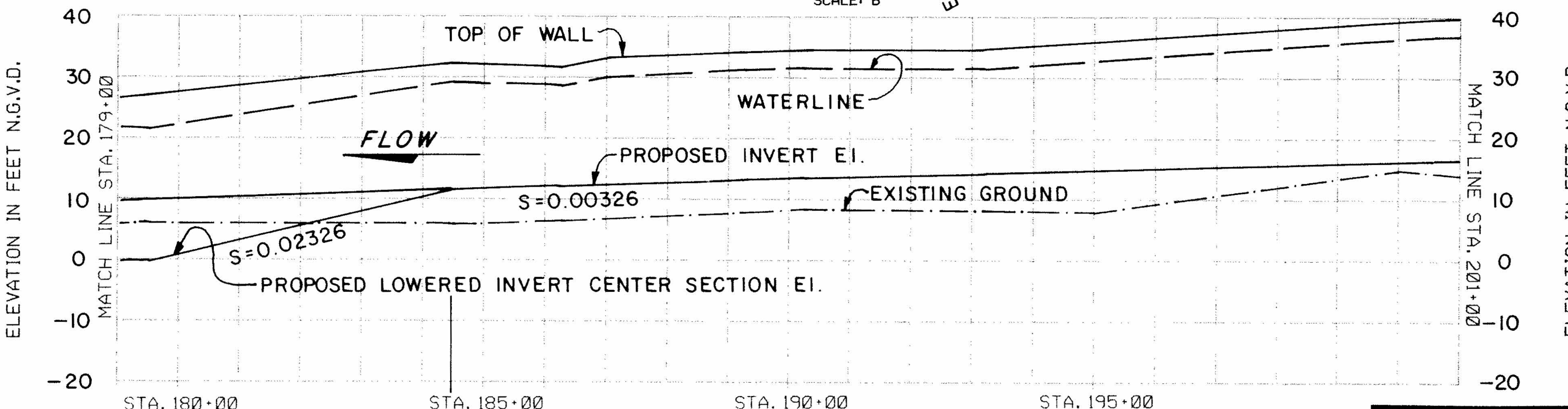
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199




PLAN
SCALE: 'B'




STA. 184+48.51

TRAPEZOIDAL CHANNEL WITH LOWERED INVERT CENTER SECTION

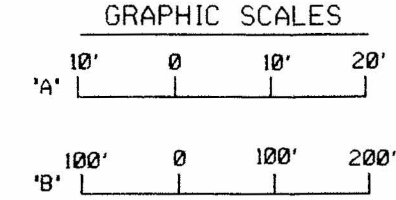
REACH 3

℄ CHANNEL PROFILE
SCALE: HORIZ. 'B'
VERT. 'A'

INVERTED TEE CHANNEL WALL

REACH 4

GRAPHIC SCALES



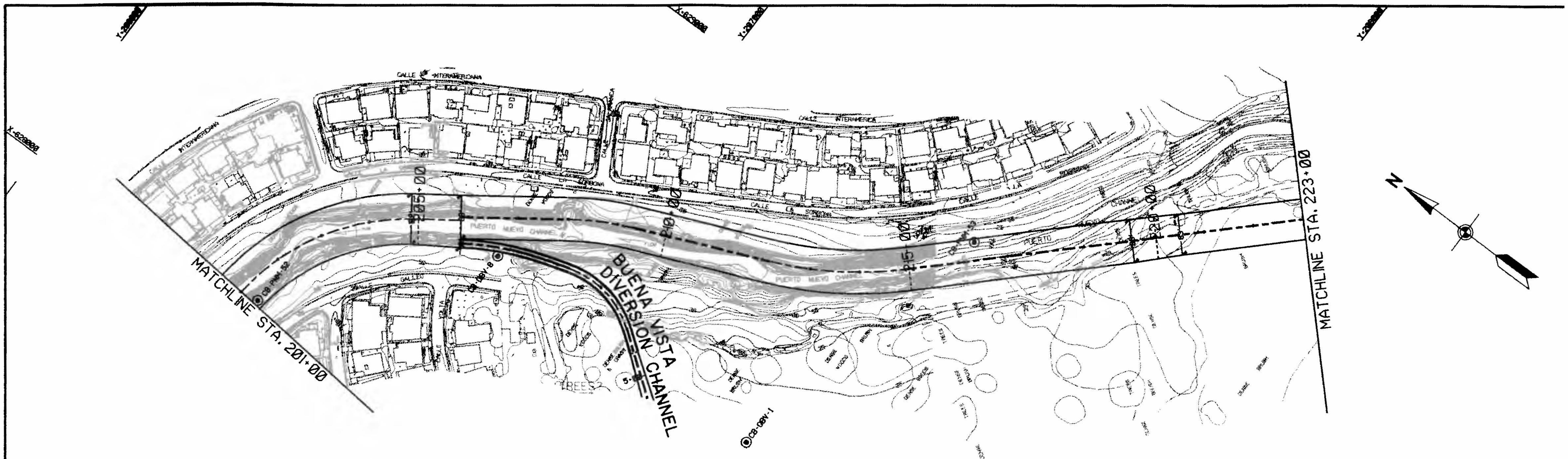

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 3
STA 179+00 TO STA 201+00

PLAN AND PROFILE

STRUCTURAL

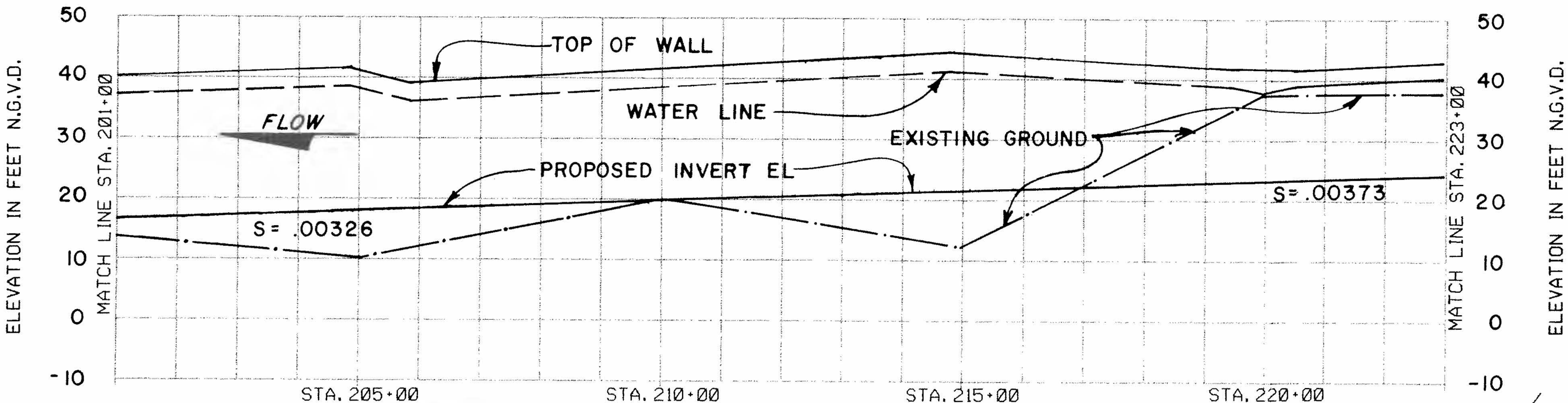
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN

SCALE: 'B'




INVERTED TEE CHANNEL WALL
REACH 4

℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

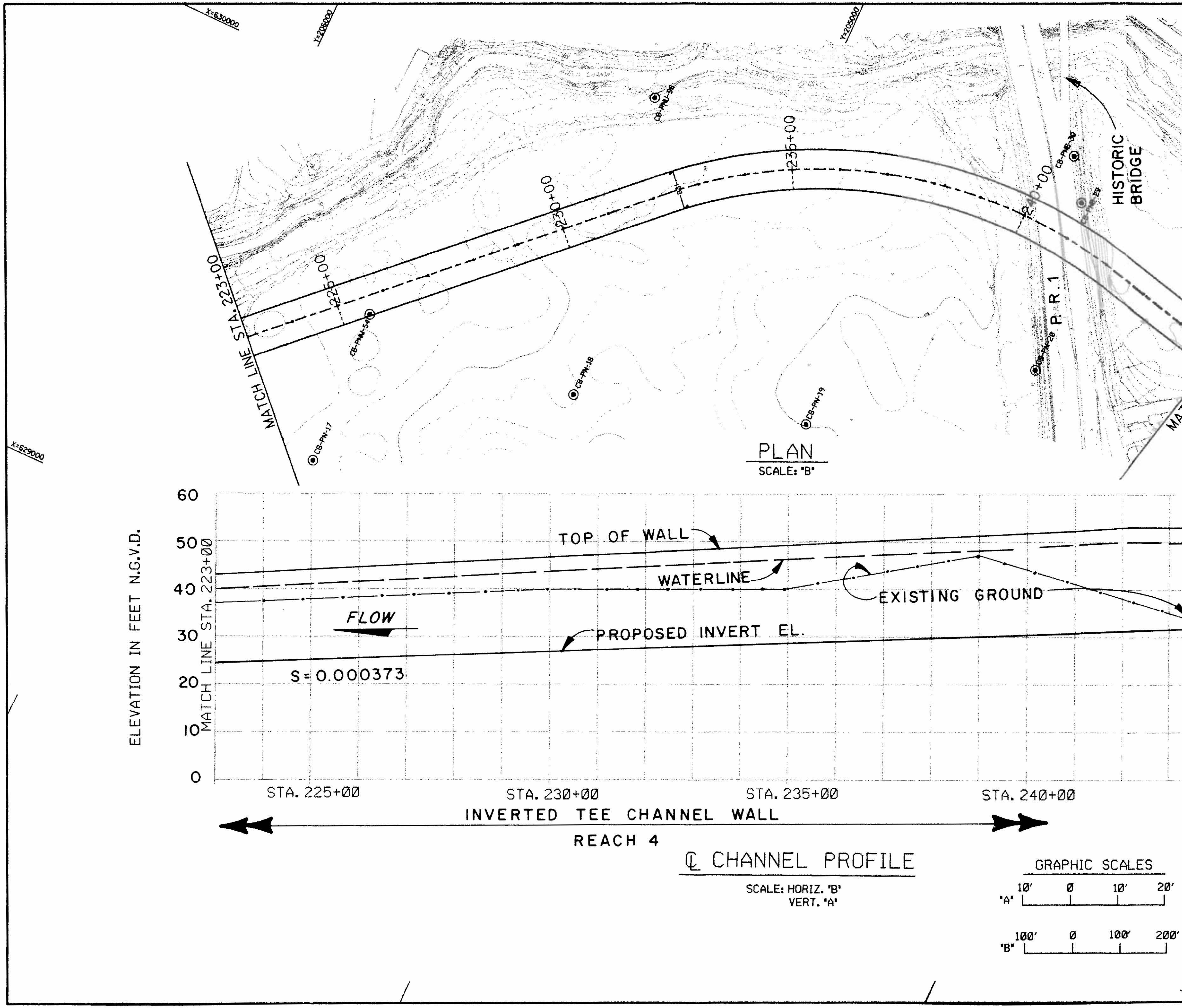
PUERTO NUEVO CHANNEL - REACH 4
STA 201+00 TO STA 223+00

PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

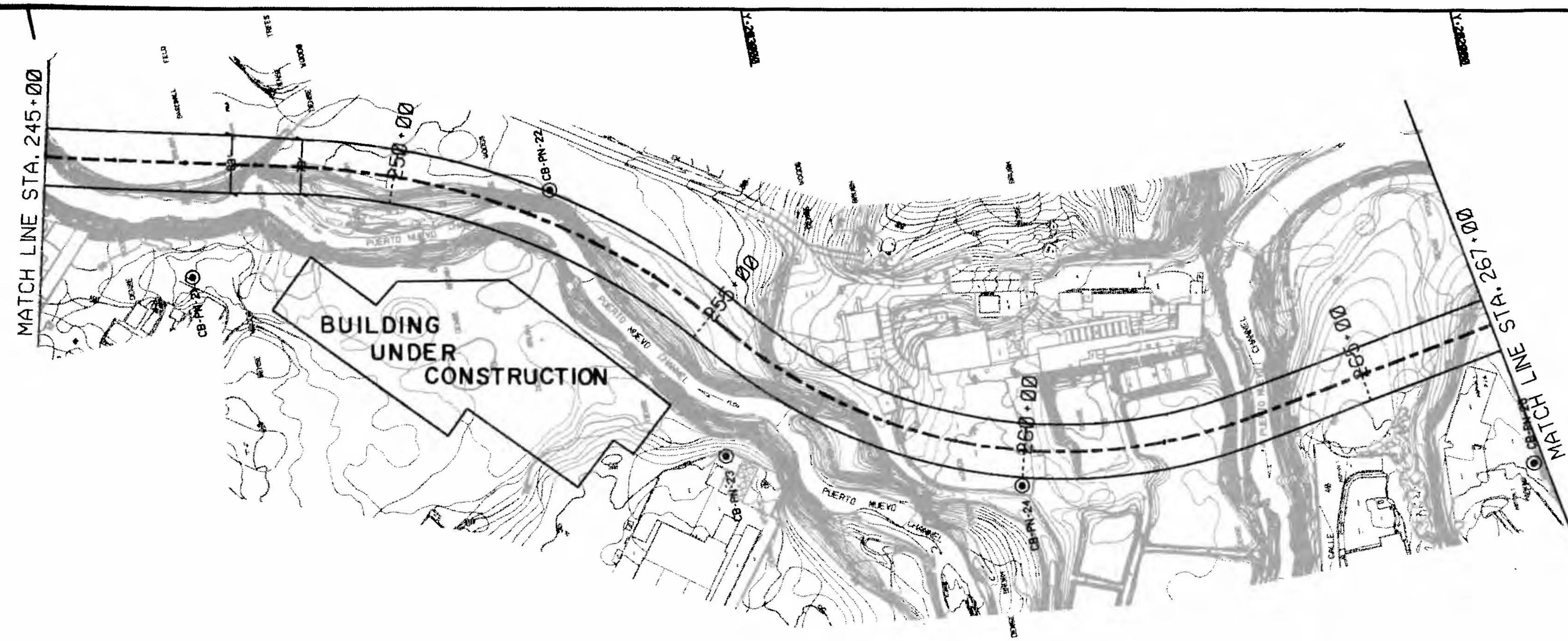
PUERTO NUEVO CHANNEL - REACH 4
STA 223+00 TO STA 245+00

PLAN AND PROFILE

STRUCTURAL

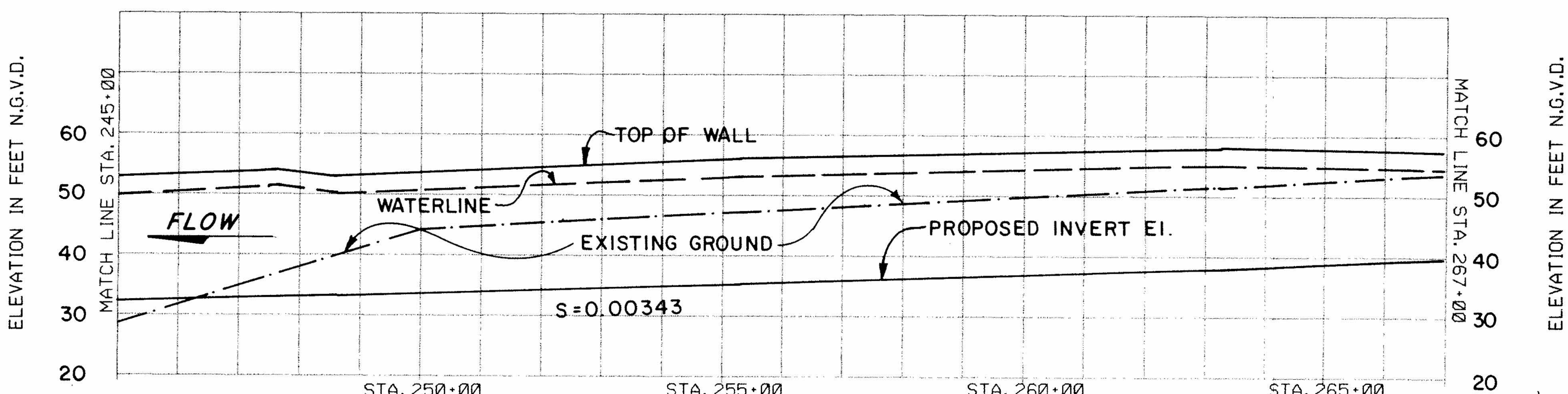
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN

SCALE: 'B'




INVERTED TEE CHANNEL WALL

REACH 4

℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 4
STA 245+00 TO STA 267+00

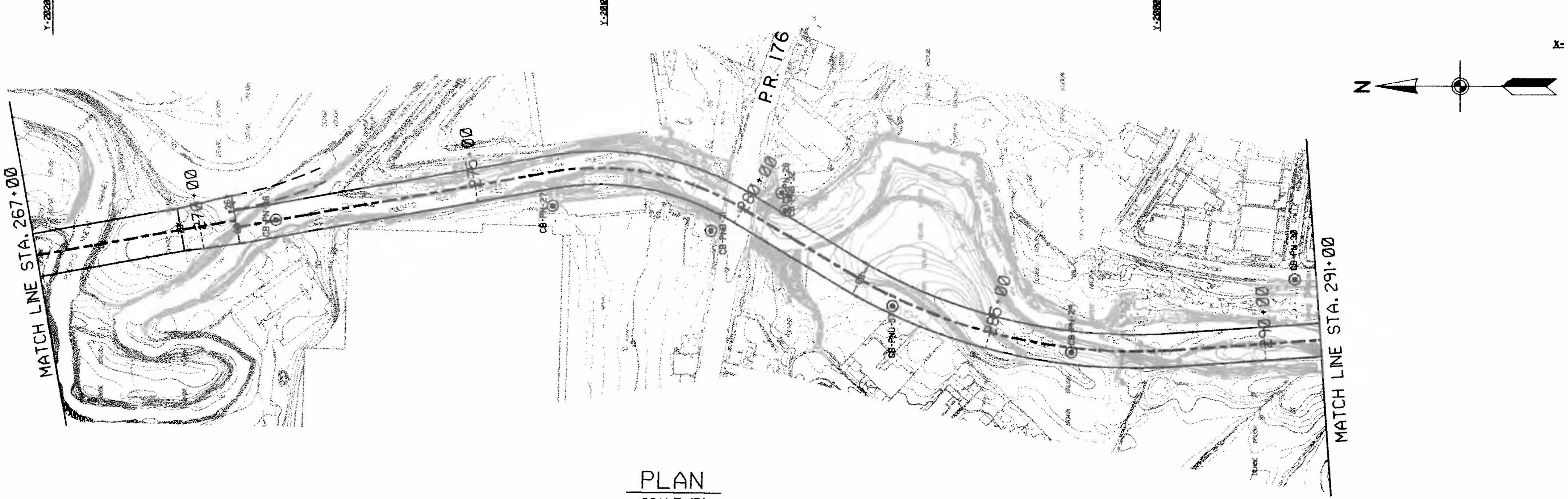
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY

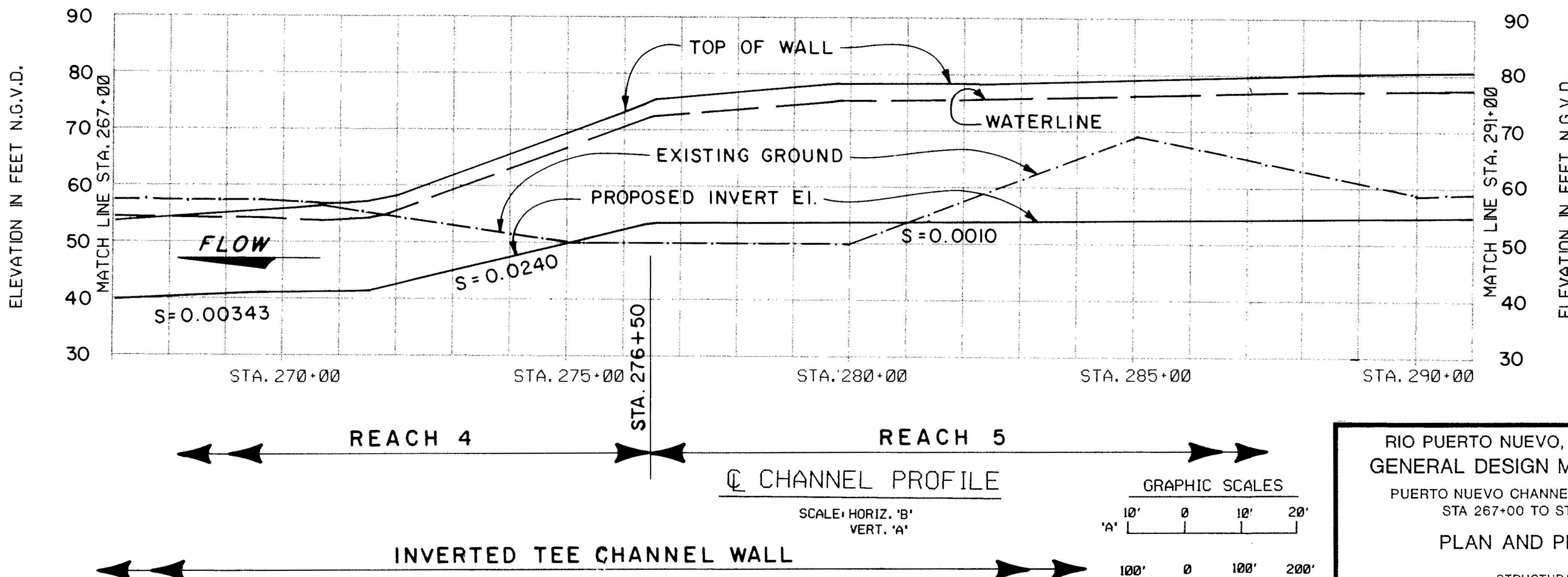
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 4 & 5
STA 267+00 TO STA 291+00

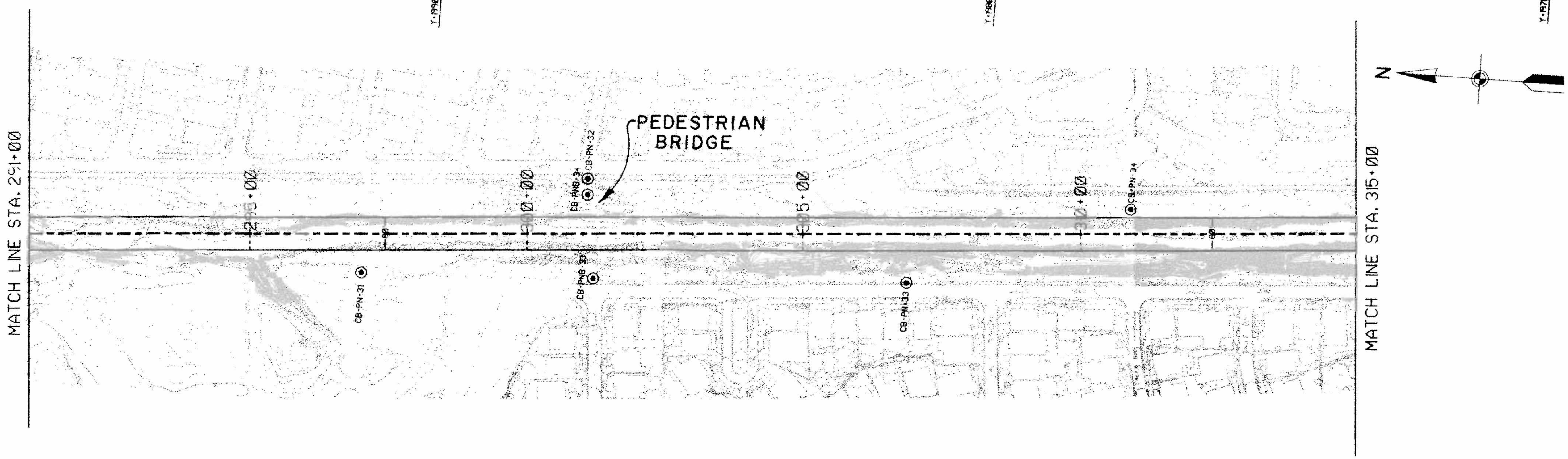
PLAN AND PROFILE

STRUCTURAL

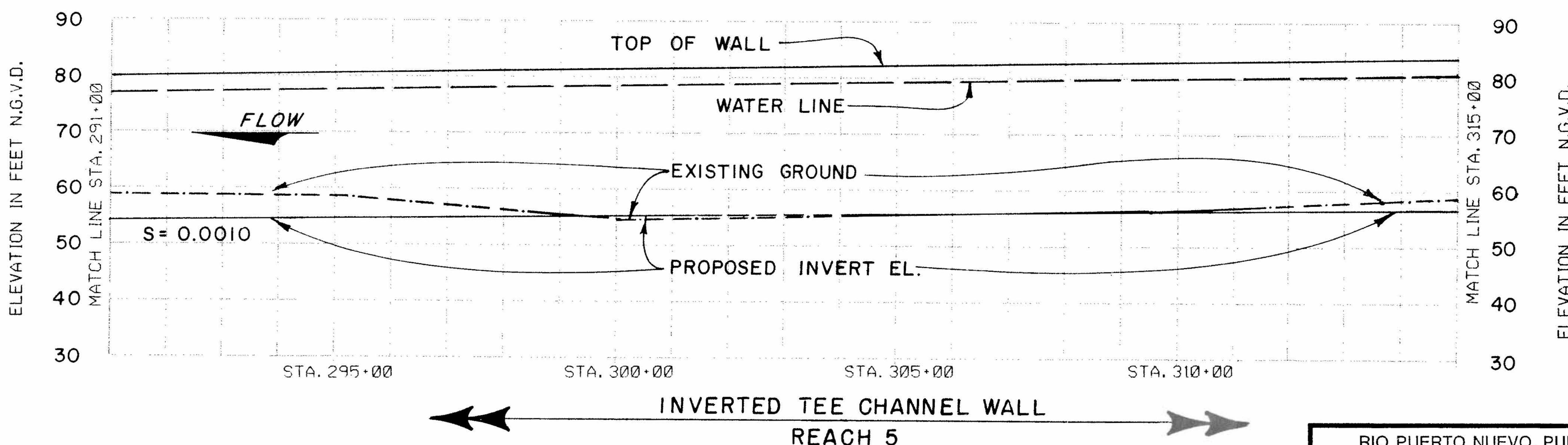
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

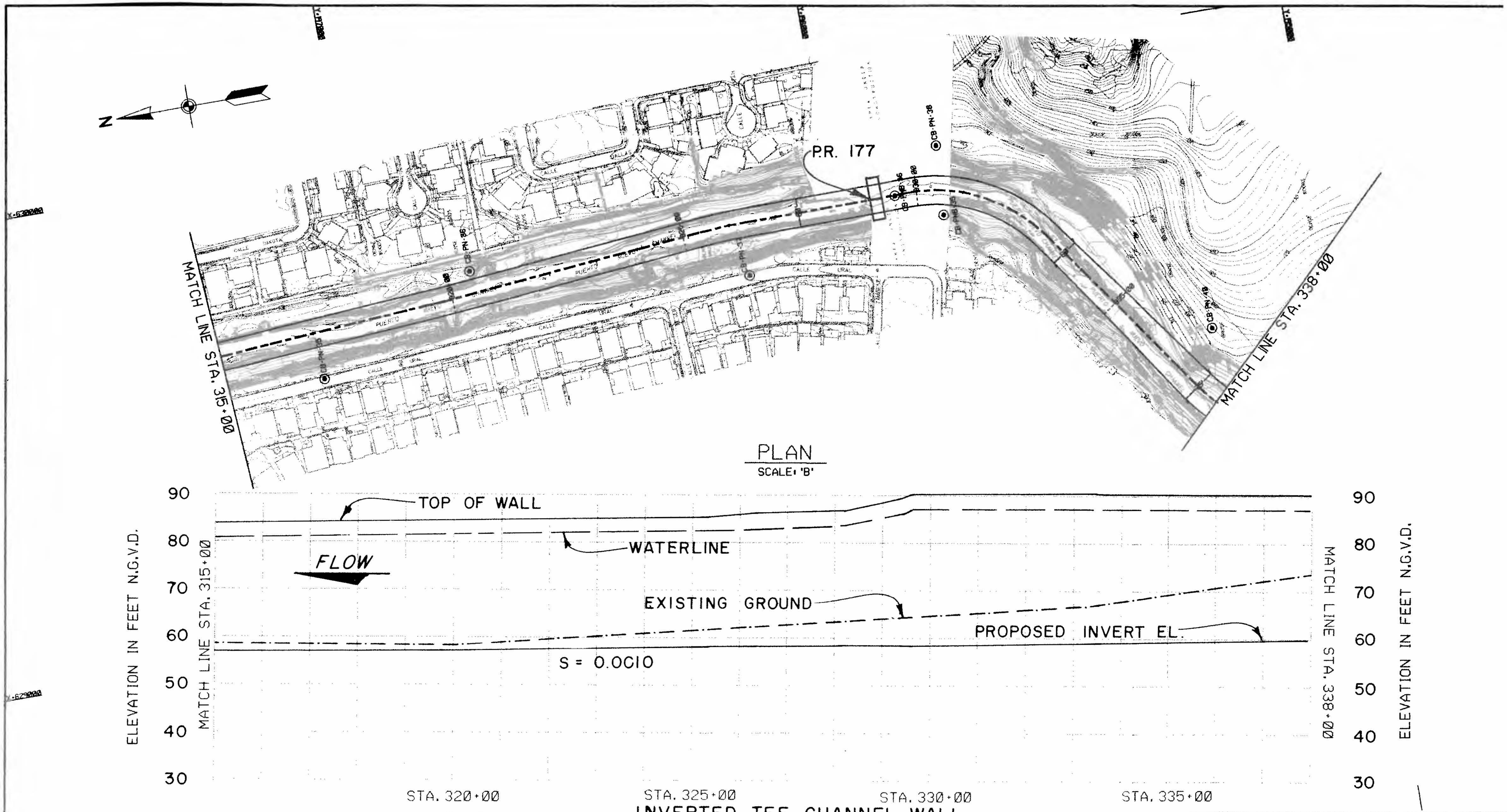
PUERTO NUEVO CHANNEL - REACH 5
STA 291+00 TO STA 315+00

PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 5

STA 315+00 TO STA 338+00

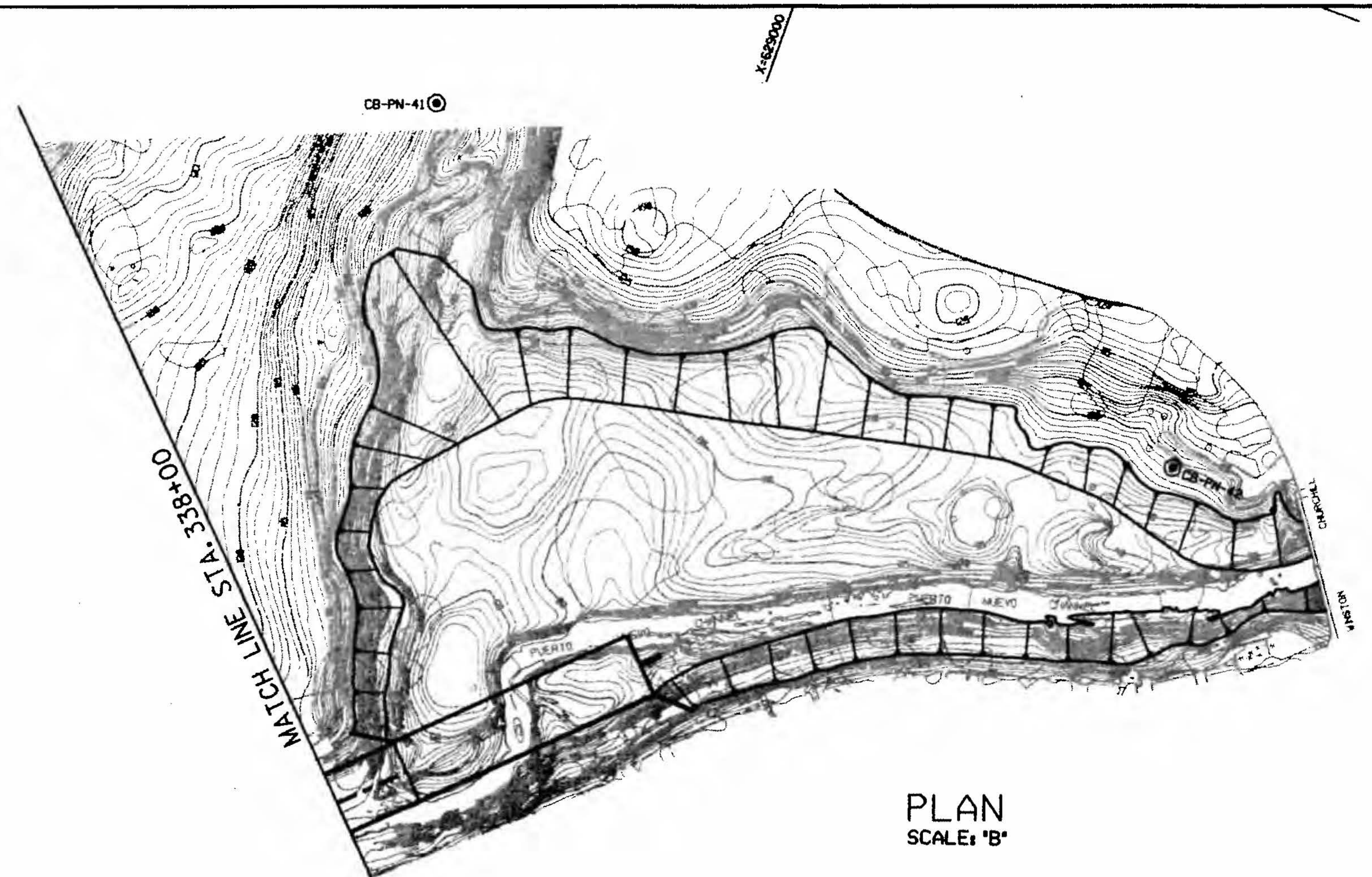
PLAN AND PROFILE

STRUCTURAL

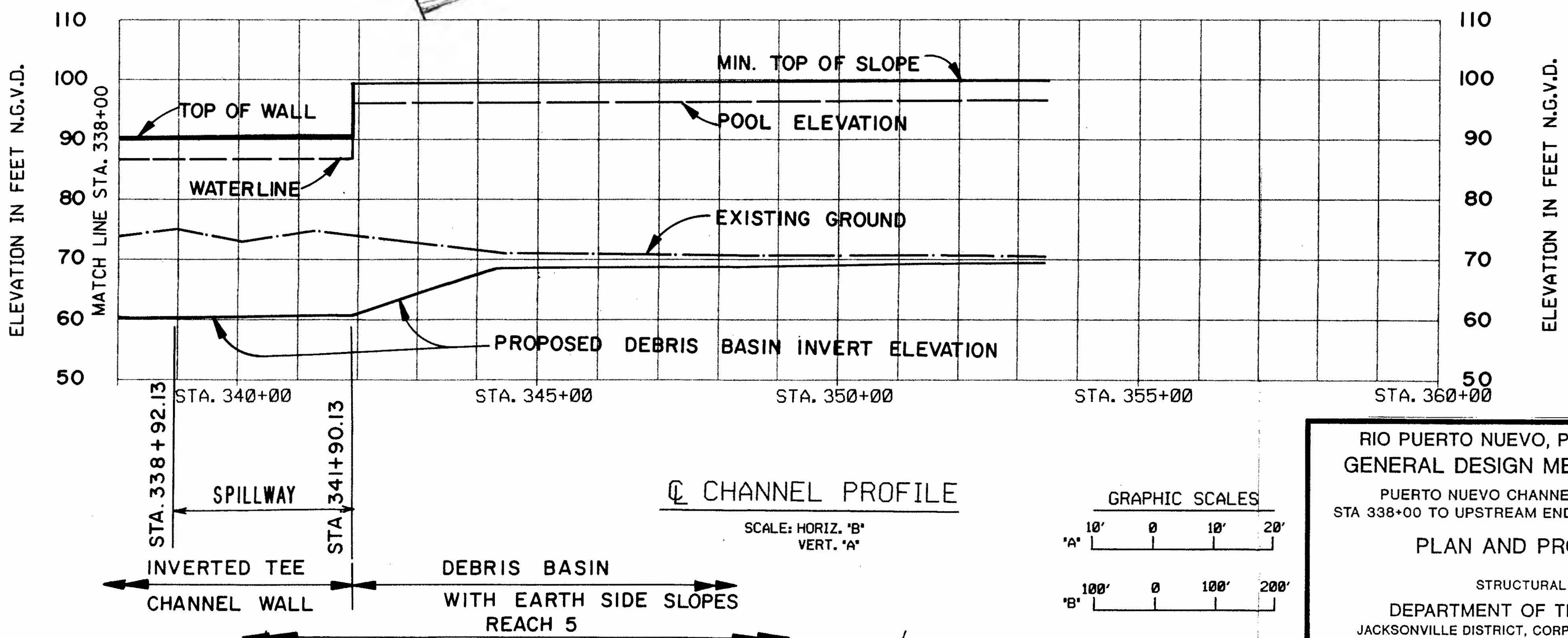
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10′ 0 10′ 20′

'B' 100′ 0 100′ 200′

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 5
STA 338+00 TO UPSTREAM END OF DEBRIS BASIN

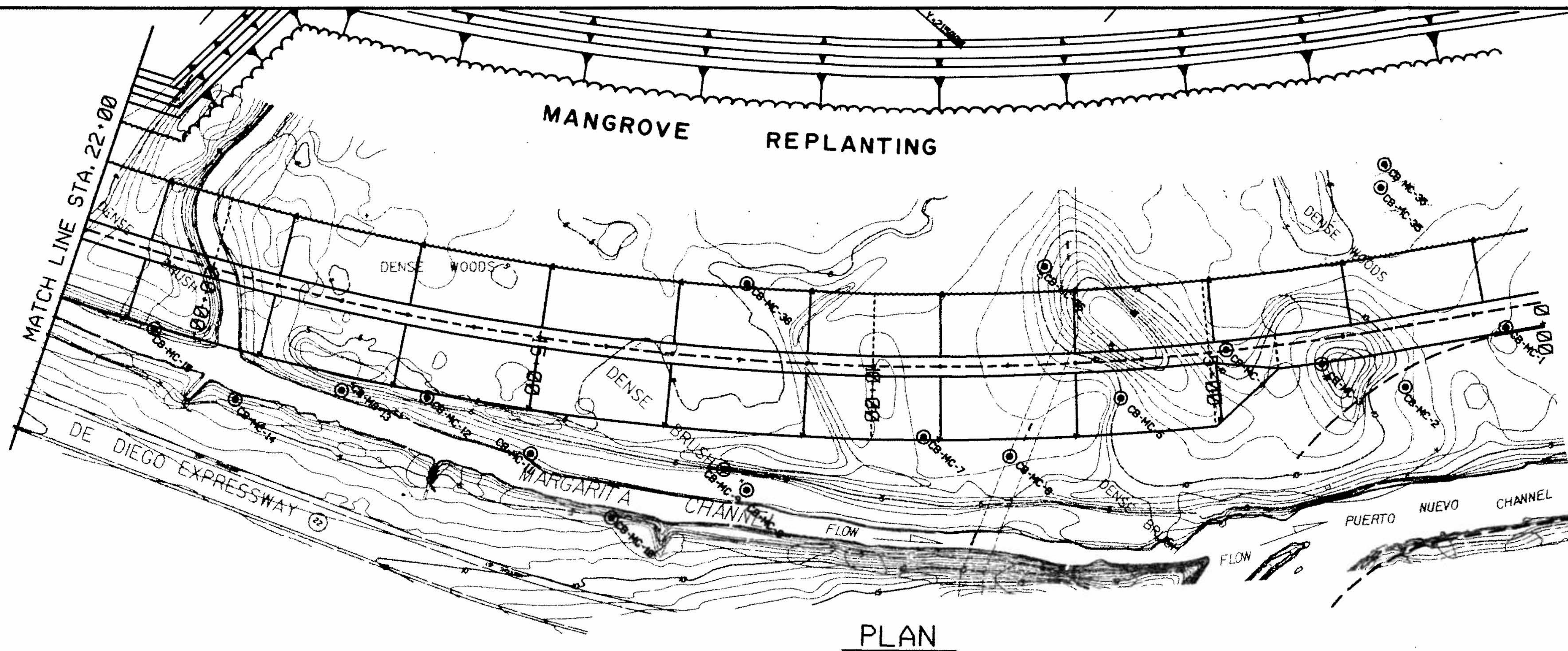
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

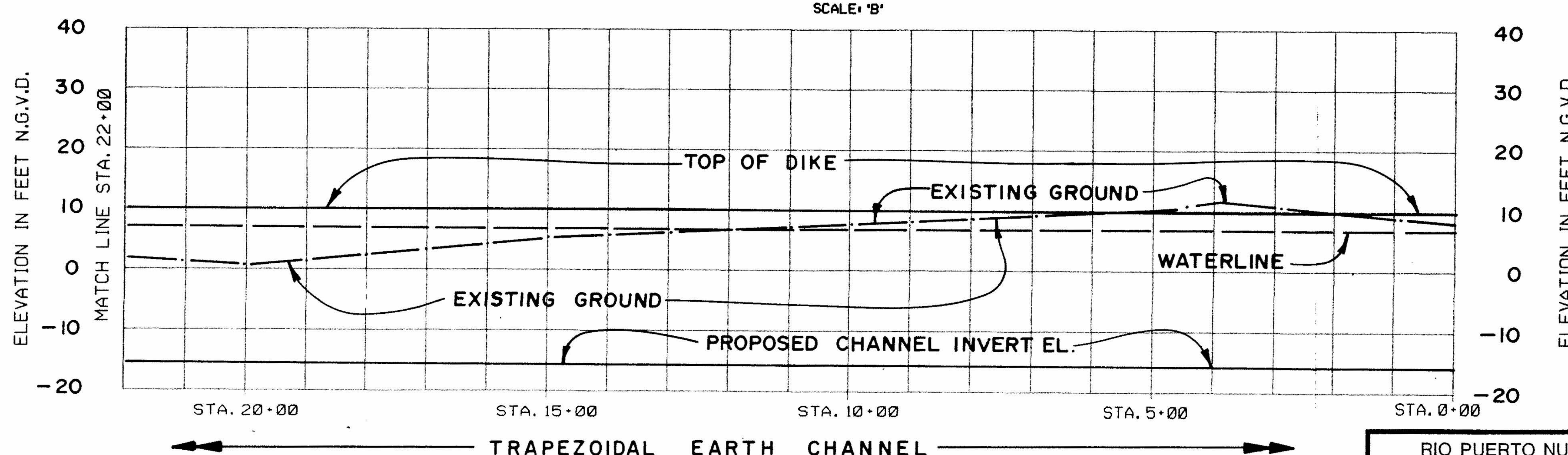
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-37




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 10'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY
STA 0+00 TO STA 22+00

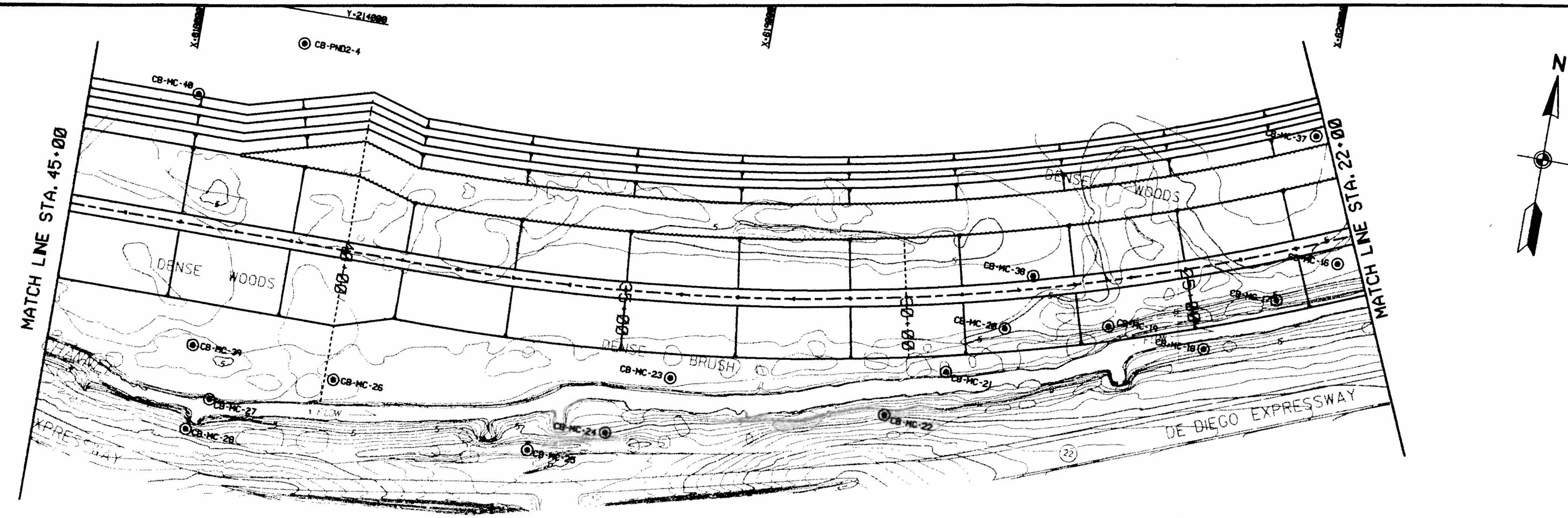
PLAN AND PROFILE

STRUCTURAL

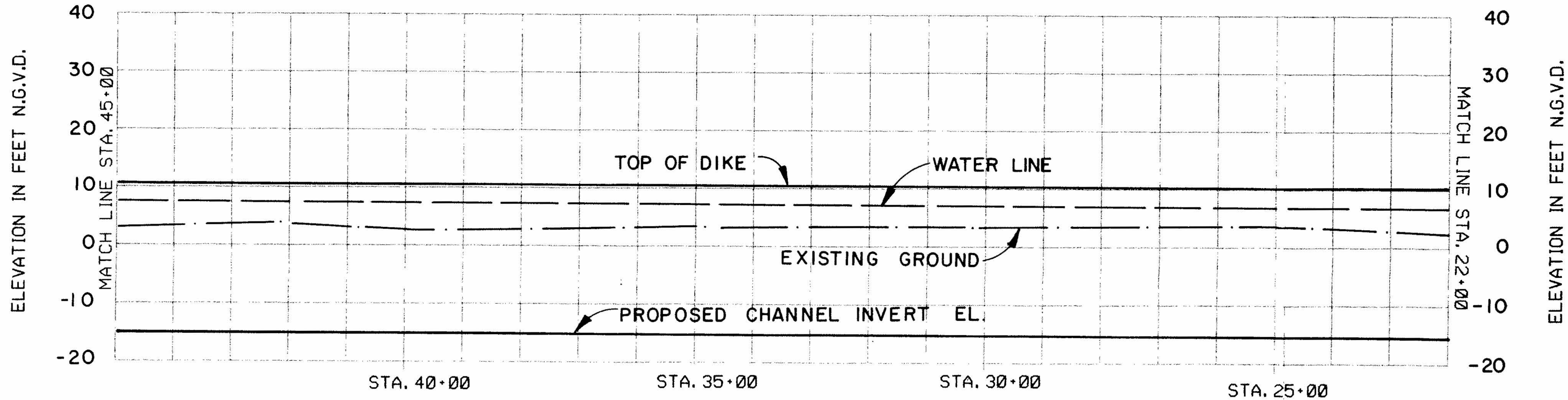
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-38




PLAN
SCALE: 'B'



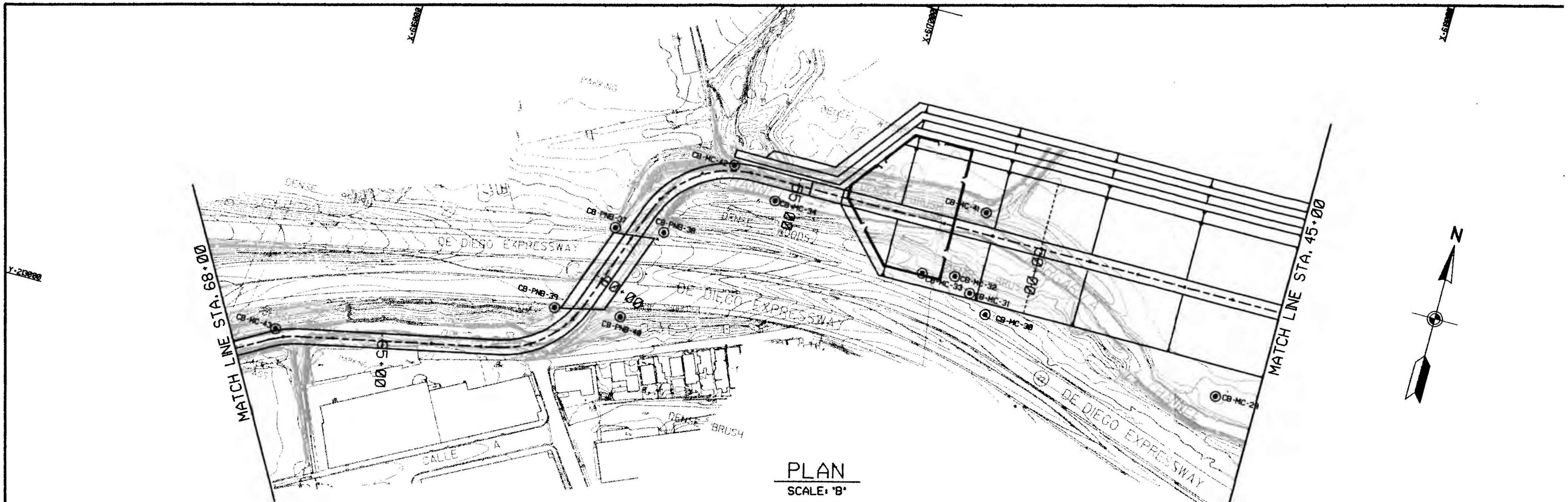

TRAPEZOIDAL EARTH CHANNEL

℄ CHANNEL PROFILE
SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES
'A' 5' 0 5' 10'
'B' 100' 0 100' 200'

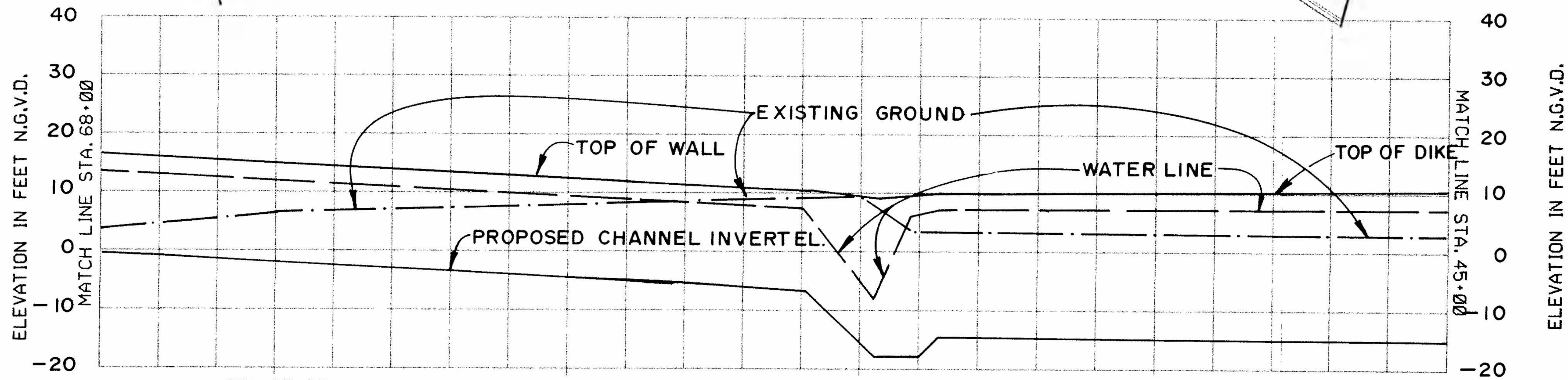
Y-212000

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY
STA 22+00 TO STA 45+00
PLAN AND PROFILE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 199
PLATE S-3




PLAN

SCALE: 'B'




STILLING AREA

STA. 54+75 STA. 54+10

## ℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

CONCRETE U-FRAME CHANNEL

TRAPEZOIDAL EARTH CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

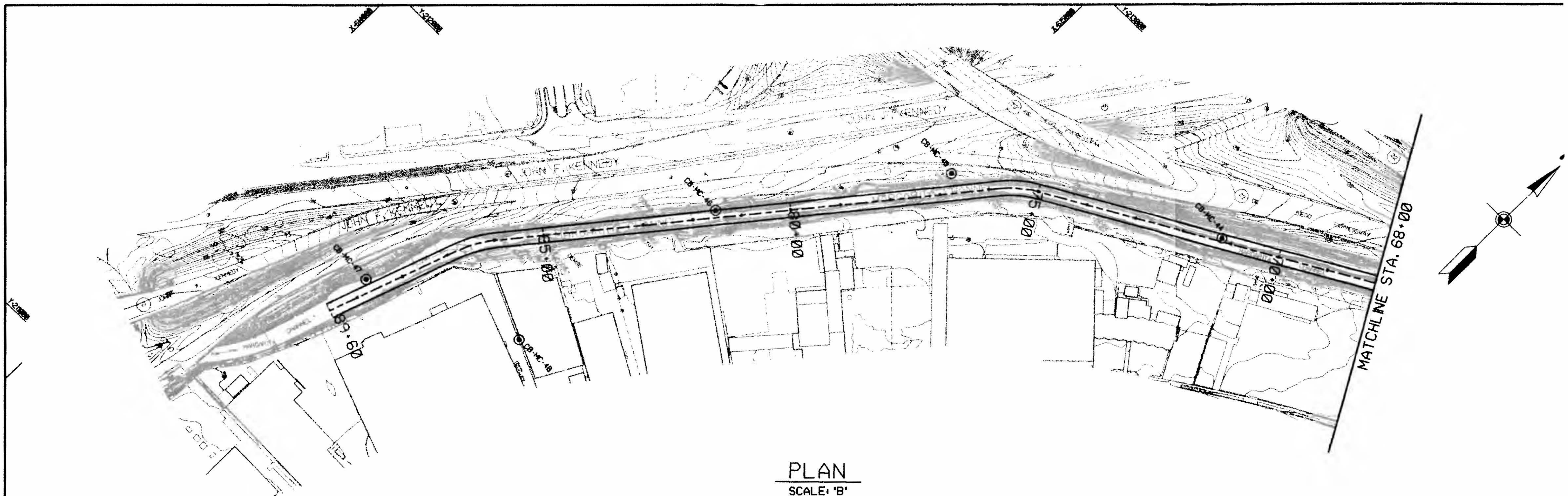
MARGARITA TRIBUTARY
STA 45+00 TO STA 68+00

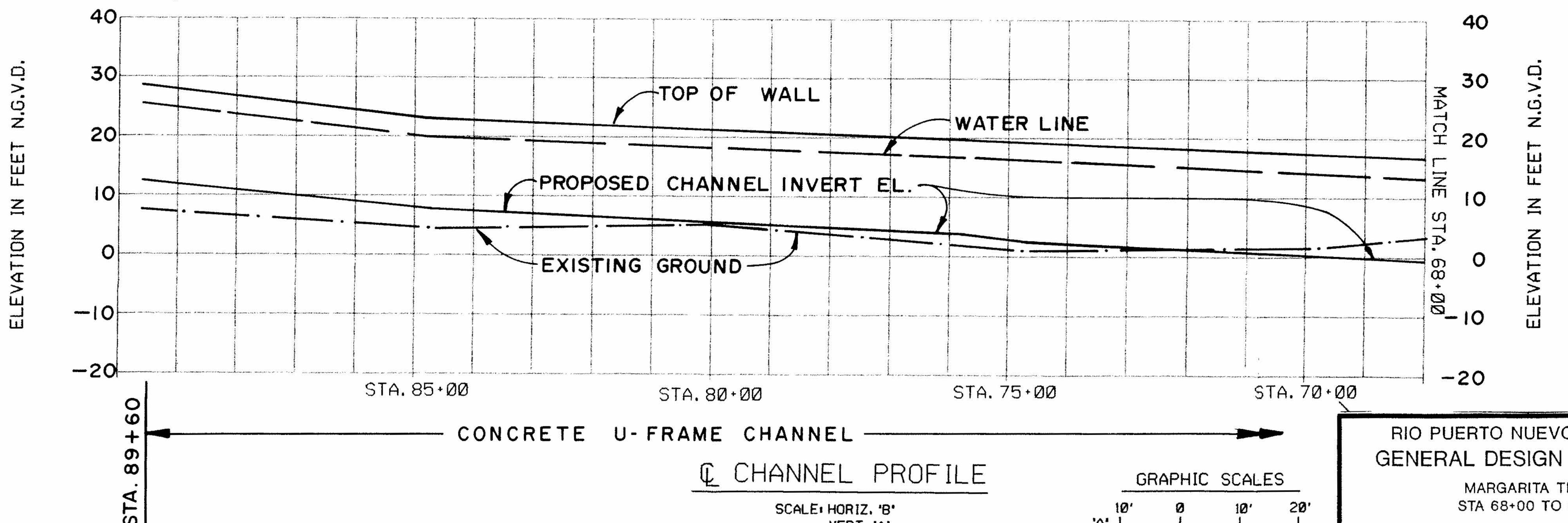
PLAN AND PROFILE

STRUCTURAL

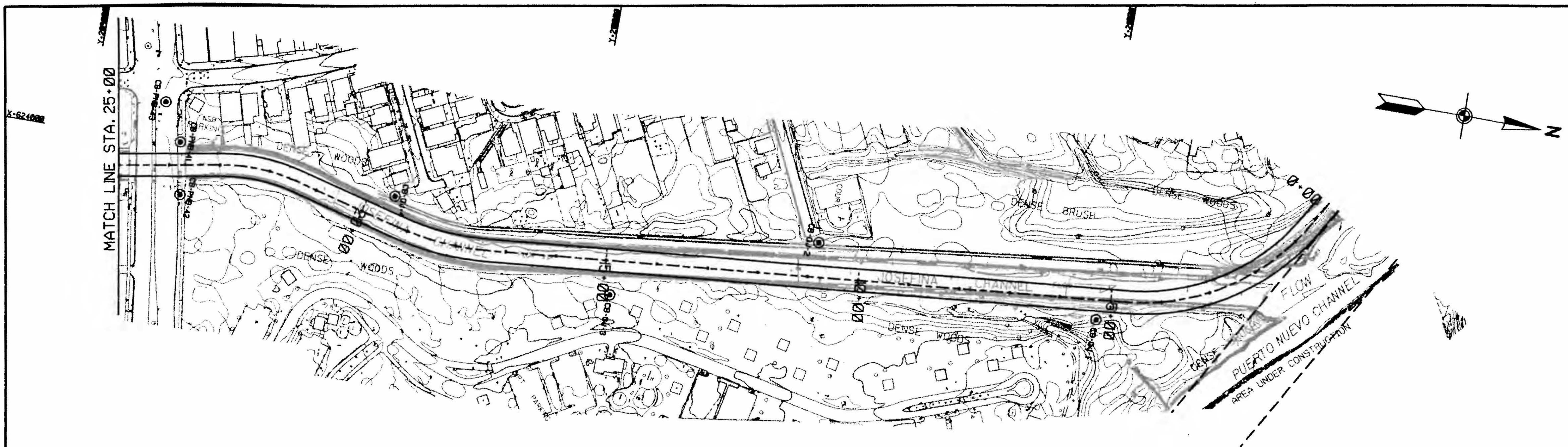
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199

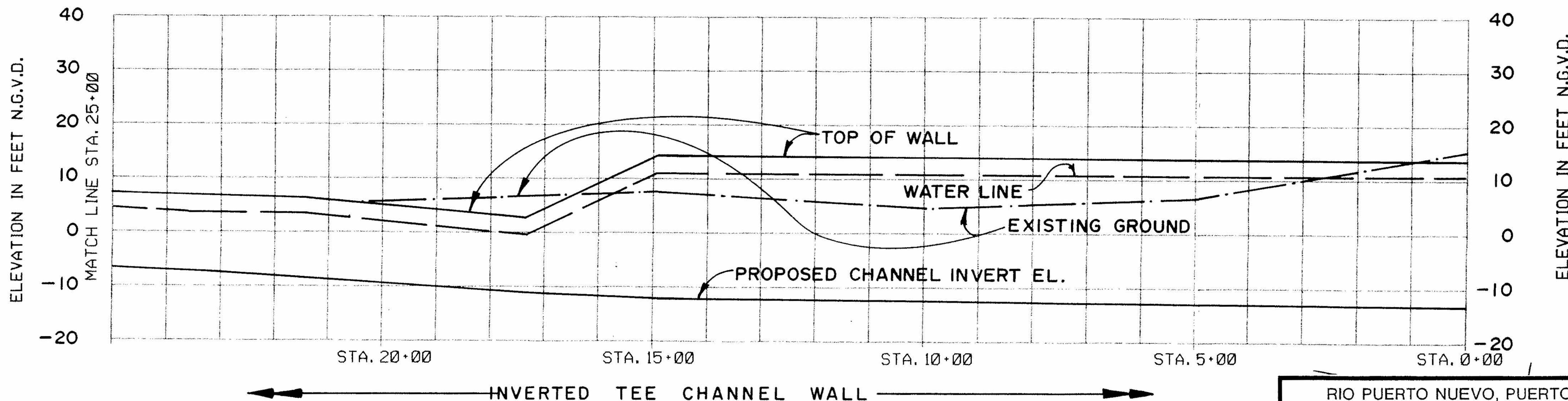



RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY
STA 68+00 TO STA 89+60
PLAN AND PROFILE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 199




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE
SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

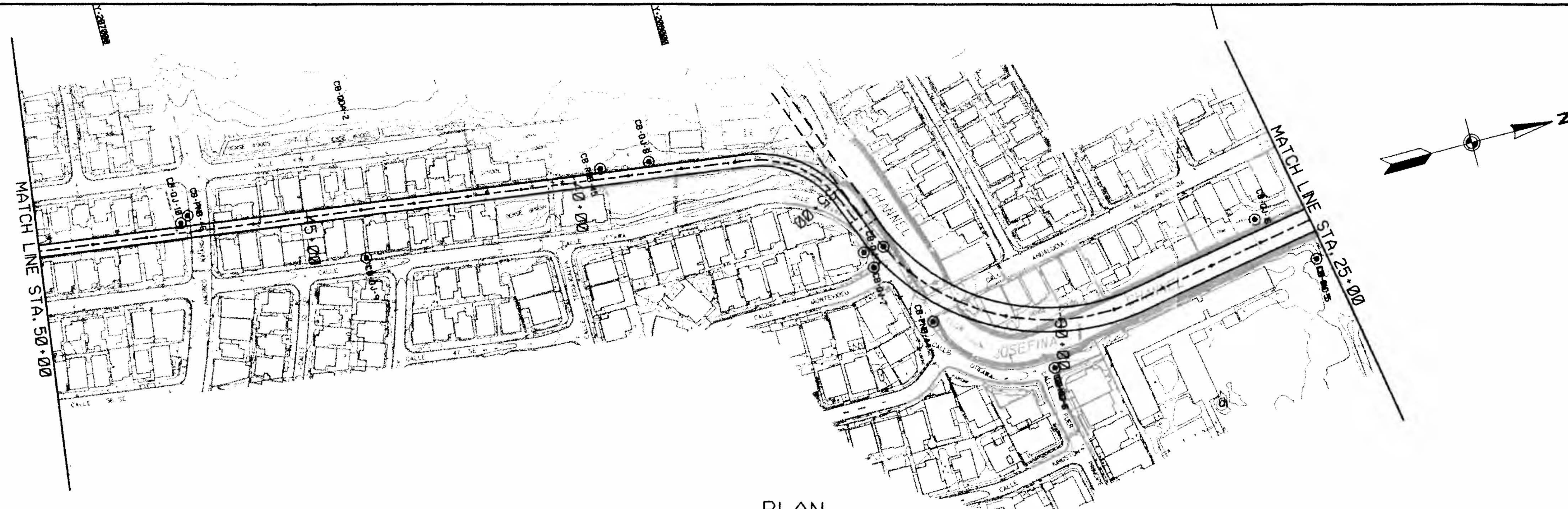
'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDU
JOSEFINA TRIBUTARY
STA 0+00 TO STA 25+00

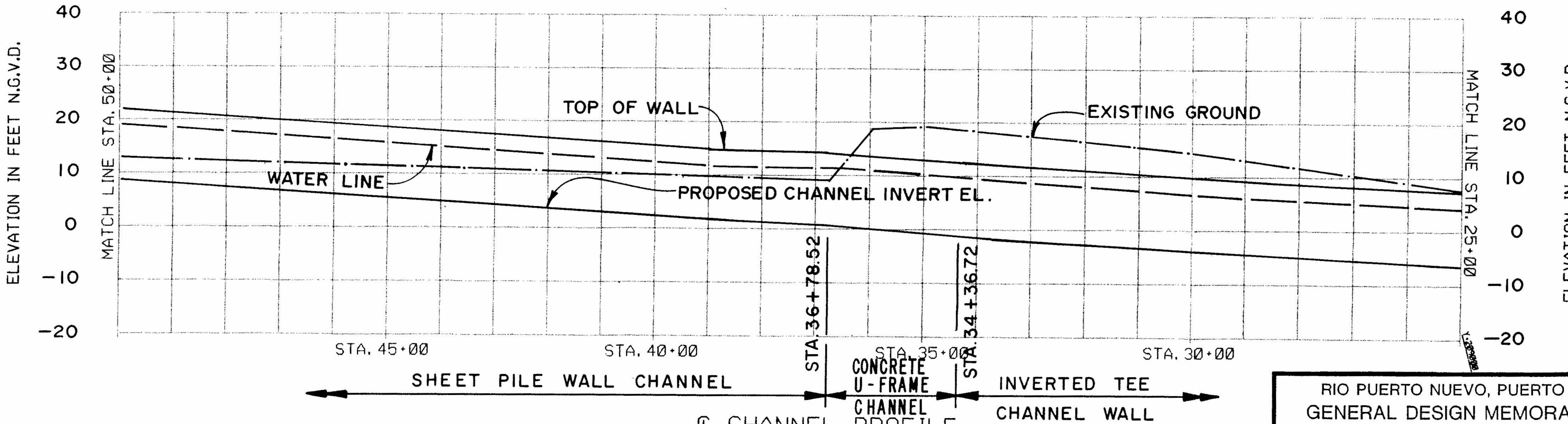
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 19



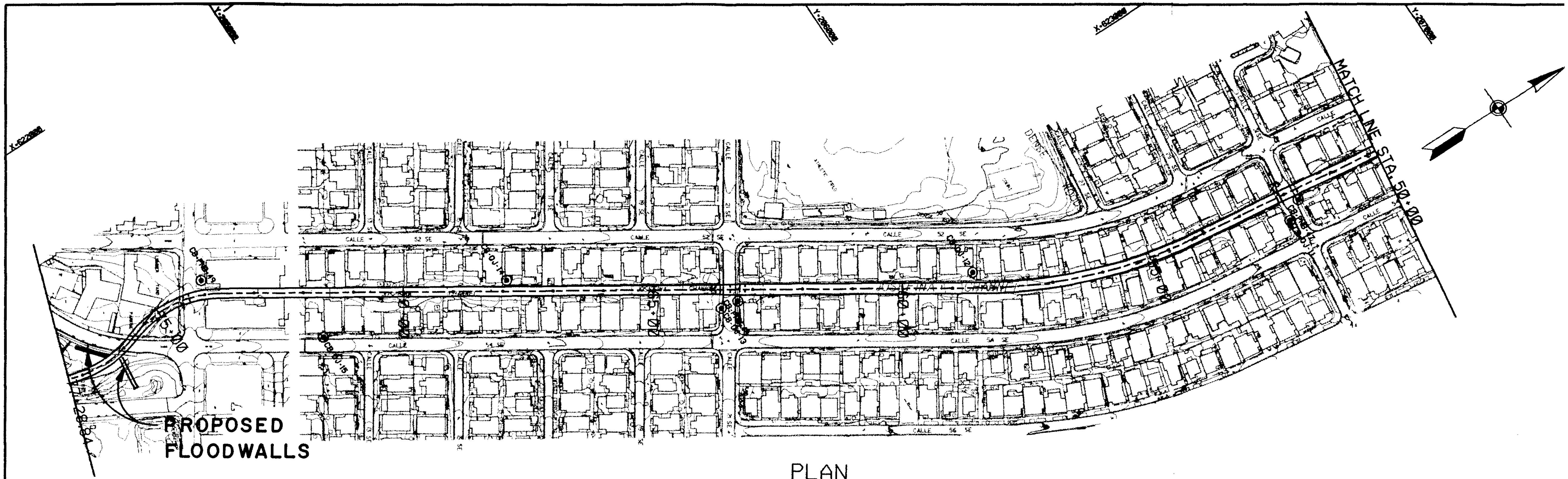

PLAN
SCALE: 'B'



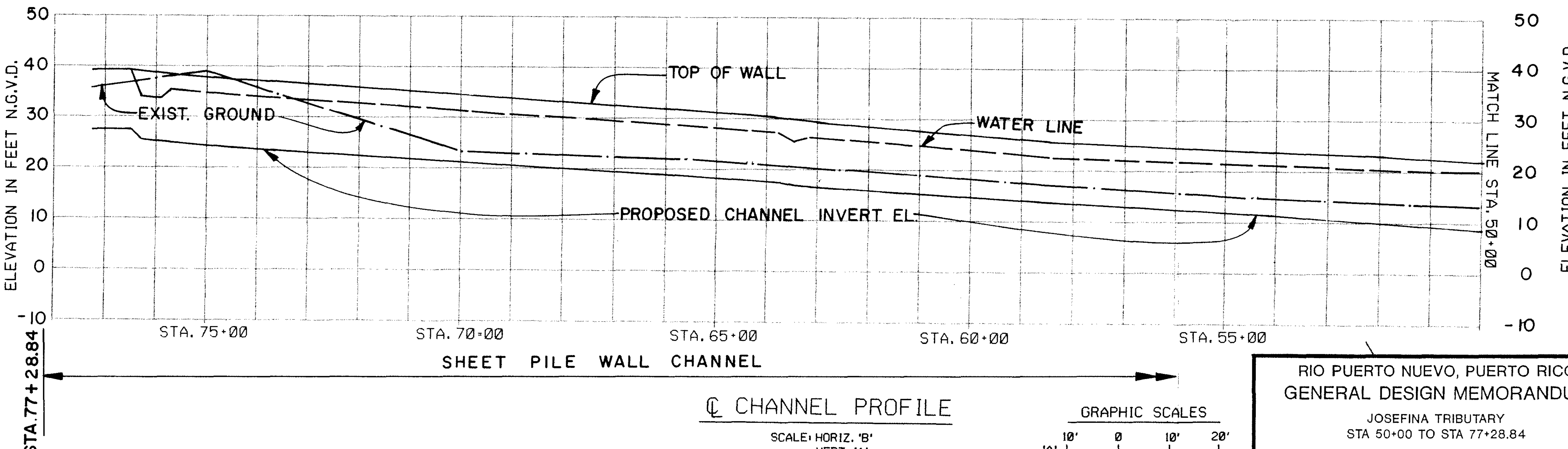

℄ CHANNEL PROFILE
SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES
'A' 10' 0 10' 20'
'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
STA 25+00 TO STA 50+00
PLAN AND PROFILE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 199




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY
STA 50+00 TO STA 77+28.84

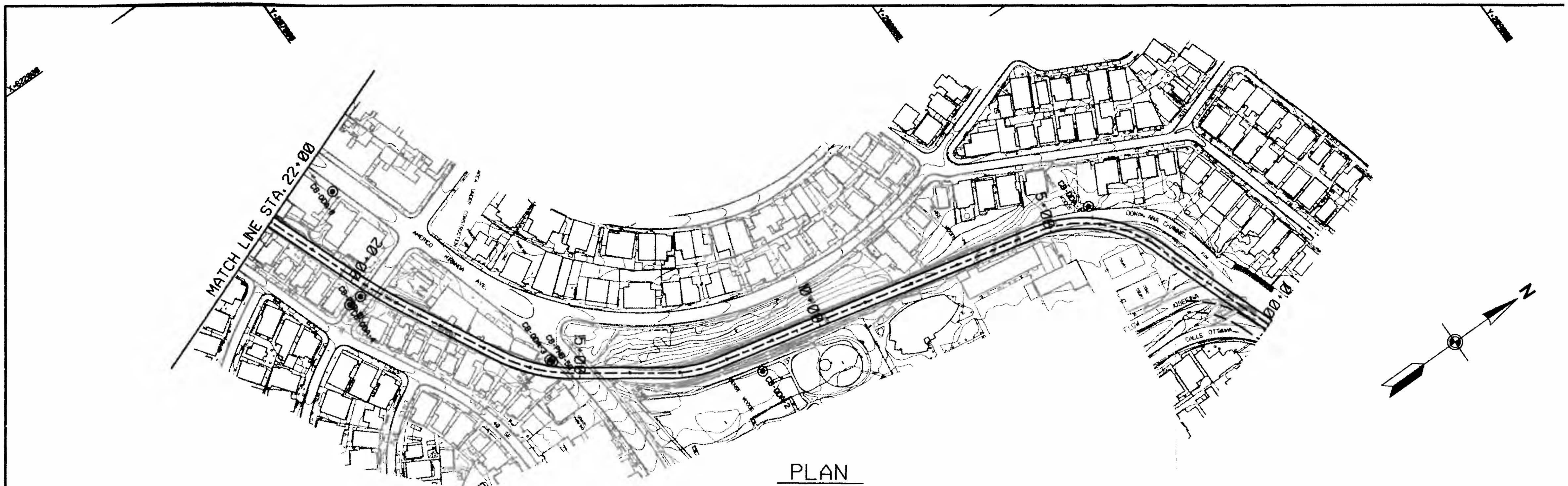
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

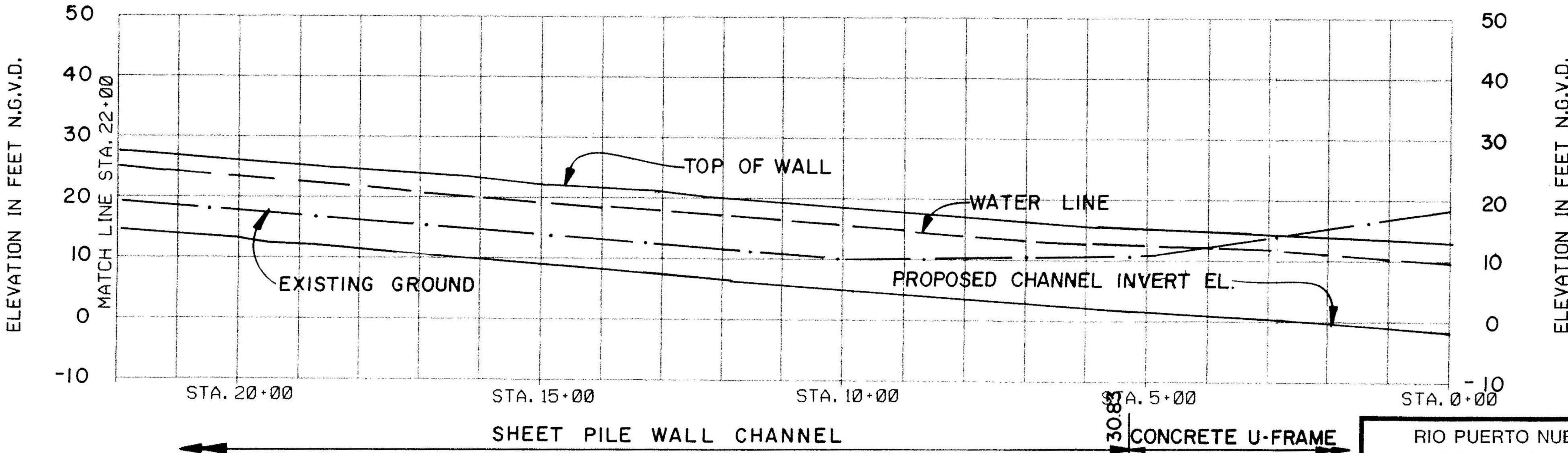
D.O. FILE NO. 102-35,578 DECEMBER 19

PLATE S-




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

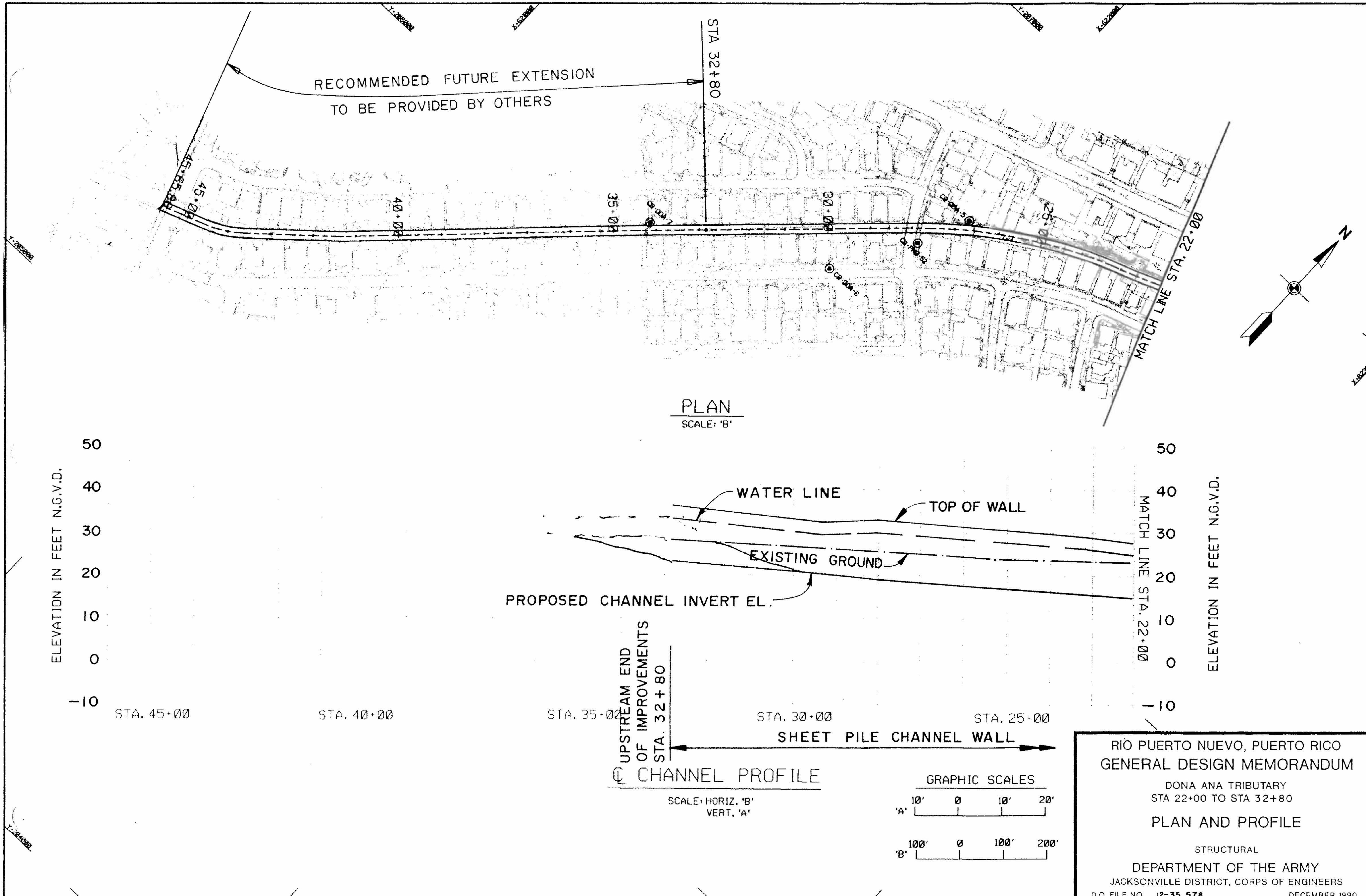
DONA ANA TRIBUTARY
STA 0+00 TO STA 22+00

PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

DONA ANA TRIBUTARY

STA 22+00 TO STA 32+80

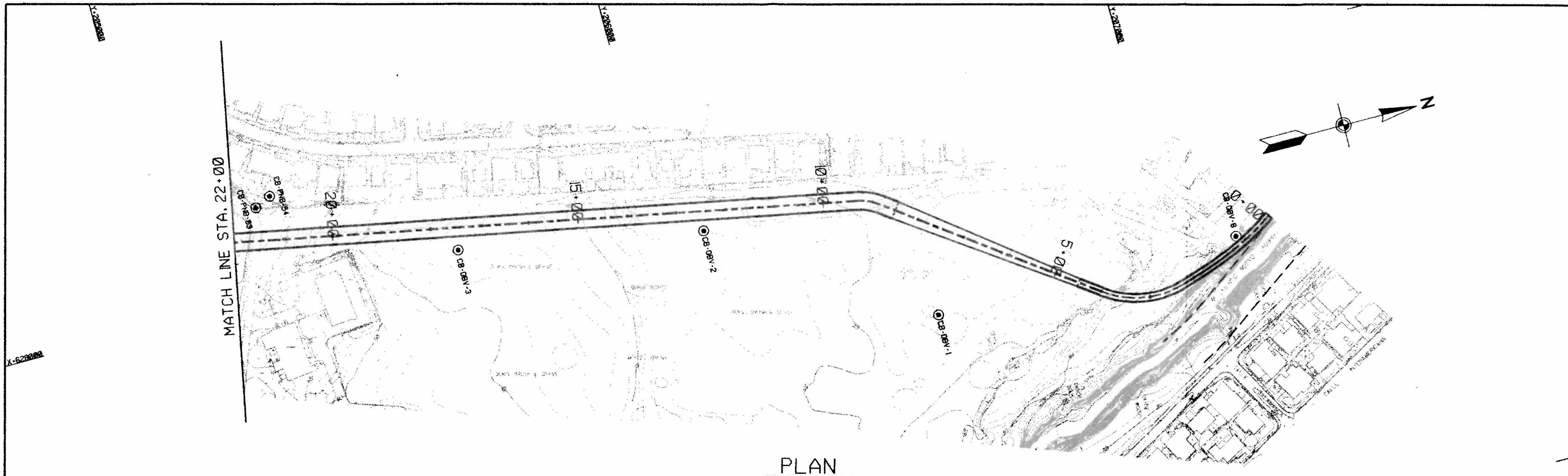
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY

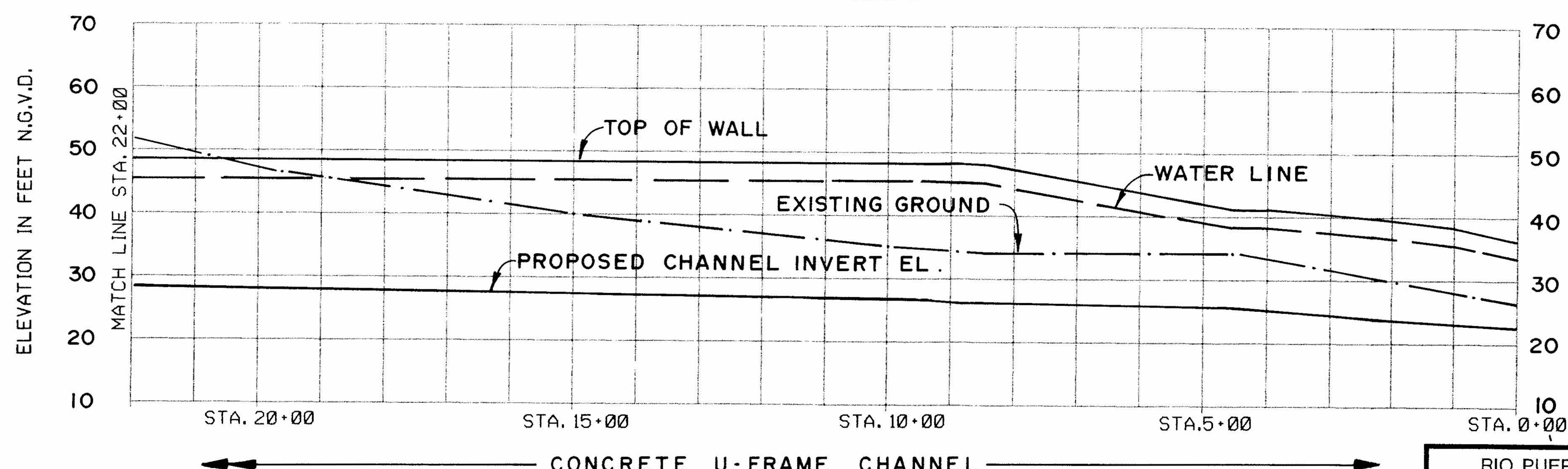
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 12-35,578 DECEMBER 1990




PLAN

SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

BUENA VISTA DIVERSION CHANNEL
STA 0+00 TO STA 22+00

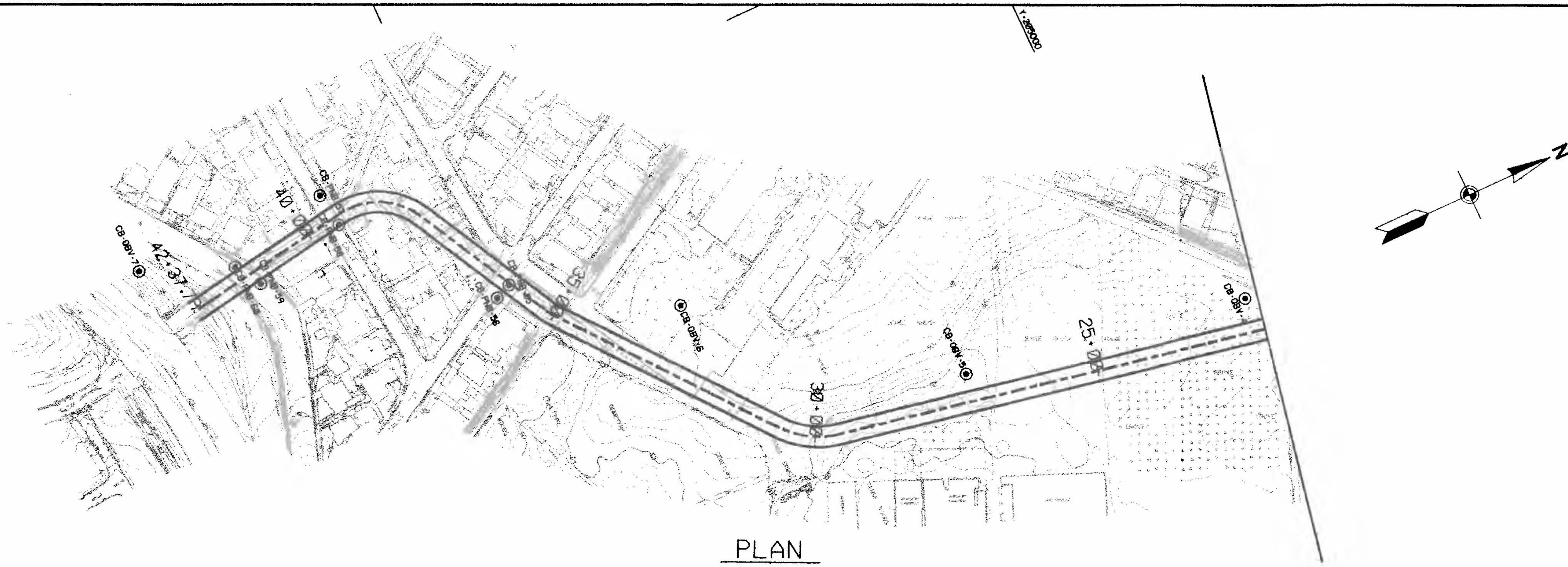
PLAN AND PROFILE

STRUCTURAL

DEPARTMENT OF THE ARMY

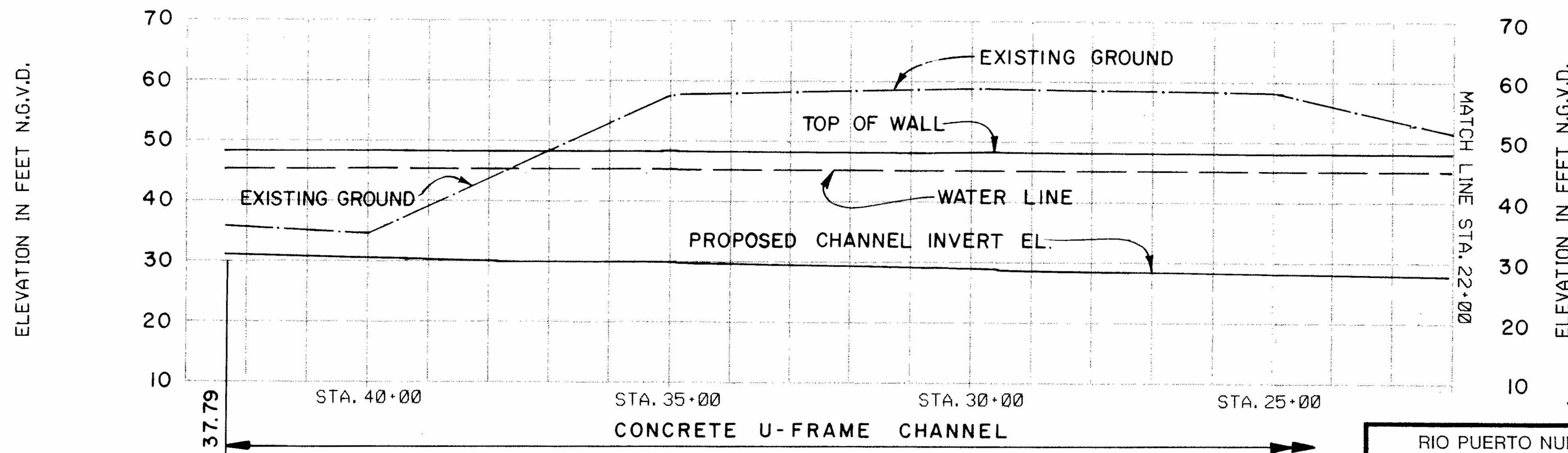
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN

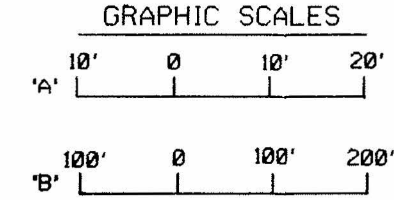
SCALE: 'B'




℄ CHANNEL PROFILE

SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

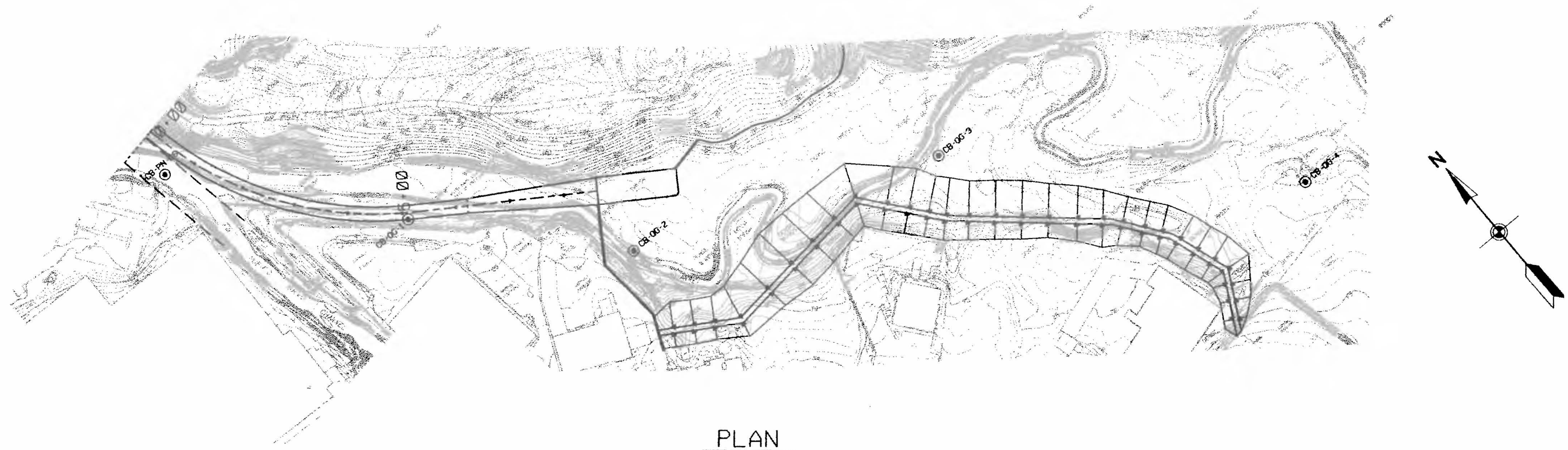
BUENA VISTA DIVERSION CHANNEL
STA 22+00 TO STA 42+37.79

PLAN AND PROFILE

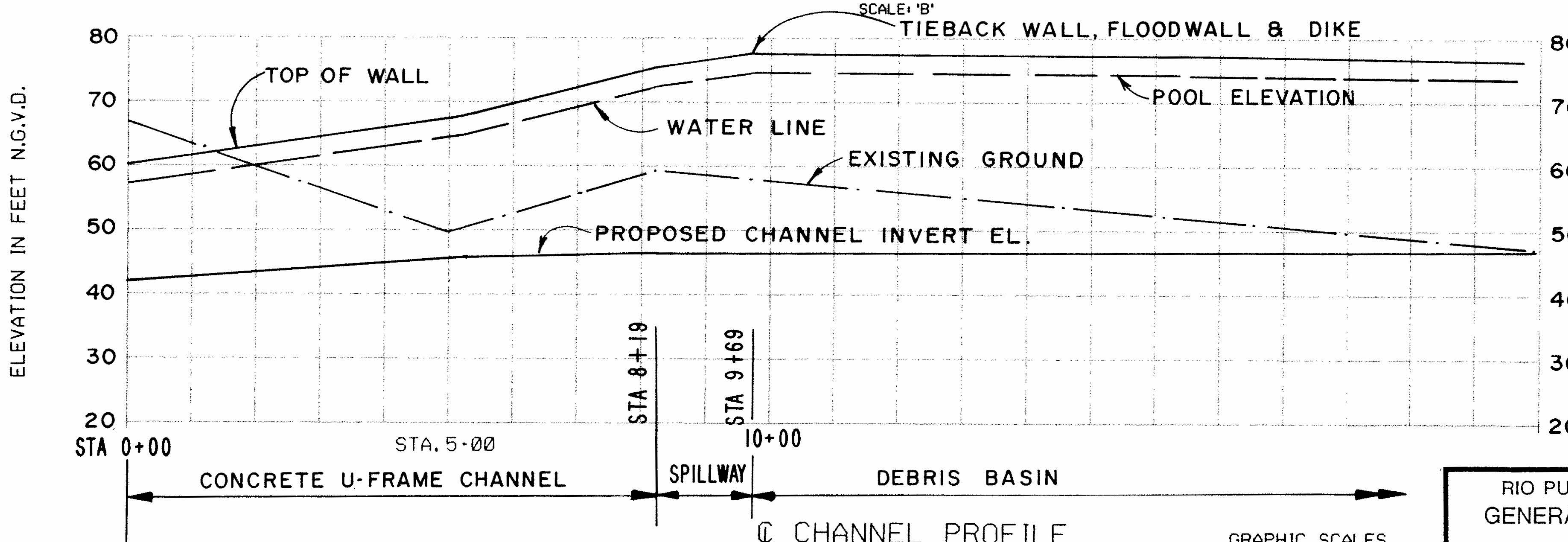
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PLAN
SCALE: 'B'




℄ CHANNEL PROFILE

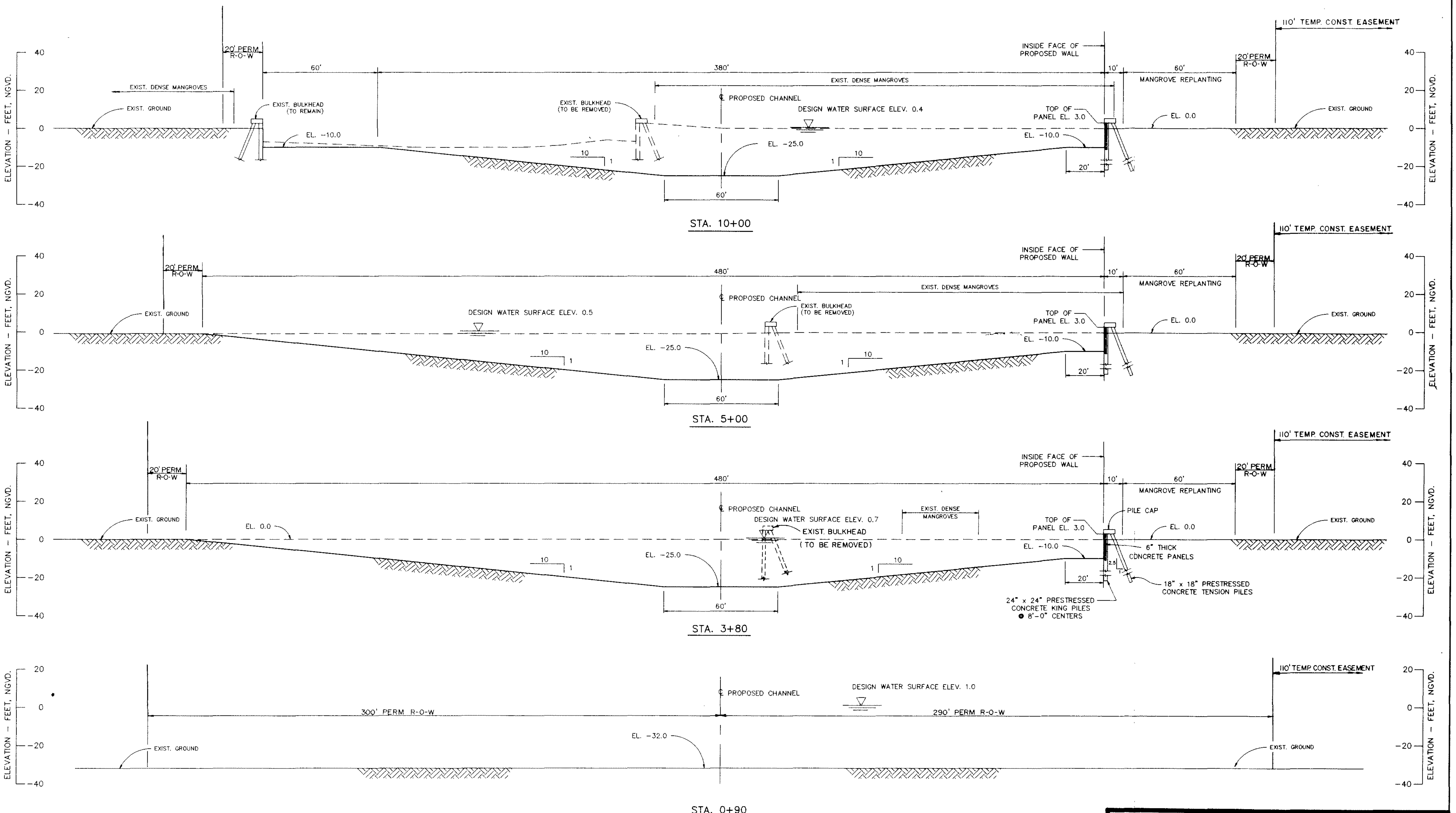
SCALE: HORIZ. 'B'
VERT. 'A'

GRAPHIC SCALES

'A' 10' 0 10' 20'

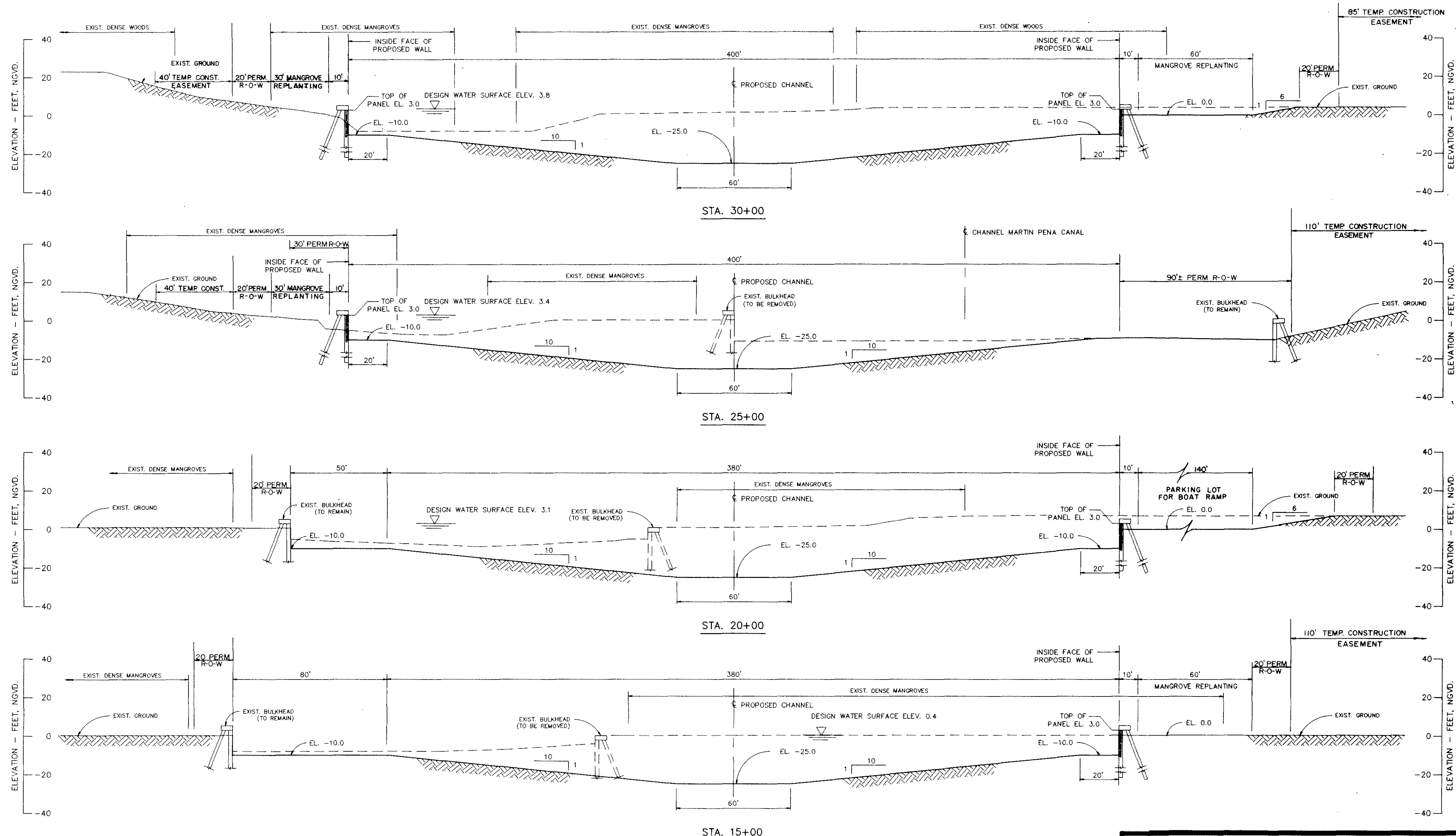
'B' 100' 0 100' 200'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
GUARACANAL
STA 0+00 TO UPSTREAM END OF DEBRIS BASIN
PLAN AND PROFILE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 1
STA 0+90 TO STA 10+00
CHANNEL CROSS SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 1
STA 15+00 TO STA 30+00

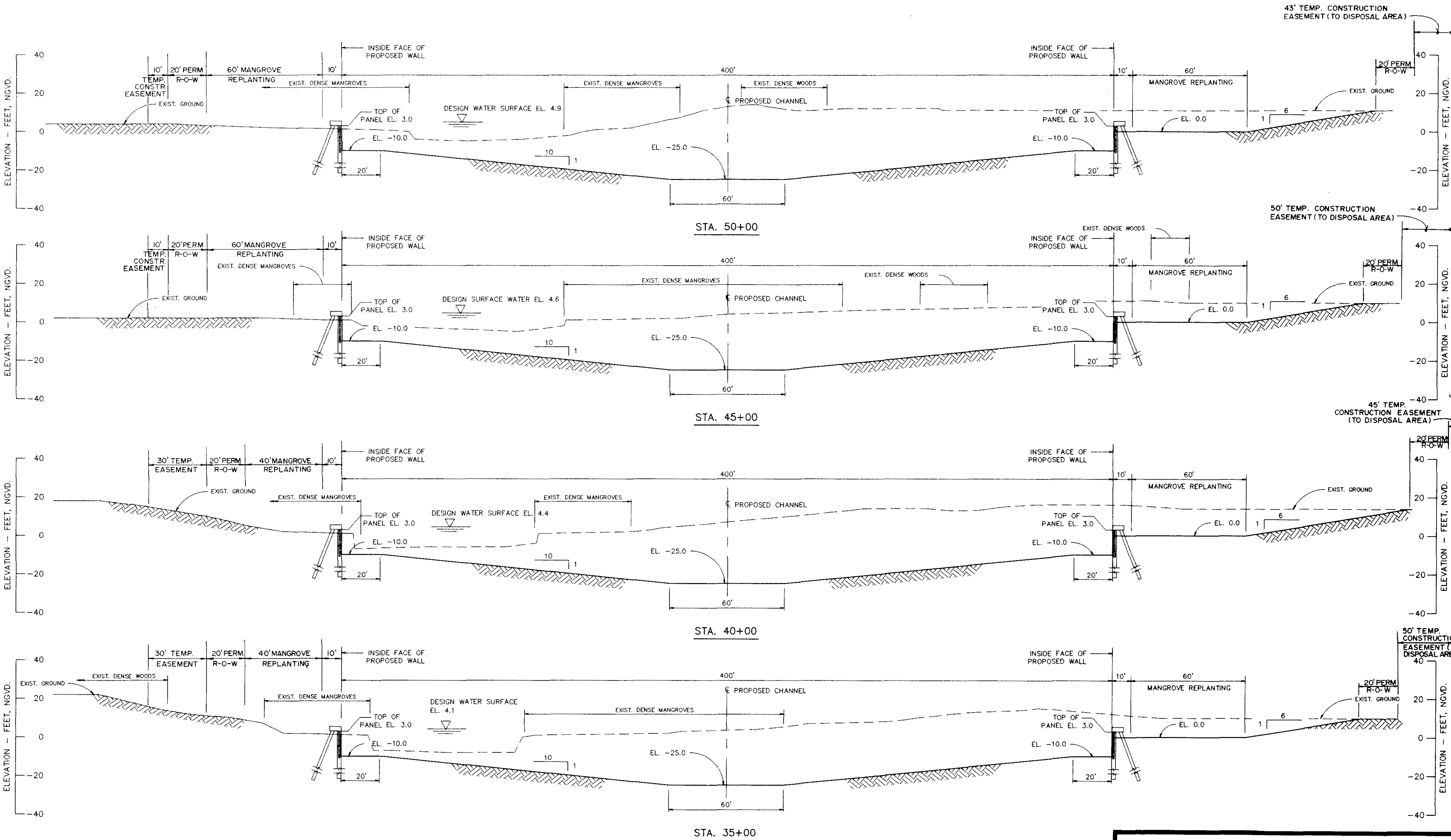
CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-51




PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

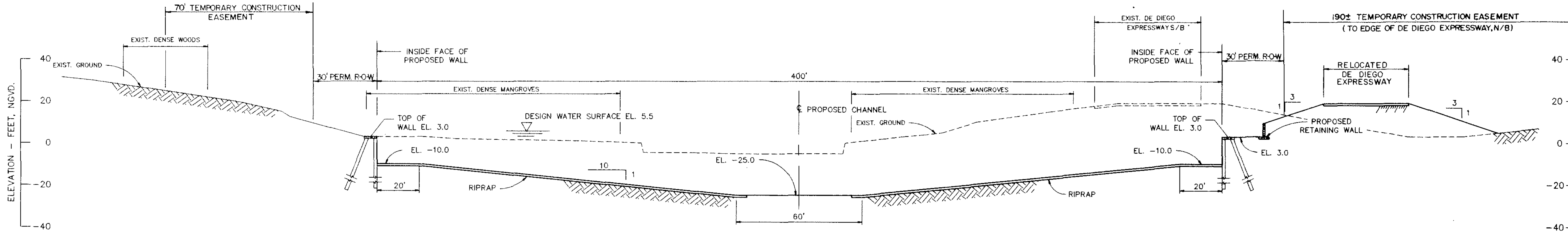
PUERTO NUEVO CHANNEL - REACH 1
STA 35+00 TO STA 50+00

CHANNEL CROSS SECTIONS

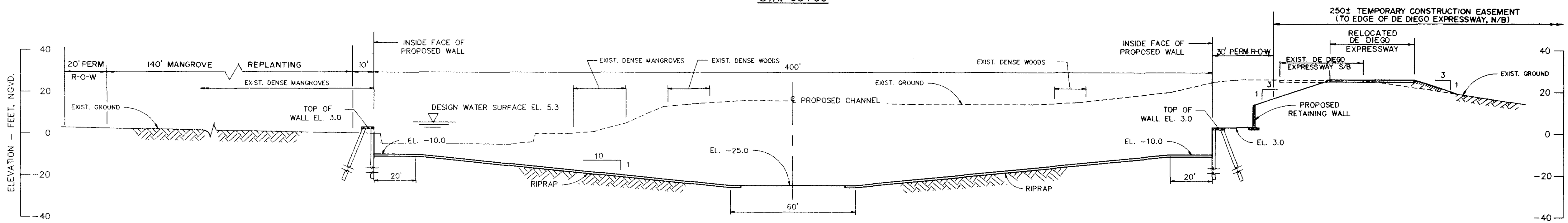
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

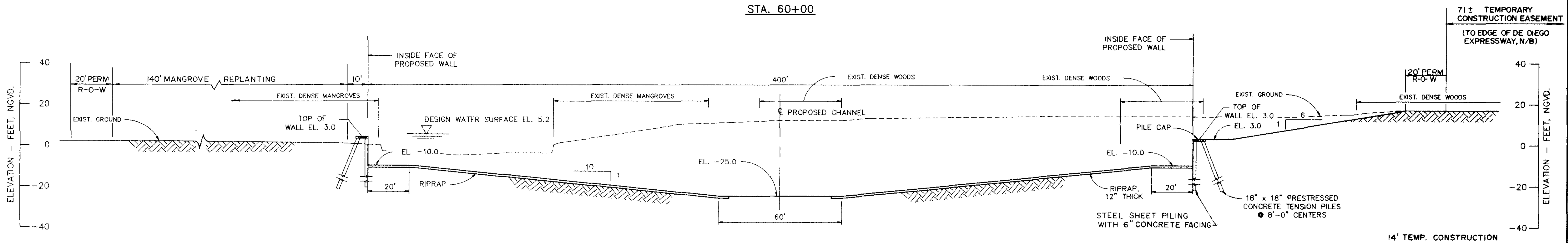
D.O. FILE NO. 102-35,578 DECEMBER 1990



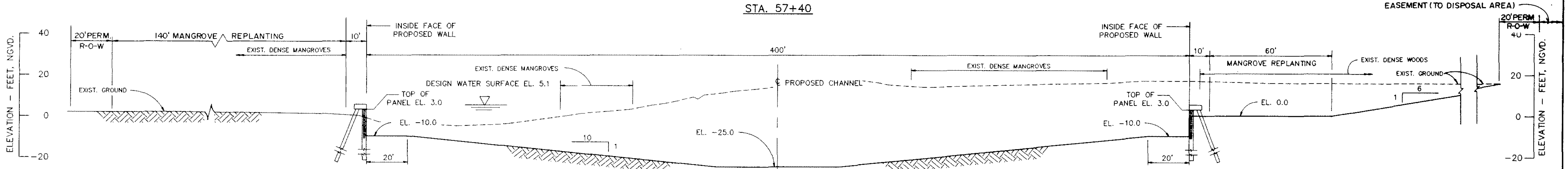
STA. 65+00



STA. 60+00



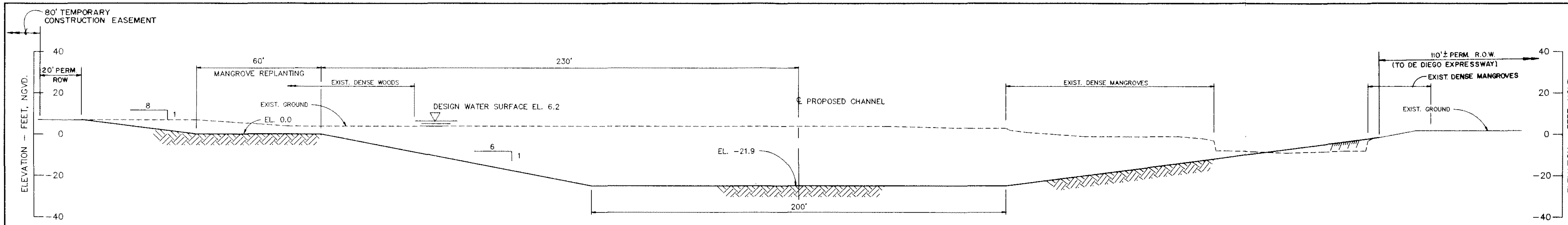
STA. 57+40



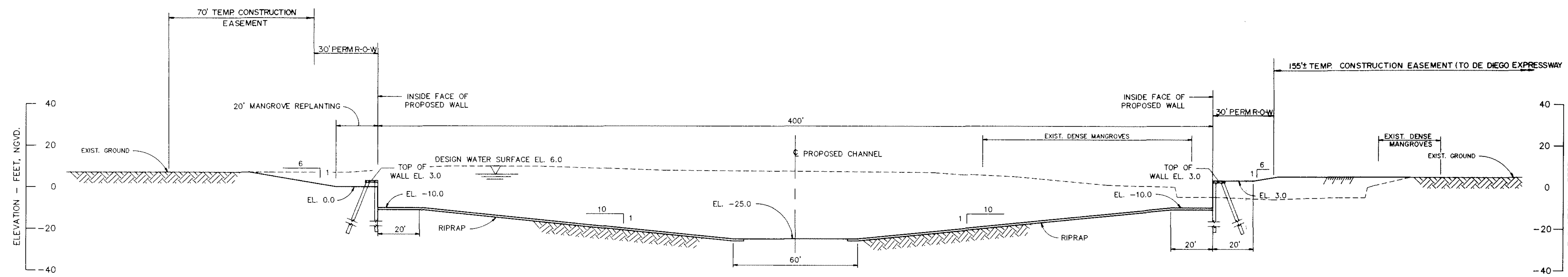
STA. 55+00

PUERTO NUEVO CHANNEL

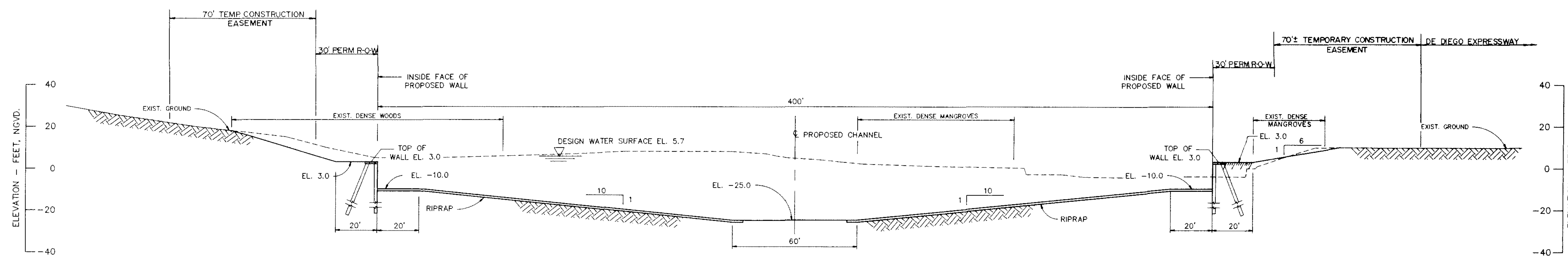
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 1
STA 55+00 TO STA 65+00
CHANNEL CROSS SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




STA. 76+32.5



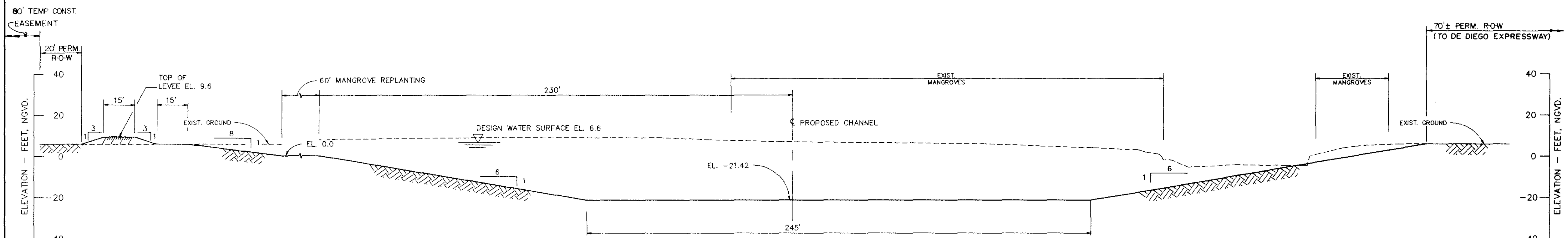

STA. 74+32.5



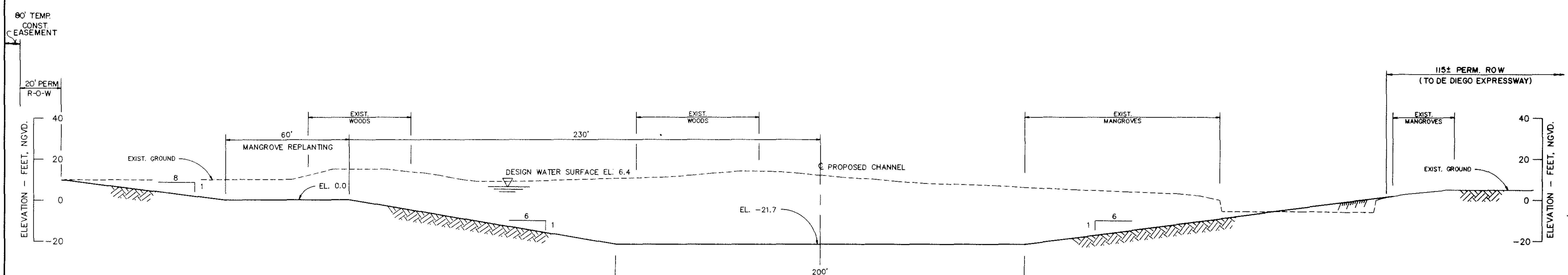

STA. 70+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 1
STA 70+00 TO STA 76+32.5
CHANNEL CROSS SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




STA. 85+00




STA. 80+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

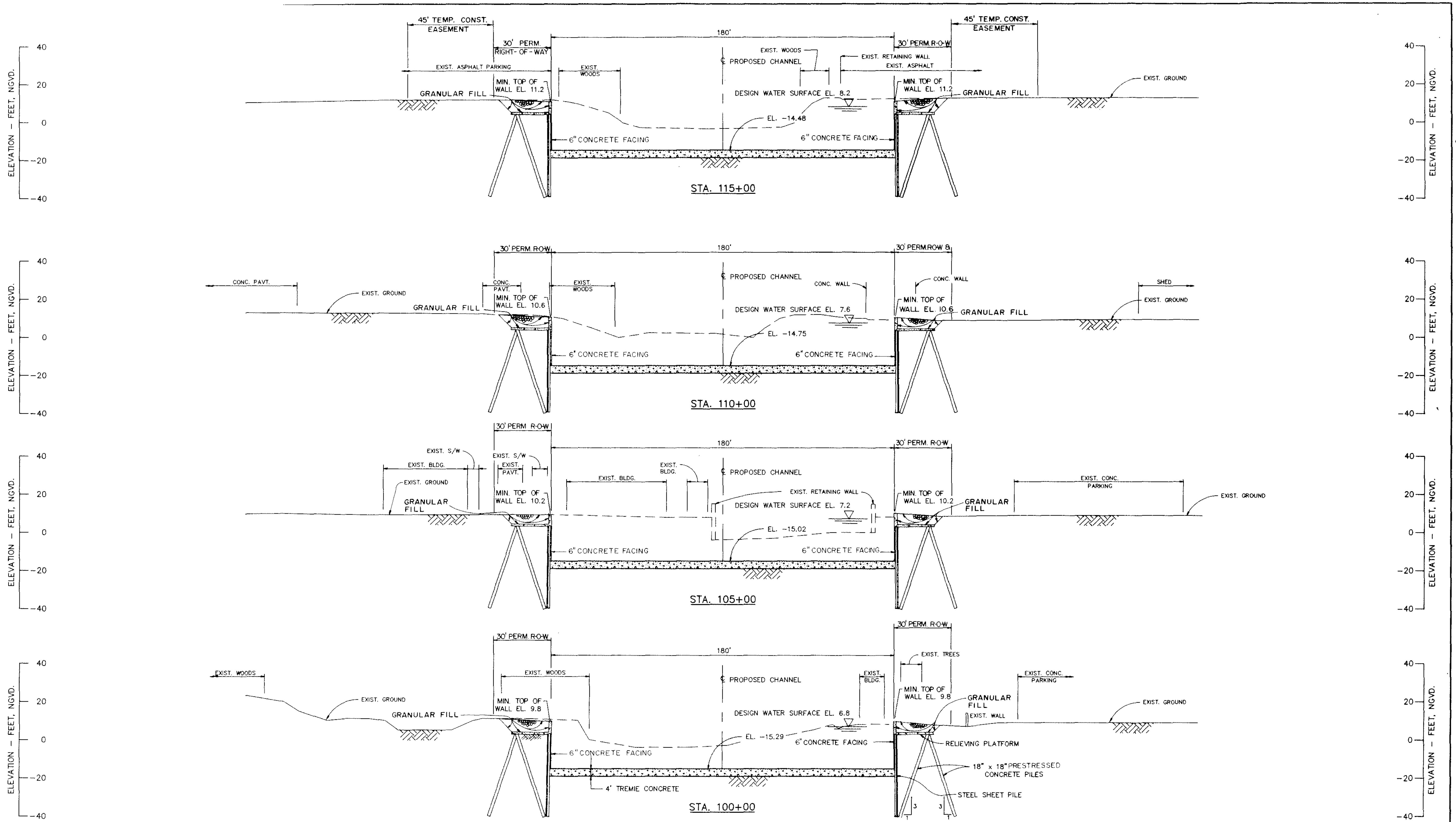
PUERTO NUEVO CHANNEL - REACH 1
STA 80+00 TO STA 85+00

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

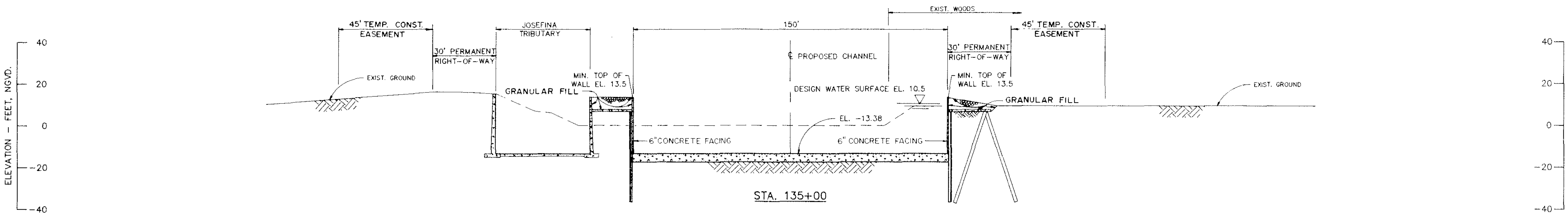
PUERTO NUEVO CHANNEL - REACH 2
STA 100+00 TO STA 115+00

CHANNEL CROSS SECTIONS

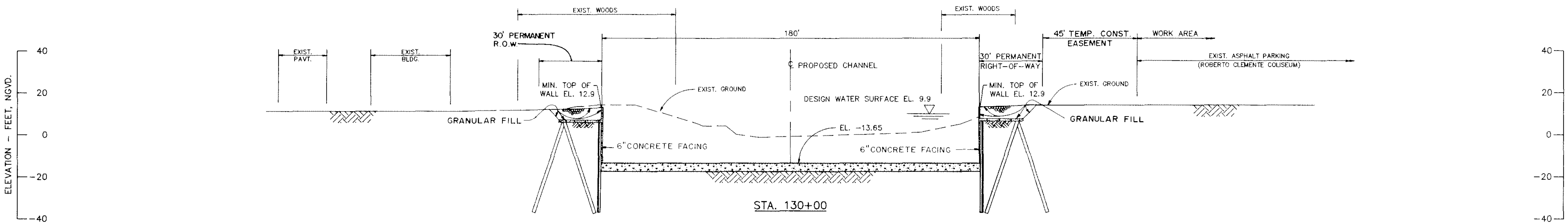
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

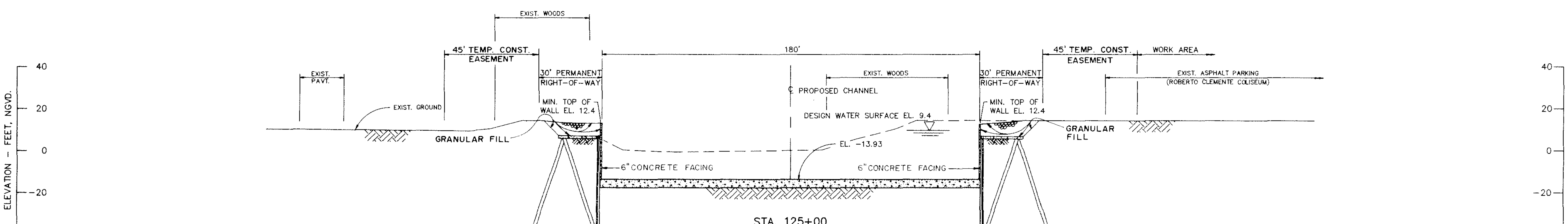
D.O. FILE NO. 102-36,678 DECEMBER 1990




STA. 135+00




STA. 130+00




STA. 125+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

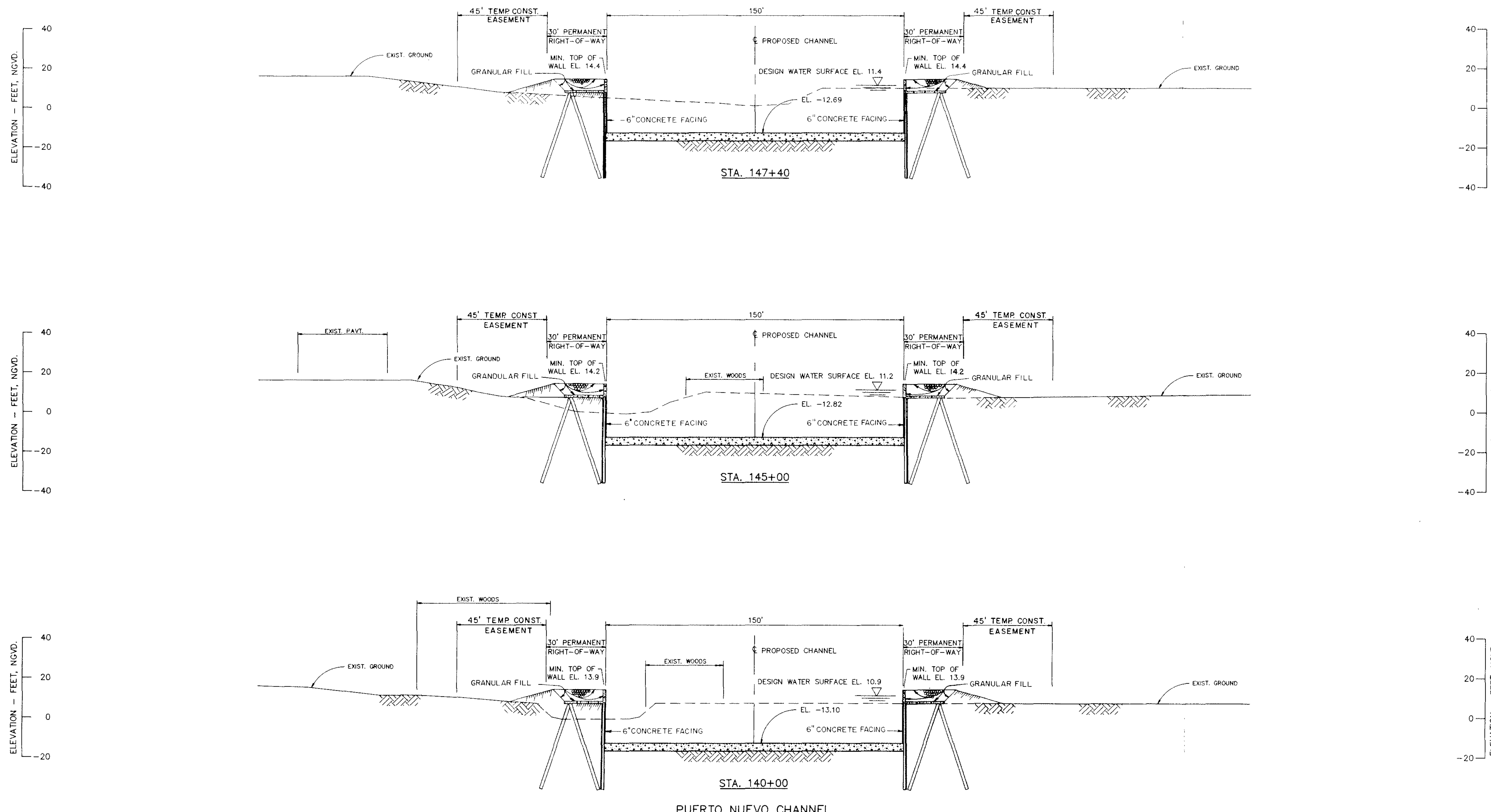
PUERTO NUEVO CHANNEL - REACH 2
STA 125+00 TO STA 135+00

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 2
STA 140+00 TO STA 147+40

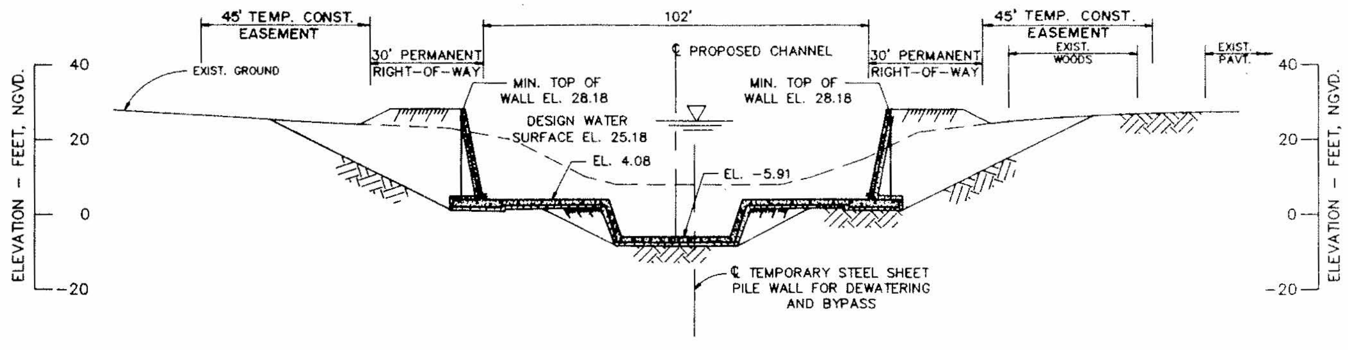
CHANNEL CROSS SECTIONS

STRUCTURAL

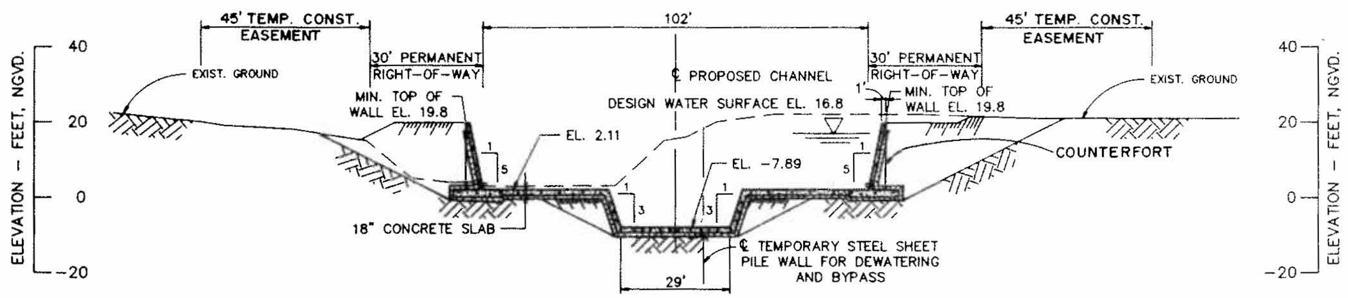
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

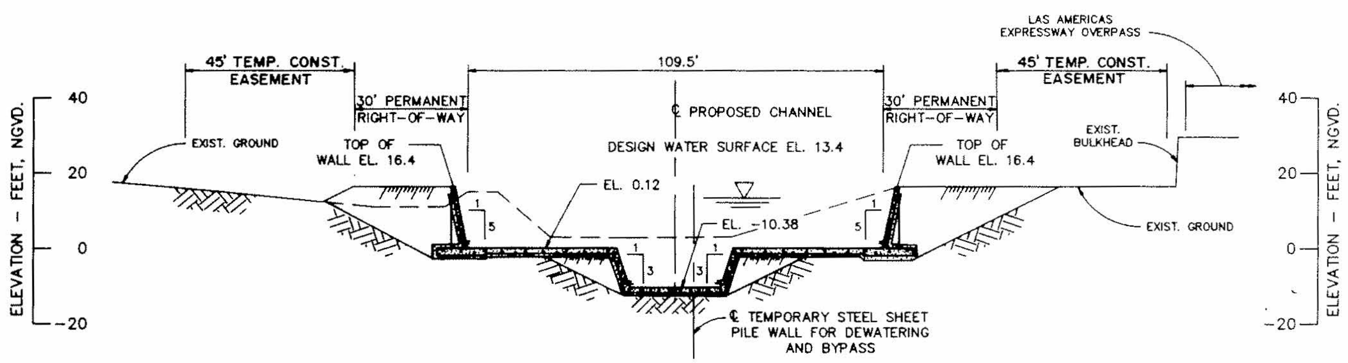
PLATE S-58



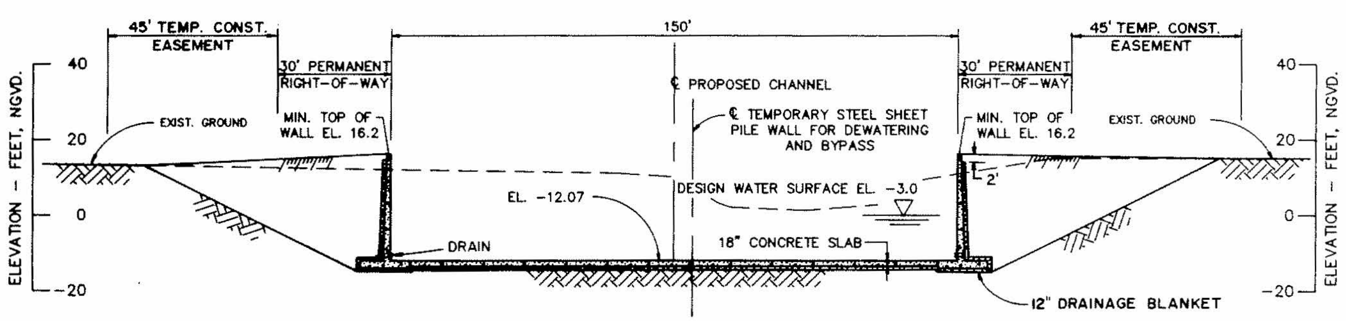

STA. 165+00




STA. 160+00

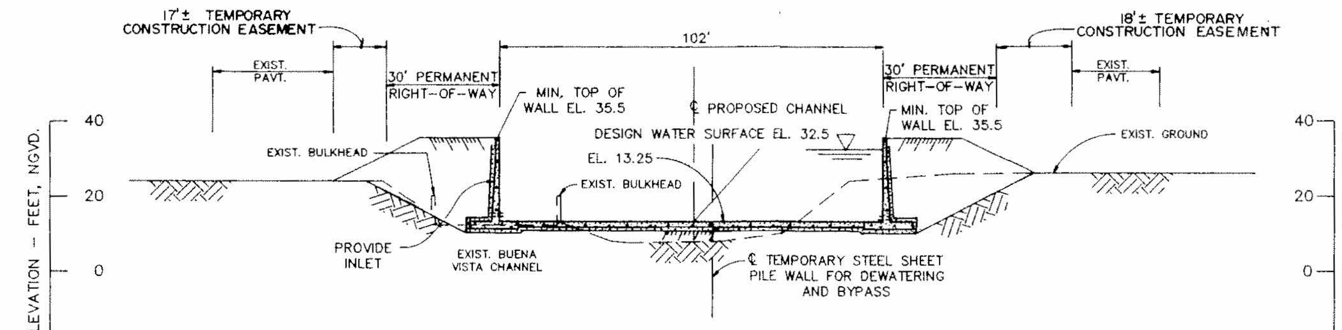



STA. 155+00

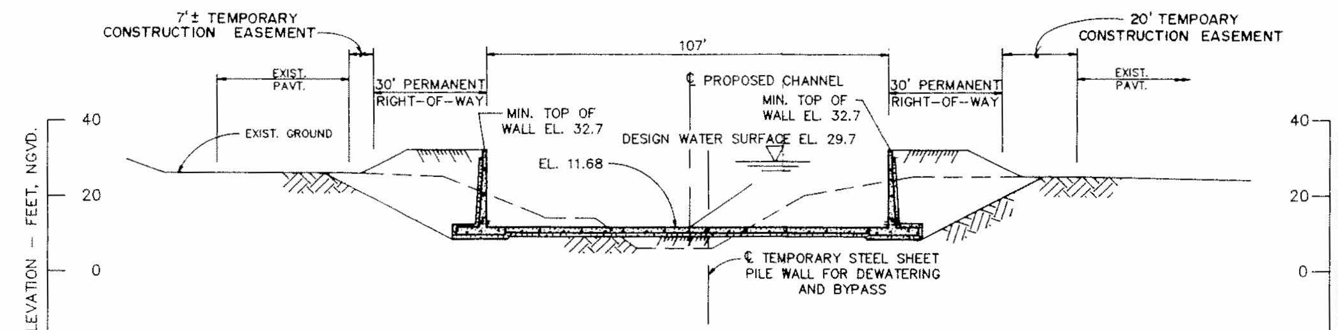



STA. 150+00

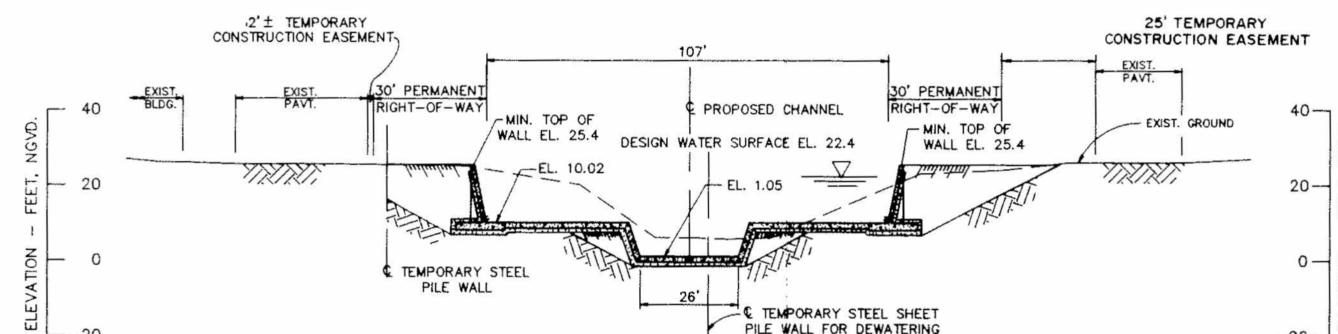
PUERTO NUEVO CHANNEL



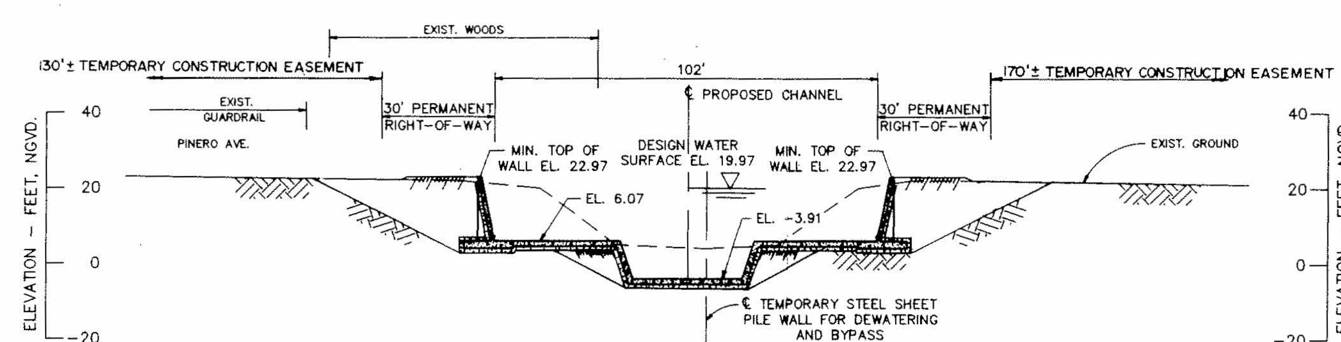

STA. 190+00




STA. 185+00




STA. 180+00




STA. 170+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

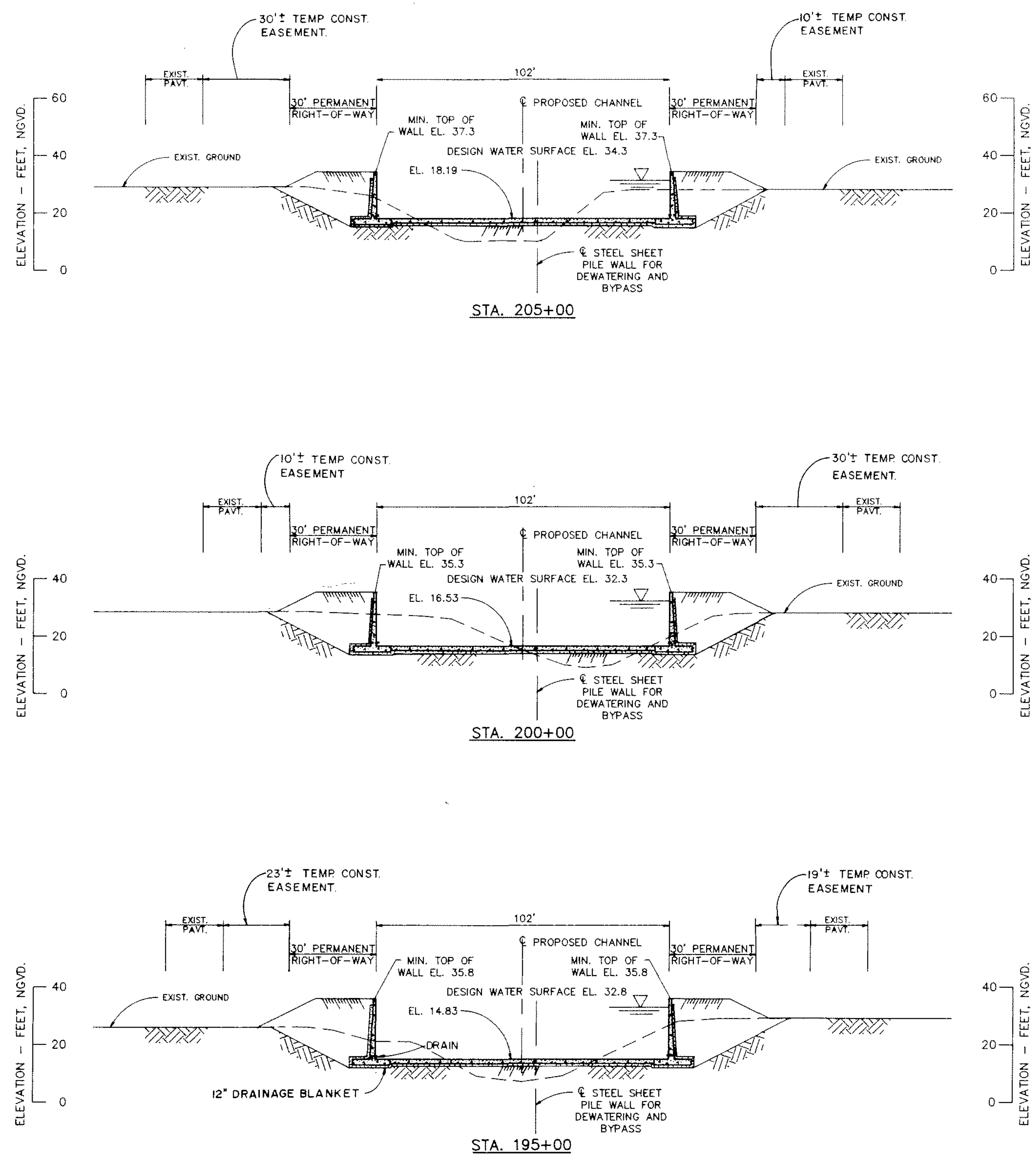
PUERTO NUEVO CHANNEL - REACH 3 & 4
STA 150+00 TO STA 190+00

CHANNEL CROSS SECTIONS

STRUCTURAL

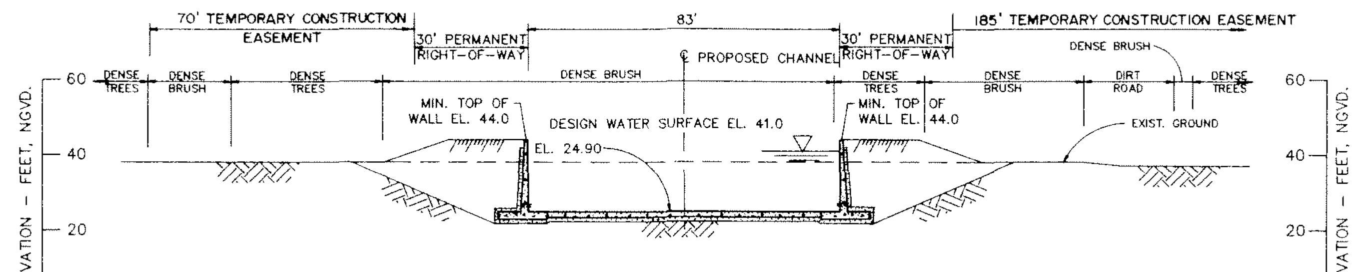
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

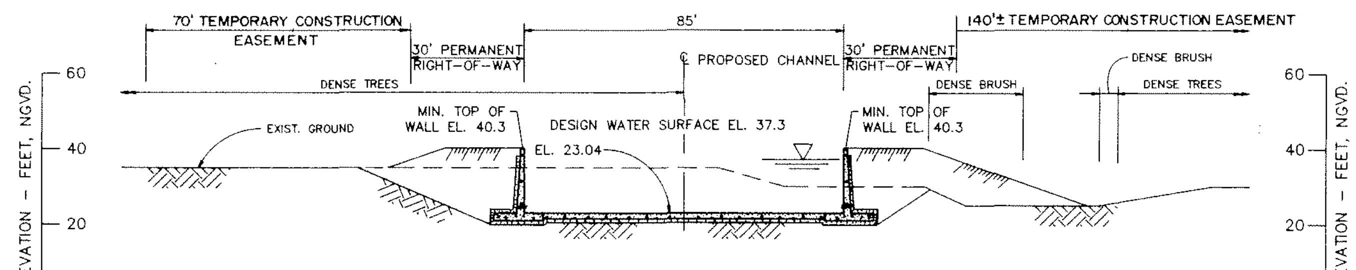



PUERTO NUEVO CHANNEL

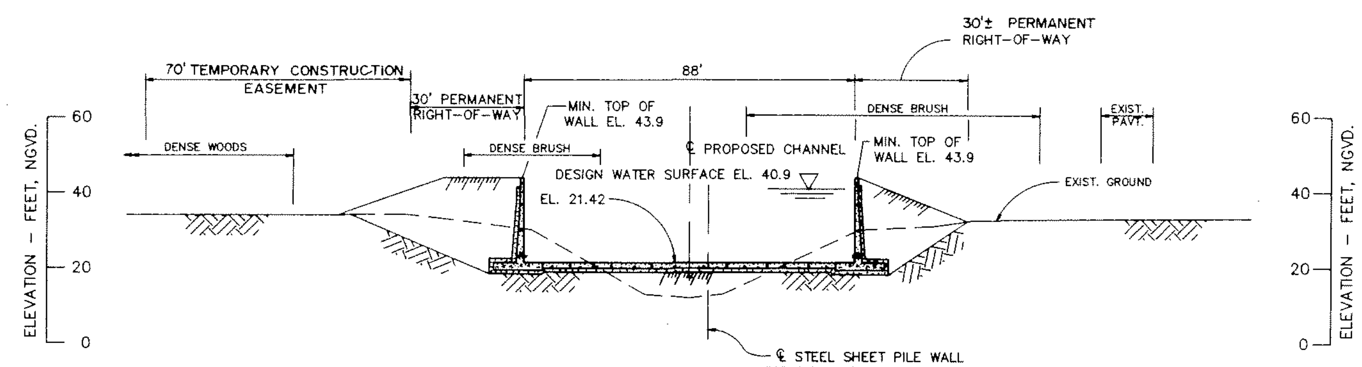
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 4
STA 195+00 TO STA 205+00
CHANNEL CROSS SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,678 DECEMBER 1990



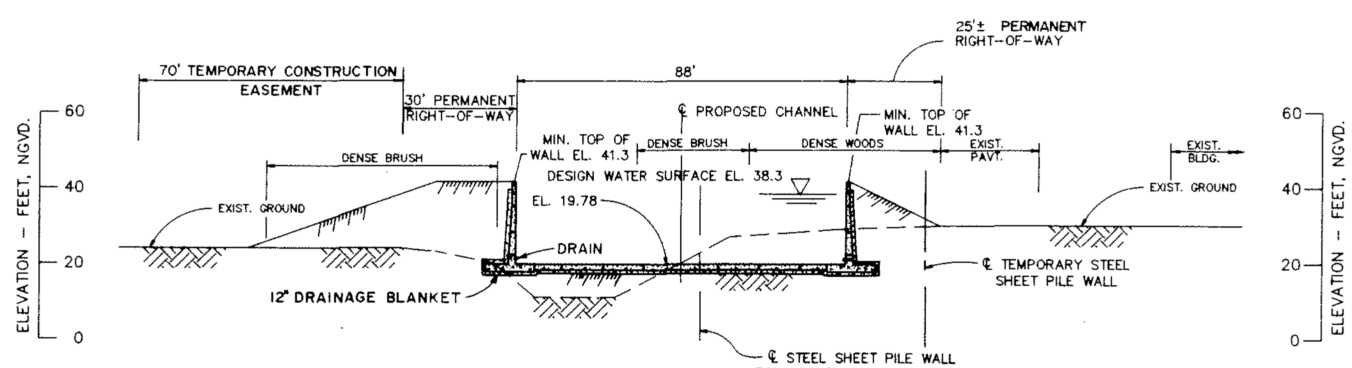

STA. 225+00




STA. 220+00




STA. 215+00




STA. 210+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL - REACH 4
STA 210+00 TO STA 225+00

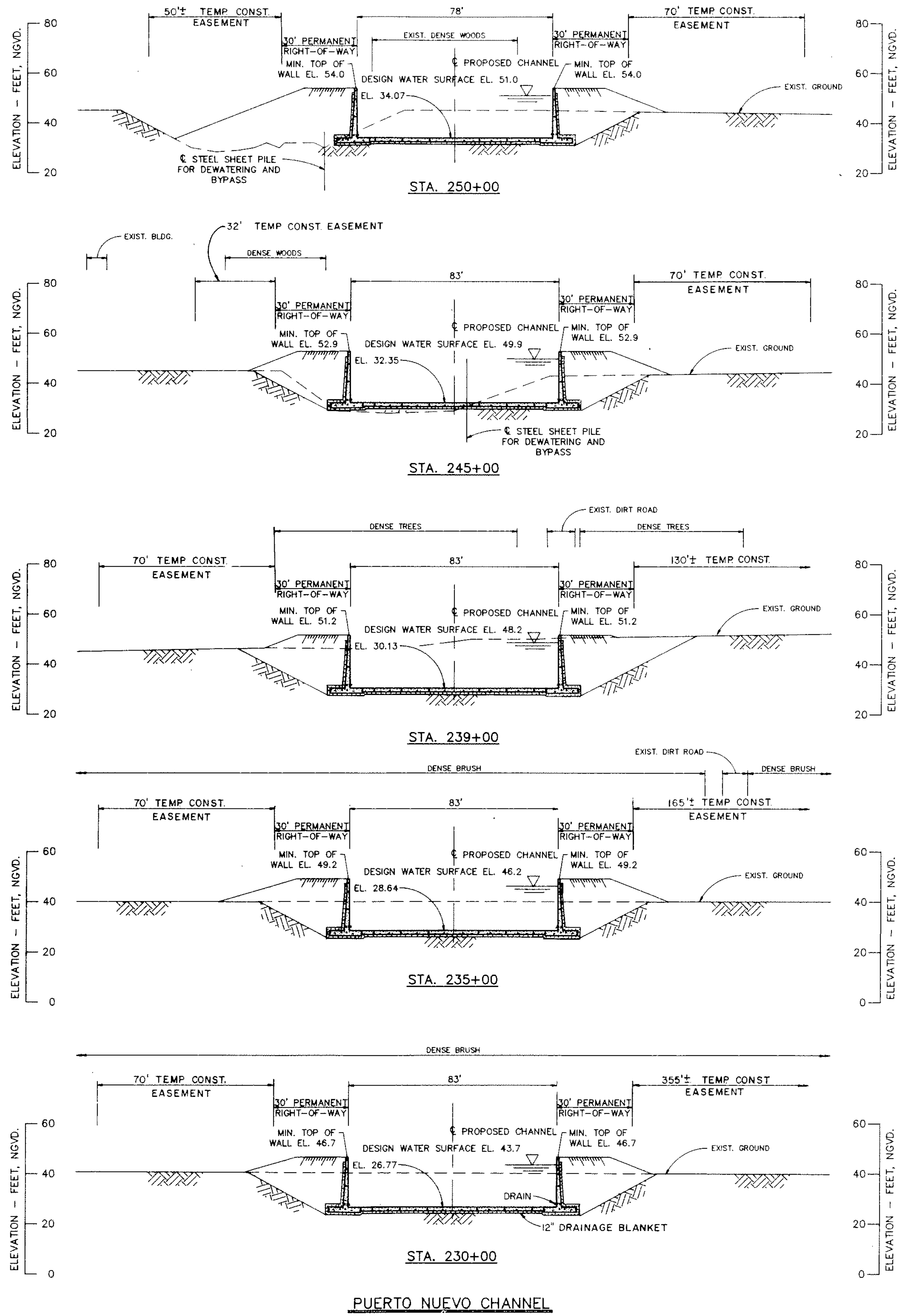
CHANNEL CROSS SECTIONS

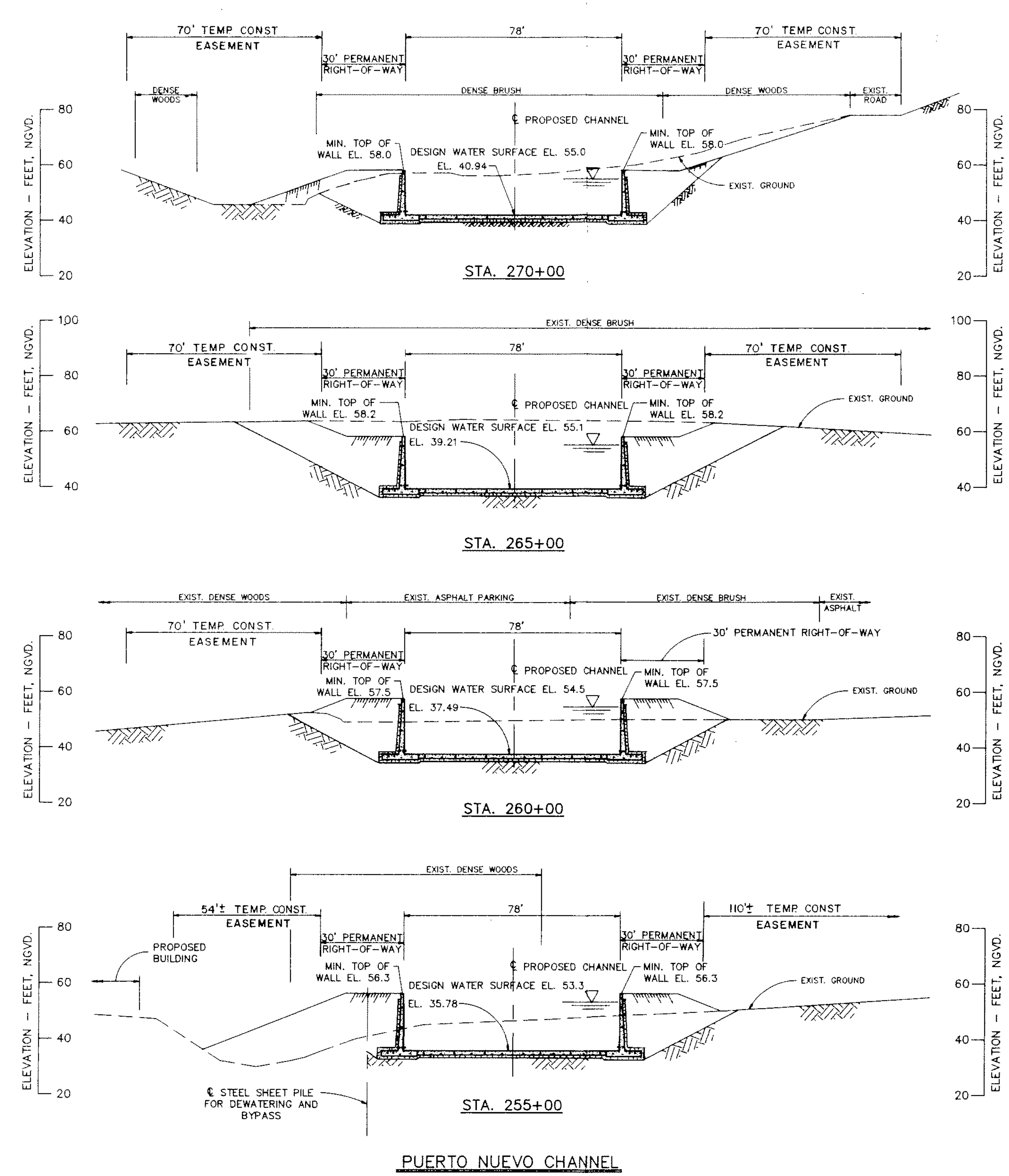
STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

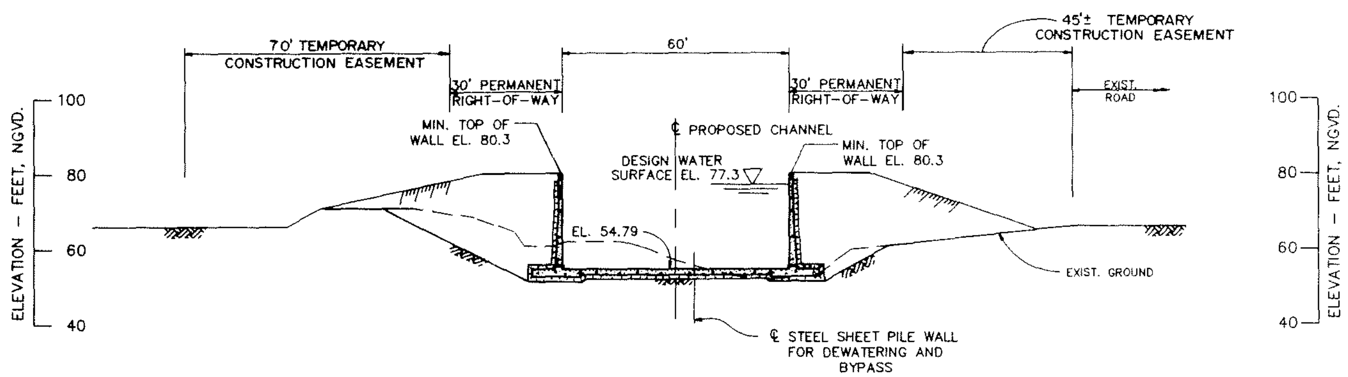
PUERTO NUEVO CHANNEL - REACH 4
STA 230+00 TO STA 270+00

CHANNEL CROSS SECTIONS

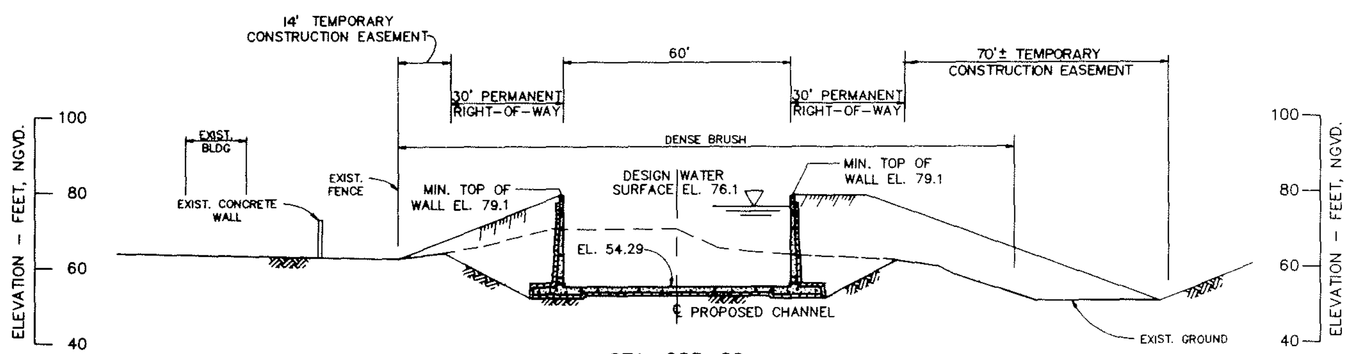
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

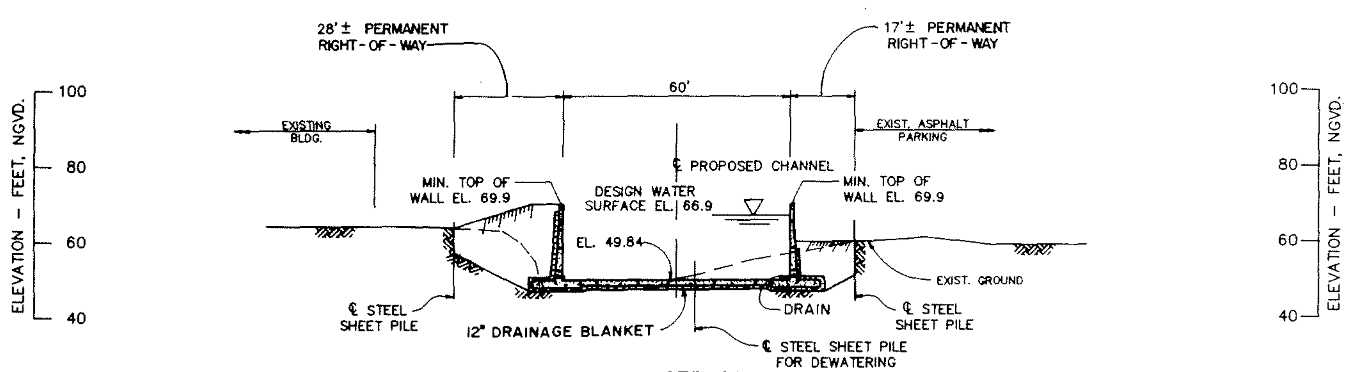
D.O. FILE NO. 102-35,578 DECEMBER 1990



STA. 290+00

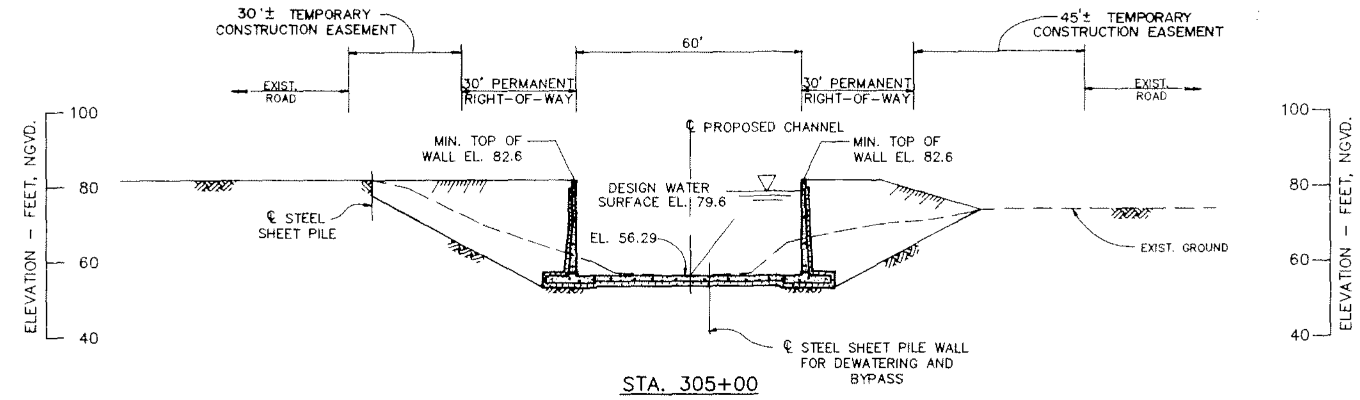


STA. 285+00

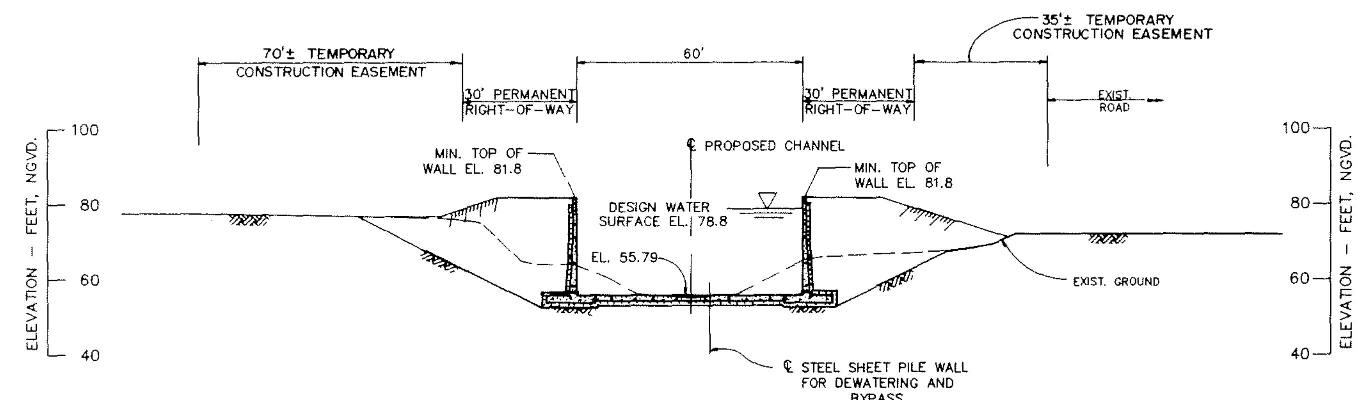


STA. 275+00

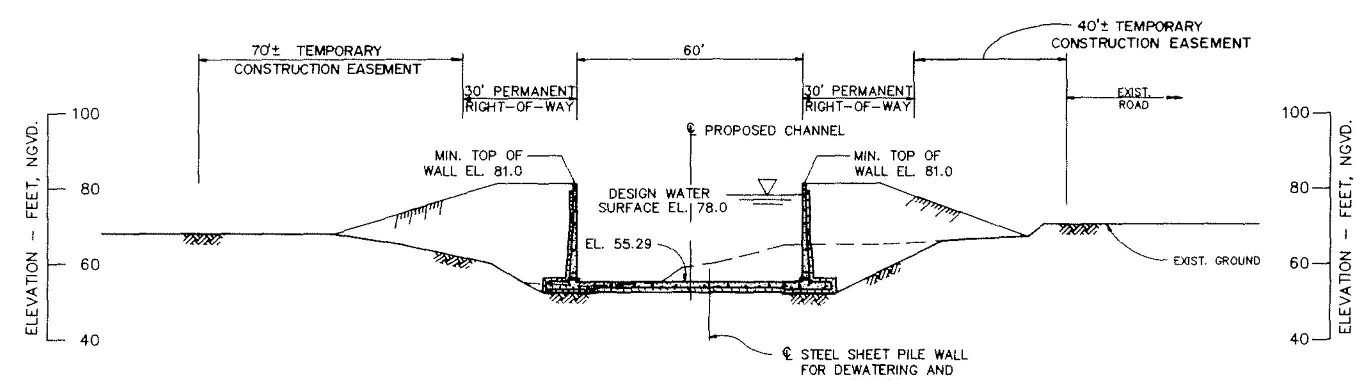
PUERTO NUEVO CHANNEL



STA. 305+00



STA. 300+00



STA. 295+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

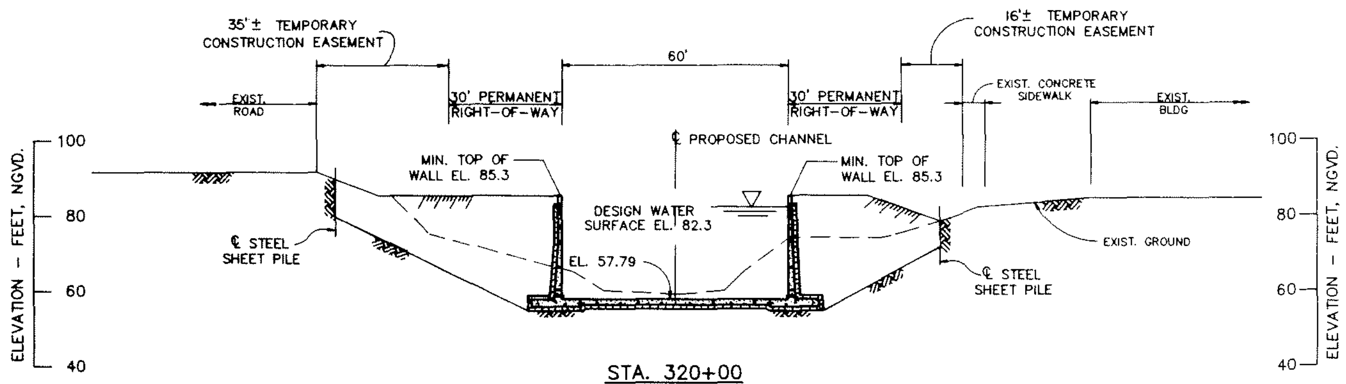
PUERTO NUEVO CHANNEL - REACH 4 & 5
STA 275+00 TO STA 305+00

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

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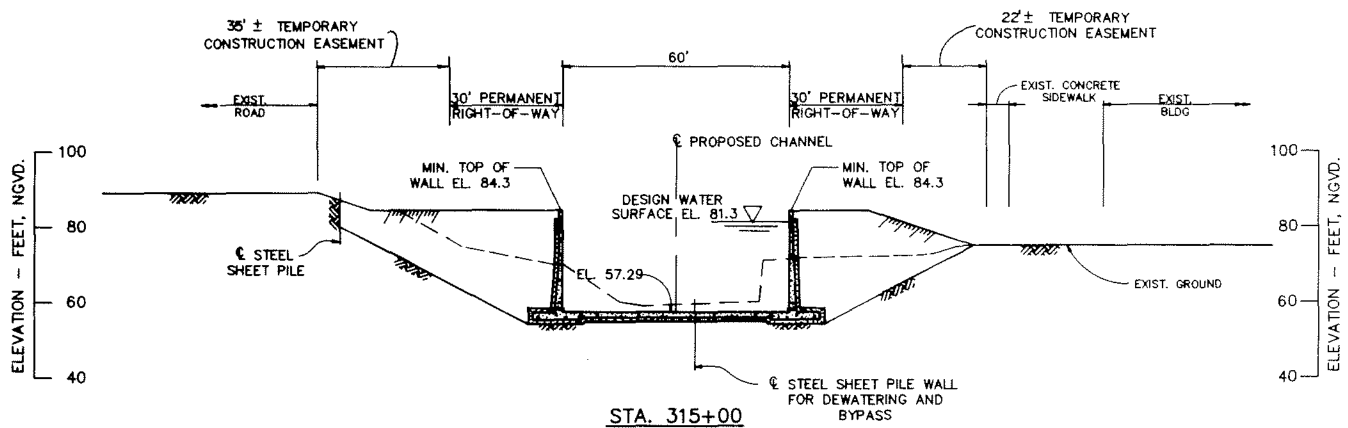
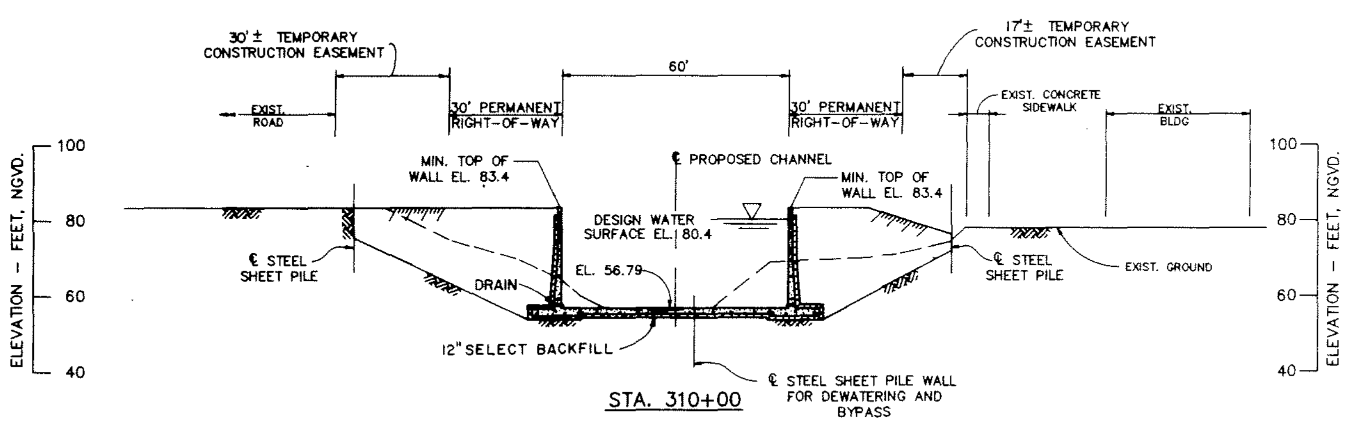
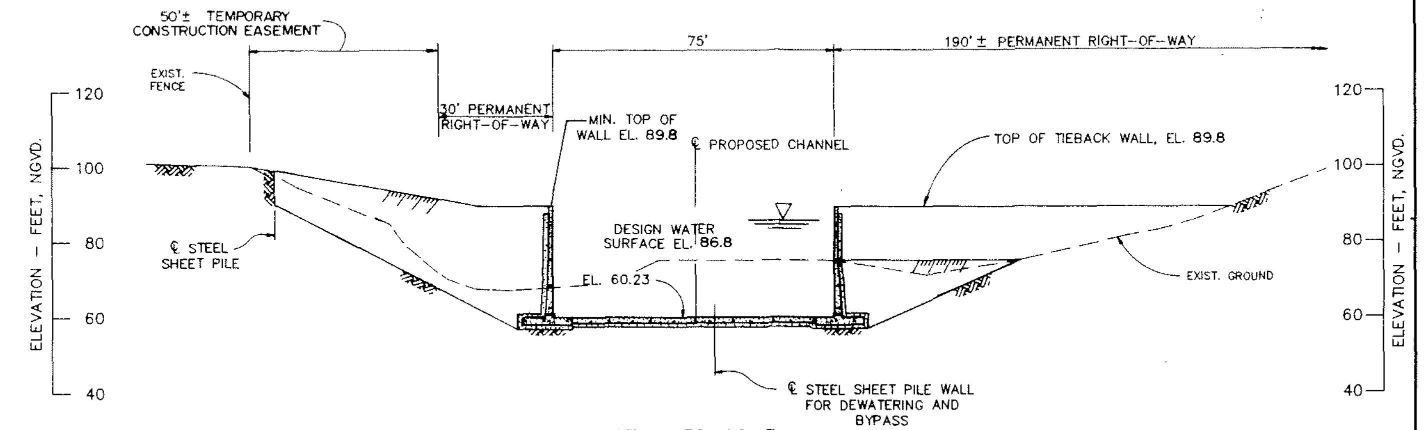



STA. 315+00

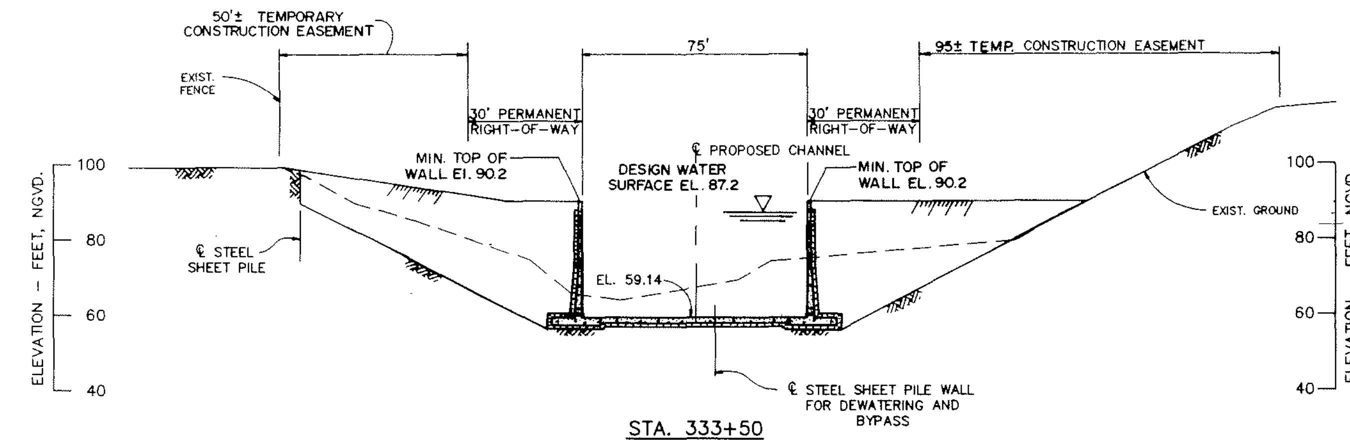



STA. 310+00

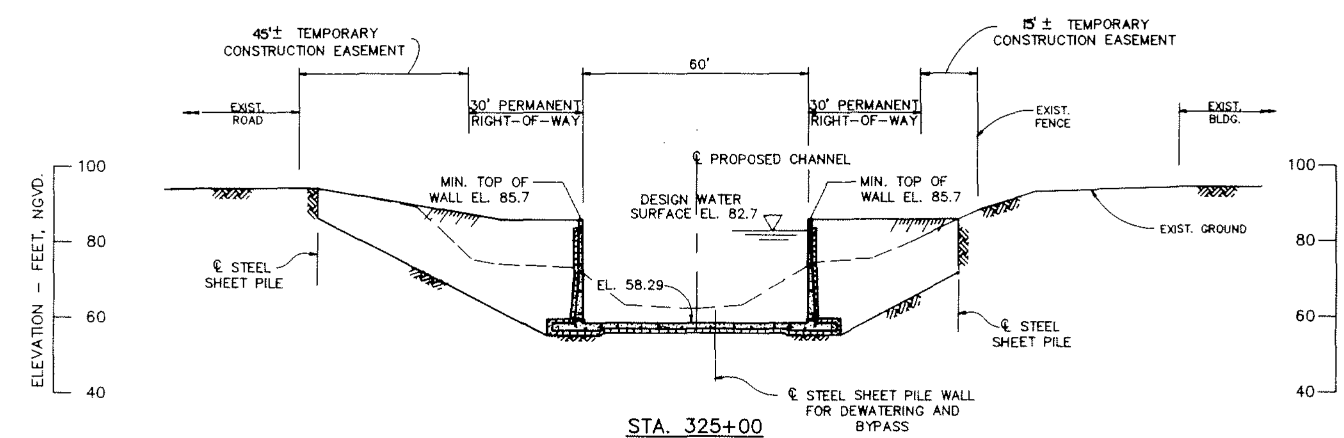
PUERTO NUEVO CHANNEL




STA. 338+92.15




STA. 333+50




STA. 325+00

PUERTO NUEVO CHANNEL

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

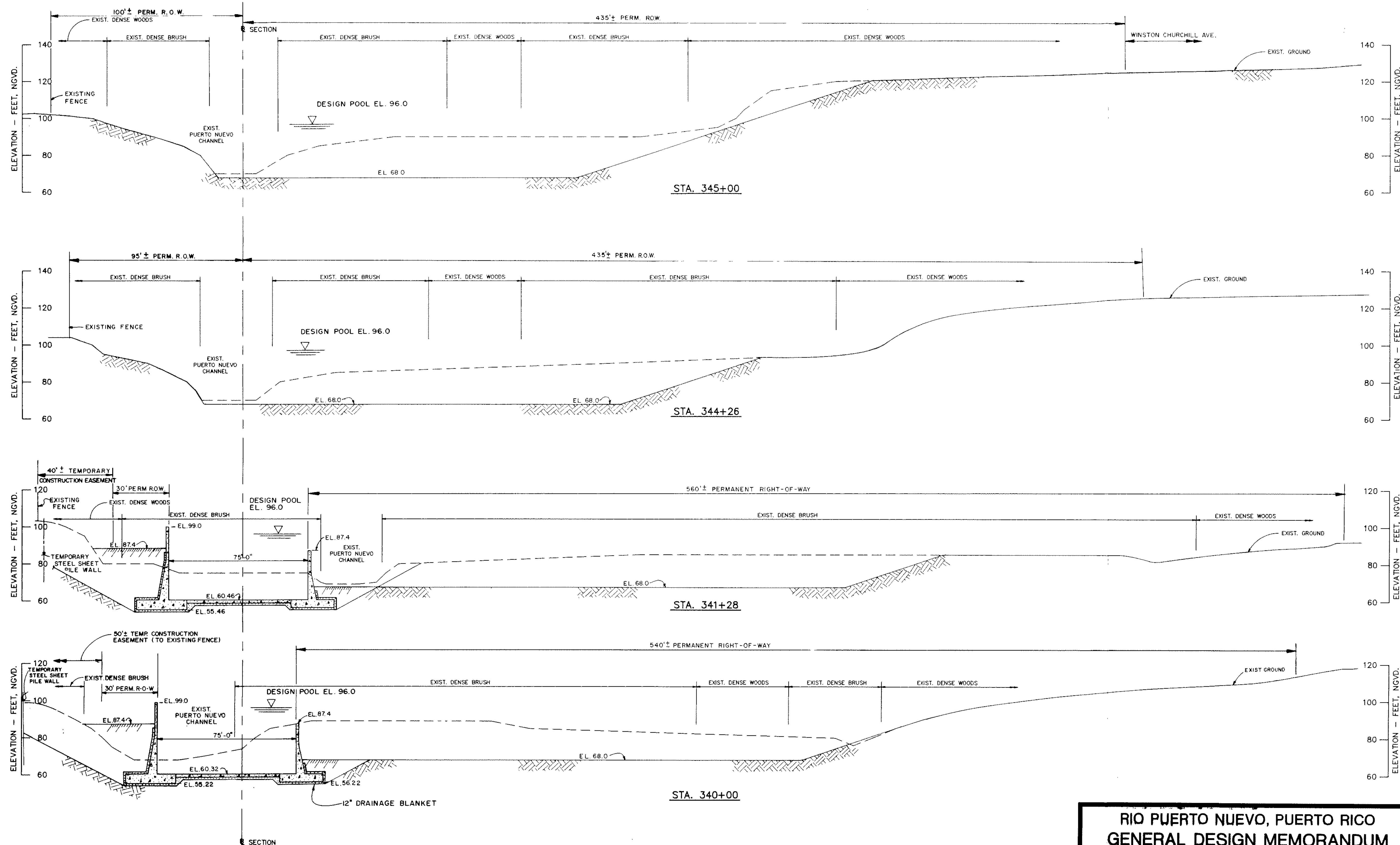
PUERTO NUEVO CHANNEL - REACH 5
STA 310+00 TO STA 338+92.15

## CHANNEL CROSS SECTIONS

STRUCTURAL

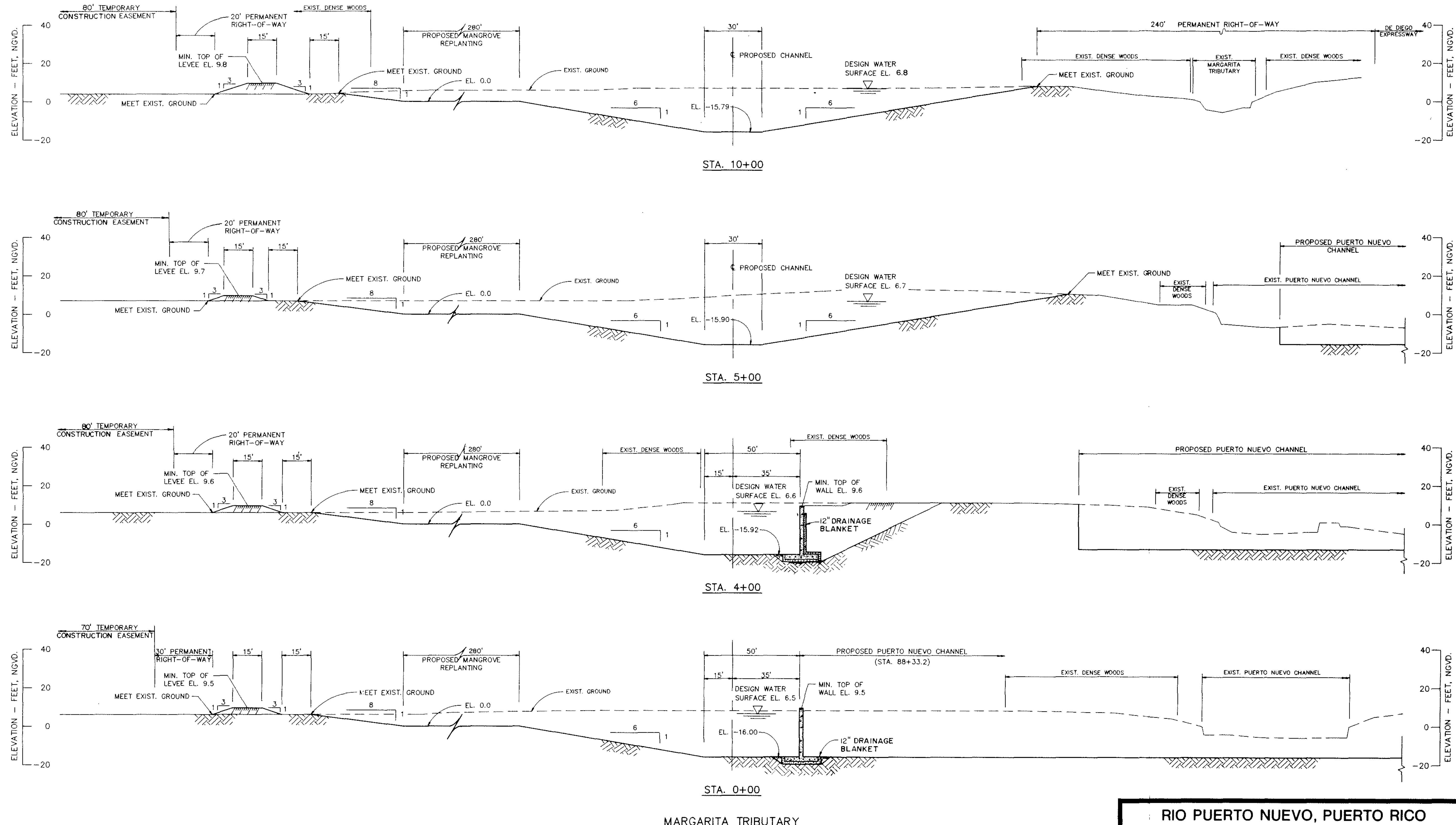
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




PUERTO NUEVO CHANNEL
DEBRIS BASIN

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL - REACH 5
STA 340+00 TO STA 345+00
CHANNEL CROSS SECTIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-65




RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

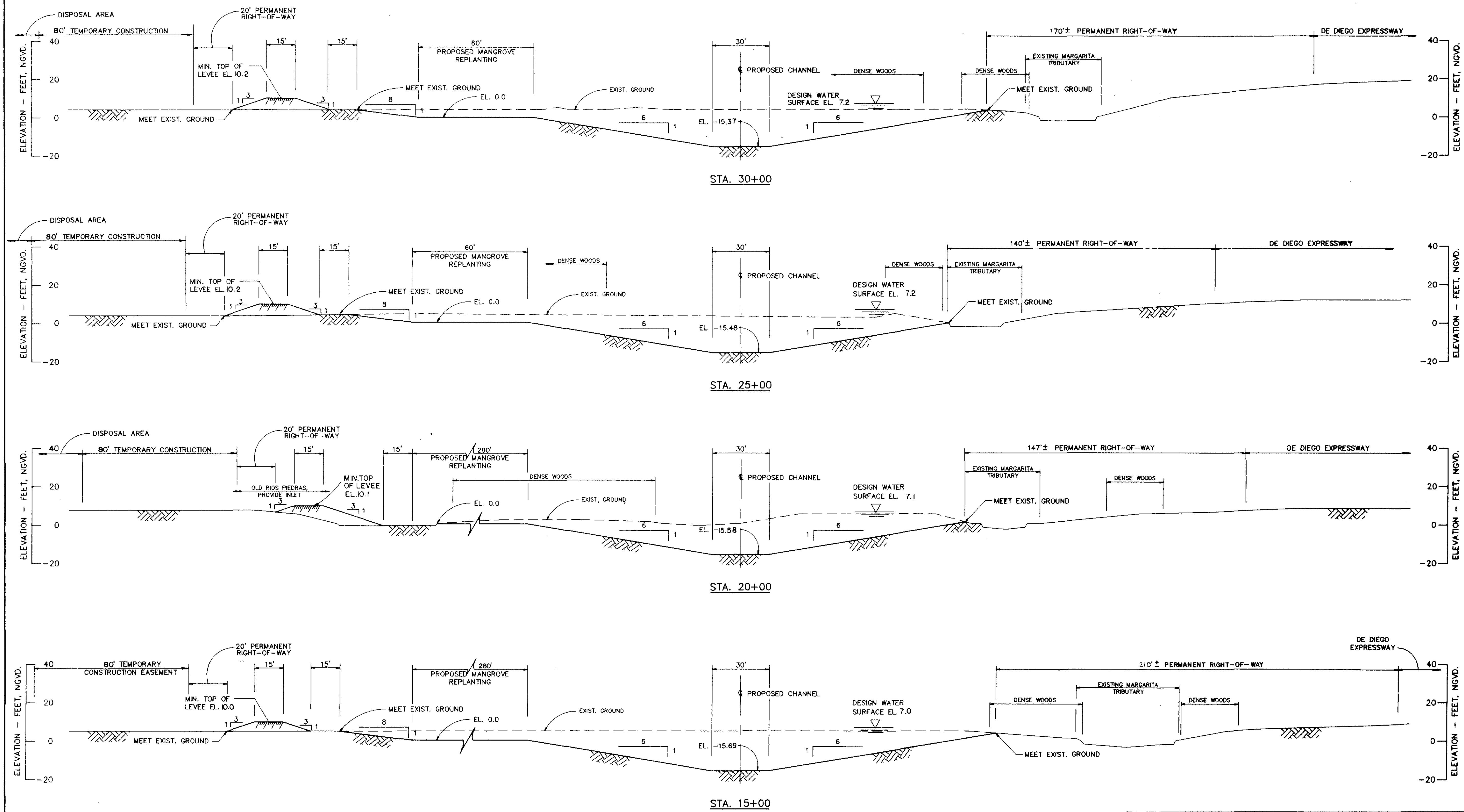
MARGARITA TRIBUTARY
STA 0+00 TO STA 10+00

## CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




MARGARITA TRIBUTARY

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY
STA 15+00 TO STA 30+00

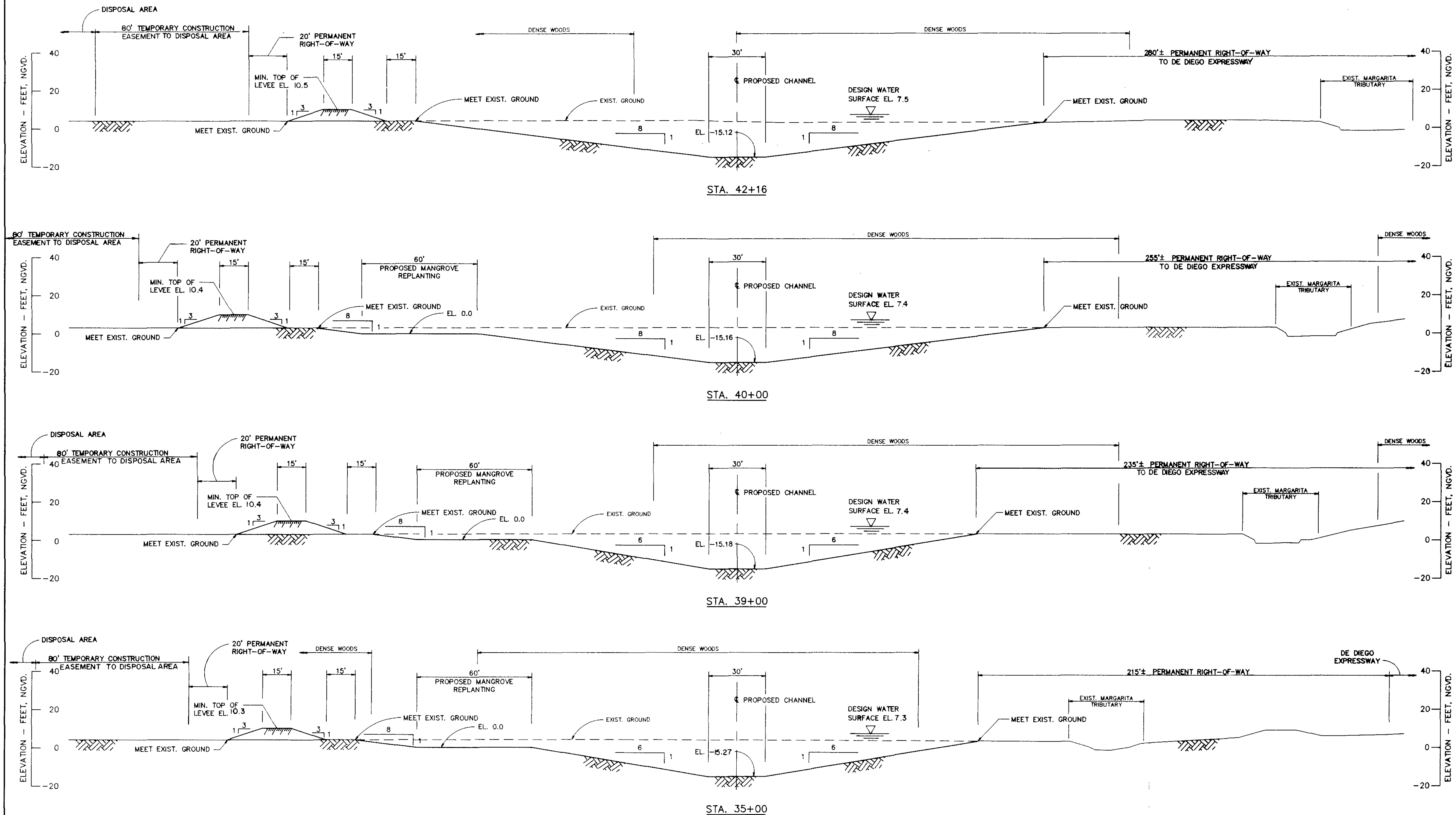
CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,678 DECEMBER 1990

PLATE S-67




MARGARITA TRIBUTARY

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

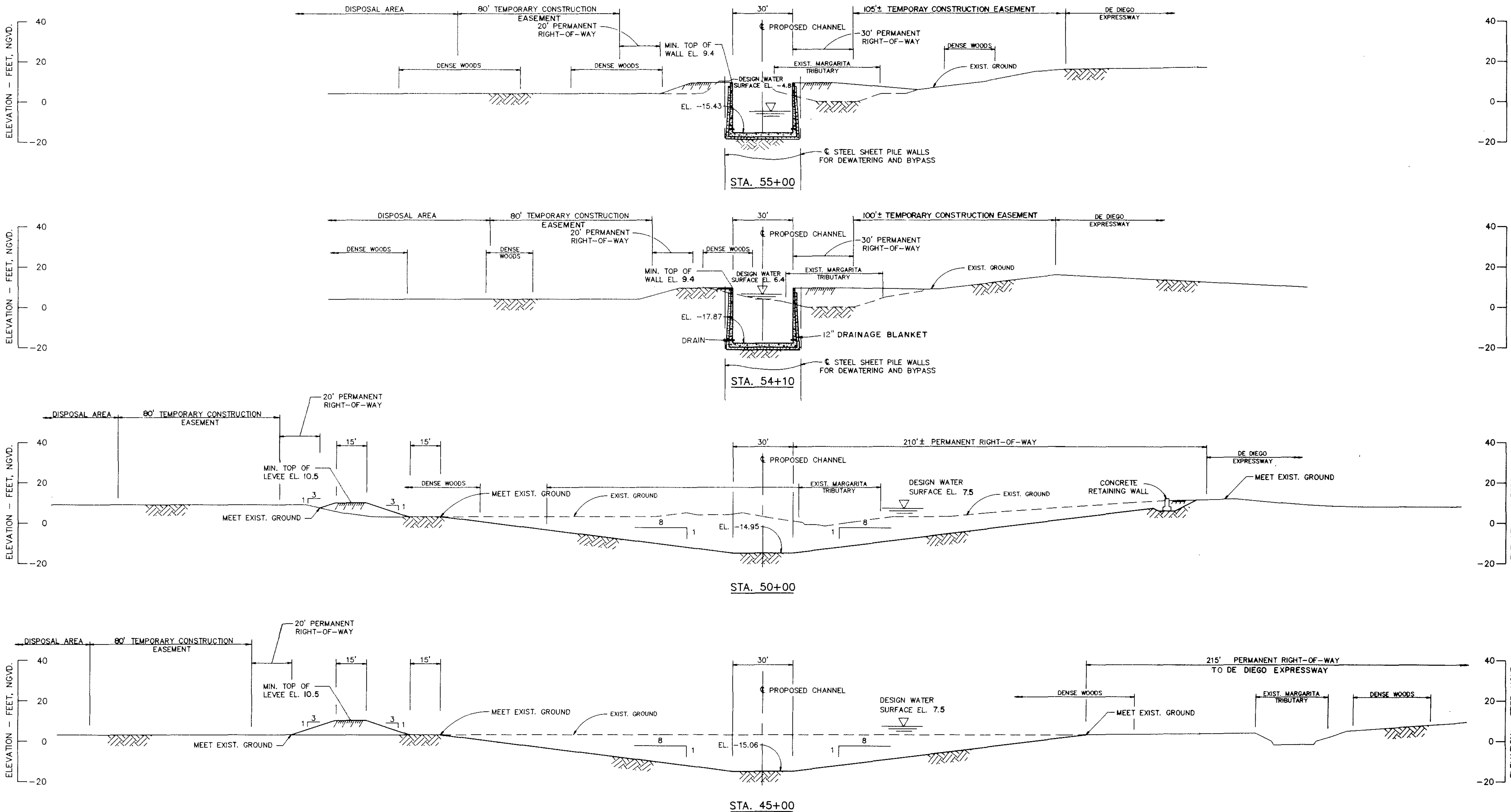
MARGARITA TRIBUTARY
STA 35+00 TO STA 42+16

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




MARGARITA TRIBUTARY

RIO PUERTO NUEVO, PUERTO RICO

## GENERAL DESIGN MEMORANDUM

MARGARITA TRIBUTARY
STA 45+00 TO STA 55+00

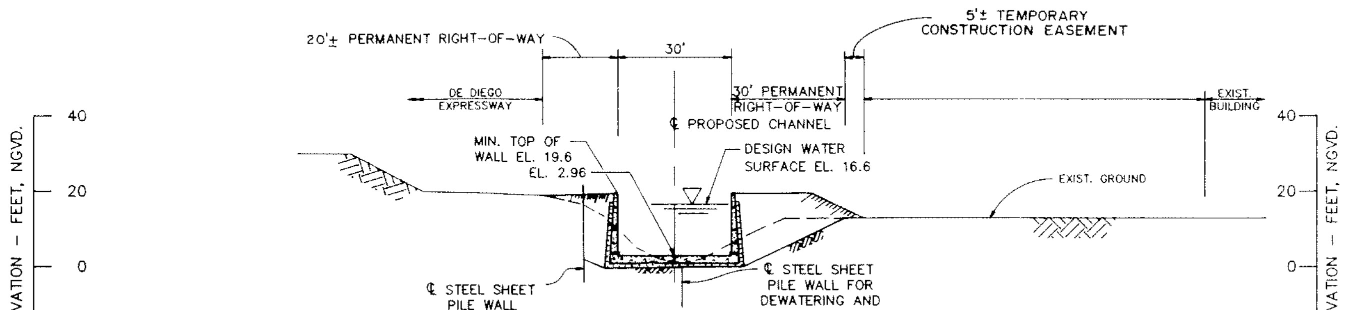
## CHANNEL CROSS SECTIONS

STRUCTURAL

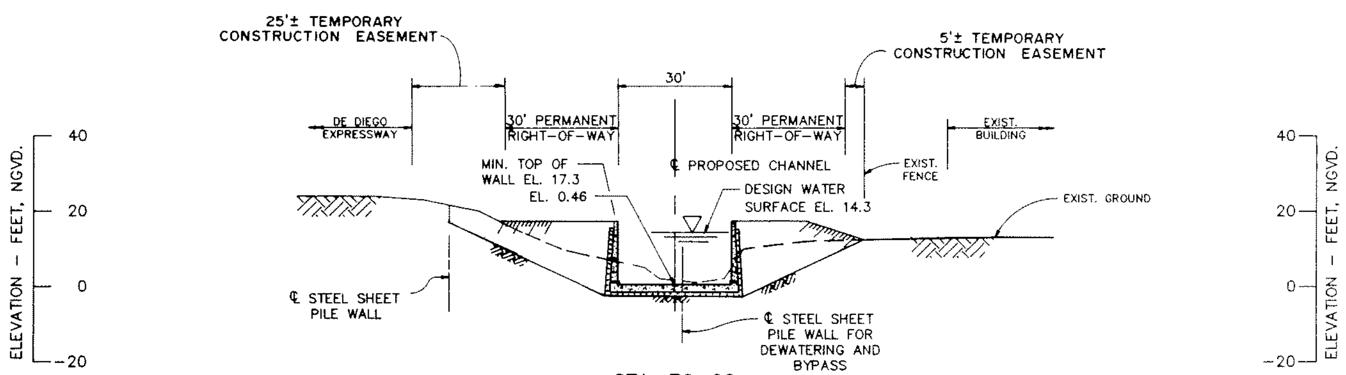
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

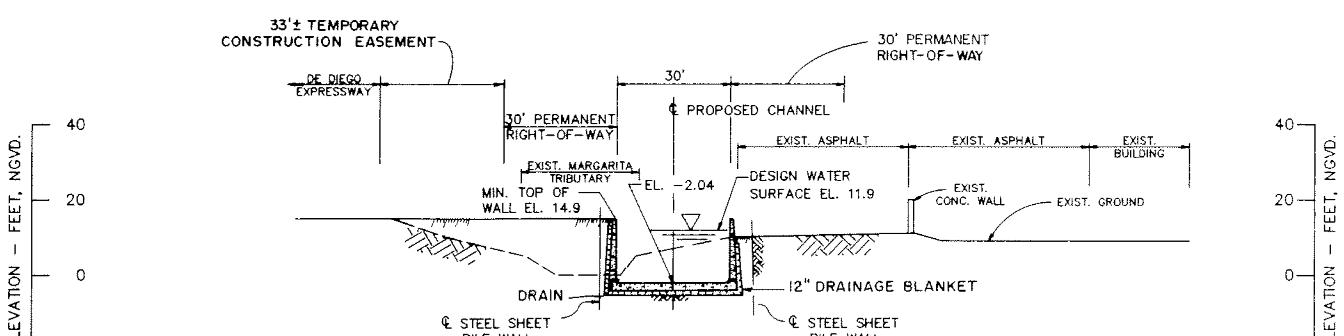
PLATE S-69



STA. 75+00

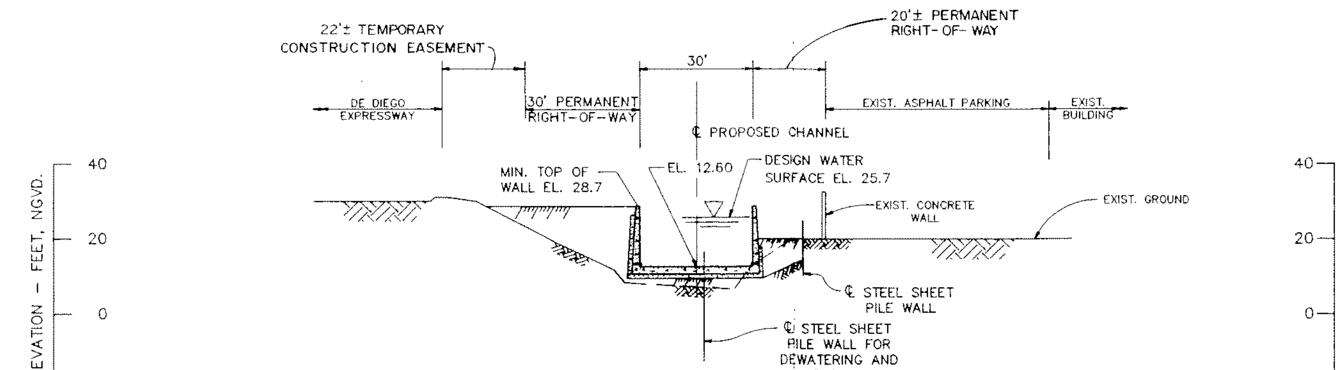


STA. 70+00

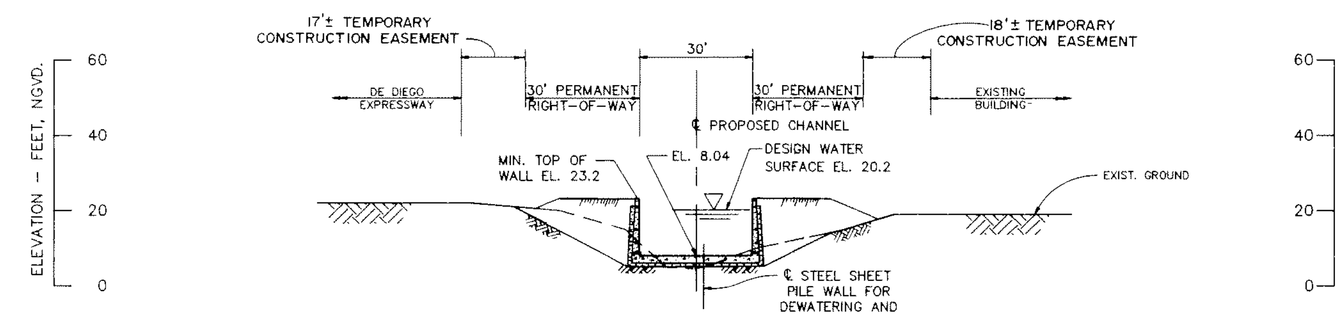


STA. 65+00

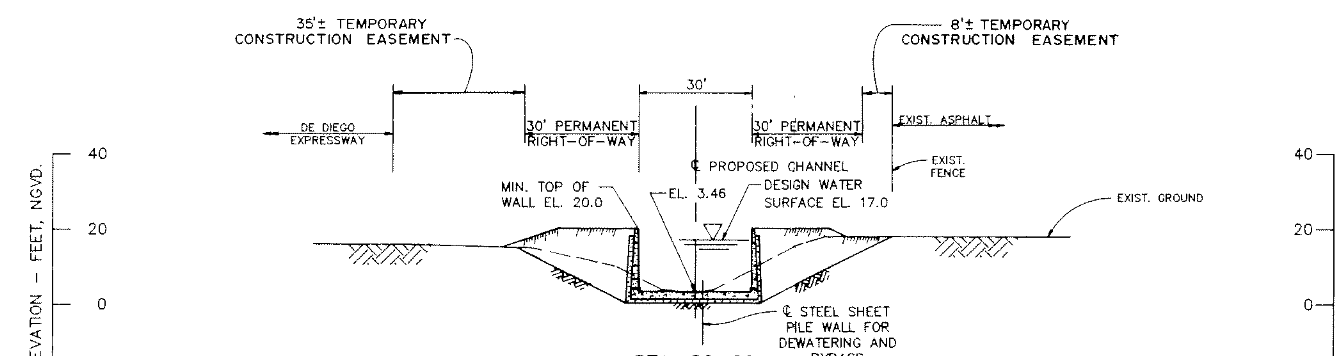
MARGARITA TRIBUTARY



STA. 89+60



STA. 85+00



STA. 80+00

MARGARITA TRIBUTARY

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

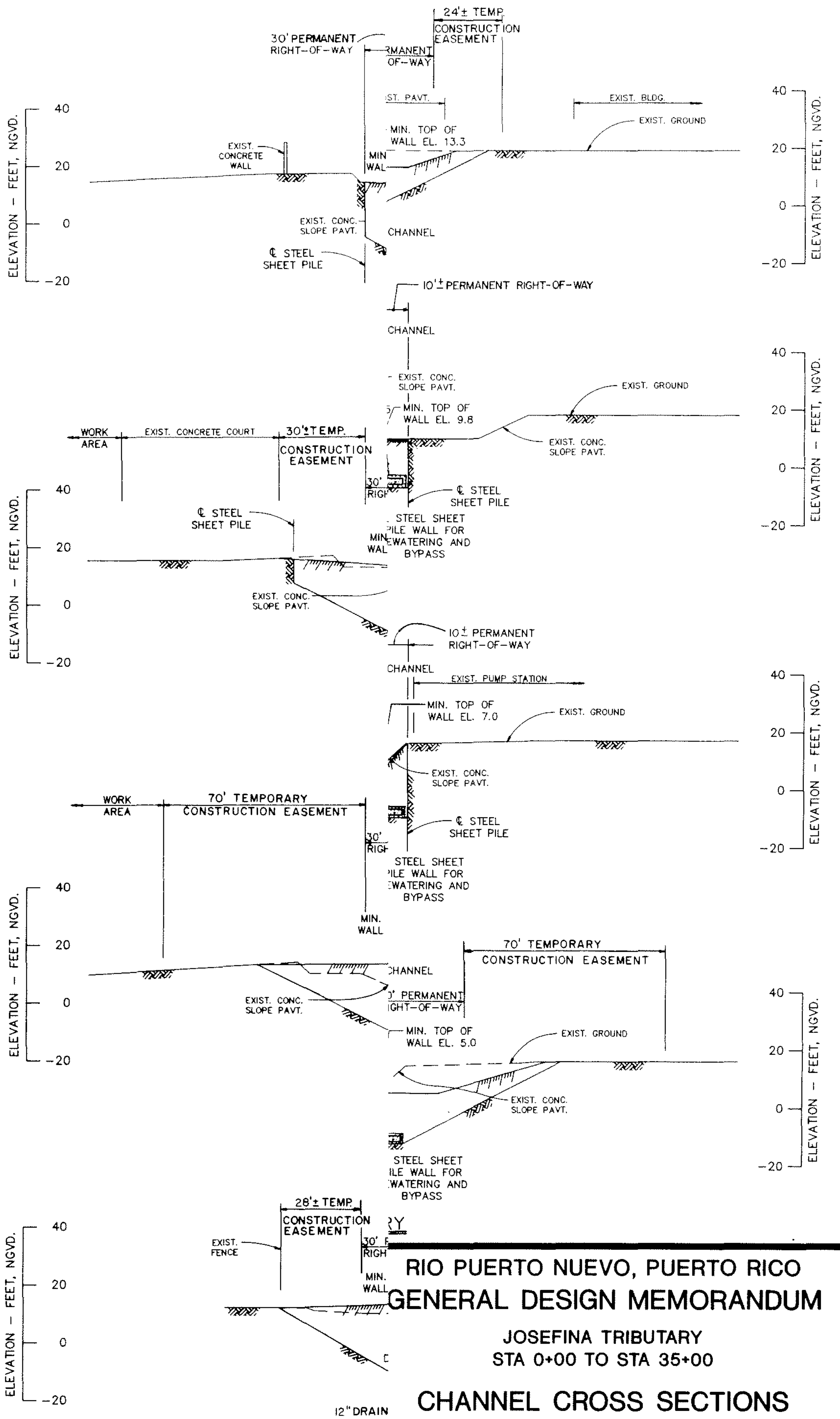
MARGARITA TRIBUTARY
STA 65+00 TO STA 89+60

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

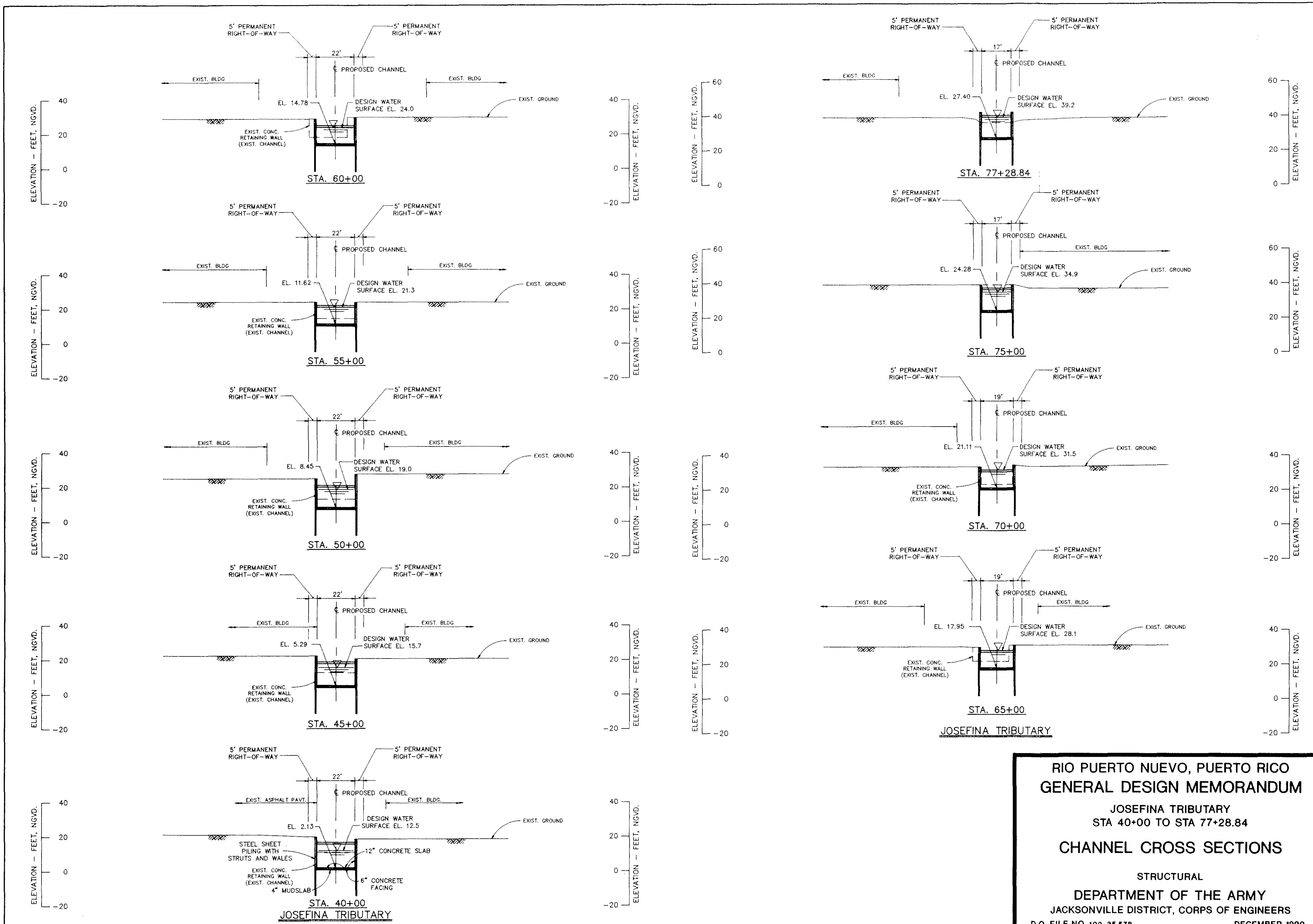
JOSEFINA TRIBUTARY
STA 0+00 TO STA 35+00

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

). FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY

STA 40+00 TO STA 77+28.84

CHANNEL CROSS SECTIONS

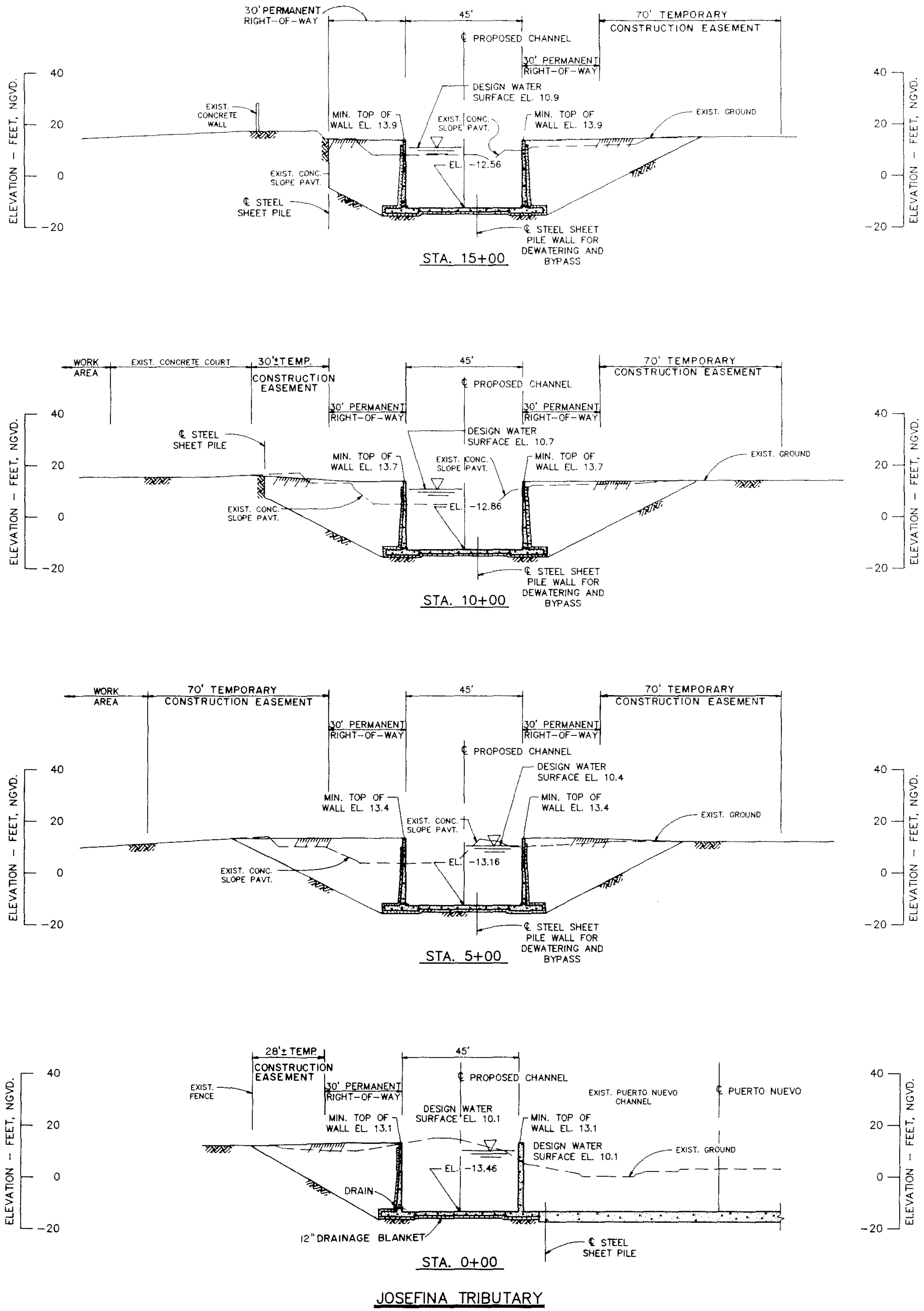
STRUCTURAL

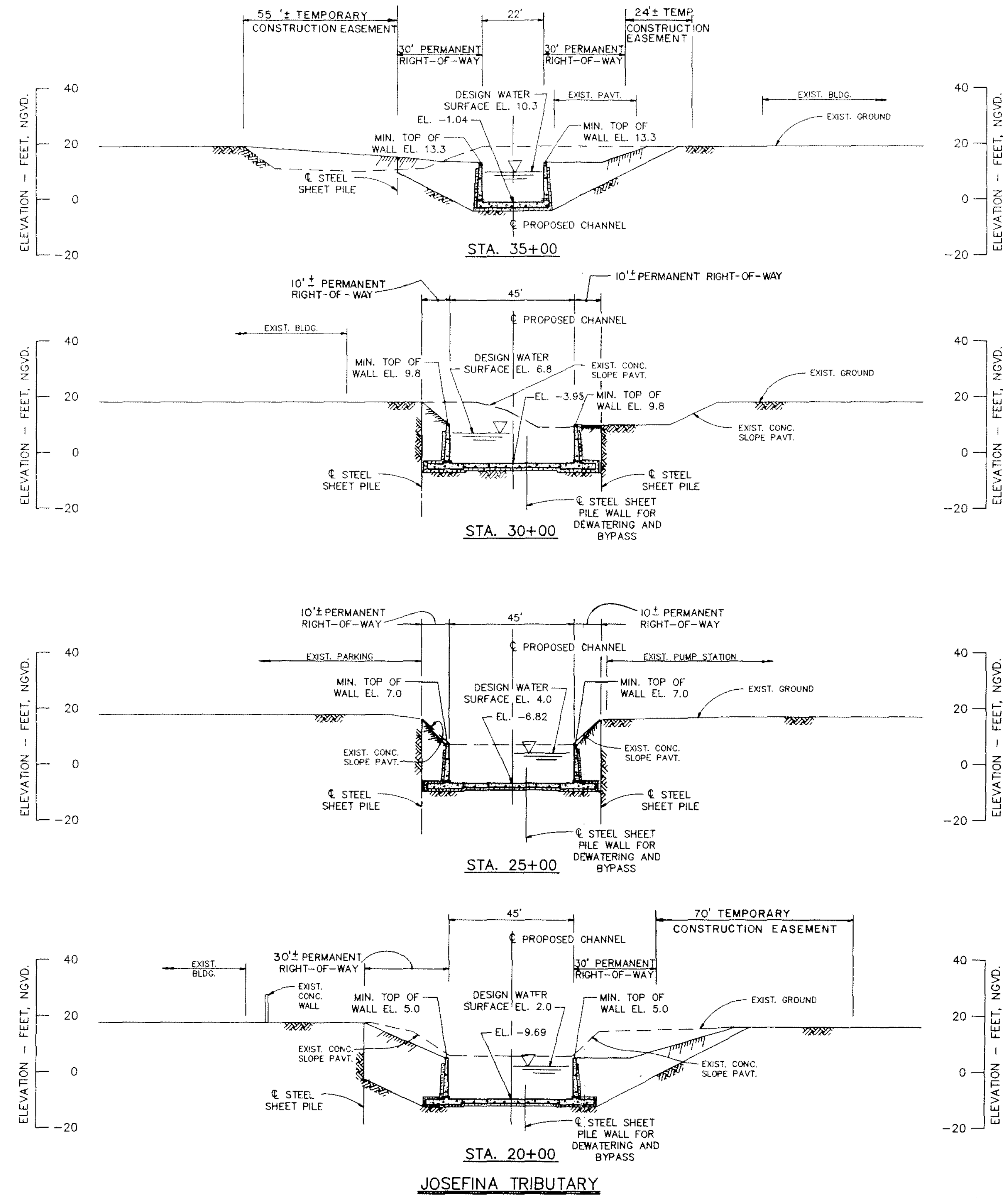
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-72




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY

STA 0+00 TO STA 35+00

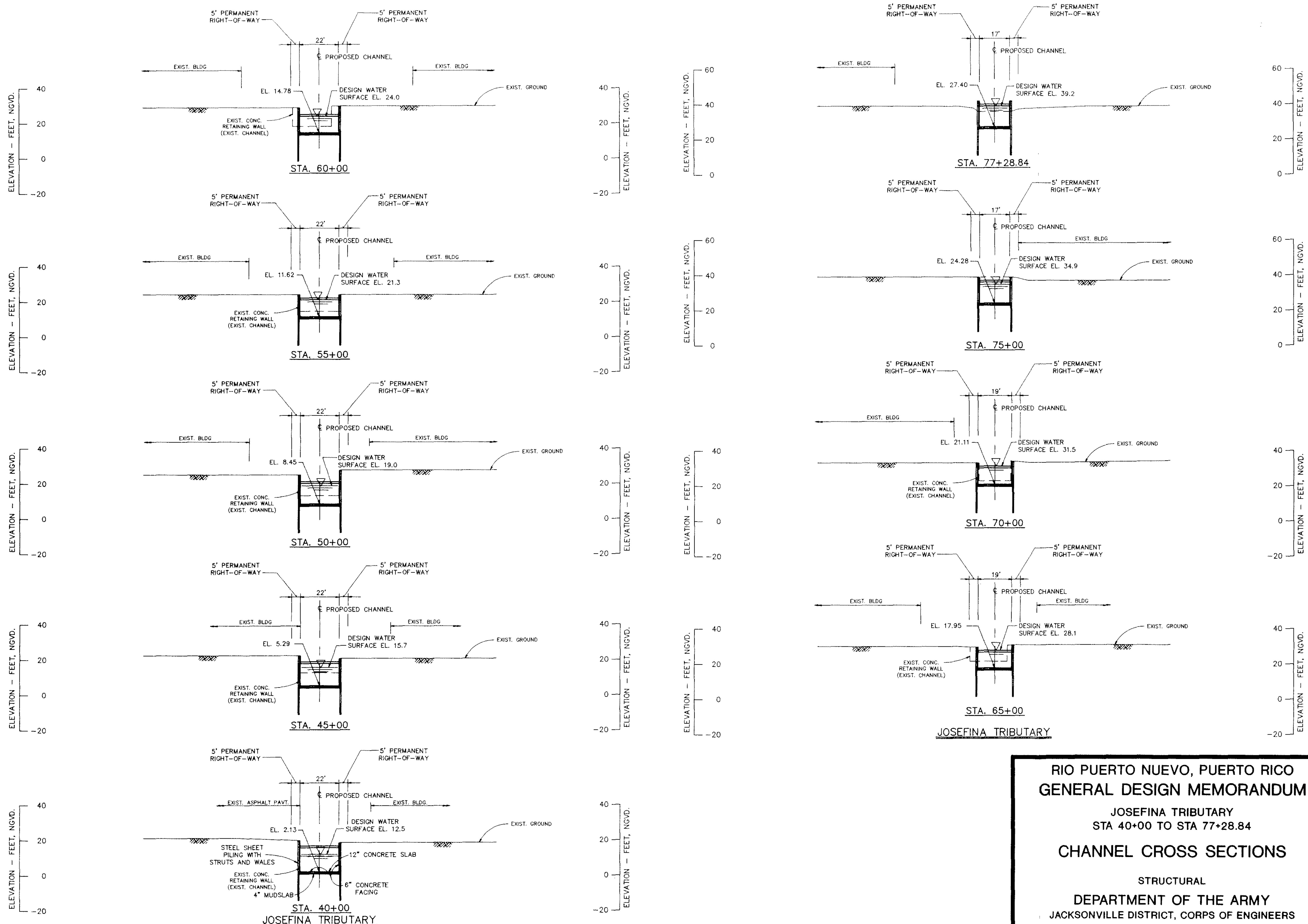
CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

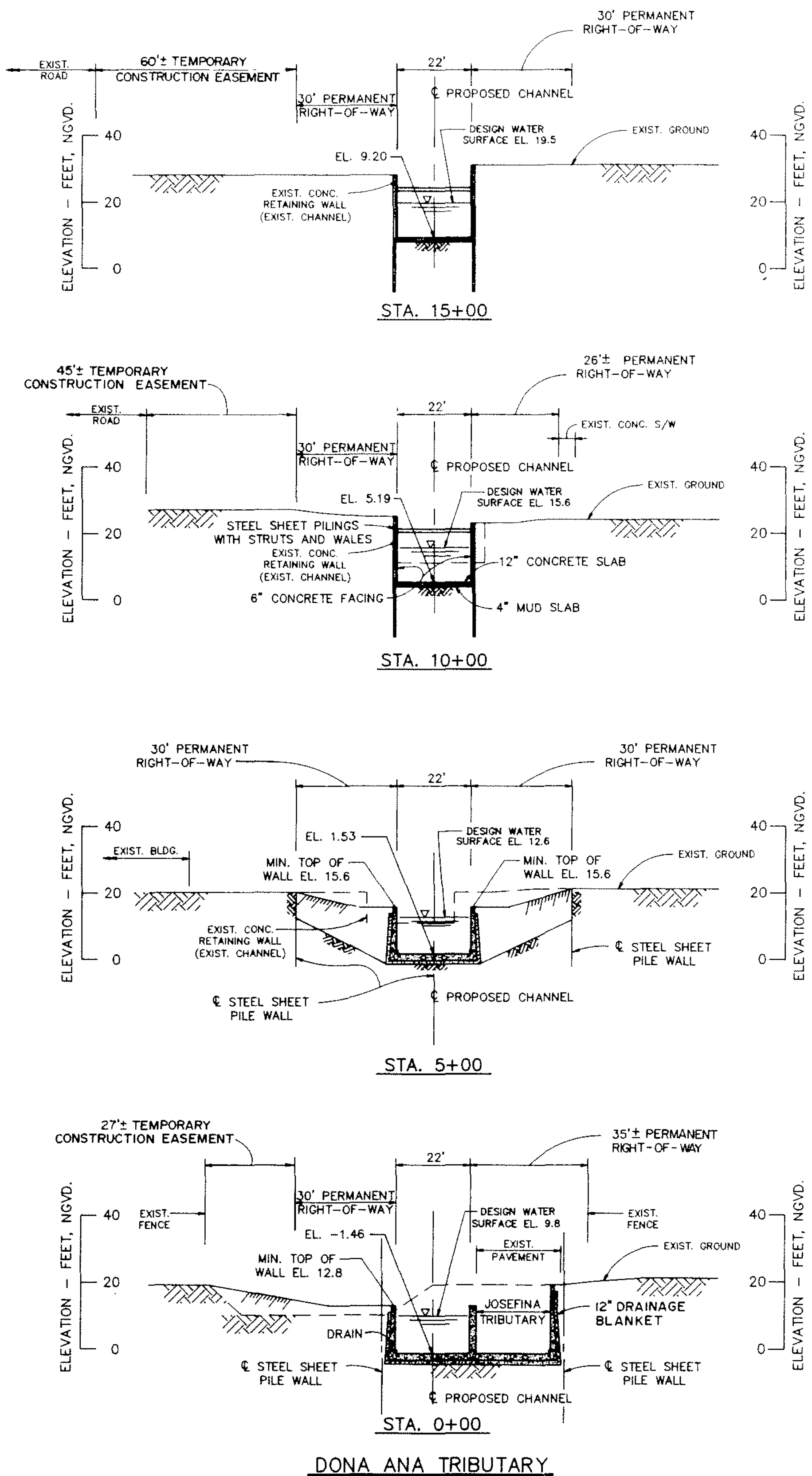
JOSEFINA TRIBUTARY
STA 40+00 TO STA 77+28.84

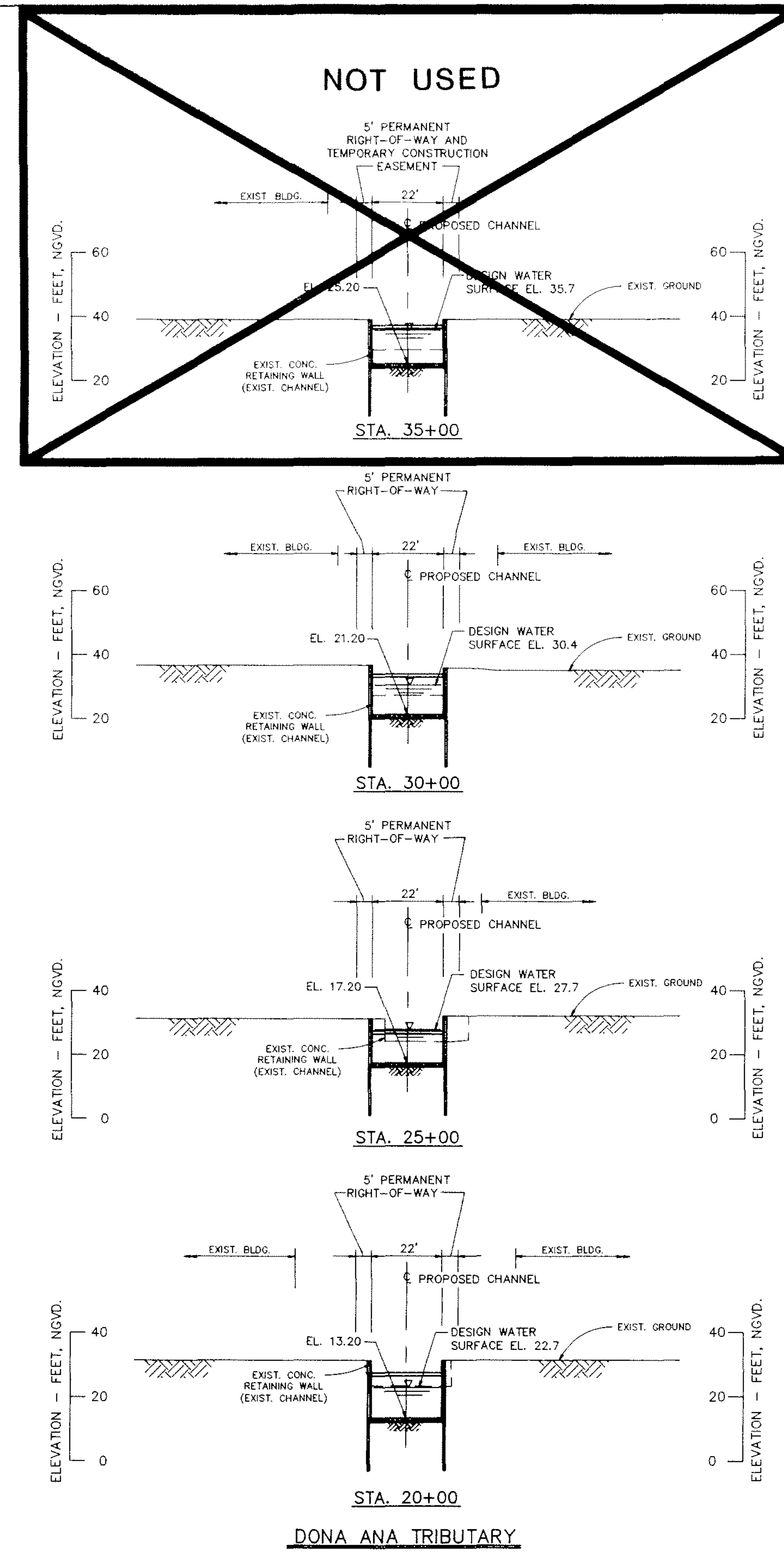
CHANNEL CROSS SECTIONS

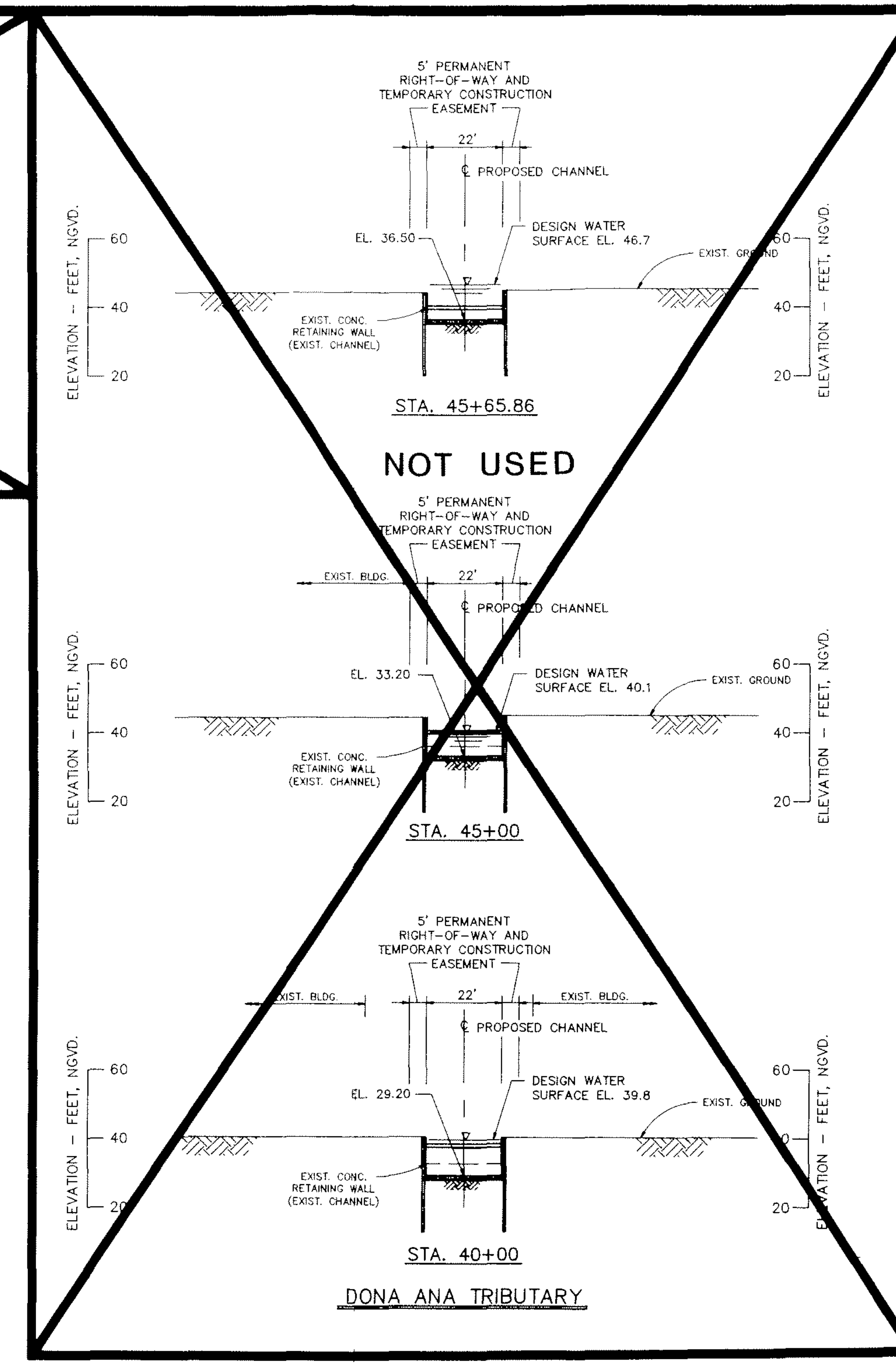
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,678 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

DONA ANA TRIBUTARY

STA 0+00 TO STA 30+00

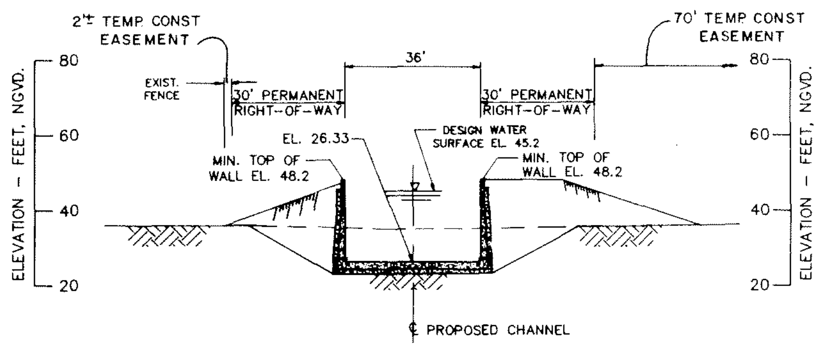
CHANNEL CROSS SECTIONS

STRUCTURAL

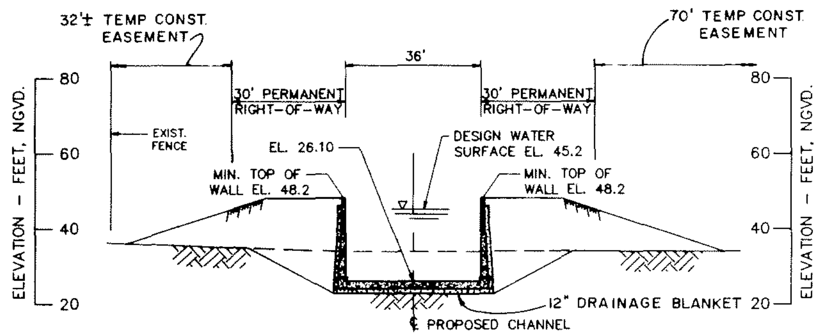
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

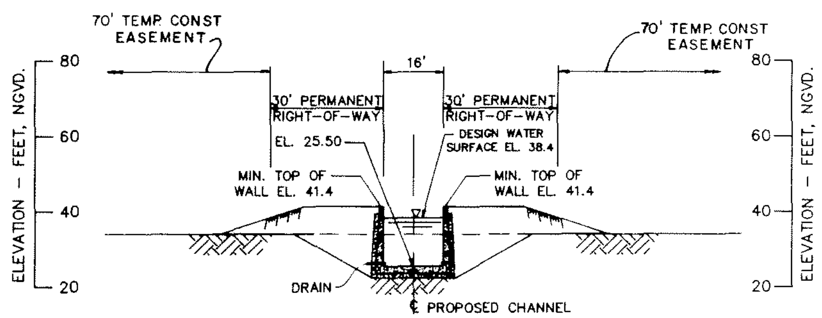
D.O. FILE NO. 102-35,578 DECEMBER 1990



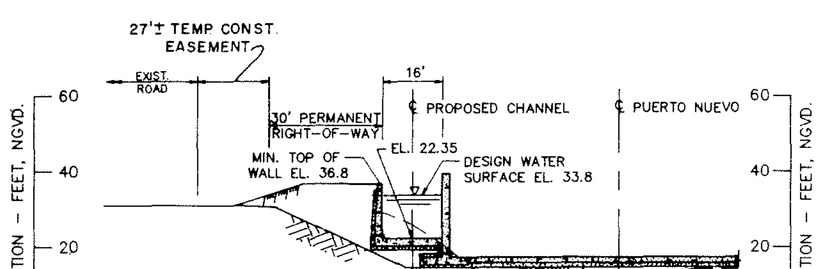

STA. 10+00




STA. 8+50



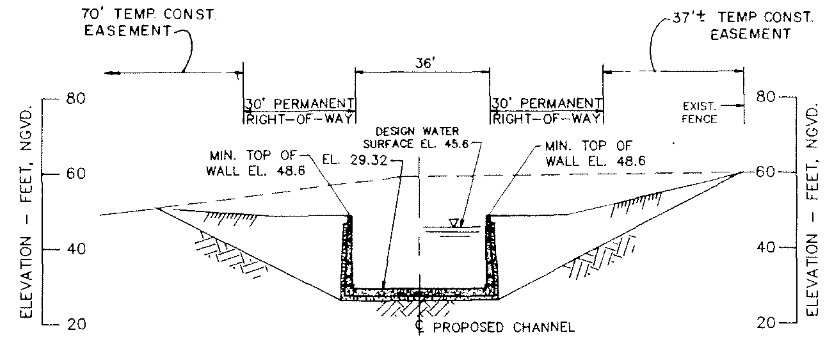

STA. 4+50



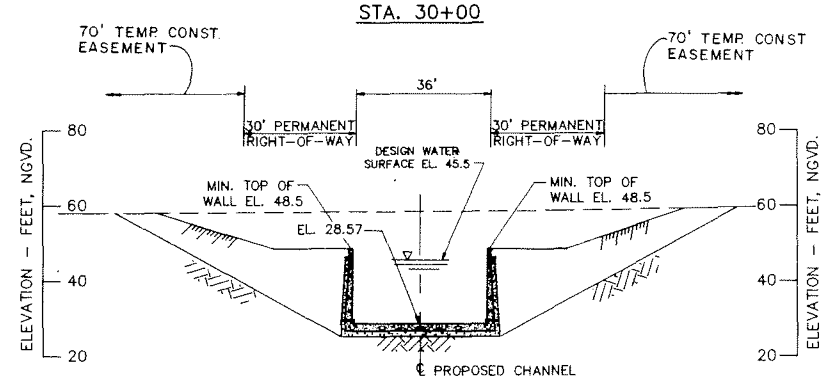

STA. 0+00

BUENA VISTA DIVERSION

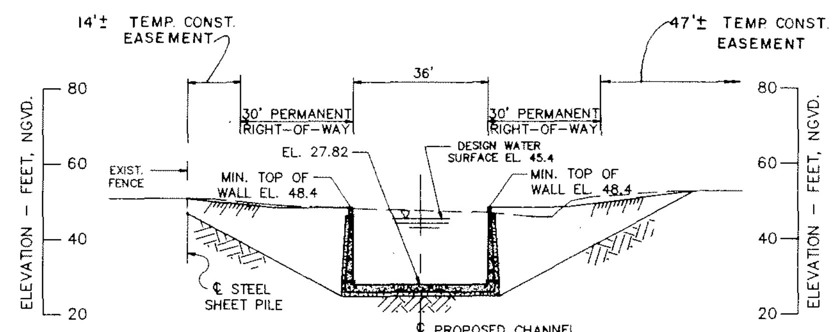
12" DRAINAGE BLANKET



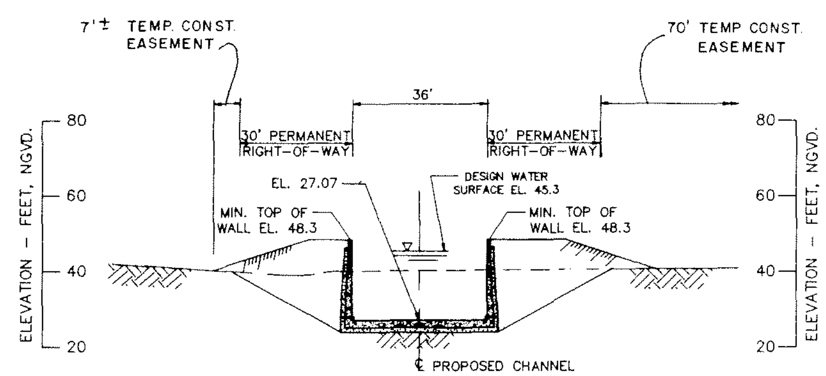

STA. 30+00




STA. 25+00

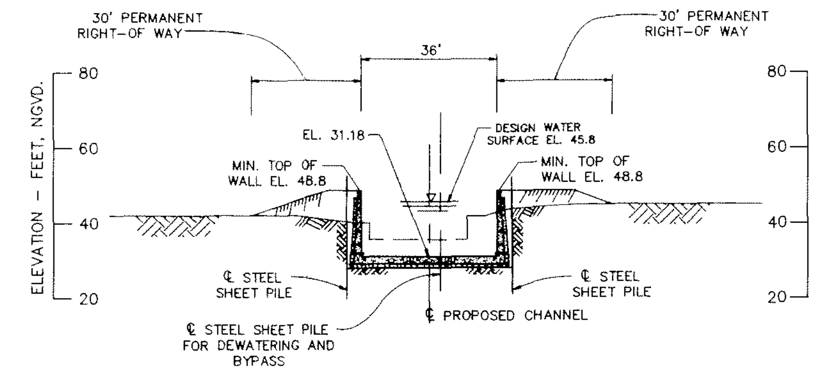



STA. 20+00

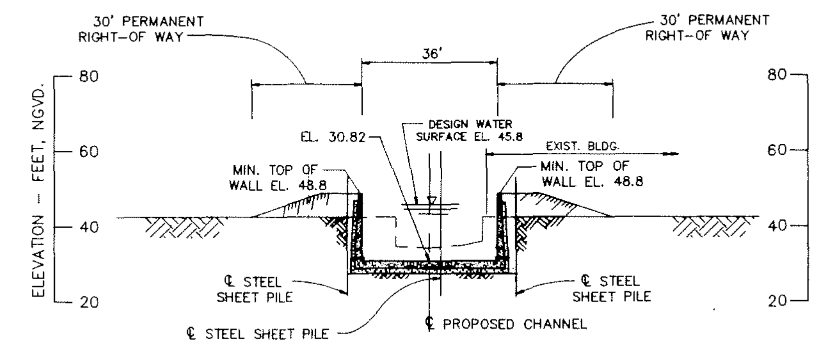



STA. 15+00

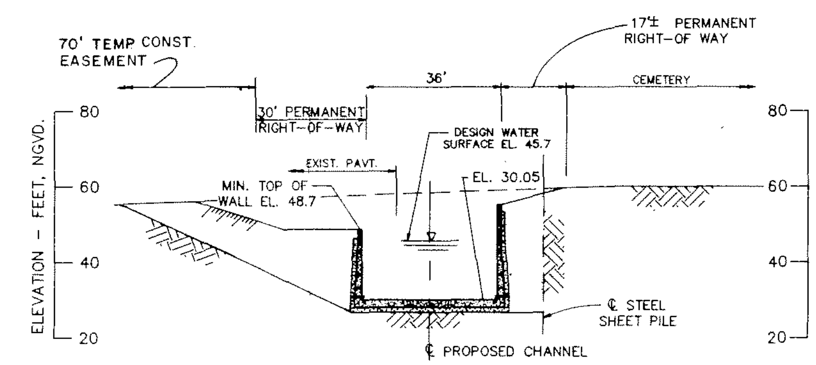
BUENA VISTA DIVERSION




STA. 42+37.79




STA. 40+00




STA. 35+00

BUENA VISTA DIVERSION

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

BUENA VISTA DIVERSION CHANNEL
STA 0+00 TO STA 42+37.79

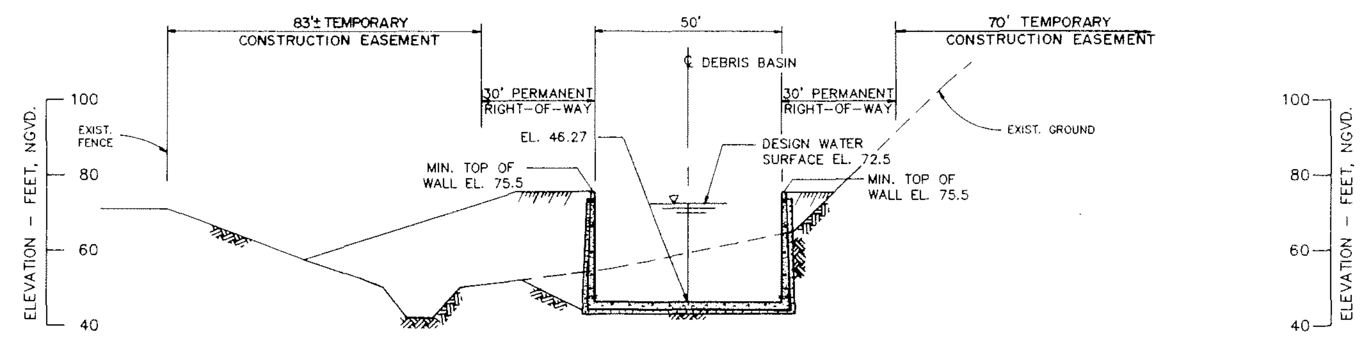
CHANNEL CROSS SECTIONS

STRUCTURAL

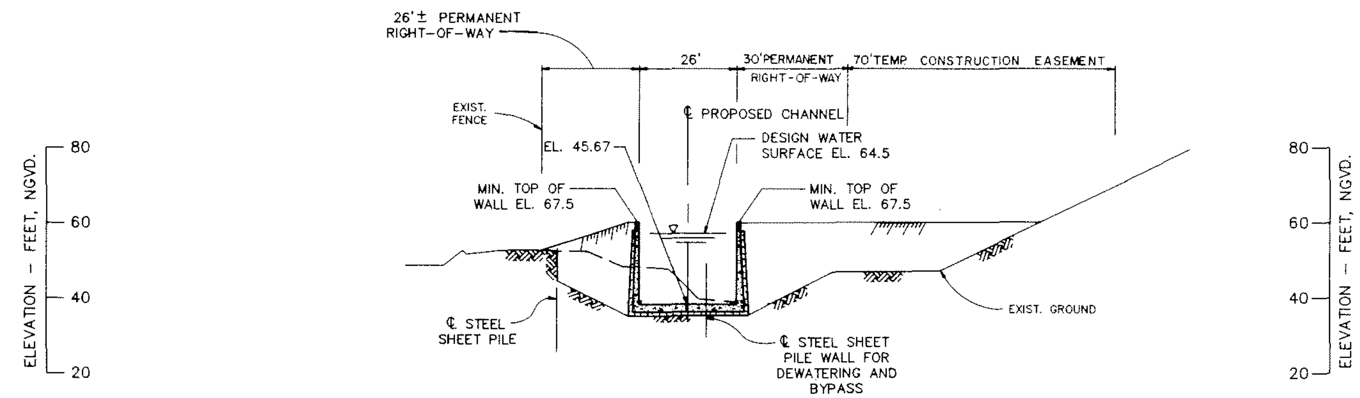
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

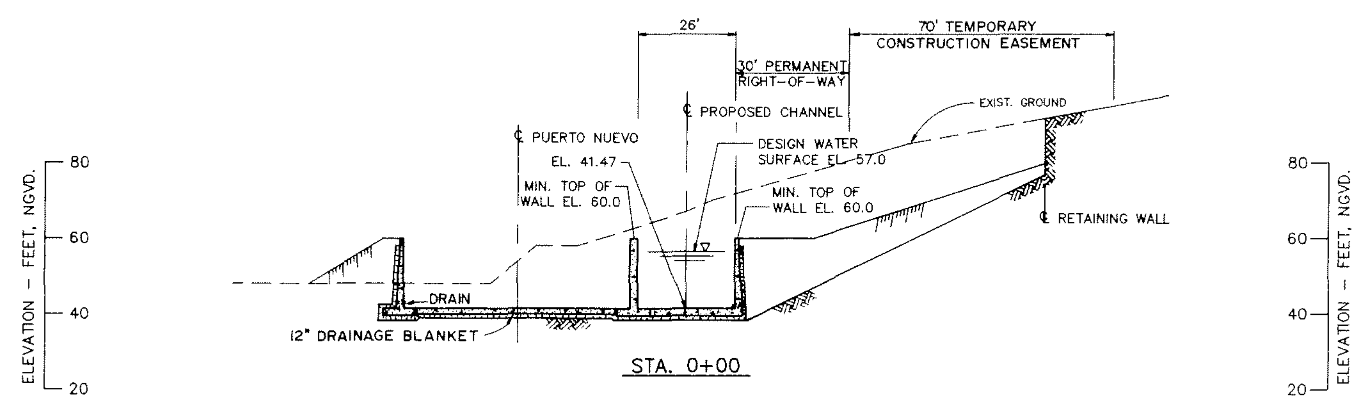
PLATE S-74




STA. 8+19




STA. 5+00




STA. 0+00

GUARACANAL

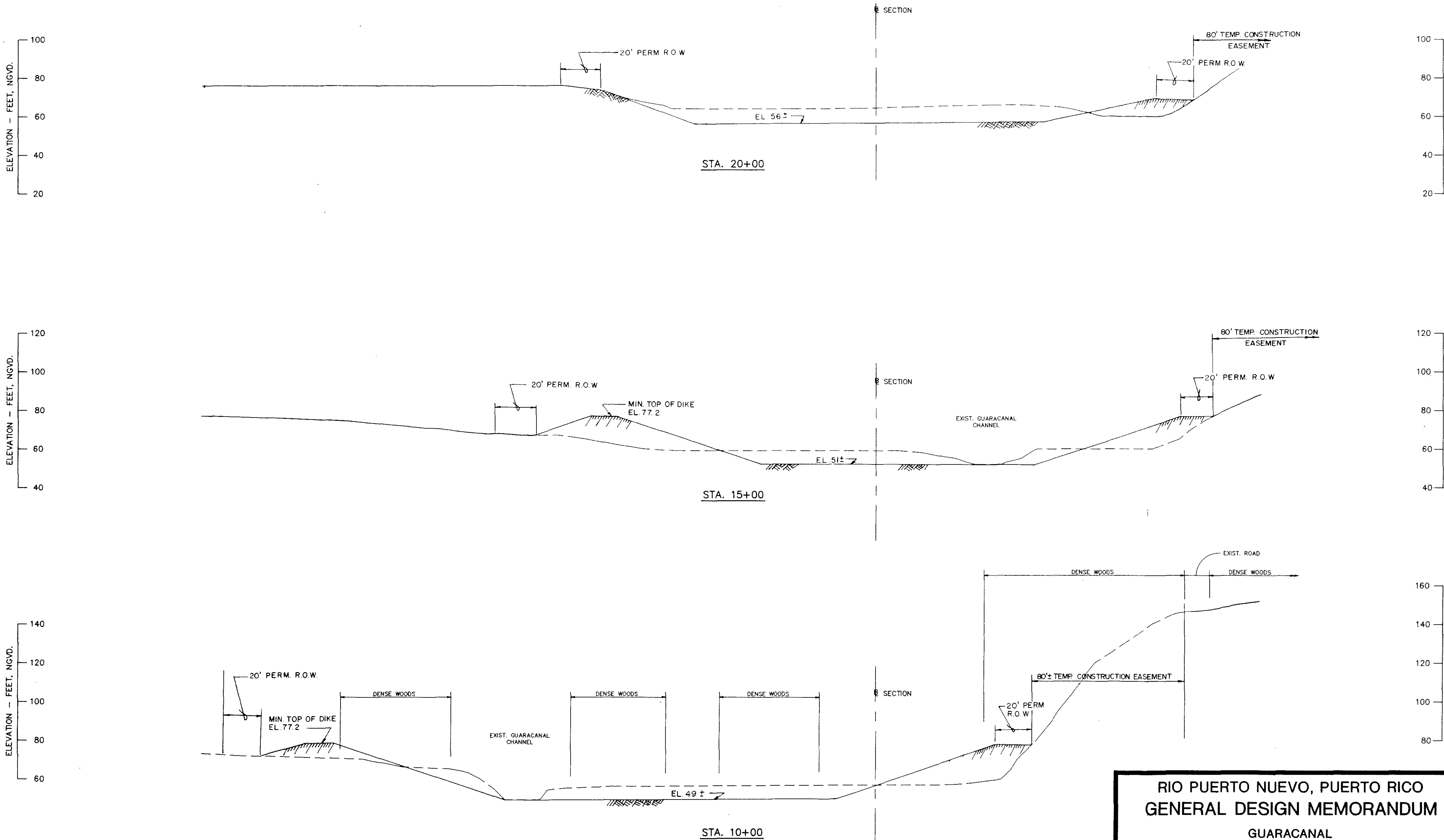
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

GUARACANAL
STA 0+00 TO STA 8+19

CHANNEL CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




GUARACANAL CHANNEL

DEBRIS BASIN

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

GUARACANAL

STA 10+00 TO STA 20+00

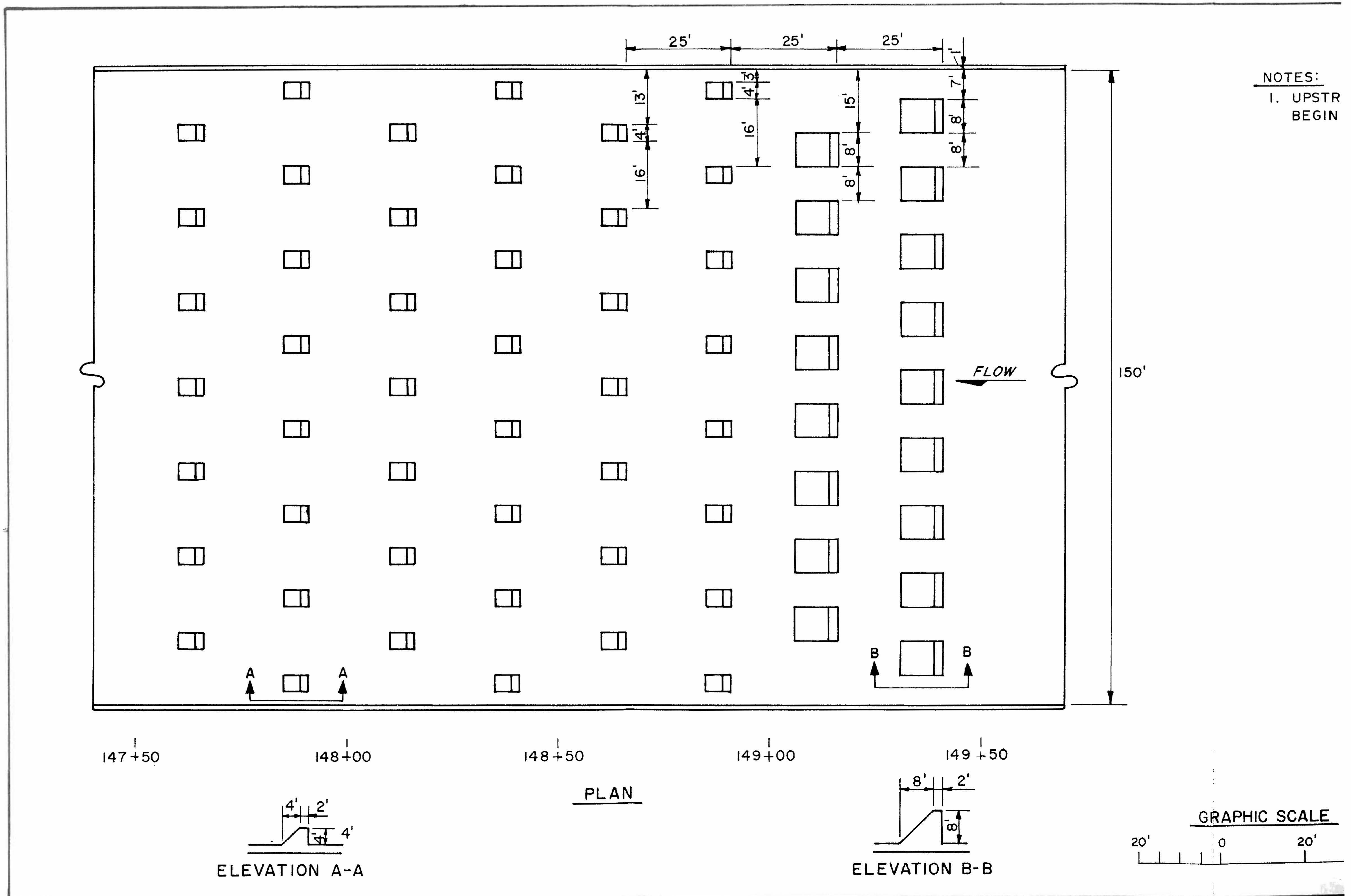
## CHANNEL CROSS SECTIONS

STRUCTURAL

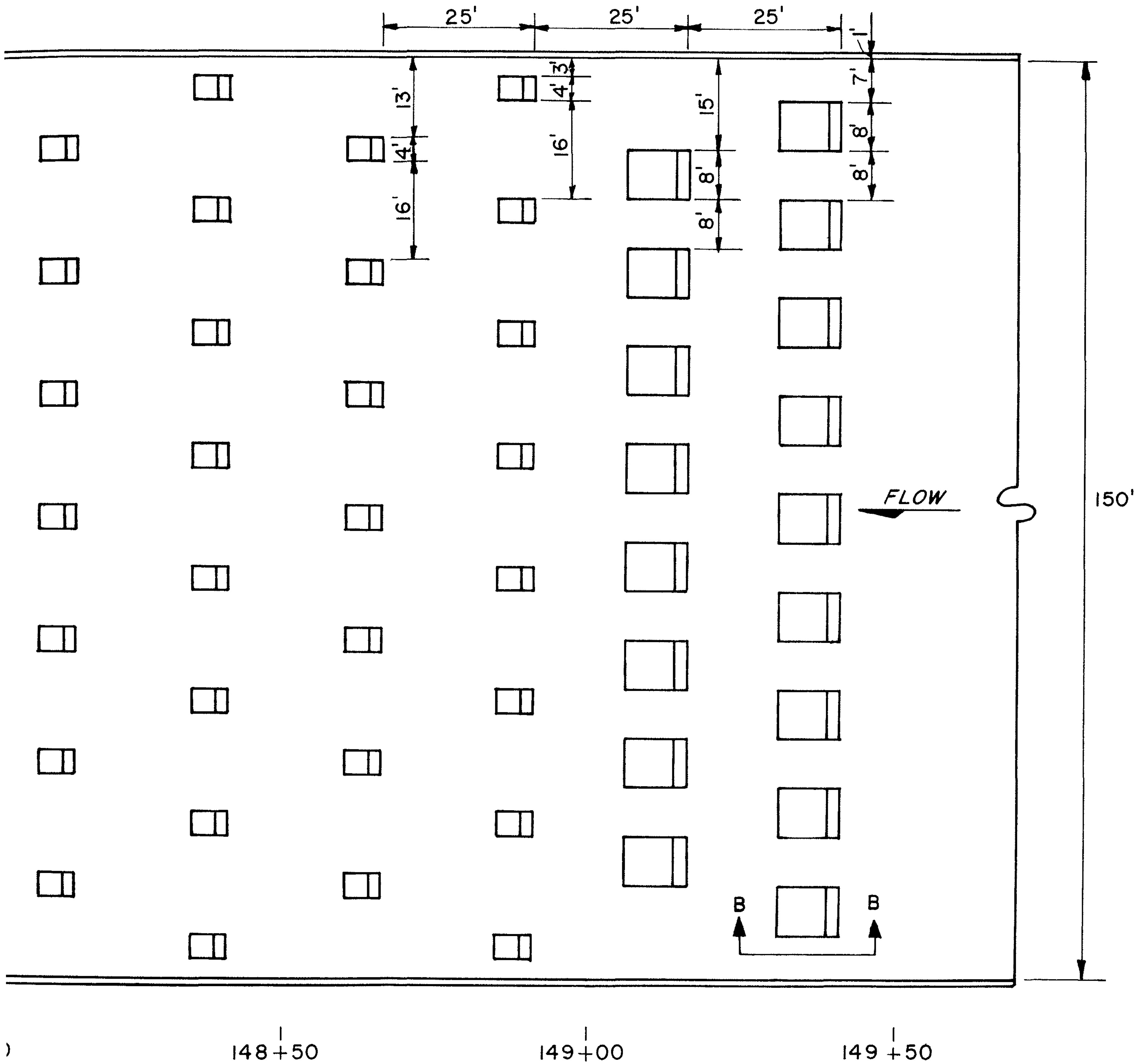
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

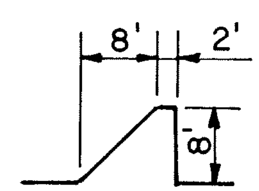
D.O. FILE NO. 102-35,578 DECEMBER 1990



25'
25'
25'
1'
13'
4'
16'
3'
4'
16'
15'
8'
8'
7'
8'
8'
150'
FLOW
A
A
B
B
147+50
148+00
148+50
149+00
149+50
PLAN
4'
2'
4'
4'
ELEVATION A-A
8'
2'
8'
ELEVATION B-B
NOTES:
1. UPSTR
BEGIN
GRAPHIC SCALE
20'
0
20'




PLAN

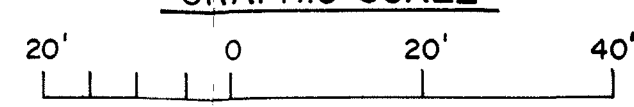



ELEVATION B-B

NOTES:

1. UPSTREAM ROW OF BAFFLES BEGIN STA. 149+41.18

GRAPHIC SCALE




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

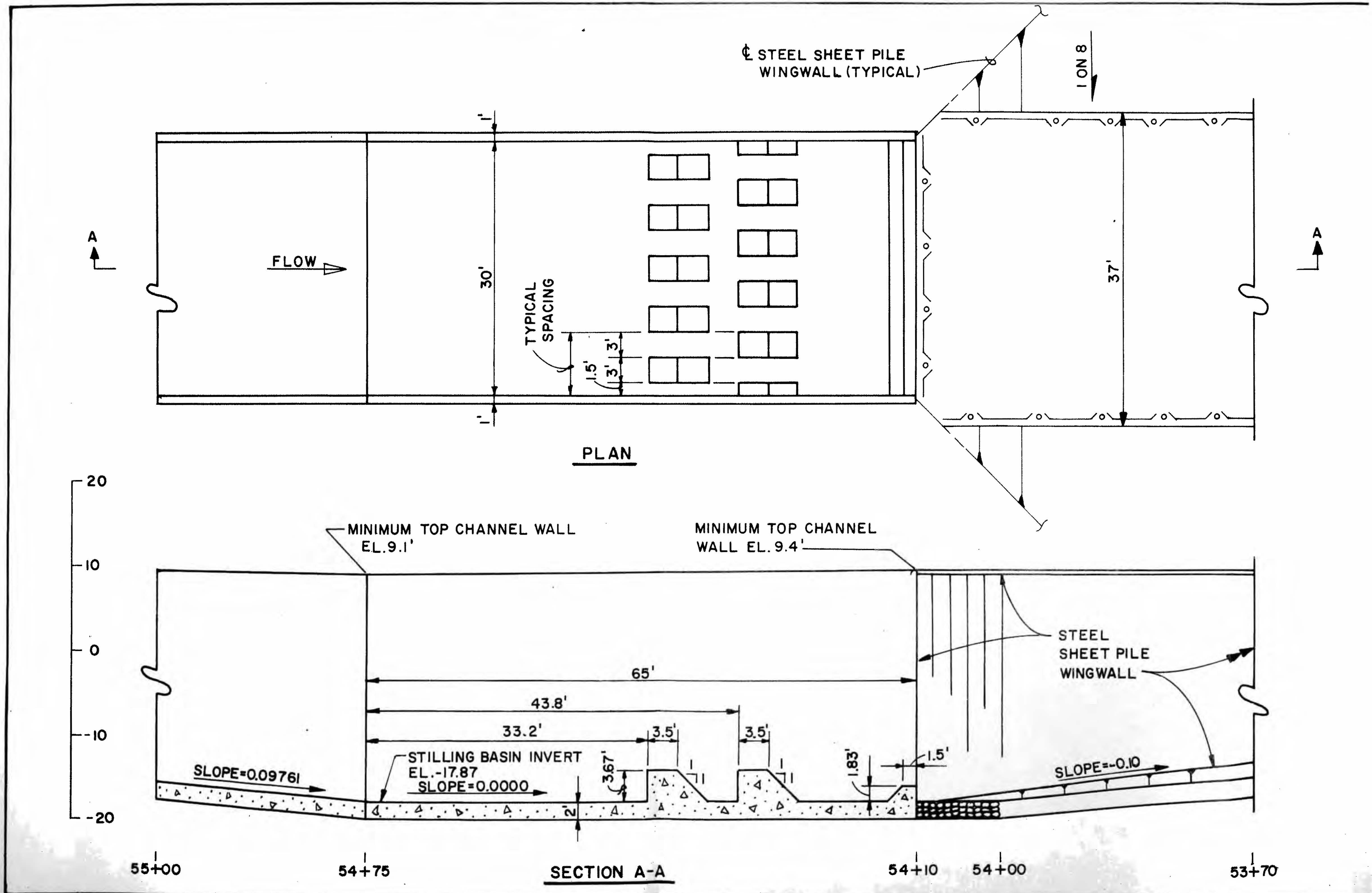
STILLING AREA

STRUCTURAL

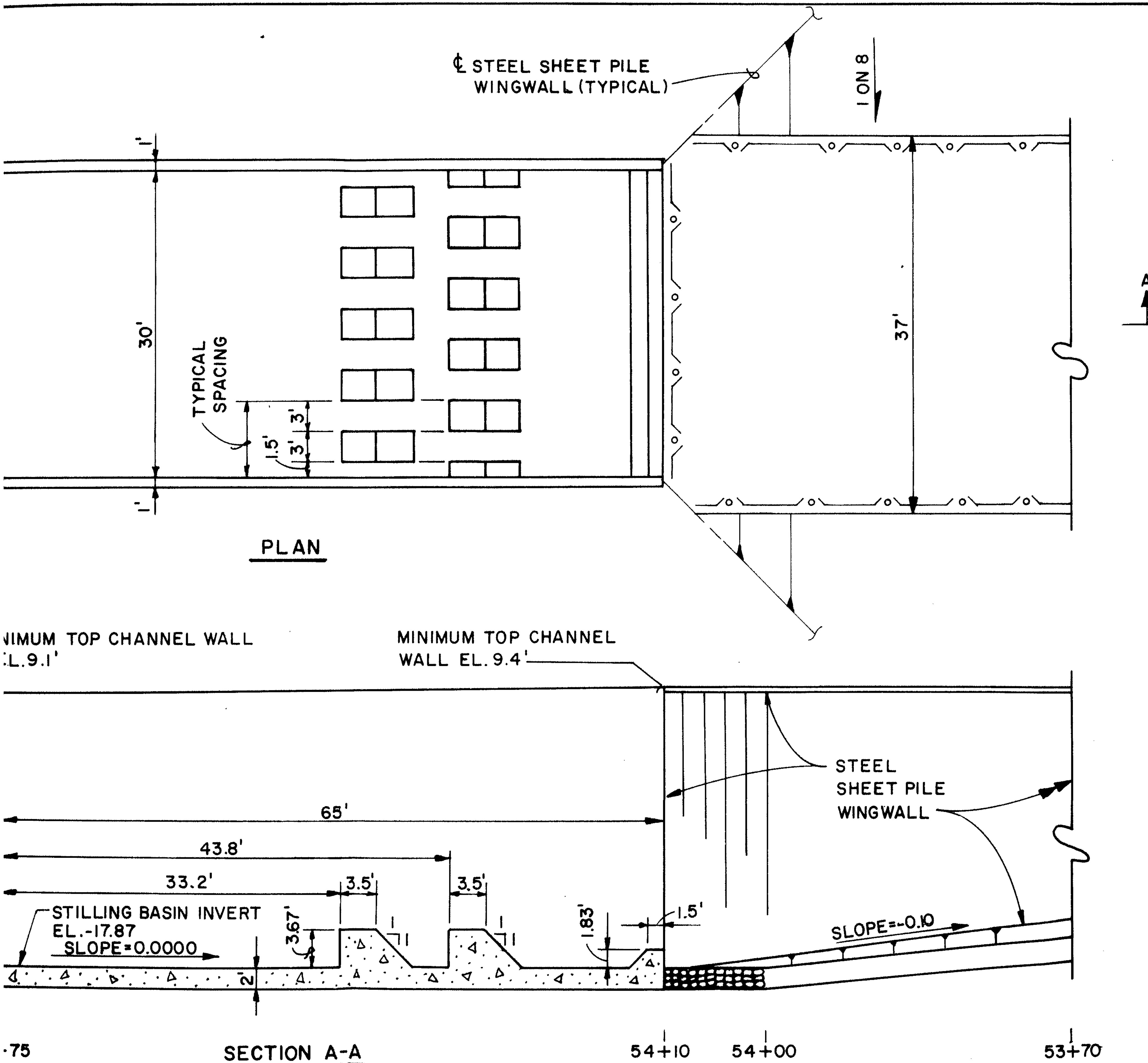
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

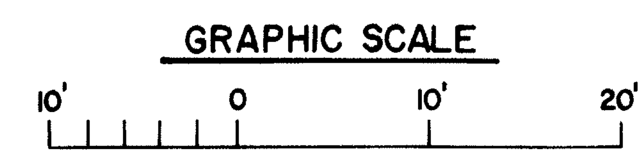
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-77



℄ STEEL SHEET PILE
WINGWALL (TYPICAL)
1 ON 8
1'
30'
37'
FLOW
TYPICAL SPACING
3'
3'
1.5'
1'
A
A
PLAN
20
10
0
-10
-20
MINIMUM TOP CHANNEL WALL
EL. 9.1'
MINIMUM TOP CHANNEL
WALL EL. 9.4'
STEEL
SHEET PILE
WINGWALL
65'
43.8'
33.2'
3.5'
3.5'
STILLING BASIN INVERT
EL. -17.87
SLOPE = 0.0000
SLOPE = 0.09761
3.67'
1.83'
1.5'
2'
SLOPE = -0.10
55+00
54+75
54+10
54+00
53+70
SECTION A-A



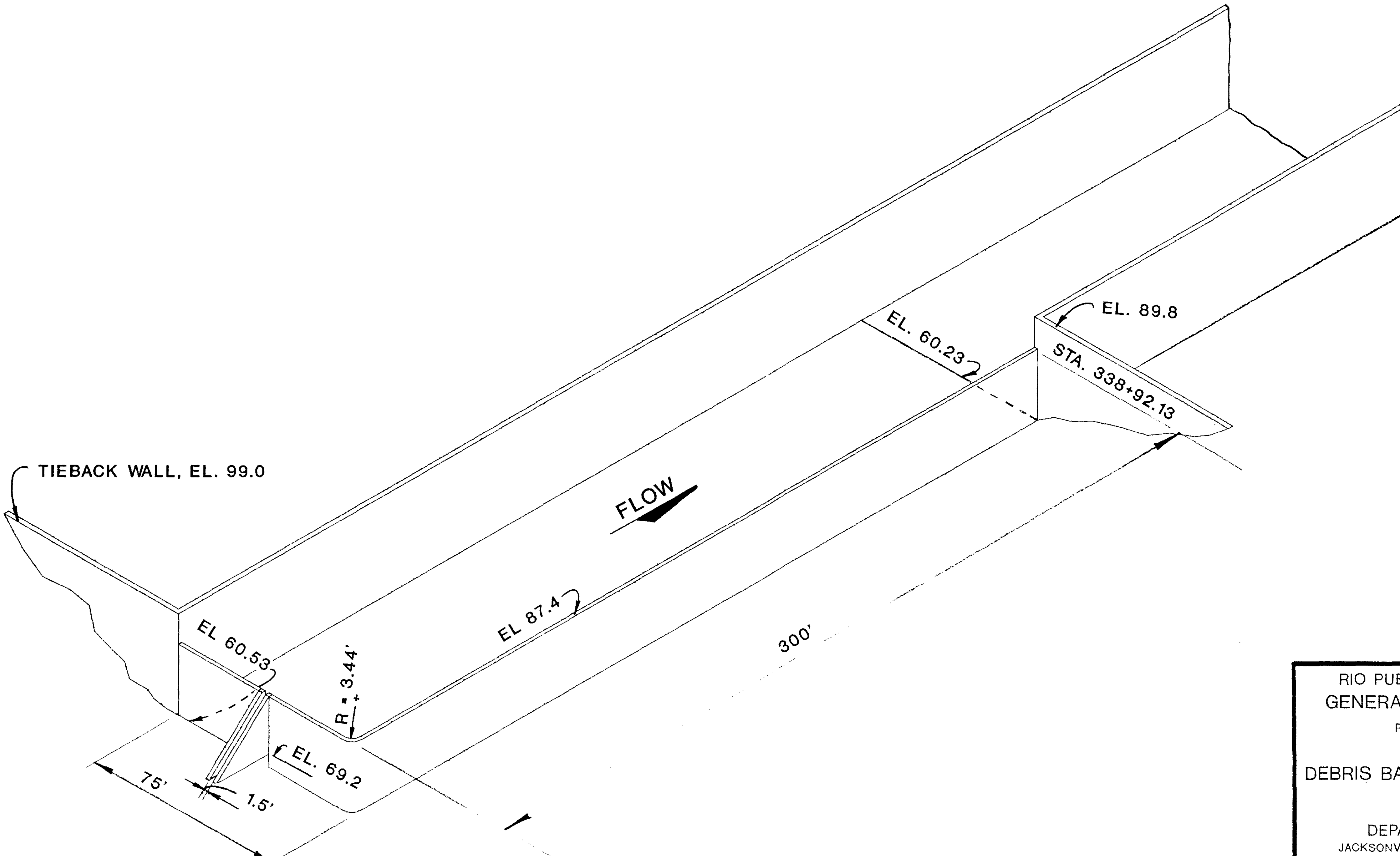




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY

STILLING AREA

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-36,678 DECEMBER 1990



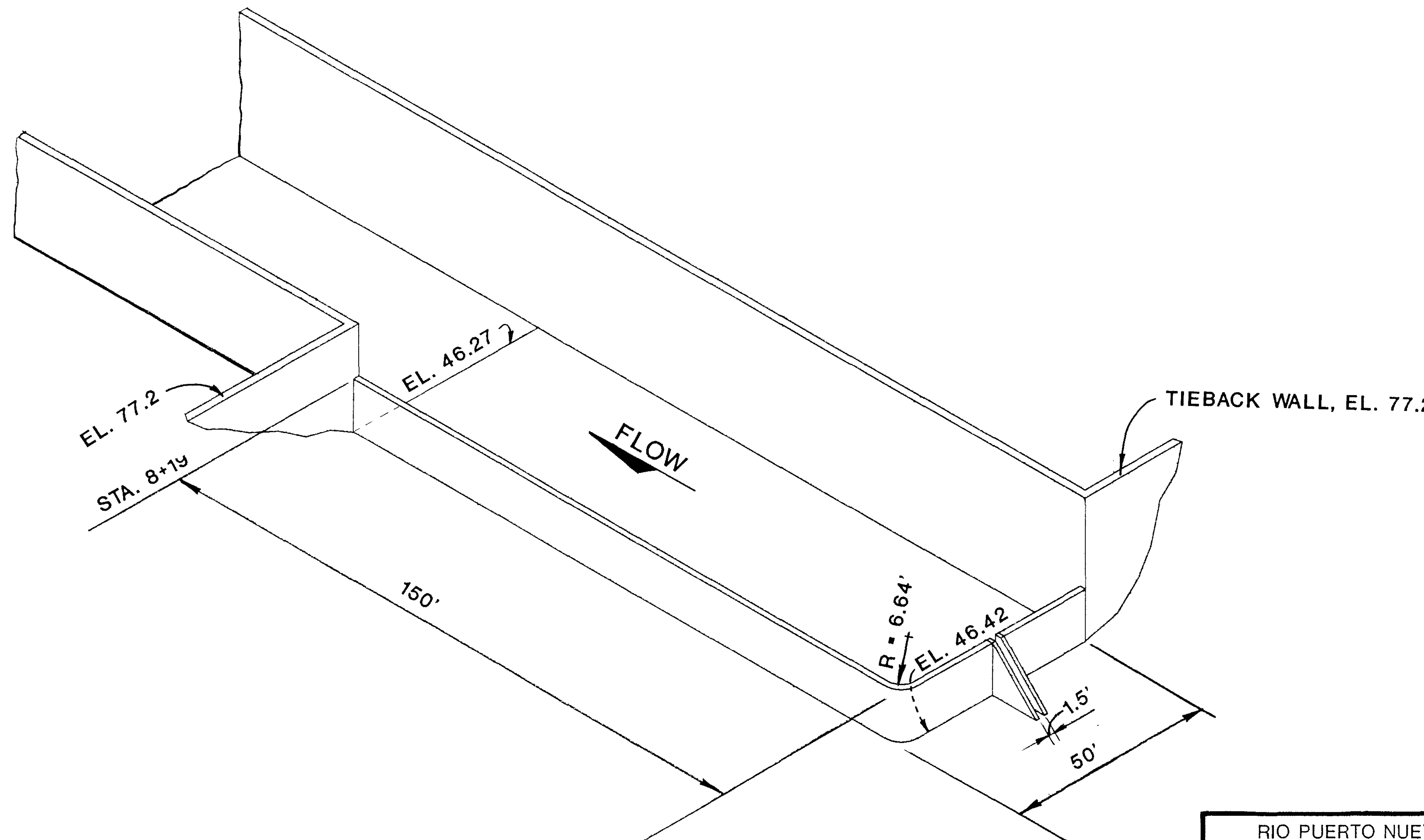

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL

DEBRIS BASIN OVER-FLOW SPILLWAY

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
GUARACANAL

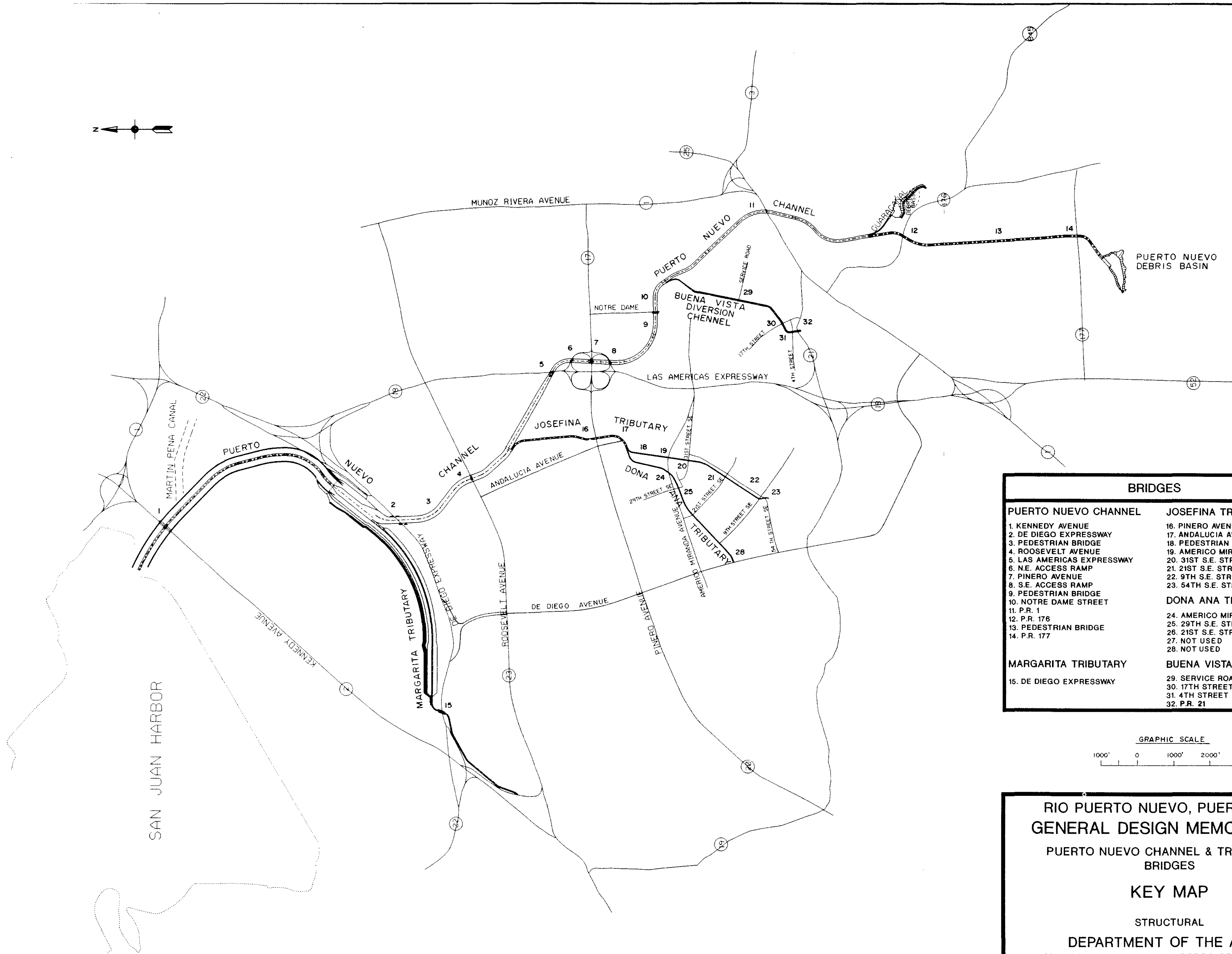
DEBRIS BASIN OVER-FLOW SPILLWA

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-8C




## BRIDGES

**PUERTO NUEVO CHANNEL**

1. KENNEDY AVENUE
2. DE DIEGO EXPRESSWAY
3. PEDESTRIAN BRIDGE
4. ROOSEVELT AVENUE
5. LAS AMERICAS EXPRESSWAY
6. N.E. ACCESS RAMP
7. PINERO AVENUE
8. S.E. ACCESS RAMP
9. PEDESTRIAN BRIDGE
10. NOTRE DAME STREET
11. P.R. 1
12. P.R. 176
13. PEDESTRIAN BRIDGE
14. P.R. 177

**MARGARITA TRIBUTARY**

15. DE DIEGO EXPRESSWAY

**JOSEFINA TRIBUTARY**

16. PINERO AVENUE
17. ANDALUCIA AVENUE
18. PEDESTRIAN BRIDGE
19. AMERICO MIRANDA AVENUE
20. 31ST S.E. STREET
21. 21ST S.E. STREET
22. 9TH S.E. STREET
23. 54TH S.E. STREET

**DONA ANA TRIBUTARY**

24. AMERICO MIRANDA AVENUE
25. 29TH S.E. STREET
26. 21ST S.E. STREET
27. NOT USED
28. NOT USED

**BUENA VISTA DIVERSION**

29. SERVICE ROAD
30. 17TH STREET
31. 4TH STREET
32. P.R. 21

GRAPHIC SCALE

1000' 0 1000' 2000' 3000'

RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL & TRIBUTARIES
BRIDGES

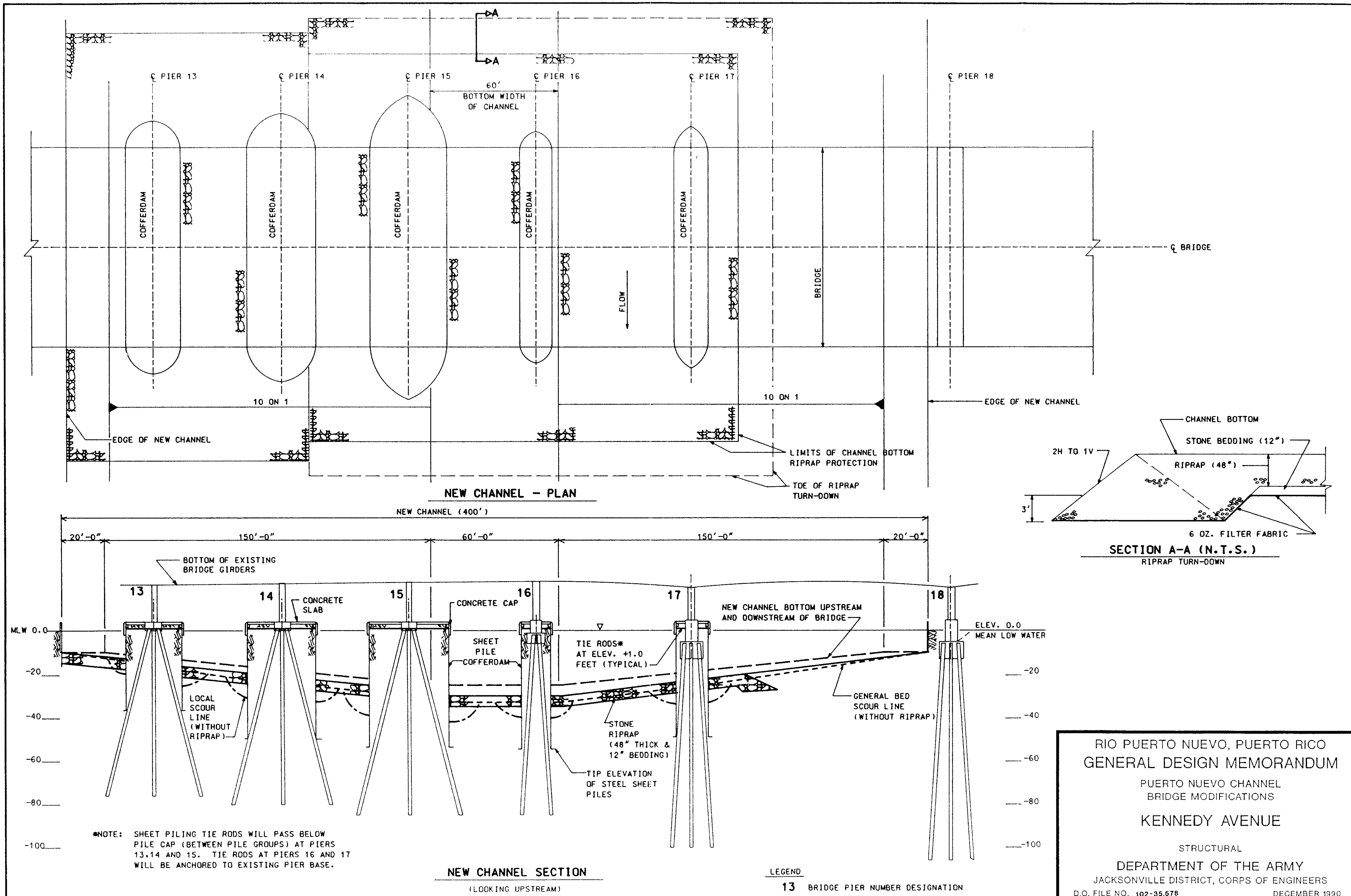
## KEY MAP

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-81




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS

KENNEDY AVENUE

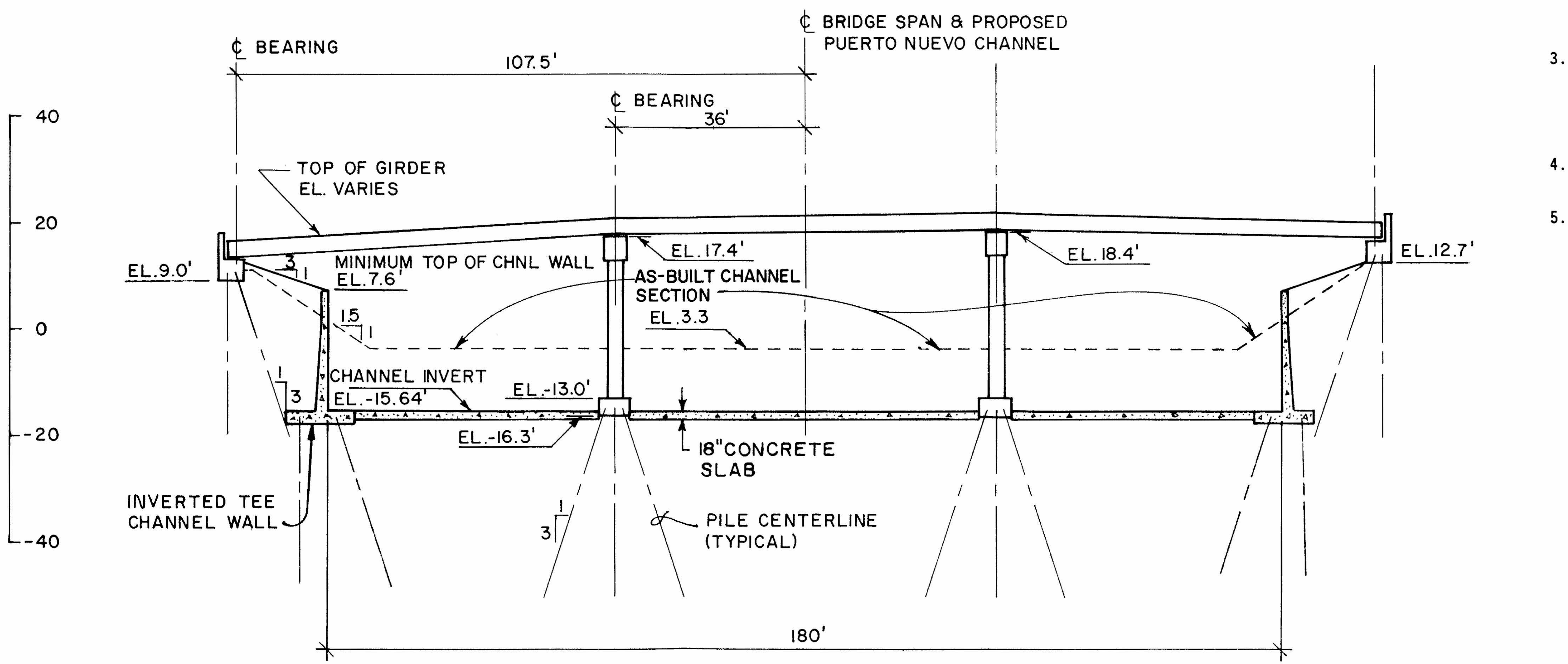
STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-82

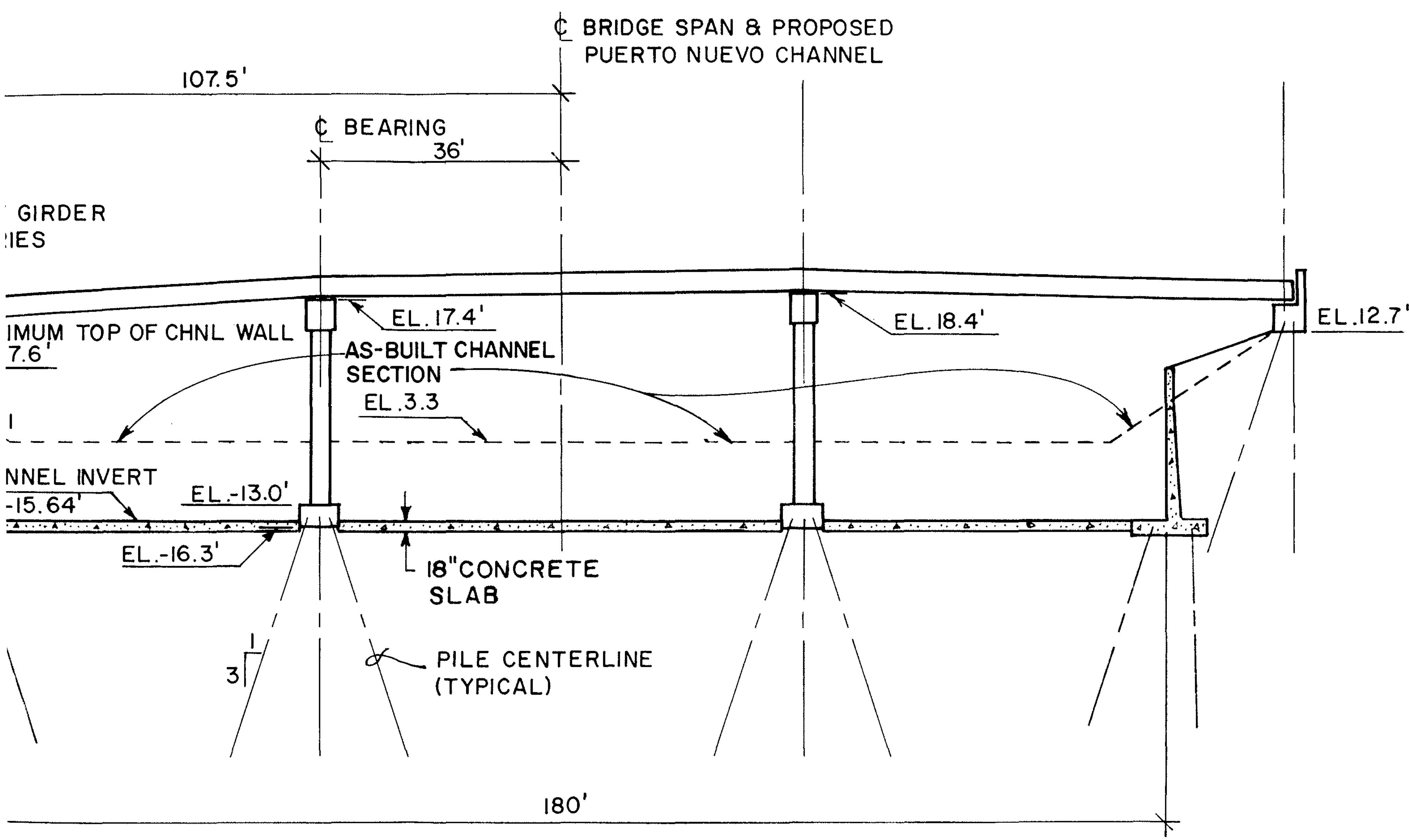



## ELEVATION

PUERTO NUEVO STA. 93 + 58

VIEW: UPSTREAM

DE DIEGO EXPRESSWAY - PUERTO NUEVO




## ELEVATION

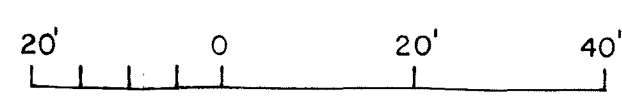
PUERTO NUEVO STA. 93 + 58

VIEW: UPSTREAM

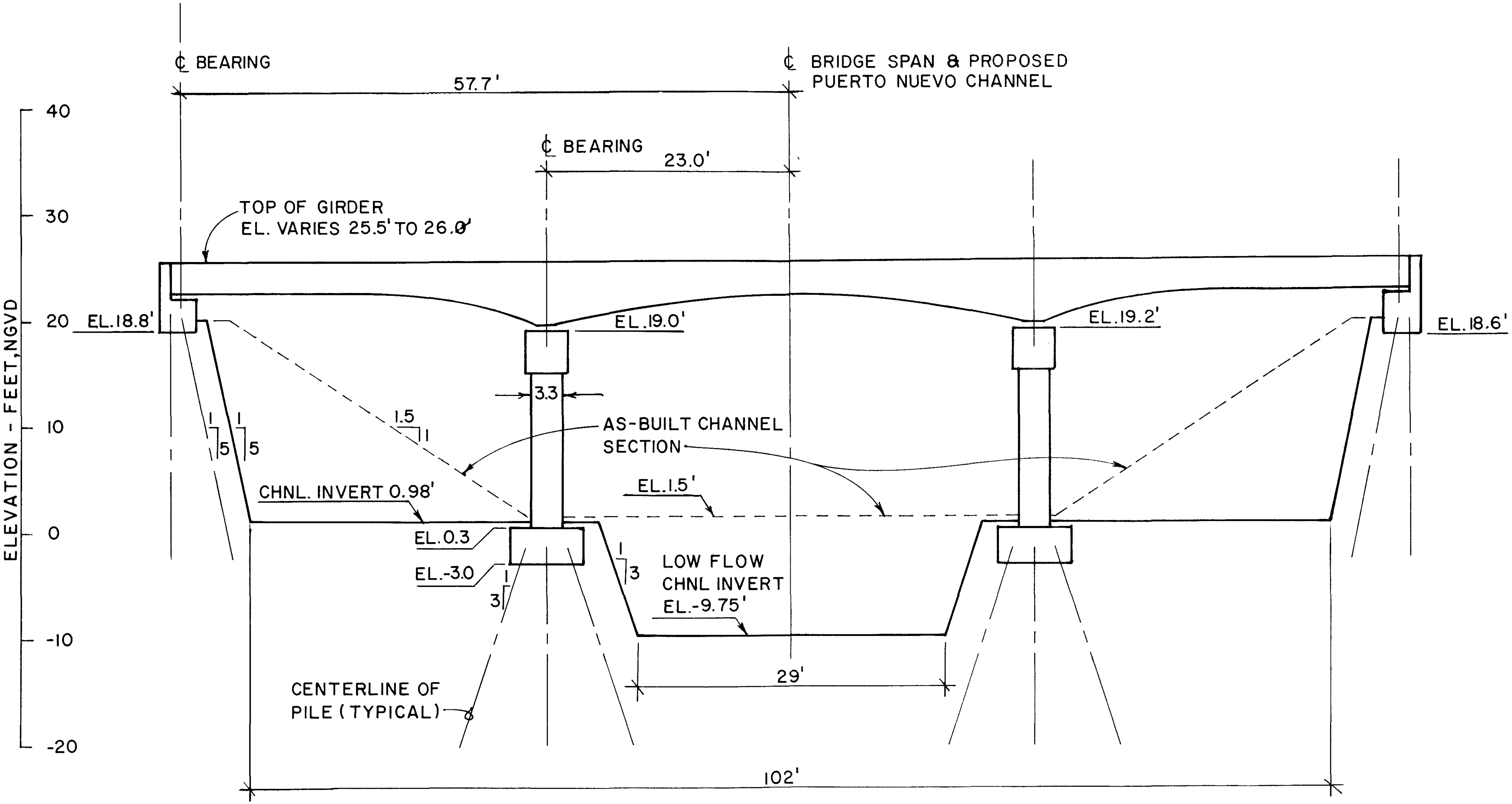
**NOTES**:

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 65 FEET FOR EAST BOUND BRIDGE AND 75 FEET FOR WEST BOUND BRIDGE.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 46 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.

GRAPHIC SCALE




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
DE DIEGO EXPRESSWAY
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



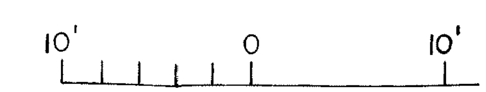

ELEVATION

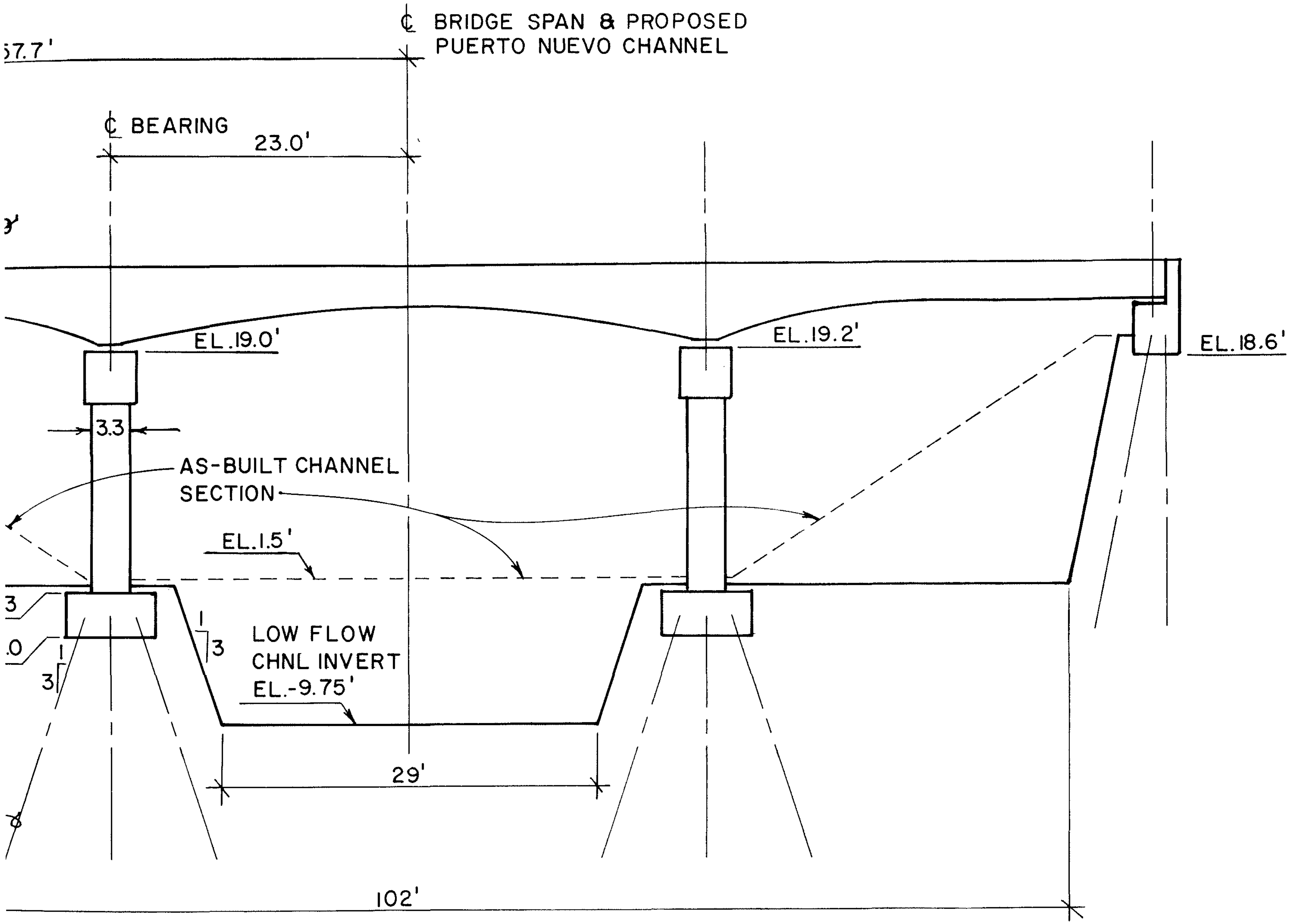
PUERTO NUEVO STA. 156 + 65

**NOTES**:

1. EXI REM
2. ALL APP CON
3. PIL DRA CON FEE
4. BRI ABO
5. CHA AT PER
6. REF CON

GRAPHIC SCAL





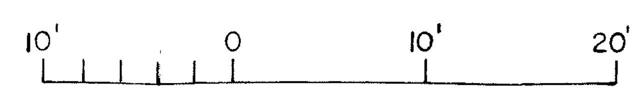

## ELEVATION

PUERTO NUEVO STA. 156 + 65

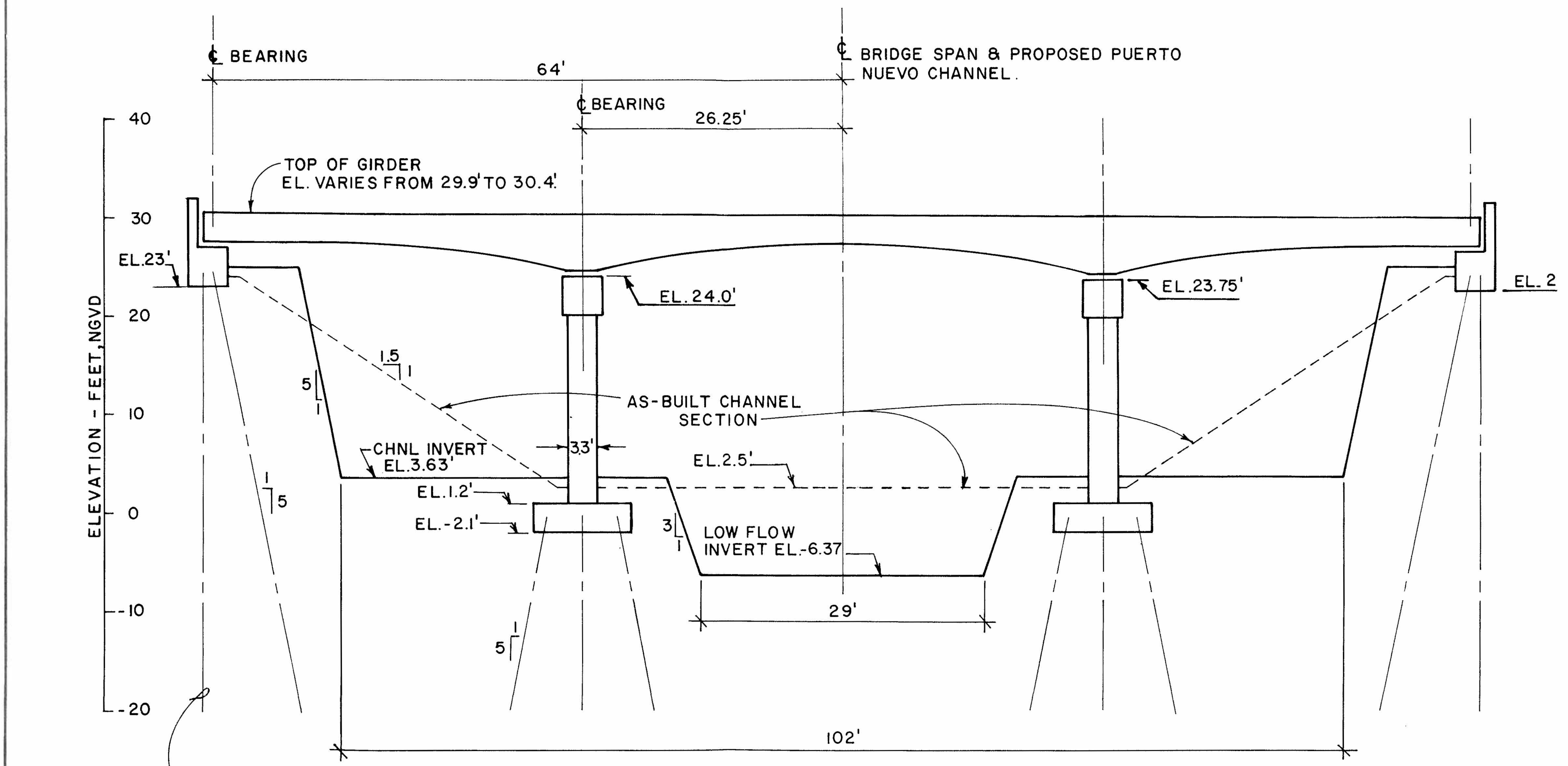
**NOTES**:

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 45 FEET FOR BRIDGE PIERS AND 50 FEET FOR ABUTMENTS.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 58 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.
6. REFERENCE PLATE NO. S-88 FOR CHANNEL CONSTRUCTION METHOD.

**GRAPHIC SCALE**

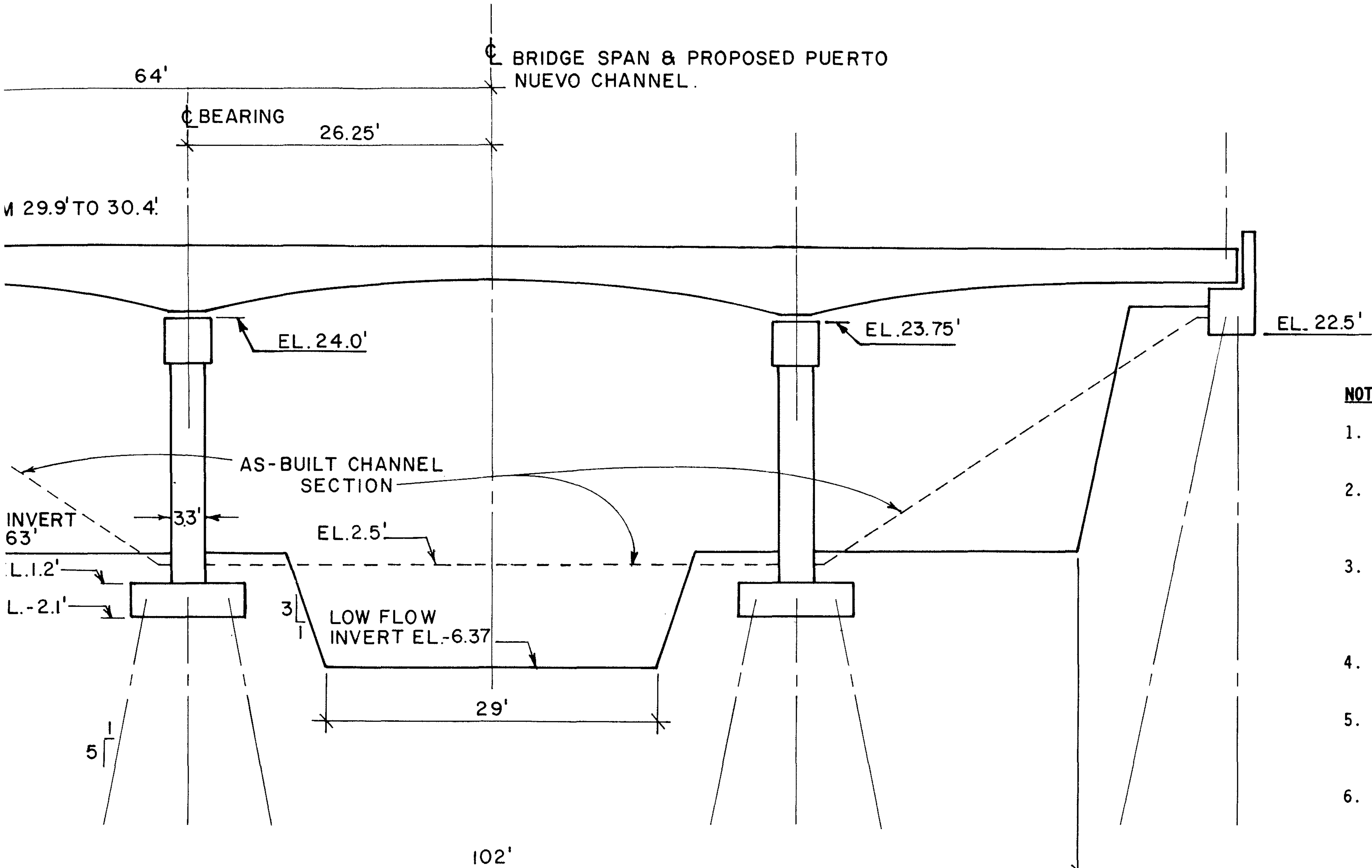



RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
LAS AMERICAS EXPRESSWAY
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




ELEVATION

PUERTO NUEVO STA. 163+85




## ELEVATION

TYPICAL)

PUERTO NUEVO STA. 163+85

**NORTH EAST ACCESS RAMP - LAS AMERICAS EXPRESSWAY**

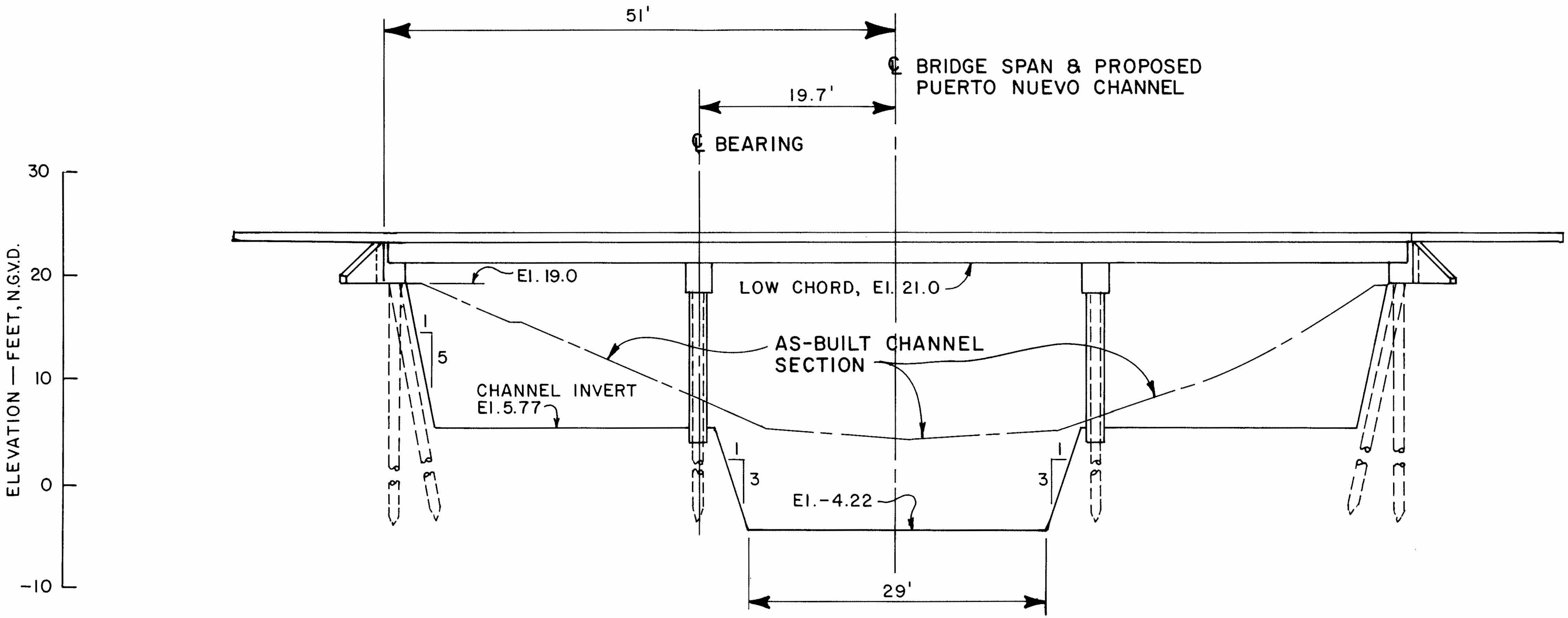
**NOTES**:

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 50 FEET FOR BRIDGE PIERS AND 55 FEET FOR ABUTMENTS.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 58 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.
6. REFERENCE PLATE NO. S-88 FOR CHANNEL CONSTRUCTION METHOD.

GRAPHIC SCALE

10' 0 10' 20'

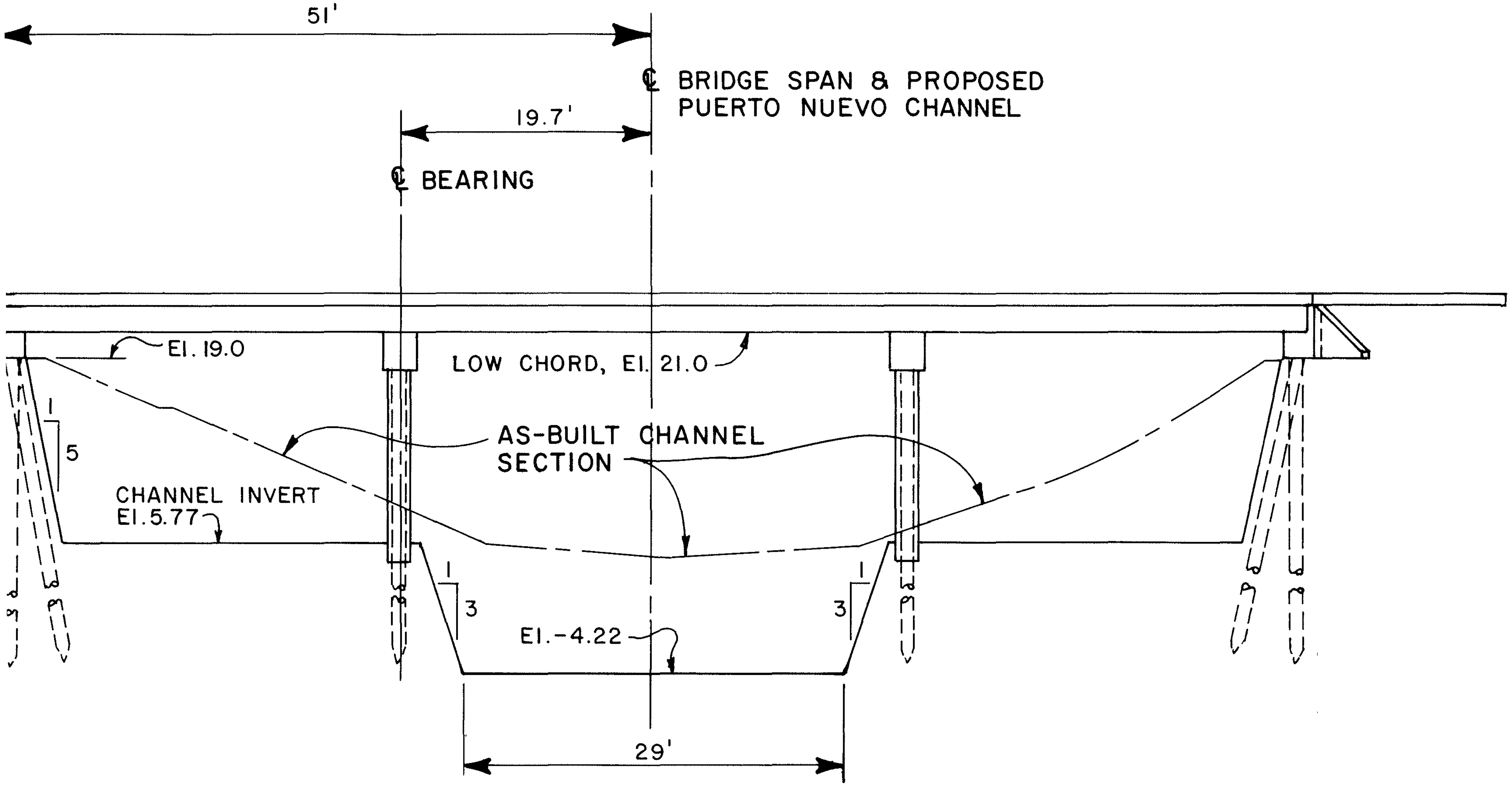
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
N. E. ACCESS RAMP
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-85



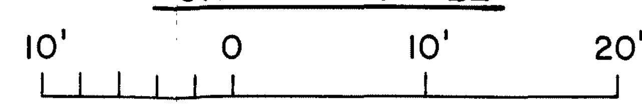

## ELEVATION
## PUERTO NUEVO STA. 169+22

**NOTES:**

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 50 FEET FOR BRIDGE PIERS AND ABUTMENTS.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 84 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.
6. REFERENCE PLATE NO. S-88 FOR CHANNEL CONSTRUCTION METHOD.

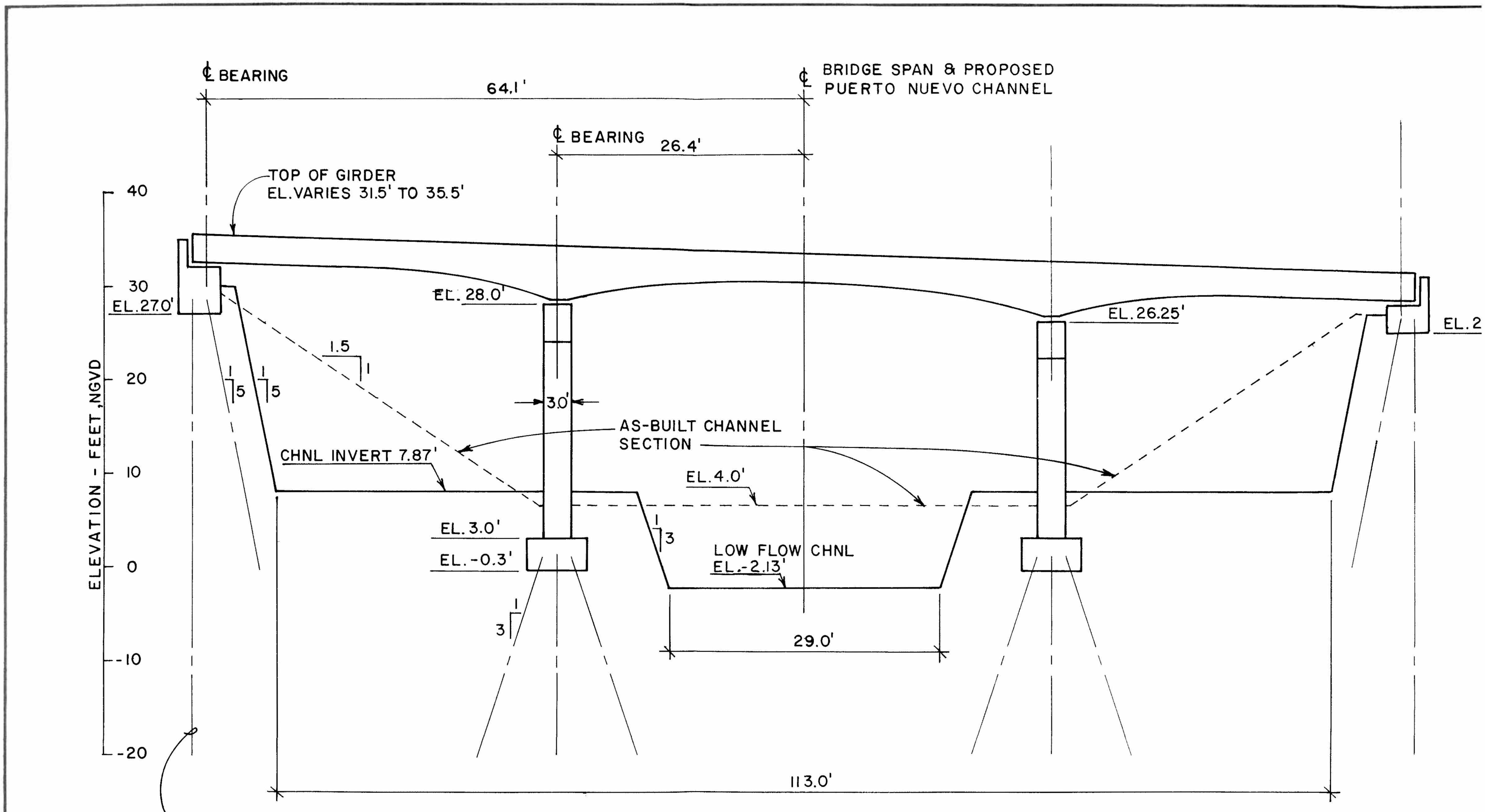



## ELEVATION
## PUERTO NUEVO STA. 169+22



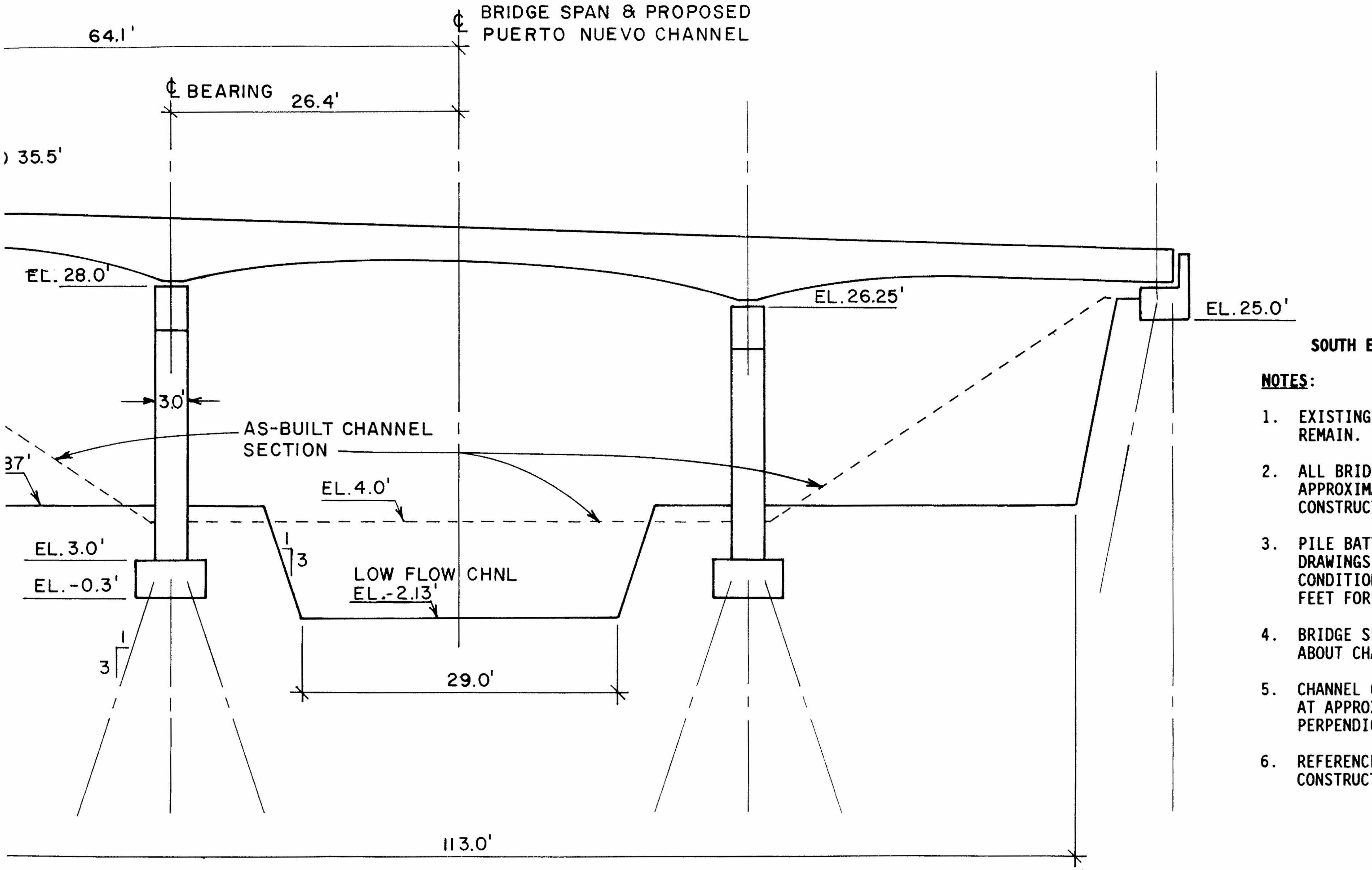

GRAPHIC SCALE

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
PINERO AVENUE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




## ELEVATION

PUERTO NUEVO STA. 174+50




## ELEVATION

PUERTO NUEVO STA. 174+50

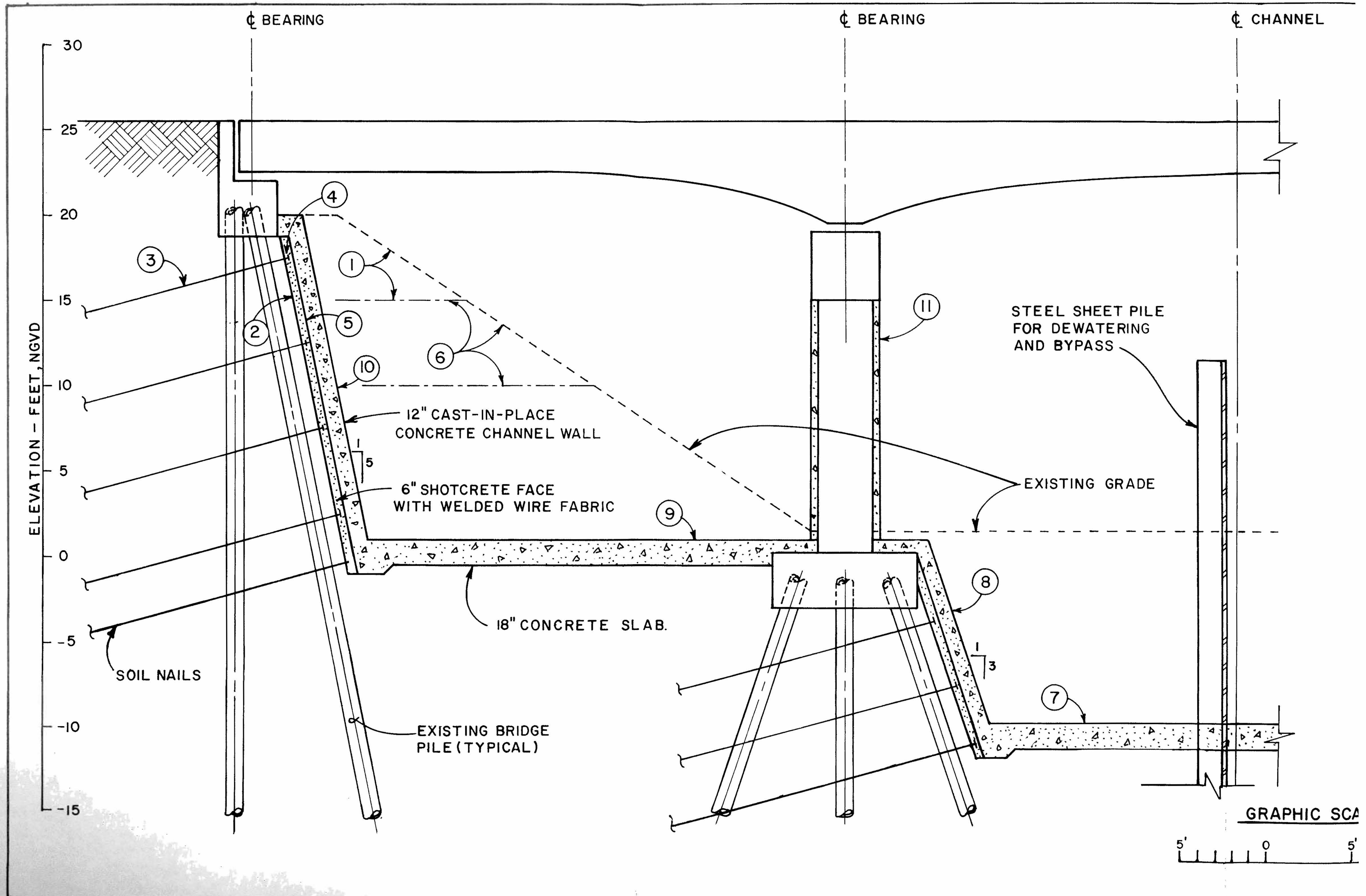
**SOUTH EAST ACCESS RAMP - LAS AMERICAS EXPRESSWAY**

**NOTES**:

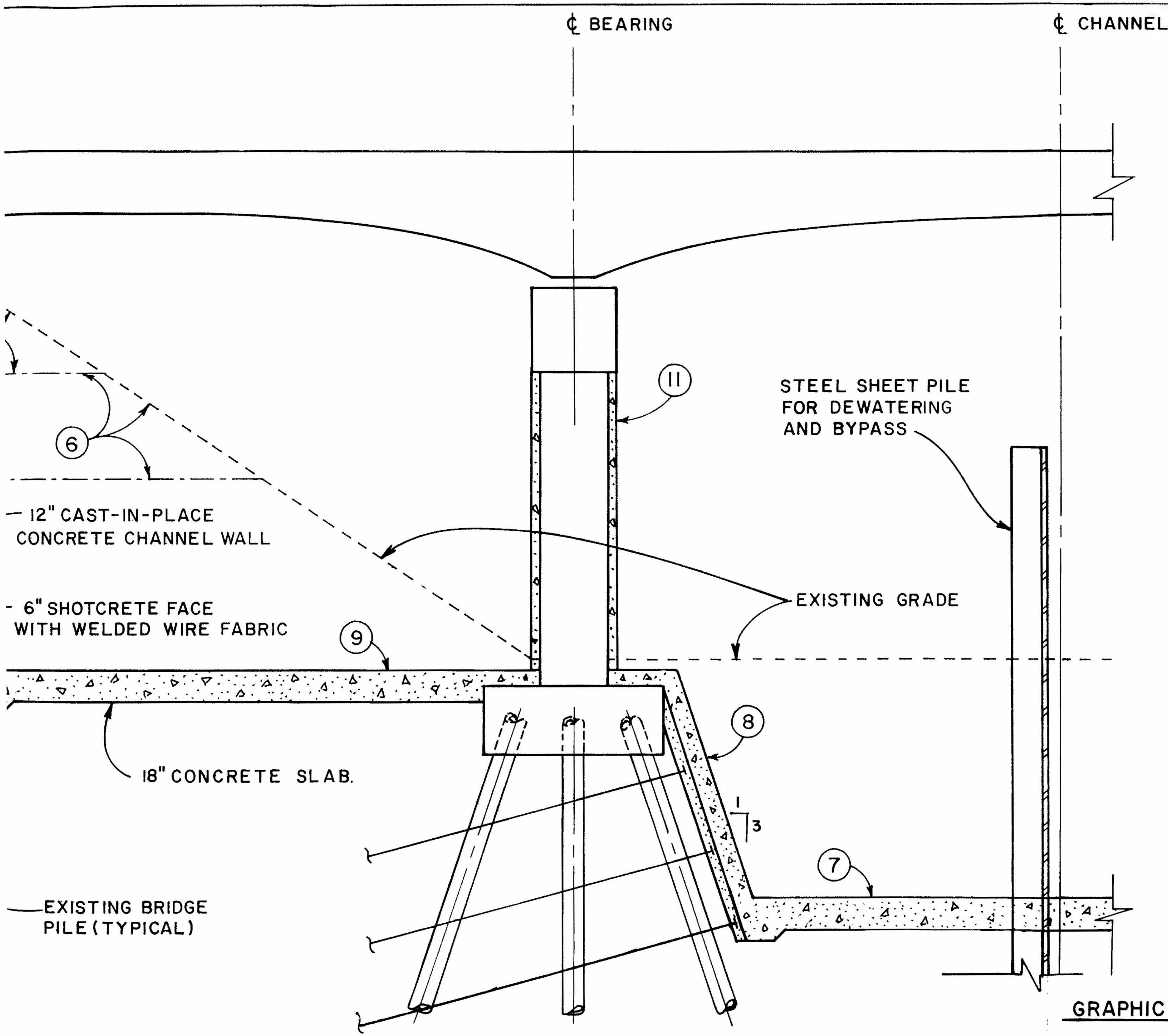
1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 45 FEET FOR BRIDGE PIERS AND 60 FEET FOR ABUTMENTS.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 75 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.
6. REFERENCE PLATE NO. S-88 FOR CHANNEL CONSTRUCTION METHOD.

**GRAPHIC SCALE**


RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
S. E. ACCESS RAMP
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



℄ BEARING
℄ BEARING
℄ CHANNEL
ELEVATION - FEET, NGVD
30
25
20
15
10
5
0
-5
-10
-15
1
2
3
4
5
6
7
8
9
10
11
12" CAST-IN-PLACE CONCRETE CHANNEL WALL
6" SHOTCRETE FACE WITH WELDED WIRE FABRIC
18" CONCRETE SLAB.
SOIL NAILS
EXISTING BRIDGE PILE (TYPICAL)
STEEL SHEET PILE FOR DEWATERING AND BYPASS
EXISTING GRADE
GRAPHIC SCA
5'
0
5'




**TYPICAL CONSTRUCTION SEQUENCE**

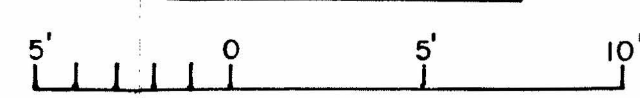
1. MAKE A ±5 FOOT CUT NEAR ABUTMENT.
2. SPRAY ±3 INCHES OF SHOTCRETE ONTO EXPOSED FACE.
3. DRILL HOLES FOR SOIL NAILS, INSERT NAILS (REINFORCING BARS), AND GROUT IN PLACE.
4. INSTALL WIRE MESH AND BEARING PLATES, THEN PARTIALLY TENSION EACH NAIL.
5. CLEAN FACE OF CUT AND SPRAY SECOND ±3 INCH LAYER OF SHOTCRETE.
6. EXCAVATE NEXT ±5 CUT, REPEATING PREVIOUS STEPS UNTIL FINAL LIMIT OF EXCAVATION IS REACHED.
7. POUR LOW FLOW CHANNEL BOTTOM SLAB.
8. CAST LOW FLOW CHANNEL WALL AGAINST THE SOIL NAILED FACE.
9. POUR MAIN CHANNEL BOTTOM SLAB.
10. CAST MAIN CHANNEL WALL AGAINST THE SOIL NAILED FACE.
11. CONSTRUCT BRIDGE PIER PROTECTION.

**LEGEND**

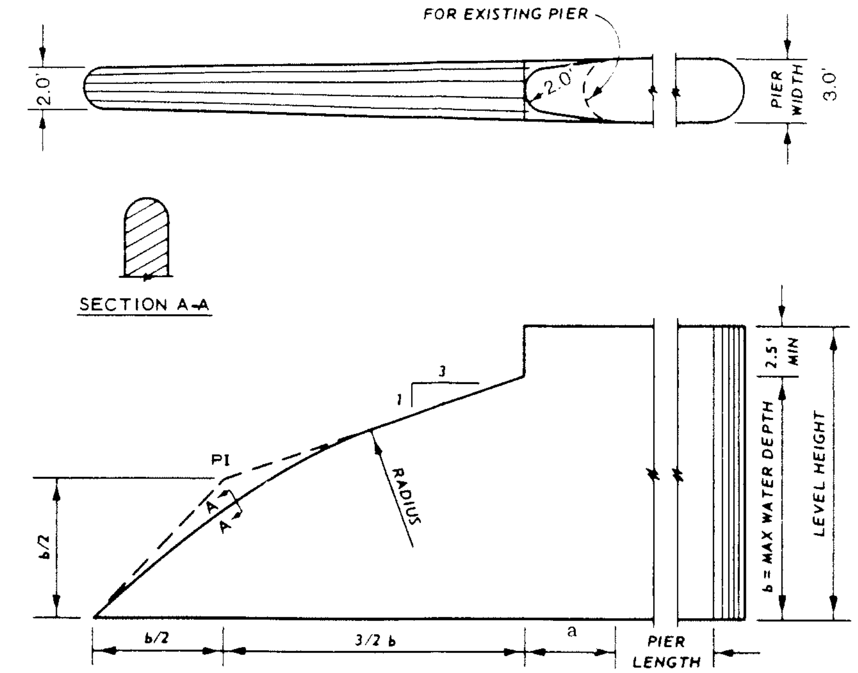
(1) CONSTRUCTION SEQUENCE KEY

—·—·— CUT LIMIT LINE

**GRAPHIC SCALE**




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL BRIDGE MODIFICATIONS
CHANNEL CONSTRUCTION METHOD - LAS AMERICAS, PINERO & ACCESS RAMP BRIDGES
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO.102-38,578 DECEMBER 1990




| BRIDGE | a | b |
|---|---|---|
| LAS AMERICAS EXPRESSWAY | 84.0' | 22.4' |
| N. E. ACCESS RAMP | 6.0' | 22.4' |
| PINERO AVENUE | 6.0' | 19.1' |
| S. E. ACCESS RAMP | 6.0' | 11.3' |

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

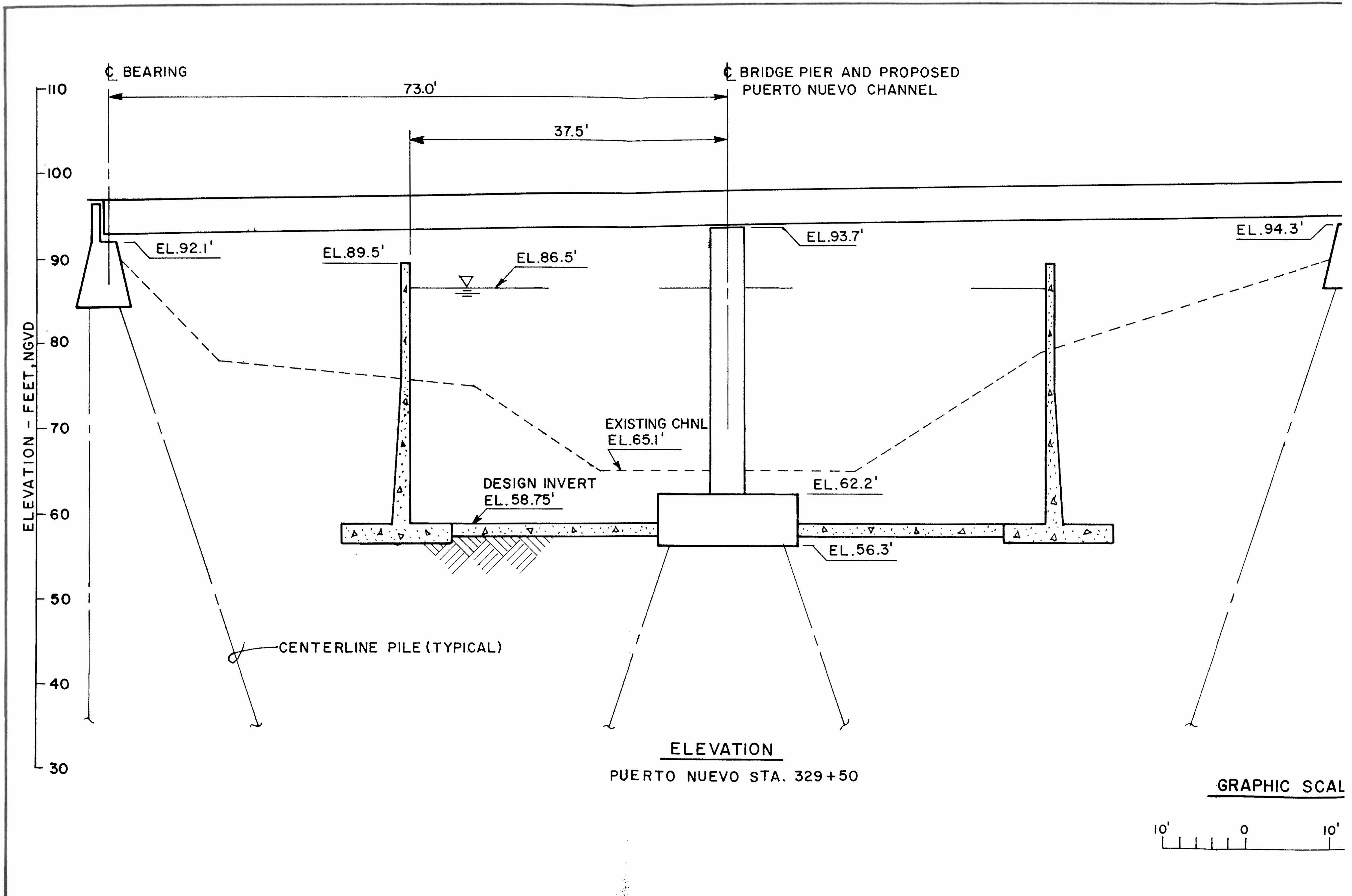
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS

BRIDGE PIER EXTENSION - LAS AMERICAS, PINERO & ACCESS RAMP BRIDGES

STRUCTURAL

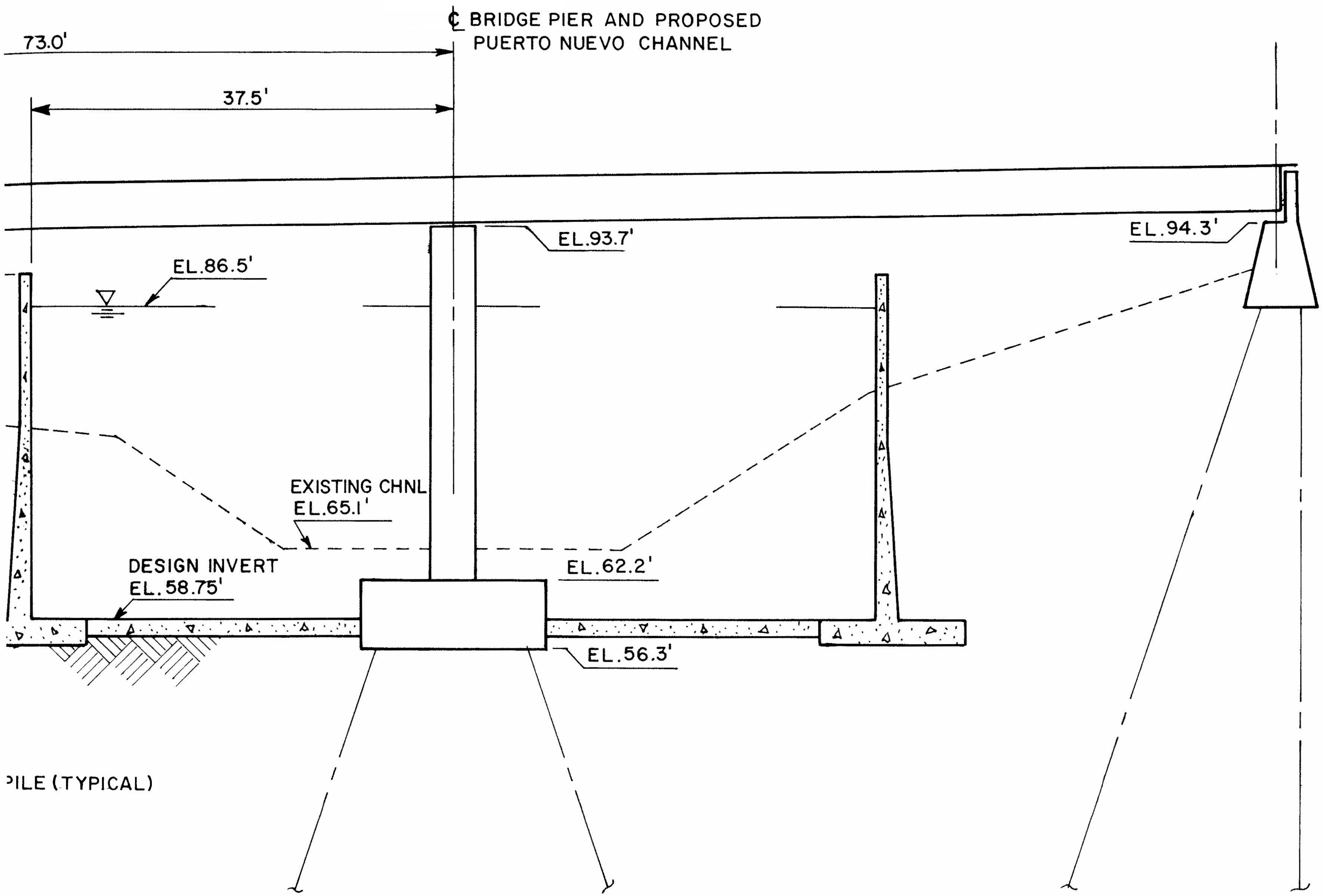
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




ELEVATION

PUERTO NUEVO STA. 329+50




## ELEVATION

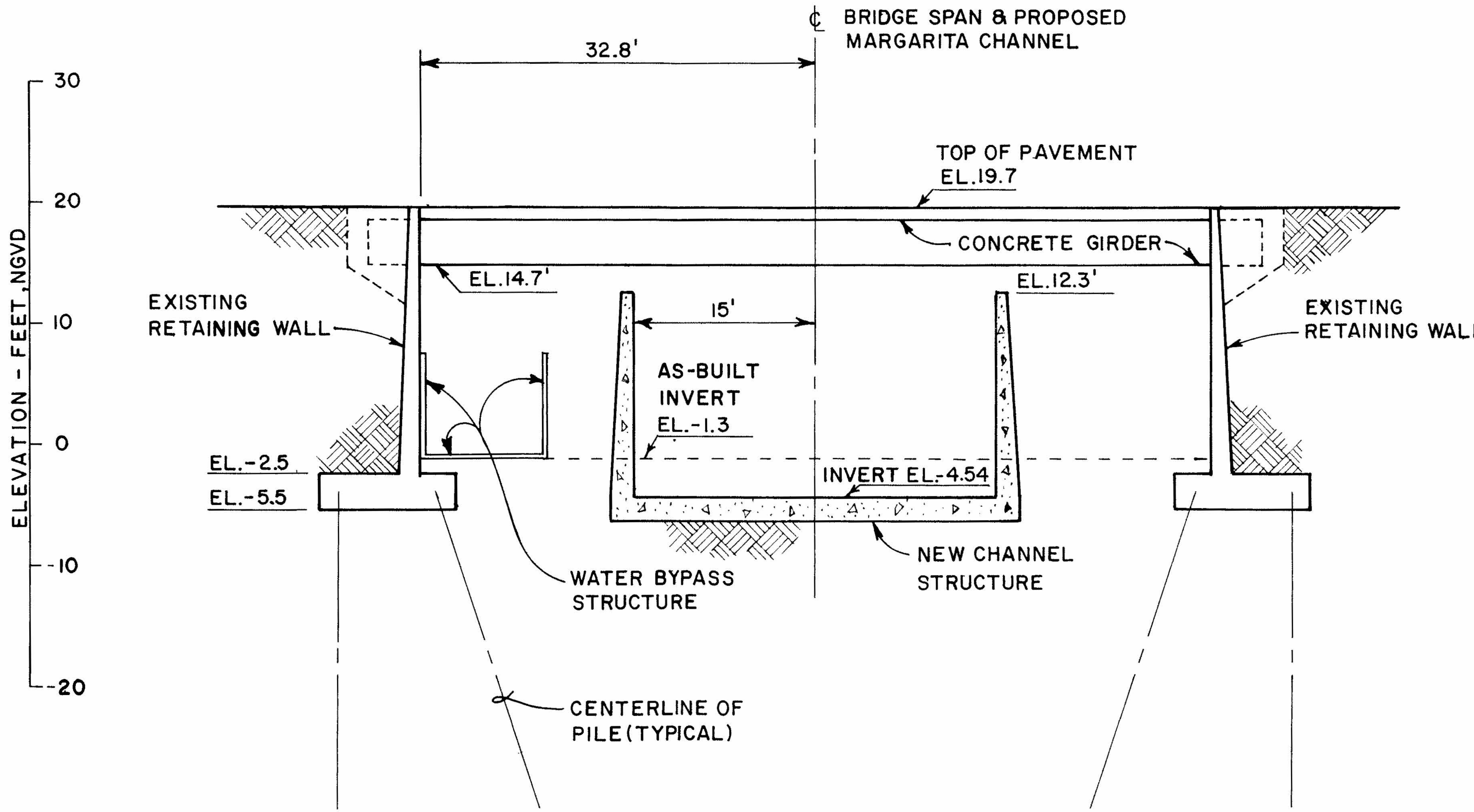
PUERTO NUEVO STA. 329+50

**NOTES:**

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 50 FEET FOR BRIDGE ABUTMENTS AND 21 FEET FOR BRIDGE PIER.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT 90 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.

GRAPHIC SCALE


RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
BRIDGE MODIFICATIONS
P. R. 177
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-36,678 DECEMBER 1990

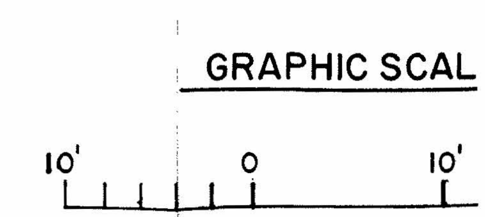


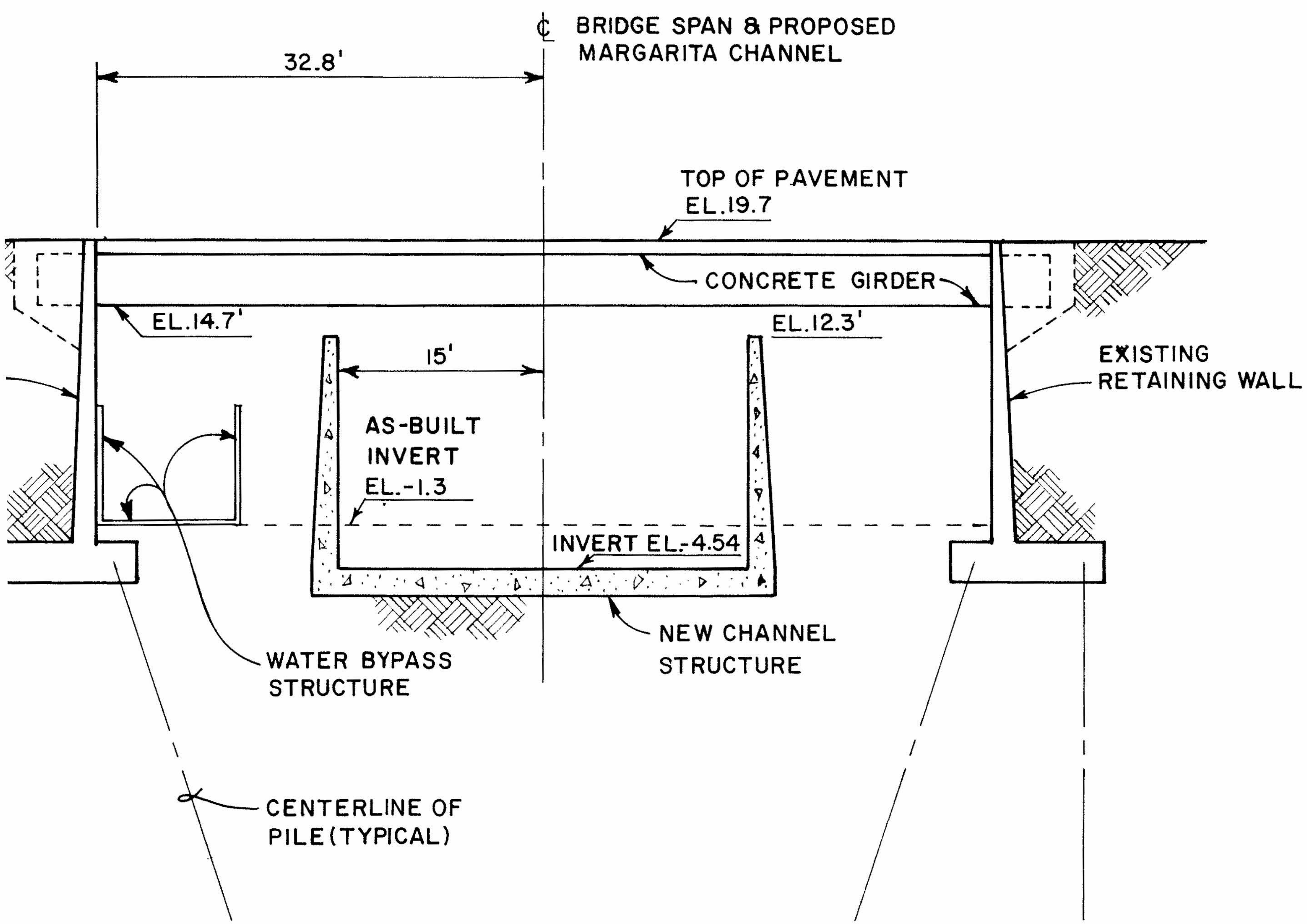

## ELEVATION

MARGARITA CHANNEL STA. 60+00

**NOTES:**

1. EX RE
2. AL AP CO
3. PI DR CO FO BR
4. BR AB
5. CH AT PE



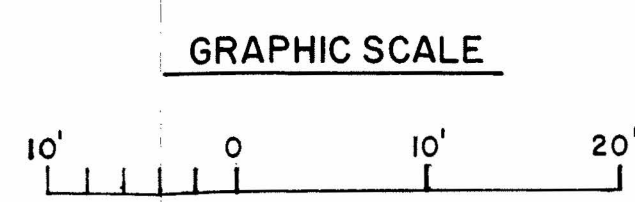



ELEVATION

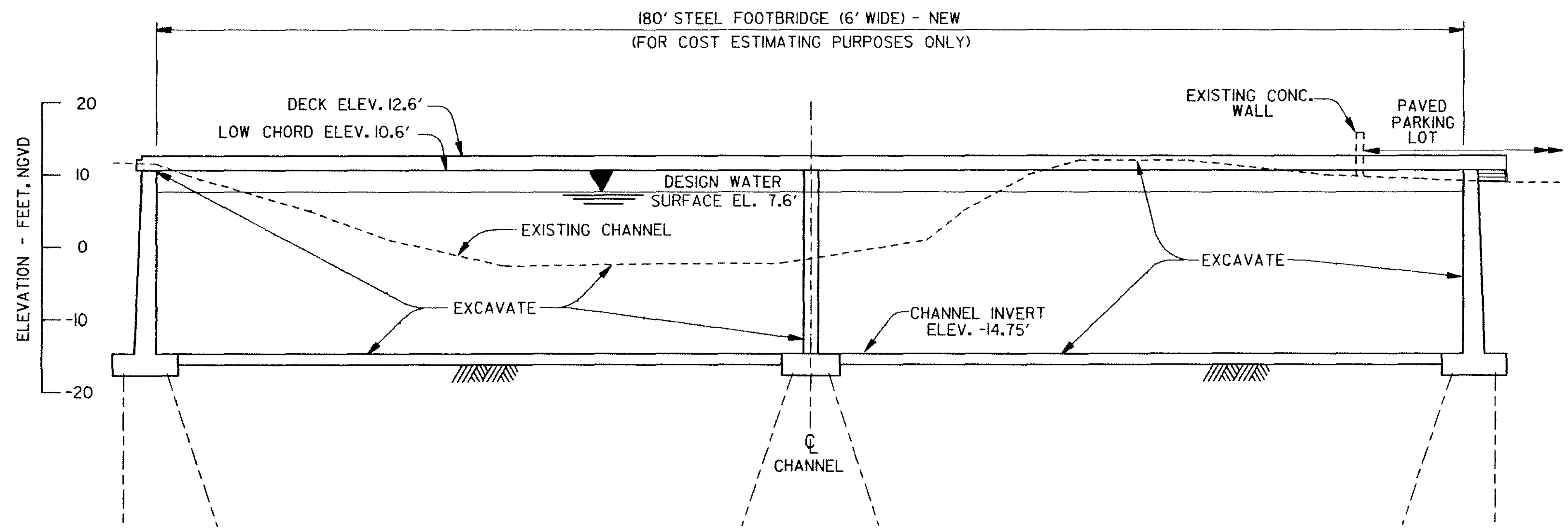
MARGARITA CHANNEL STA. 60+00

**NOTES**:

1. EXISTING REINFORCED CONCRETE BRIDGE TO REMAIN.
2. ALL BRIDGE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE, SCALED FROM PR DOT METRIC CONSTRUCTION DRAWINGS.
3. PILE BATTERS ARE TAKEN FROM PR DOT CONSTRUCTION DRAWINGS AND ARE ASSUMED TO REFLECT AS-BUILT CONDITIONS. ESTIMATED LENGTH OF PILES IS 55 FEET FOR EAST BOUND BRIDGE AND 60 FEET FOR WEST BOUND BRIDGE.
4. BRIDGE SPAN AND CHANNEL SECTION ARE SYMMETRICAL ABOUT CHANNEL CENTERLINE.
5. CHANNEL CENTERLINE INTERSECTS EXPRESSWAY CENTERLINE AT APPROXIMATELY 58 DEGREES. ELEVATION IS CUT PERPENDICULAR TO CHANNEL CENTERLINE.




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
MARGARITA TRIBUTARY
BRIDGE MODIFICATIONS
DE DIEGO EXPRESSWAY
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-38,678 DECEMBER 1990




## PEDESTRIAN BRIDGE

PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 110+06
SCALE "A"

GRAPHIC SCALE

"A" 10' 0 10' 20'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

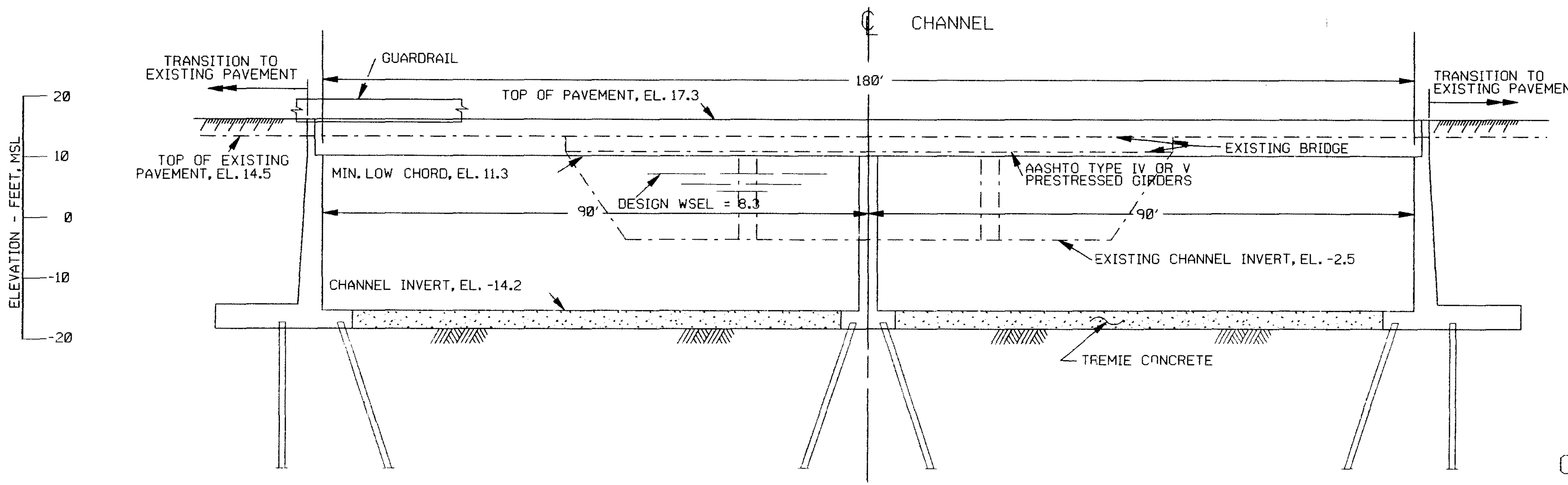
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES

PEDESTRIAN BRIDGE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

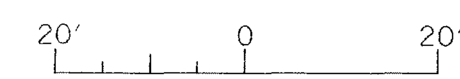
D.O. FILE NO. 102-35,578 DECEMBER 1990




ELEVATION

STA. 119+50

GRAPHIC SCALE




ROOSEVELT AVE. BRIDGE

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES

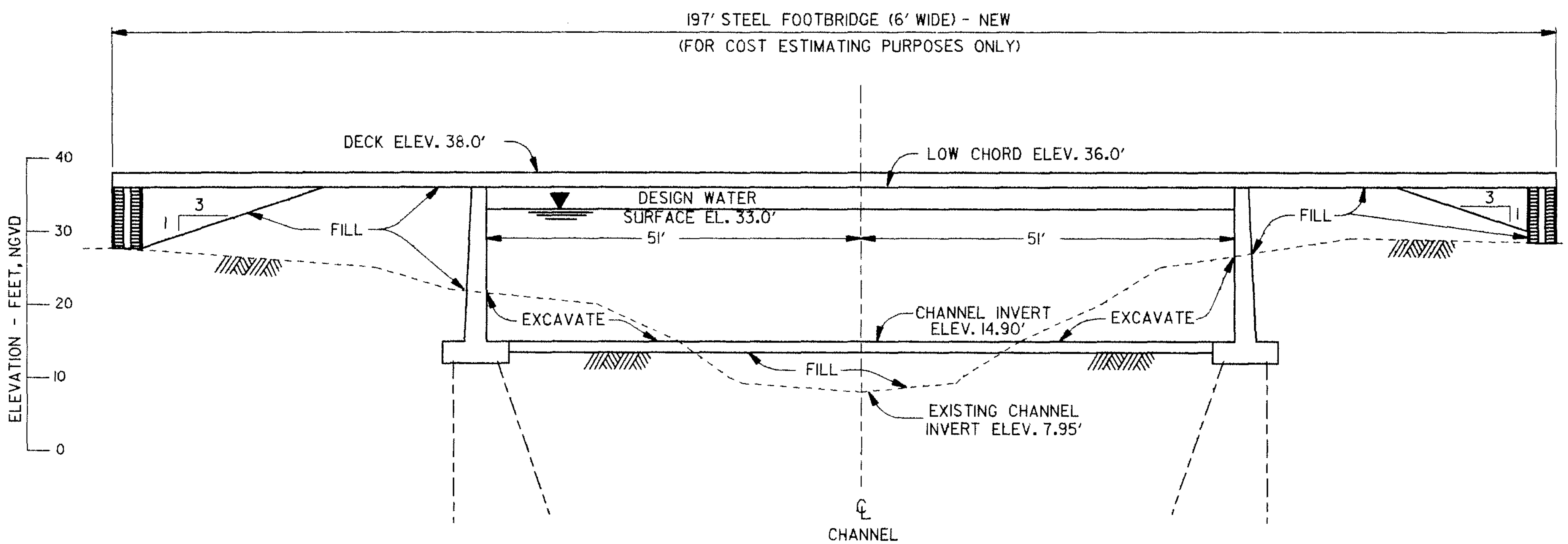
ROOSEVELT AVENUE

STRUCTURAL

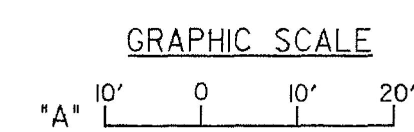
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

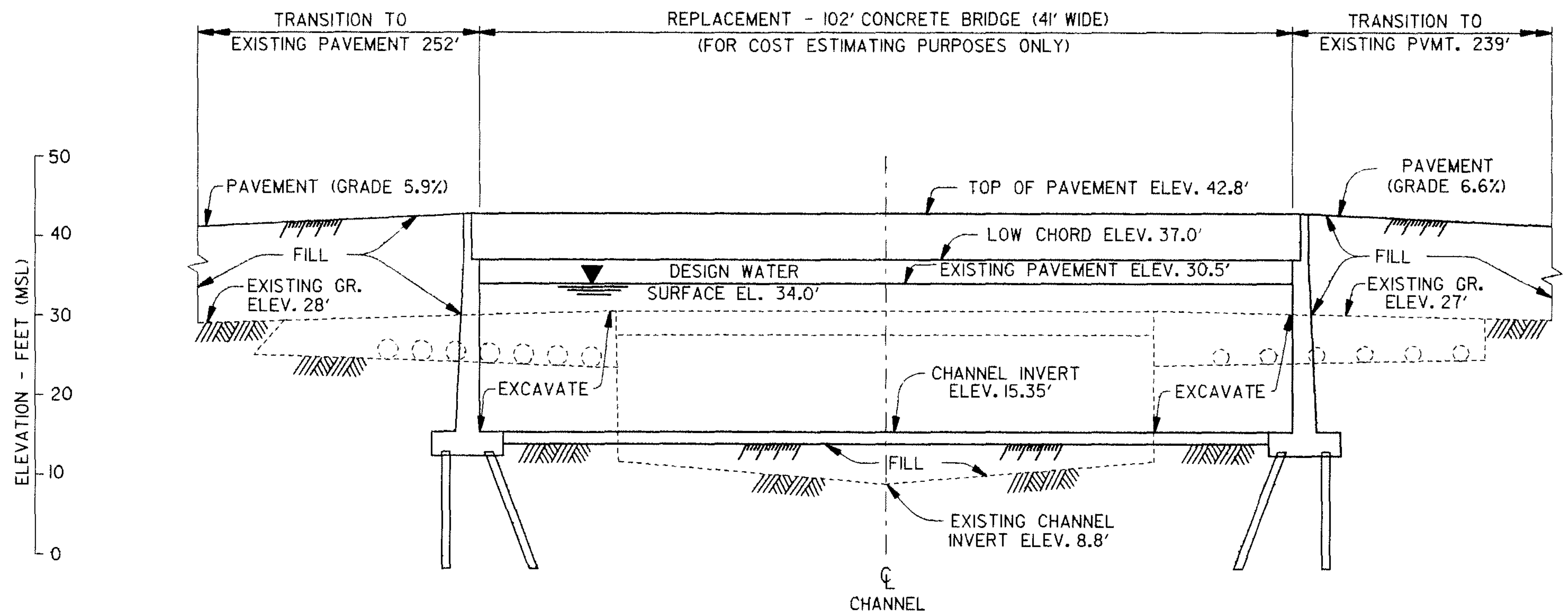
D.O. FILE NO. 102-35,578 DECEMBER 199




PEDESTRIAN BRIDGE
PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 195+00
SCALE "A"

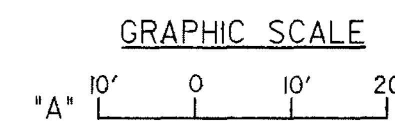



RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES
PEDESTRIAN BRIDGE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-04




# NOTRE DAME ST.

PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 196+38
SCALE "A"




RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

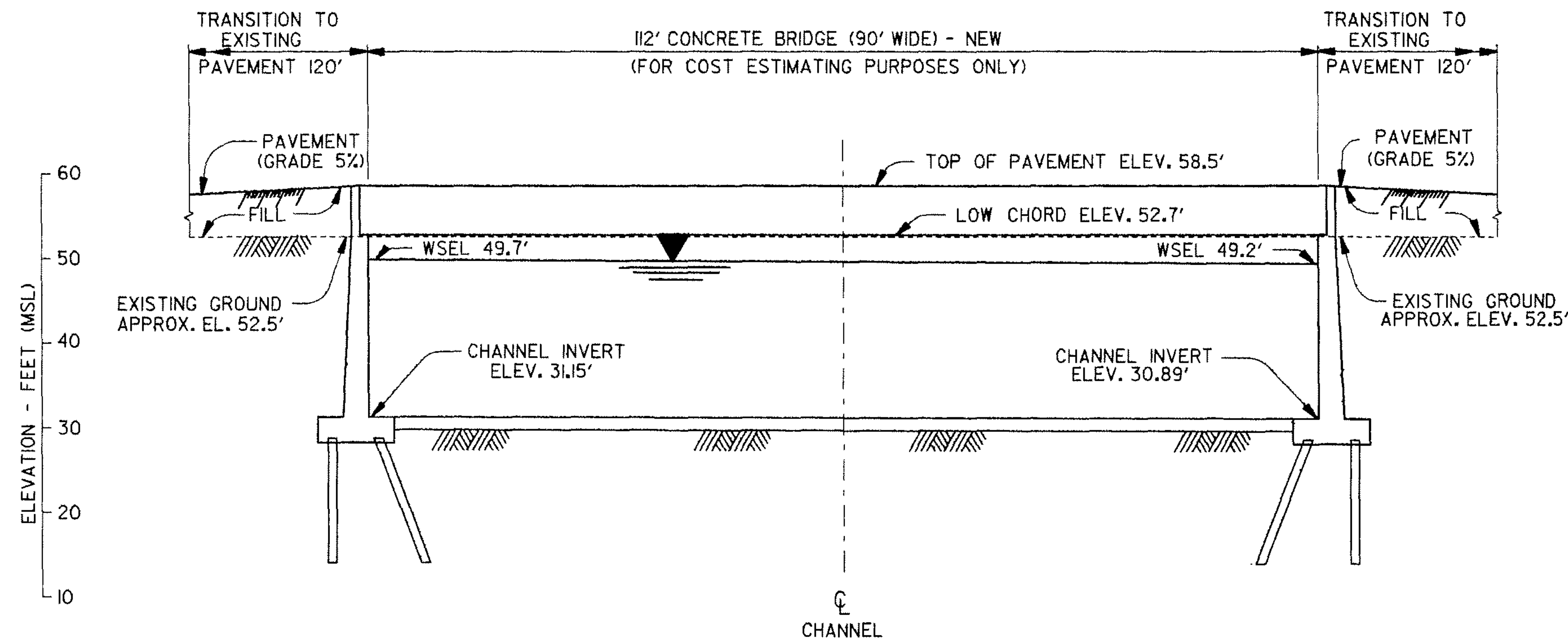
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES

NOTRE DAME STREET

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




P.R. 1

PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 241+40
SCALE "A"

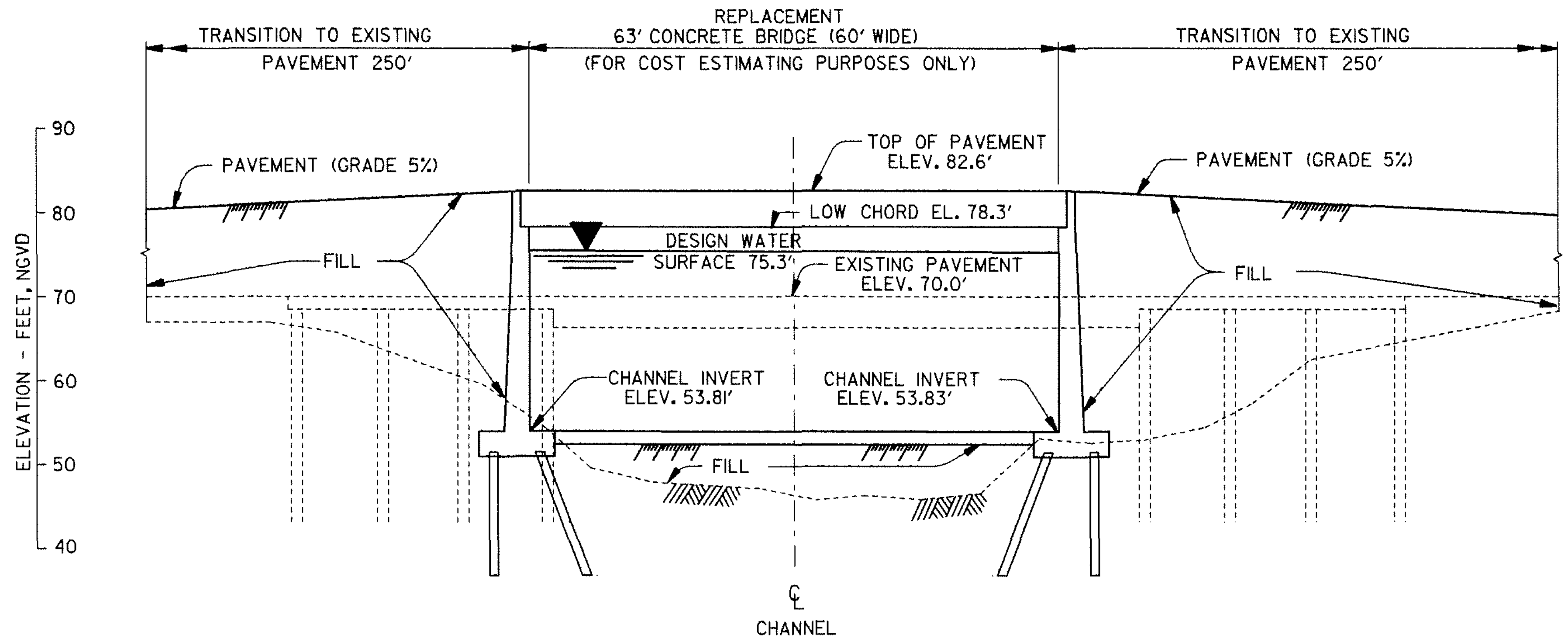
GRAPHIC SCALE

"A" 10' 0 10' 20'

NOTES:

1. CHANNEL WIDTH IS 83'.
2. 112' SPAN DUE TO 45 DEG. SKEW OF BRIDGE ALIGNMENT RELATIVE TO CHANNEL ALIGNMENT.
3. STATION AT LEFT CHANNEL WALL SECTION IS 241+75.
4. STATION AT RIGHT CHANNEL WALL SECTION IS 241+05.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES
P. R. 1
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




## P.R. 176

PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 280+27
SCALE "A"

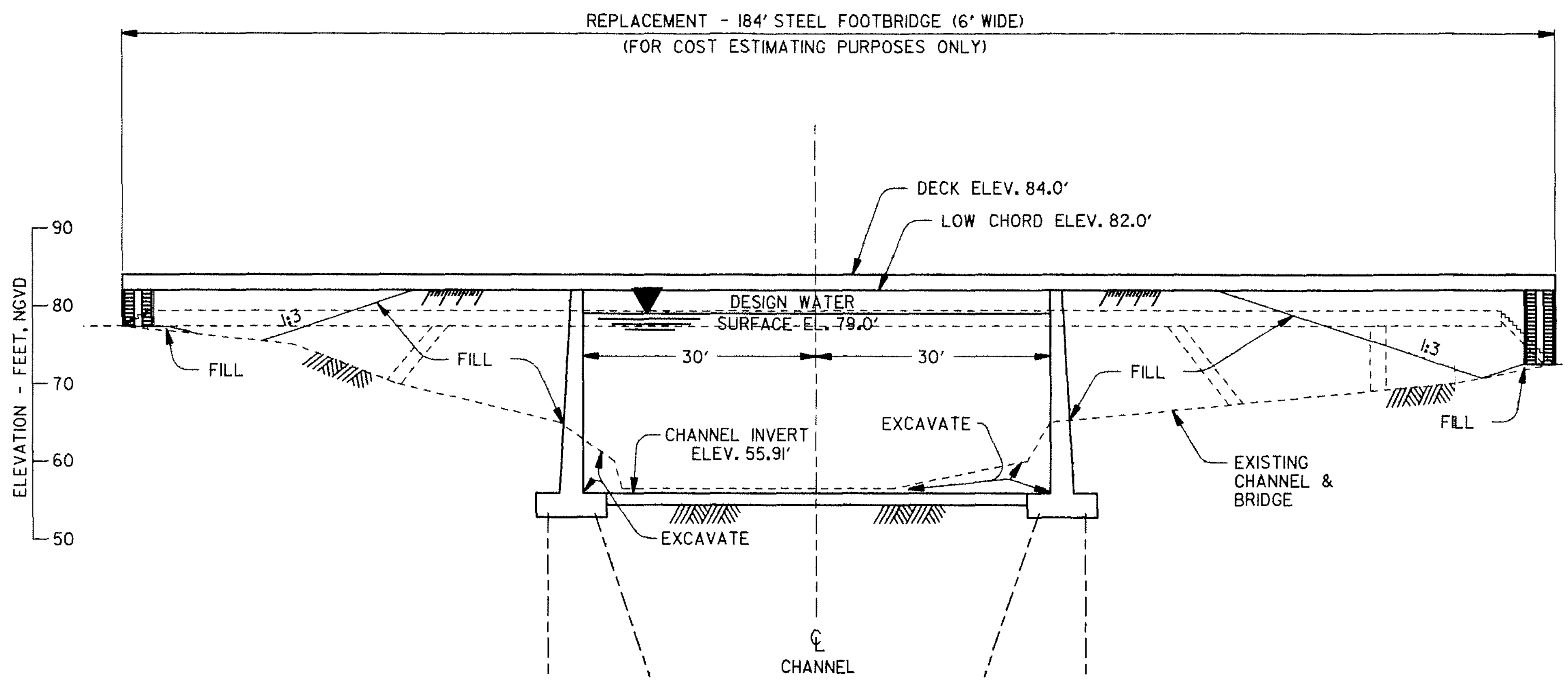
GRAPHIC SCALE

"A" 10' 0 10' 20'

NOTES:

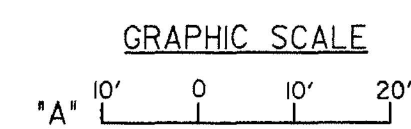
1. CHANNEL WIDTH IS 60'.
2. STATION AT LEFT CHANNEL WALL SECTION IS 280+16.
3. STATION AT RIGHT CHANNEL WALL SECTION IS 280+37.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES
P. R. 176
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

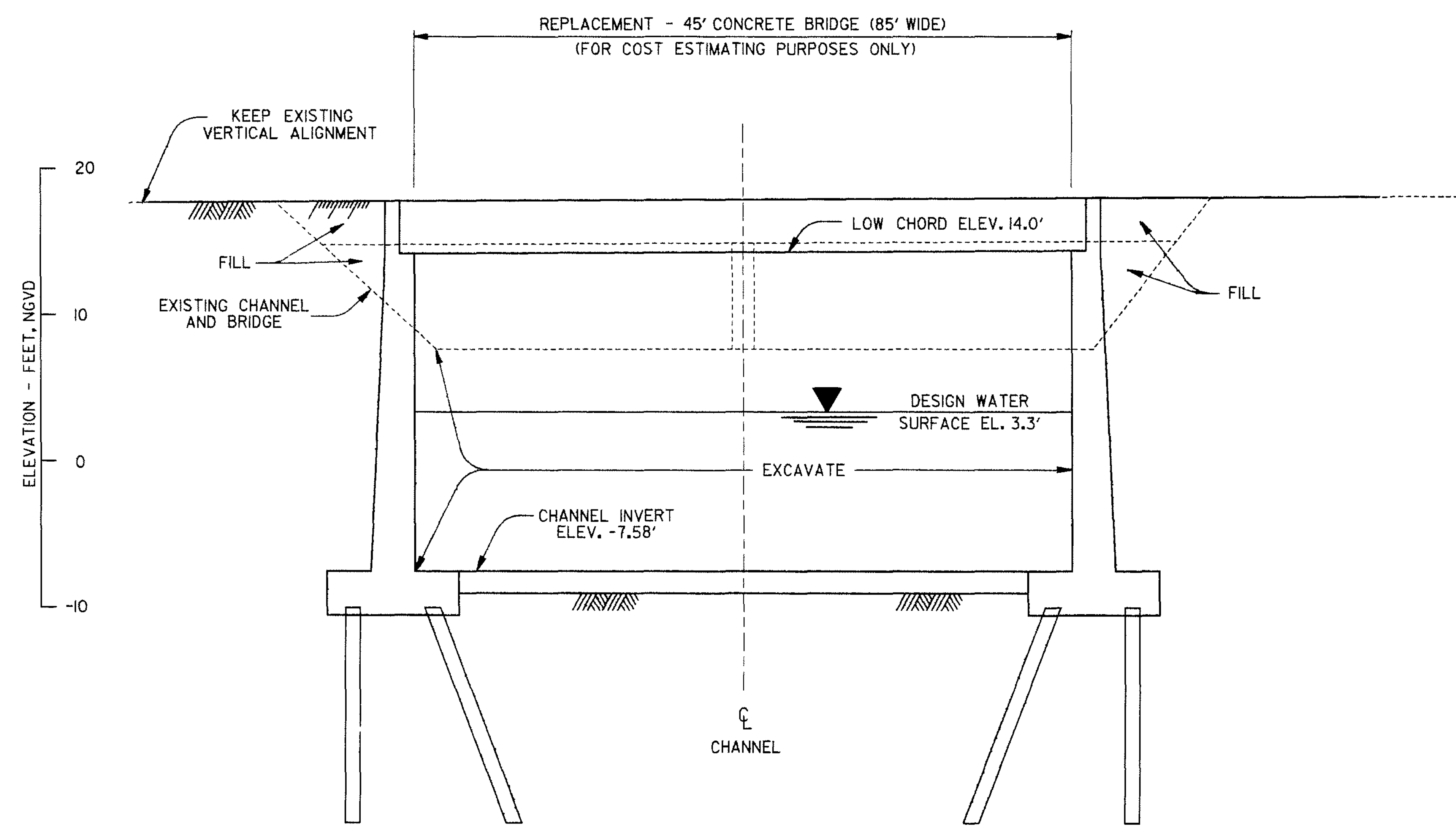



## PEDESTRIAN BRIDGE

PUERTO NUEVO CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 301+33
SCALE "A"



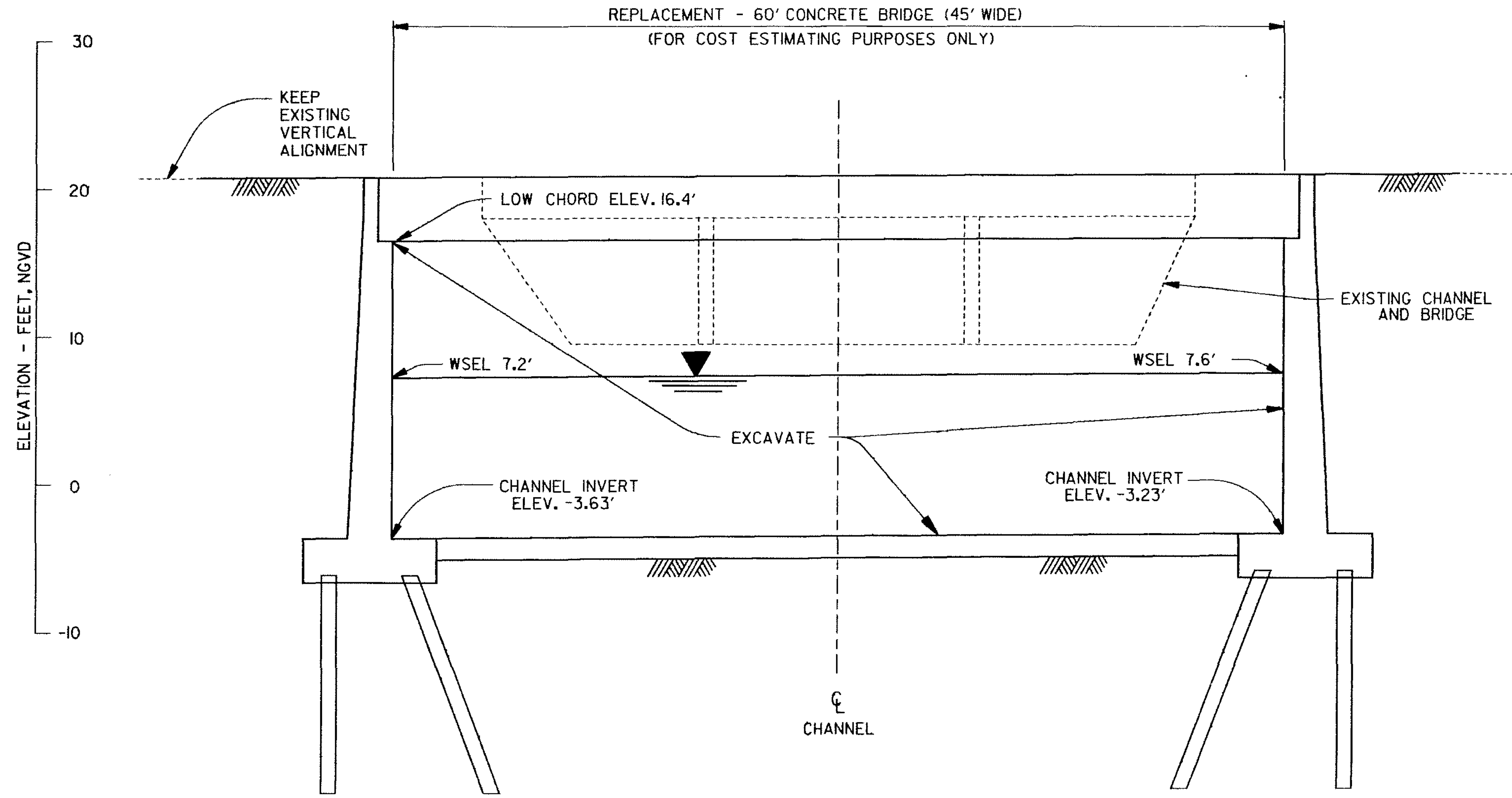

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL
NEW AND REPLACEMENT BRIDGES
PEDESTRIAN BRIDGE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO 102-35,578 DECEMBER 1990




PINERO AVENUE
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 24+67
SCALE: "B"

GRAPHIC SCALE
"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
PINERO AVENUE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990



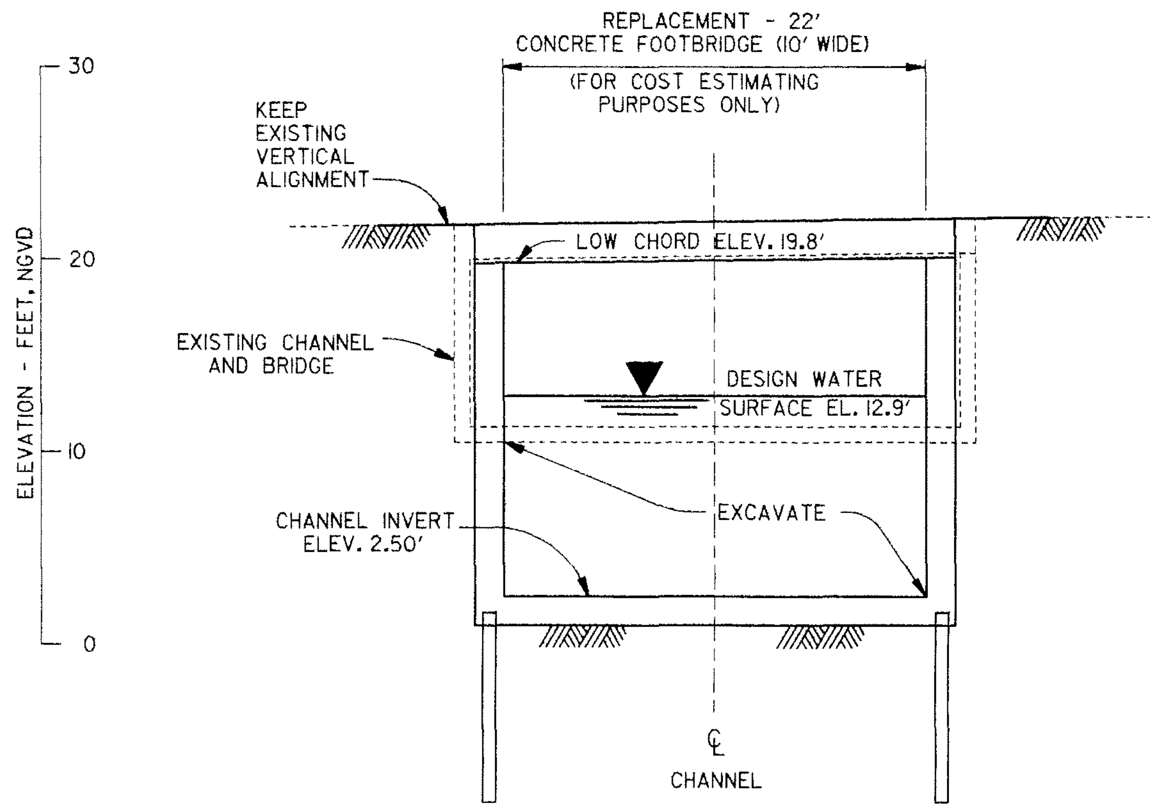

GRAPHIC SCALE

"B" 5' 0 5' 10'

## ANDALUCIA AVENUE
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 31+10
SCALE: "B"

NOTES:
1. CHANNEL WIDTH IS 45'.
2. 60' SPAN DUE TO SKEW OF BRIDGE ALIGNMENT RELATIVE TO CHANNEL ALIGNMENT.
3. STATION OF LEFT CHANNEL WALL SECTION IS 30+95.
4. STATION OF RIGHT CHANNEL WALL SECTION IS 31+25.

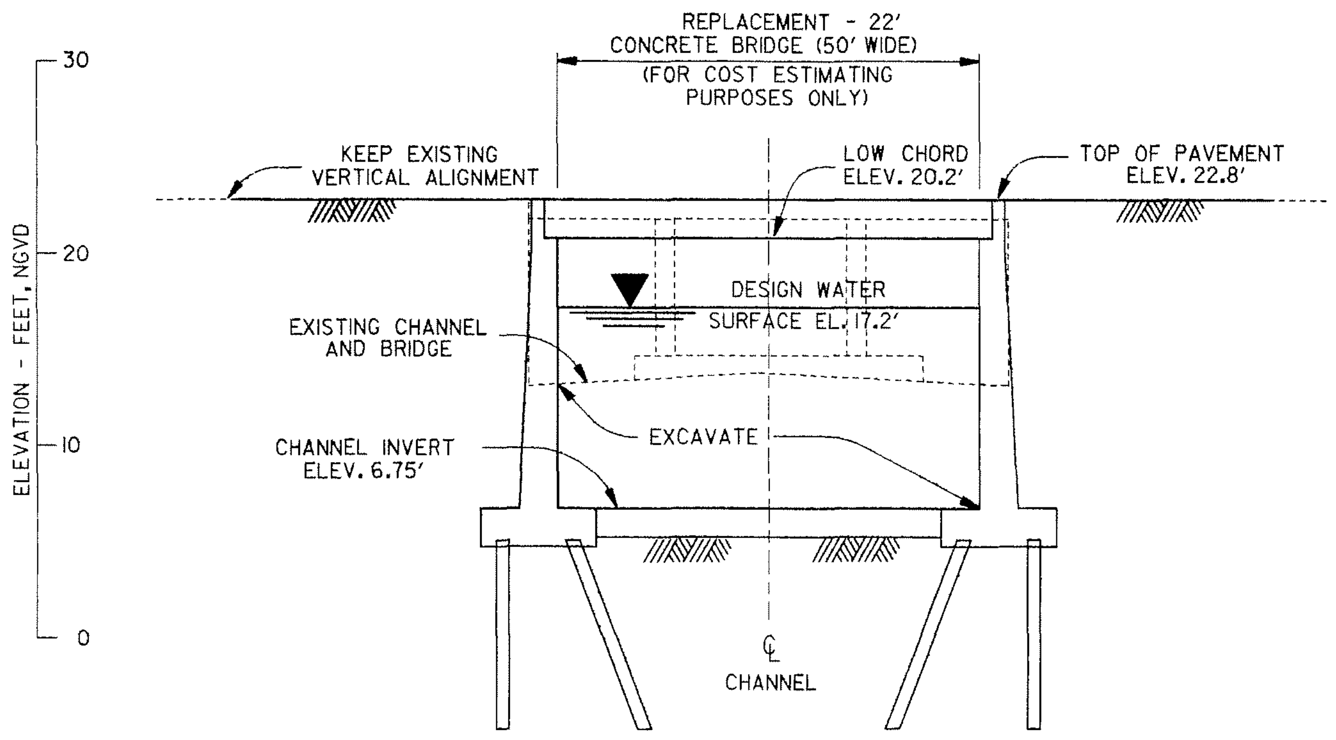
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
ANDALUCIA AVENUE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-100




PEDESTRIAN BRIDGE
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 40+58
SCALE: "B"

GRAPHIC SCALE
"B" 5' 0 5' 10'

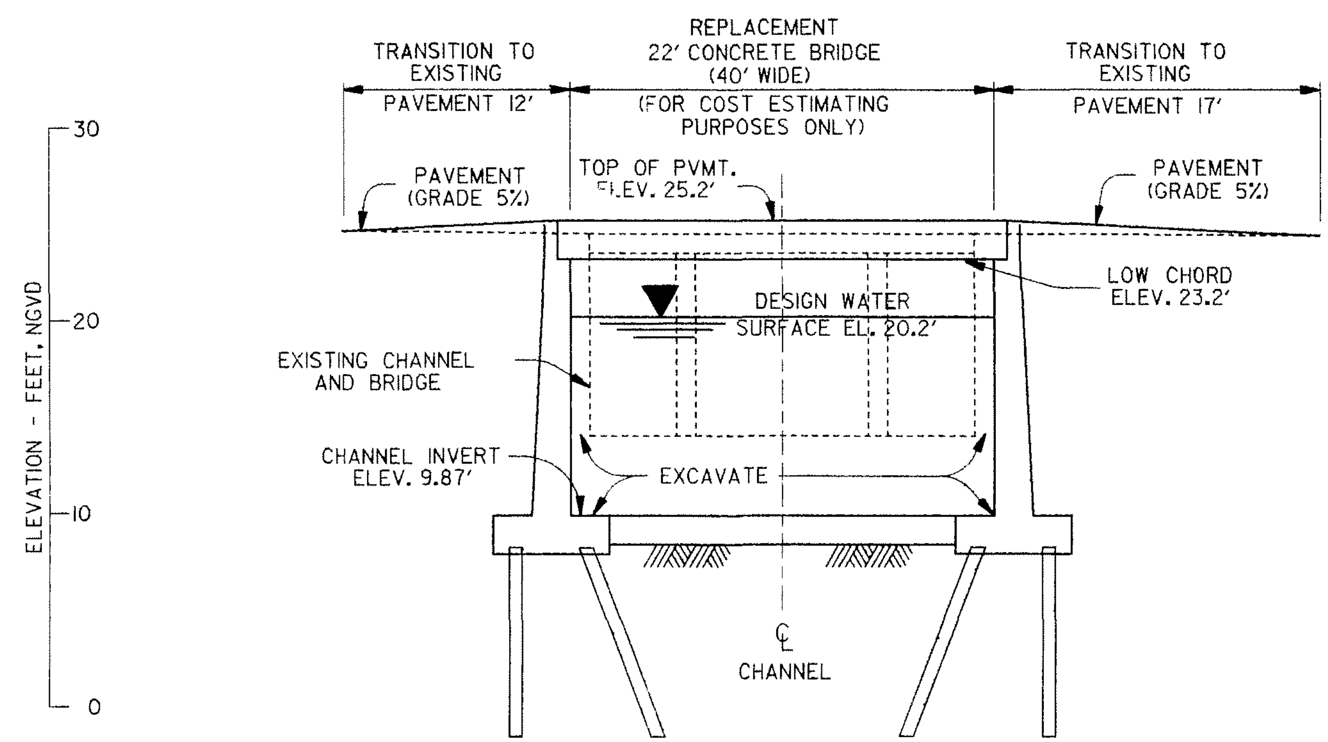
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
PEDESTRIAN BRIDGE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-10




AMERICO MIRANDA
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 47+30
SCALE: "B"

GRAPHIC SCALE
"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
AMERICO MIRANDA AVENUE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO 102-35,578 DECEMBER 1990
PLATE S-10




CALLE 31SE

JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 52+24
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES

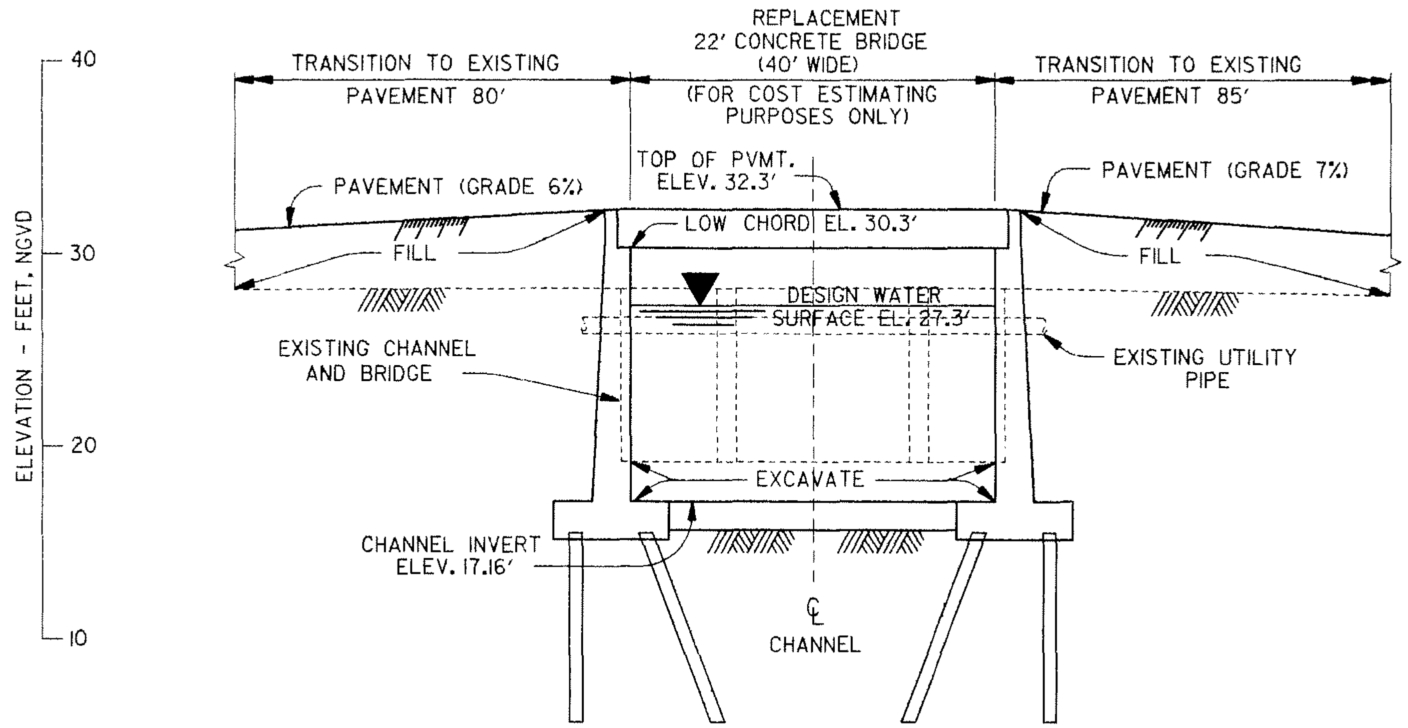
31ST S. E. STREET

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 199

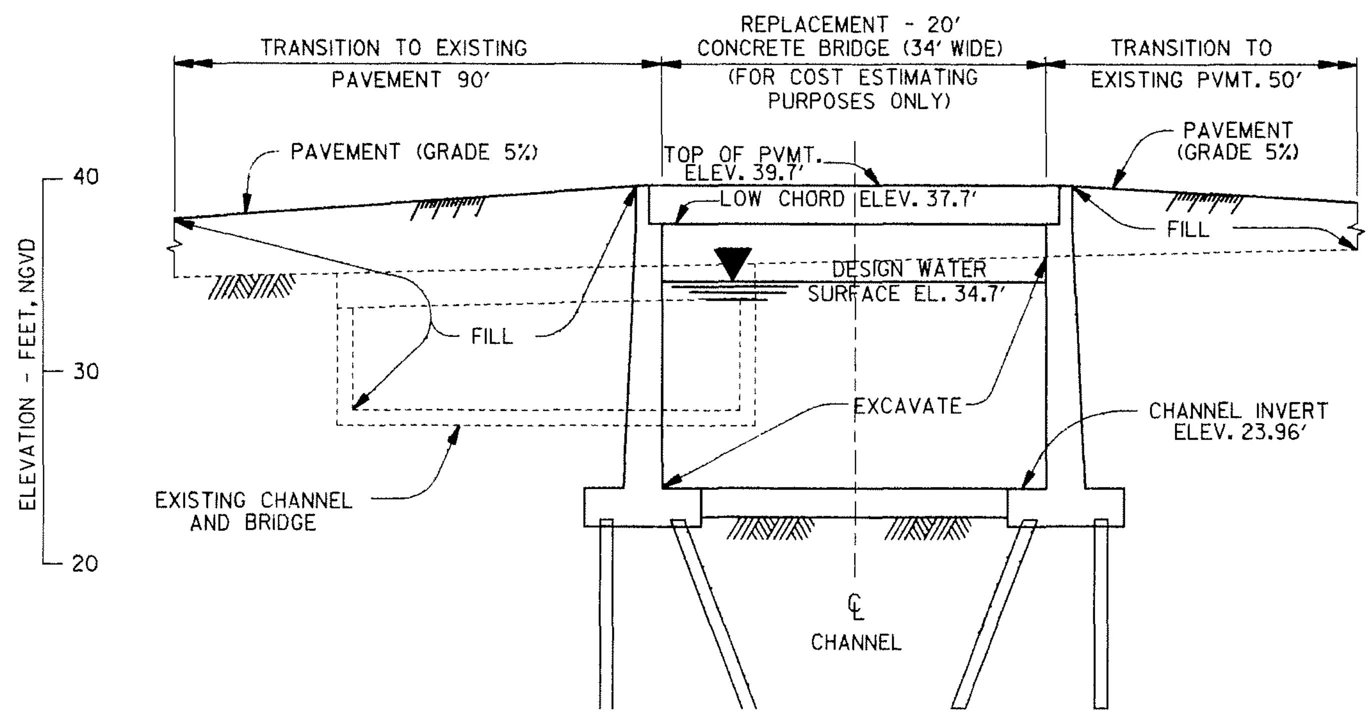
PLATE S-1




CALLE 21SE
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 63+40
SCALE: "B"

GRAPHIC SCALE
"B" 5′ 0 5′ 10′

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
21ST S. E. STREET
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-10

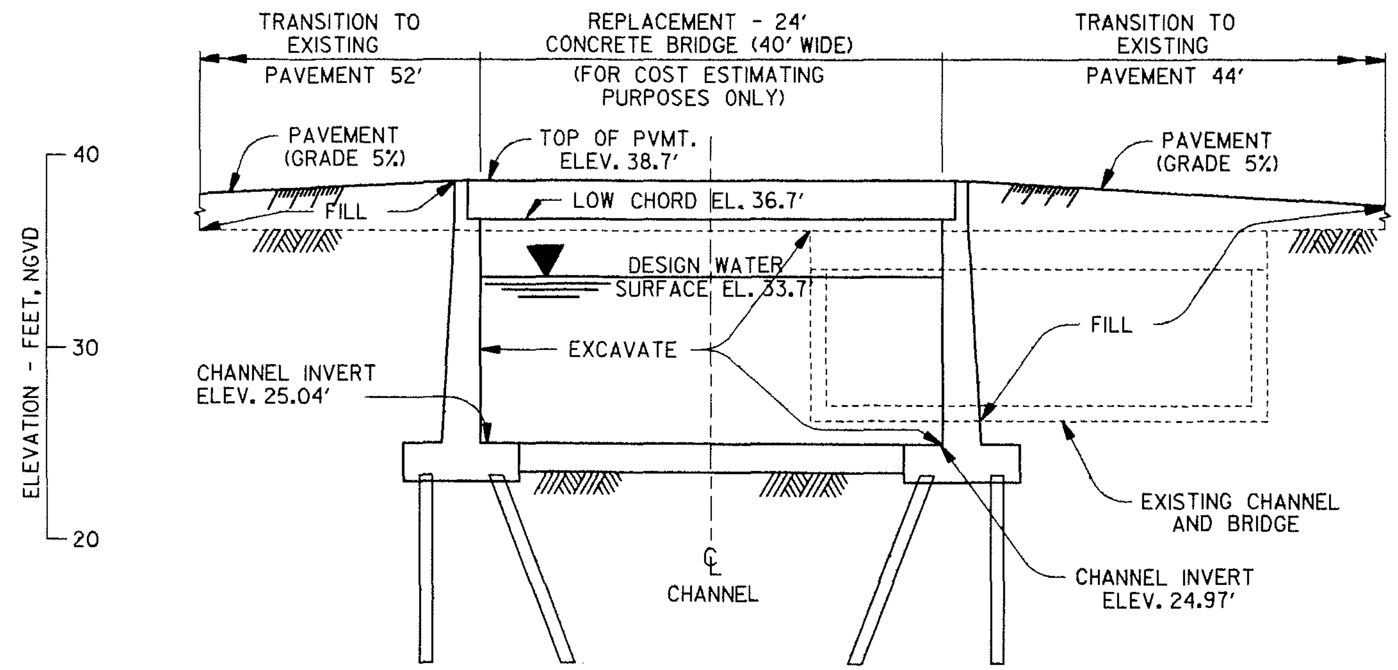



CALLE 9 SE
JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 74+50
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
9TH S. E. STREET
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-10




## CALLE 54 SE

JOSEFINA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 76+20
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

NOTES:

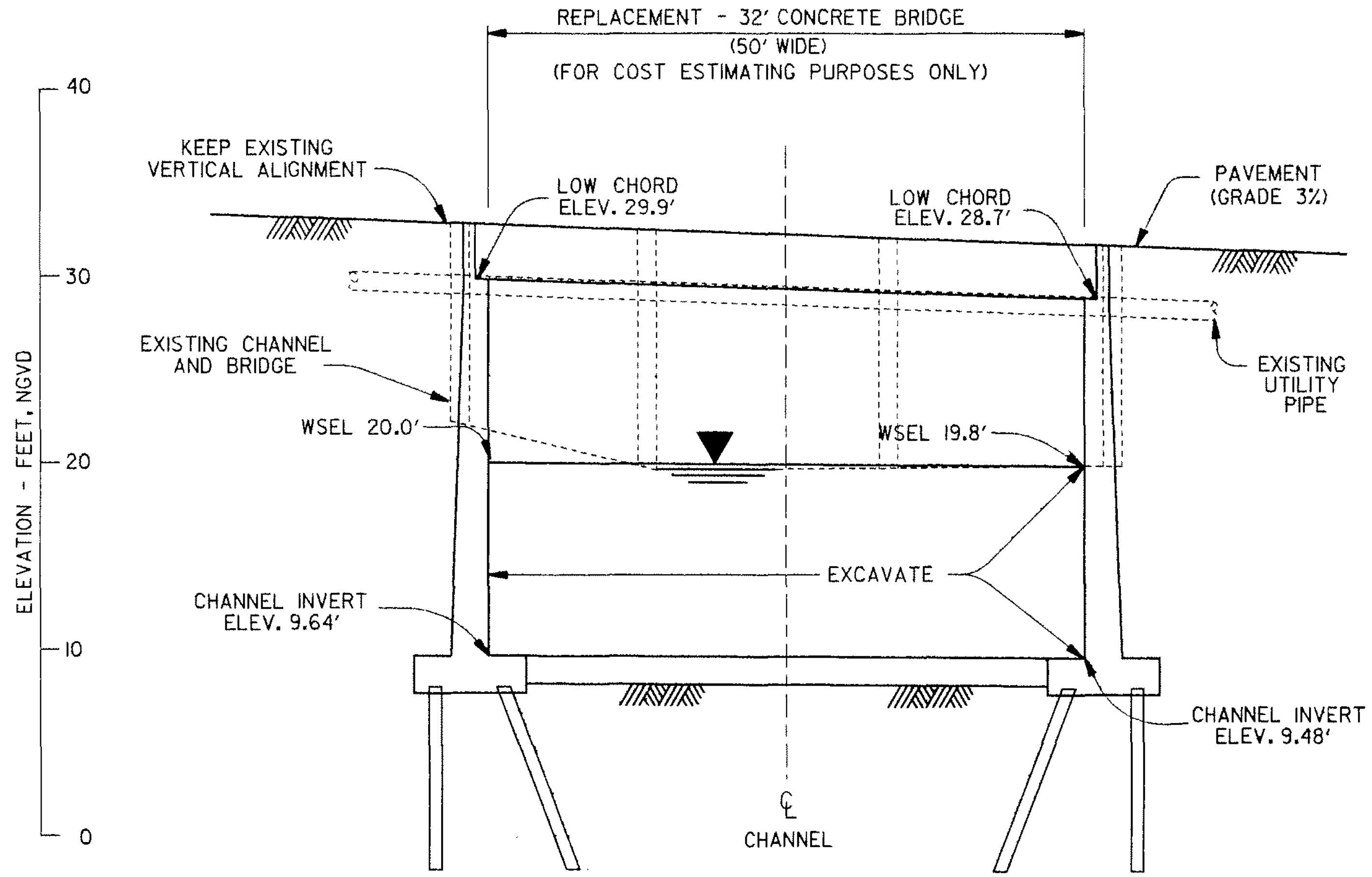
1. CHANNEL WIDTH IS 17'.
2. 24' SPAN DUE TO SKEW OF BRIDGE ALIGNMENT RELATIVE TO CHANNEL ALIGNMENT
3. STATION AT LEFT CHANNEL WALL SECTION IS 76+30.
4. STATION AT RIGHT CHANNEL WALL SECTION IS 76+10.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
JOSEFINA TRIBUTARY
NEW AND REPLACEMENT BRIDGES

54TH S. E. STREET

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




AMERICO MIRANDA
DONA ANA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 15+45
SCALE: "B"

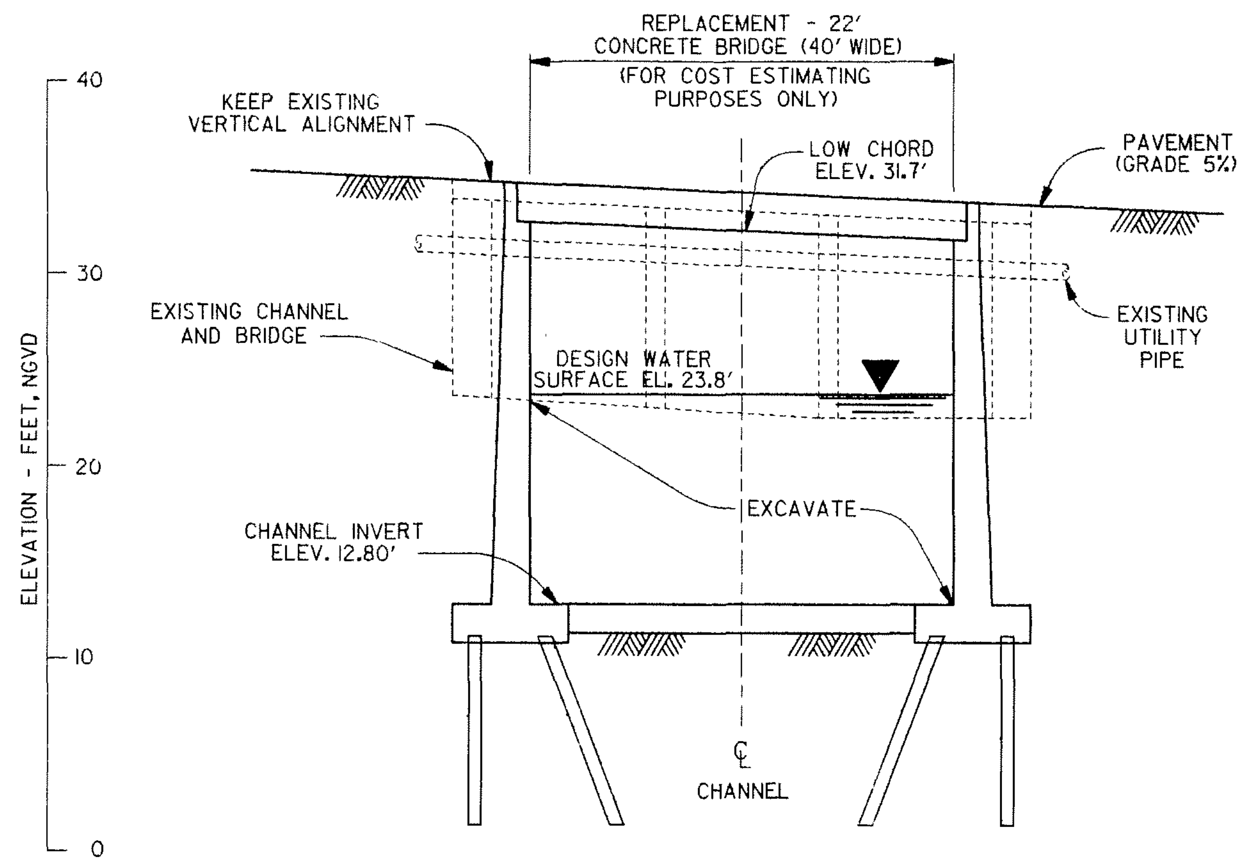
NOTES:

1. CHANNEL WIDTH IS 22'.
2. 32' SPAN DUE TO SKEW OF BRIDGE ALIGNMENT RELATIVE TO CHANNEL ALIGNMENT.
3. STATION AT LEFT CHANNEL WALL SECTION IS 15+35.
4. STATION AT RIGHT CHANNEL WALL SECTION IS 15+55.

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
DONA ANA TRIBUTARY
NEW AND REPLACEMENT BRIDGES
AMERICO MIRANDA AVENUE
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990
PLATE S-10




CALLE 29 SE
DONA ANA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 19+50
SCALE "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

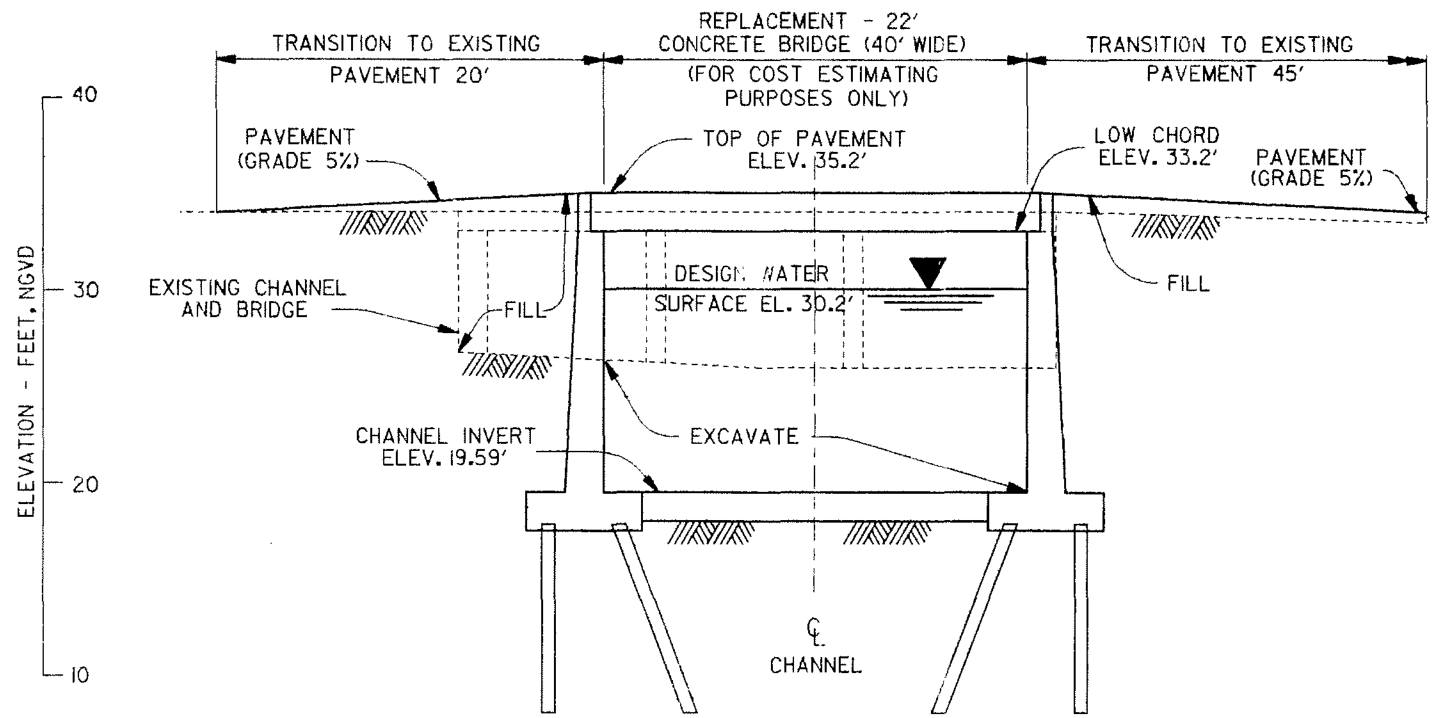
DONA ANA TRIBUTARY
NEW AND REPLACEMENT BRIDGES

29TH S. E. STREET

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990




CALLE 21 SE
DONA ANA CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 27+94
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

DONA ANA TRIBUTARY
NEW AND REPLACEMENT BRIDGES

21ST S. E. STREET

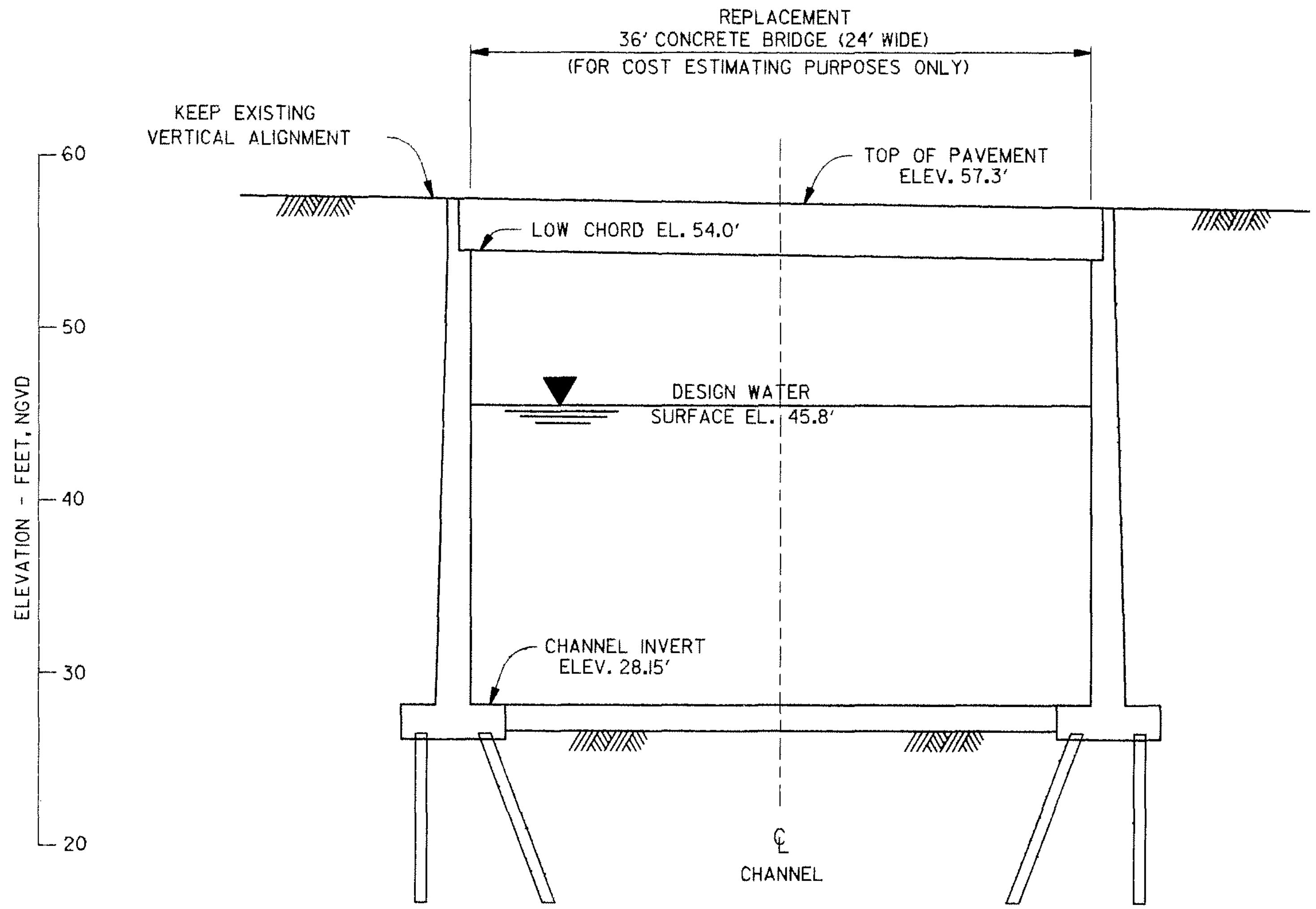
STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-10

Please Note Plate S-110 and S-111 will not beused in this Report




## SERVICE ROAD

BUENA VISTA DIVERSION CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 22+16
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

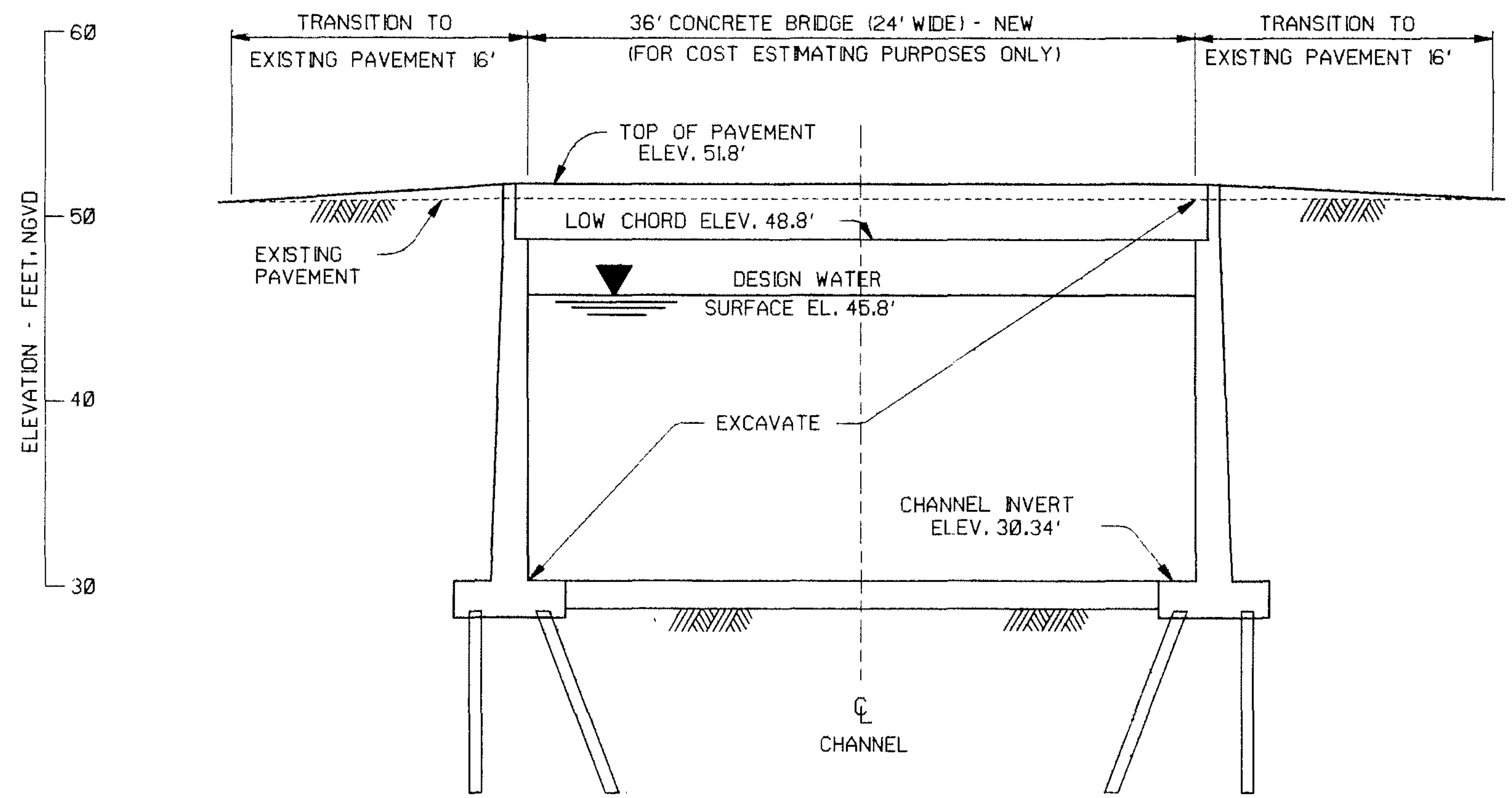
BUENA VISTA DIVERSION CHANNEL
NEW AND REPLACEMENT BRIDGES

SERVICE ROAD BRIDGE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990



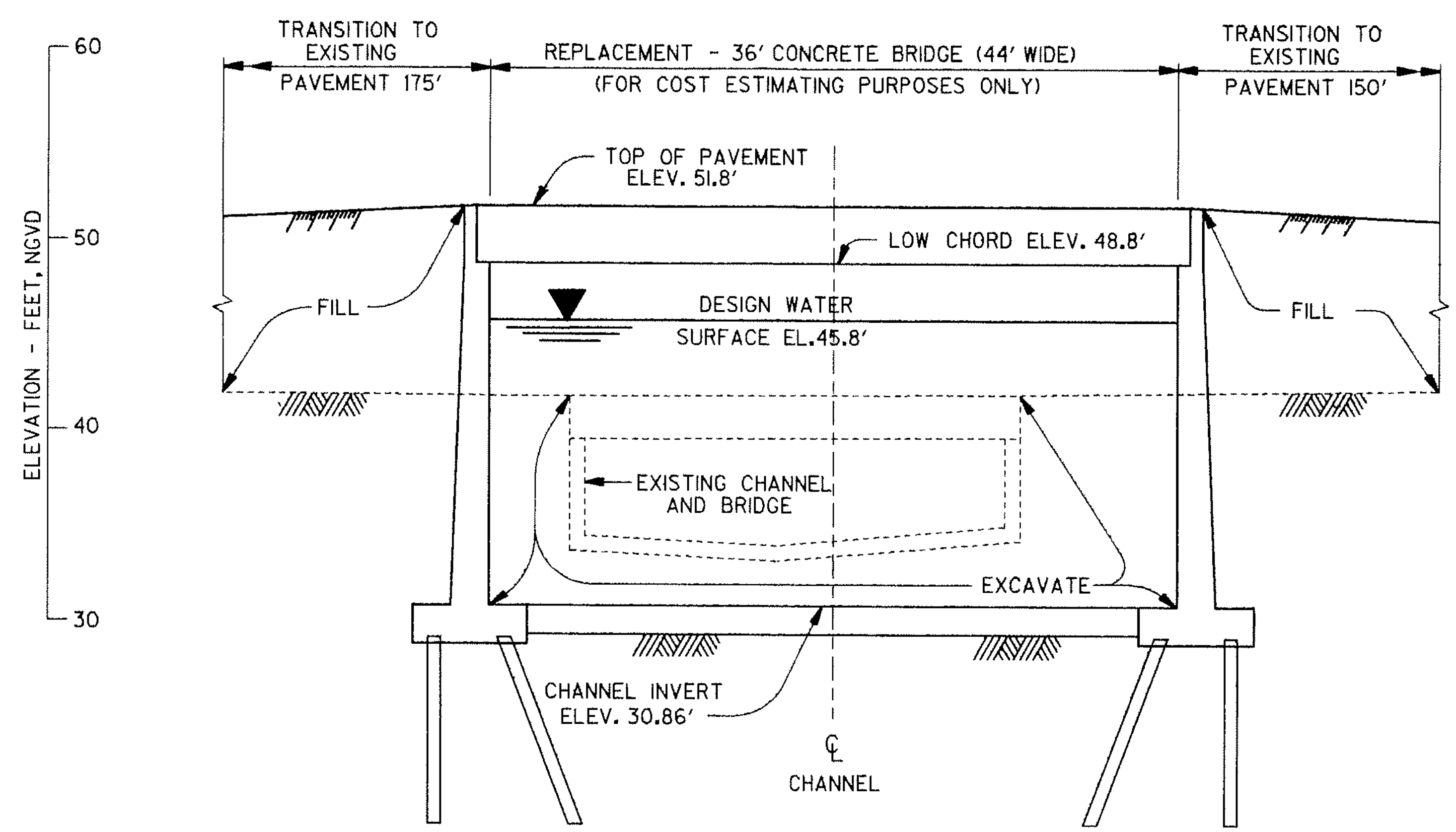

CALLE 17
BUENA VISTA DIVERSION CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 36+76
SCALE: 'B'

GRAPHIC SCALE

'B' 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
BUENA VISTA DIVERSION CHANNEL
NEW AND REPLACEMENT BRIDGES
17TH STREET
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-113




CALLE 4 SE

BUENA VISTA DIVERSION CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 40+24
SCALE: "B"

GRAPHIC SCALE

"B" 5' 0 5' 10'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

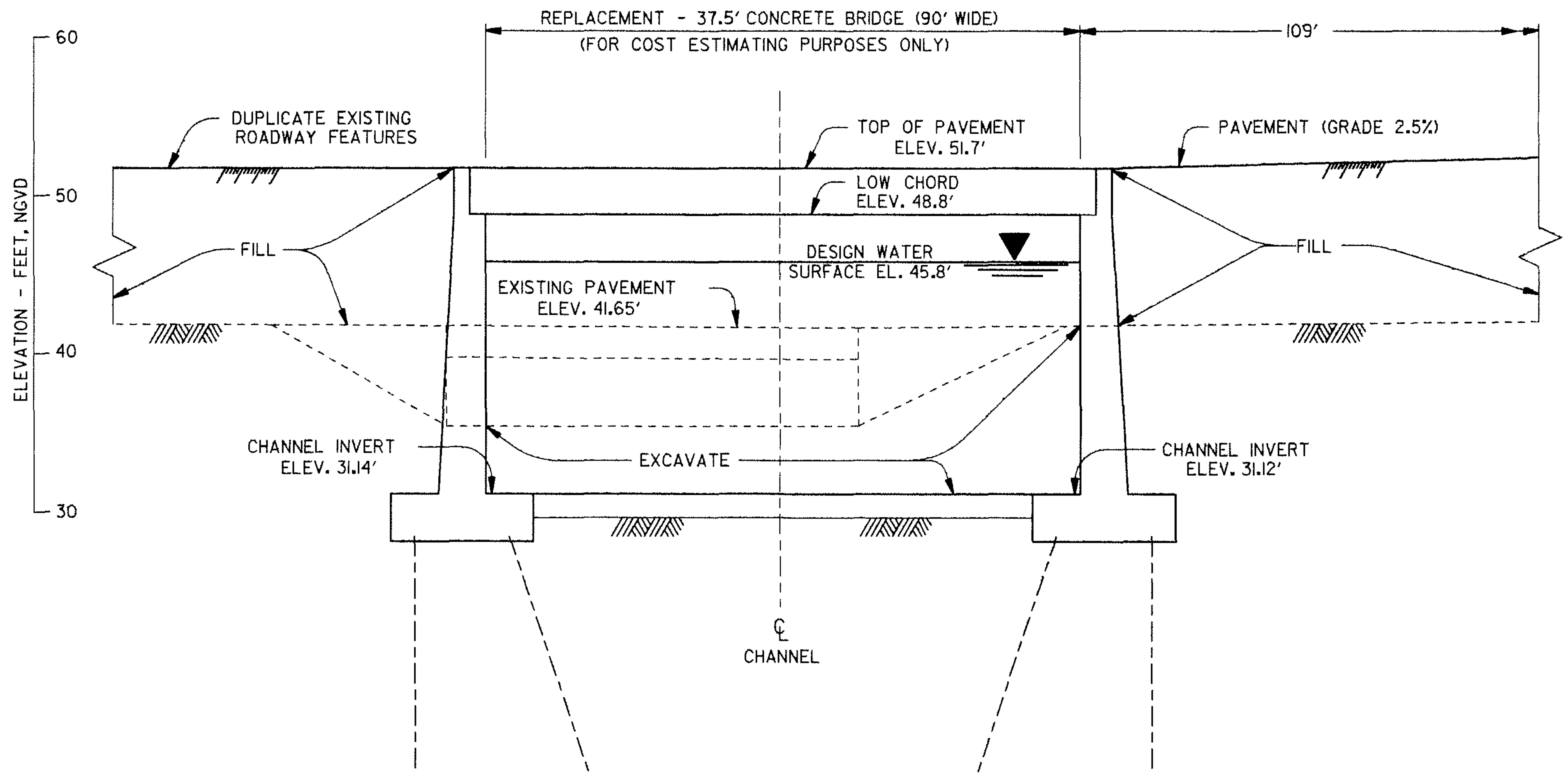
BUENA VISTA DIVERSION CHANNEL
NEW AND REPLACEMENT BRIDGES

4TH STREET

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-114




P.R. 21
BUENA VISTA DIVERSION CHANNEL
(LOOKING DOWNSTREAM)
UPSTREAM ELEVATION STA. 42+06.5
SCALE: "B"

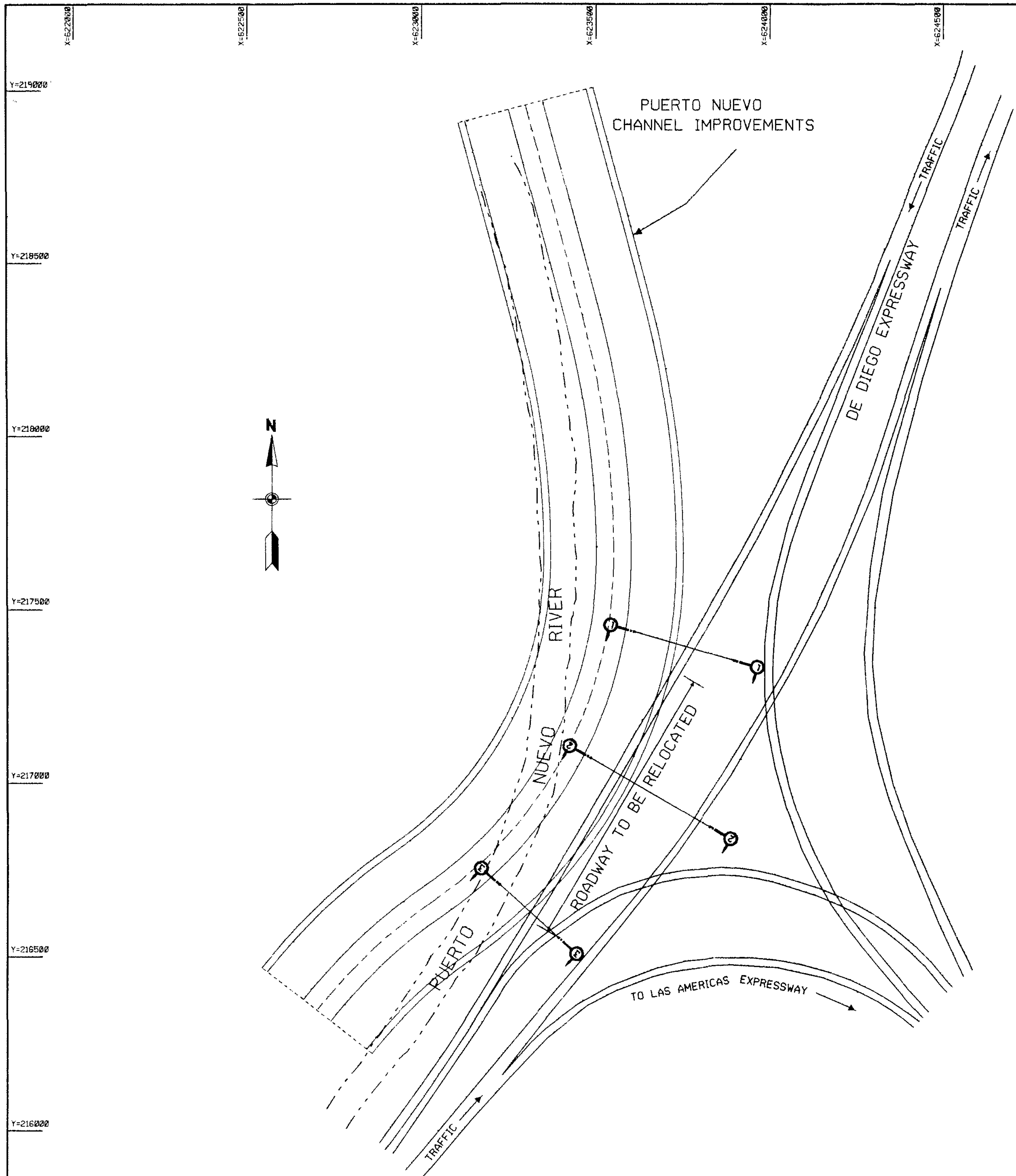
GRAPHIC SCALE

"B" 5' 0 5' 10'

NOTES:

1. CHANNEL WIDTH IS 36'.
2. 37.5' SPAN DUE TO SKEW OF BRIDGE ALIGNMENT RELATIVE TO CHANNEL ALIGNMENT.
3. STATION AT LEFT CHANNEL WALL SECTION IS 42+11.
4. STATION AT RIGHT CHANNEL WALL SECTION IS 42+01.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
BUENA VISTA DIVERSION CHANNEL
NEW AND REPLACEMENT BRIDGES
P. R. 21
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990




GRAPHIC SCALE

-200' 0 200' 400' 600'

NOTE:

FOR CROSS-SECTIONS SEE PLATE S-117.

RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

DE DIEGO EXPRESSWAY RELOCATION
EXISTING CONDITION WITH PROPOSED CHANNEL

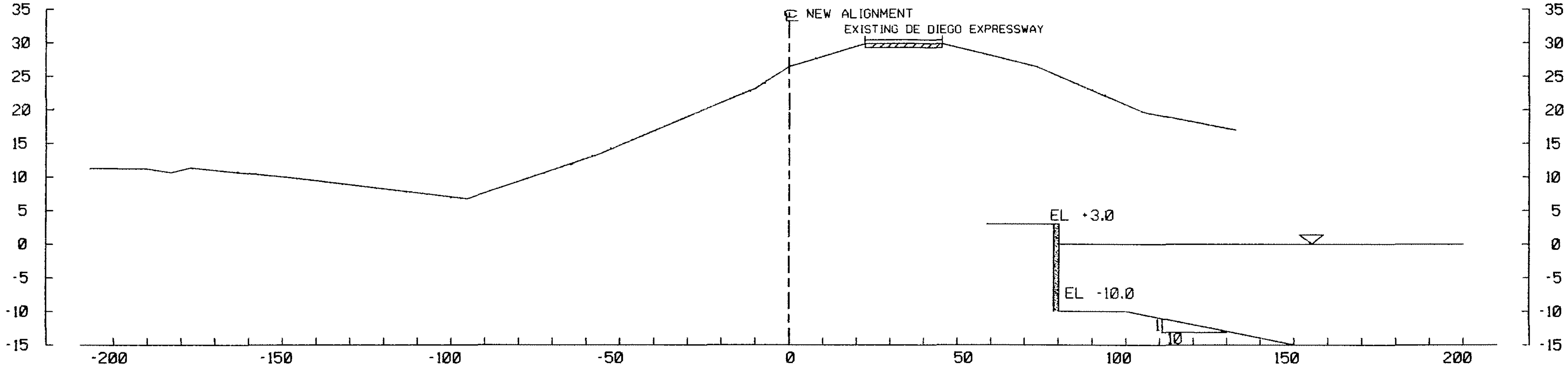
PLAN

STRUCTURAL

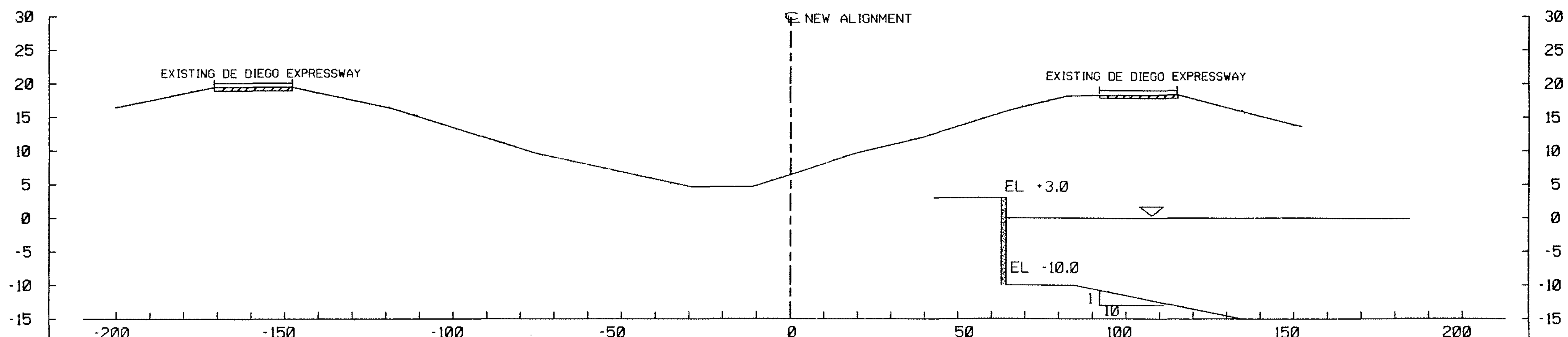
DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

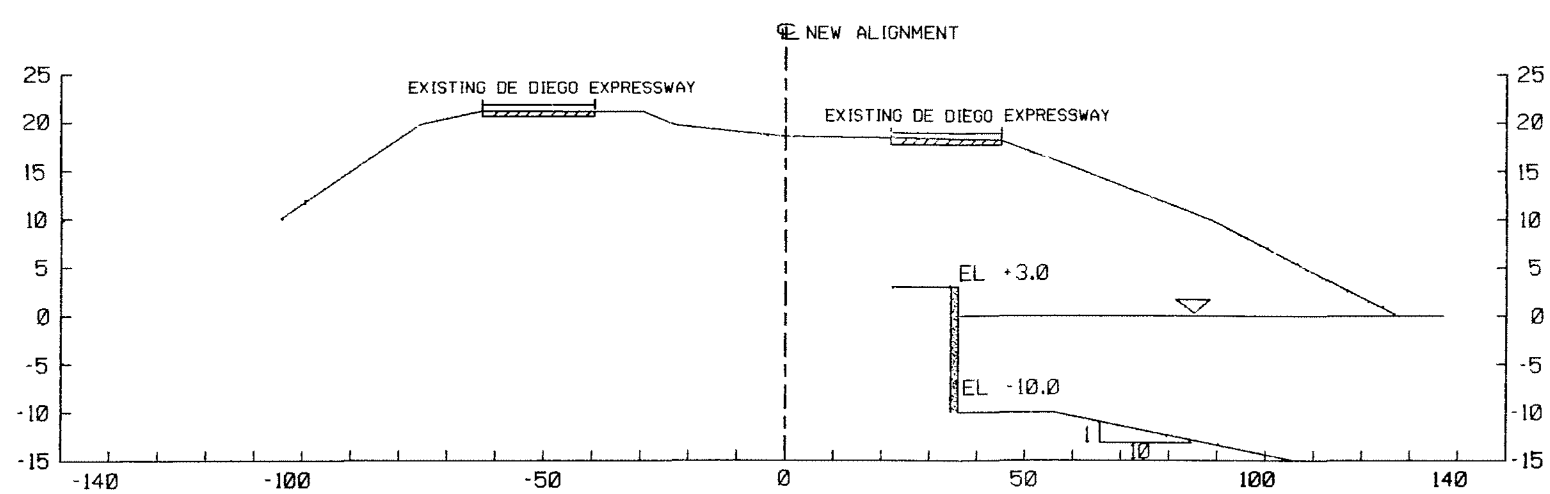
D.O. FILE NO. 102-35,578 DECEMBER 1990




SECTION 1-1



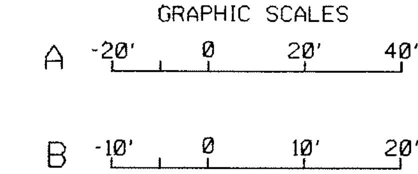

SECTION 2-2




SECTION 3-3

SCALE:
A - HORIZONTAL
B - VERTICAL

GRAPHIC SCALES




SCALES IN FEET

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

DE DIEGO EXPRESSWAY RELOCATION
EXISTING CONDITION WITH PROPOSED CHANNEL

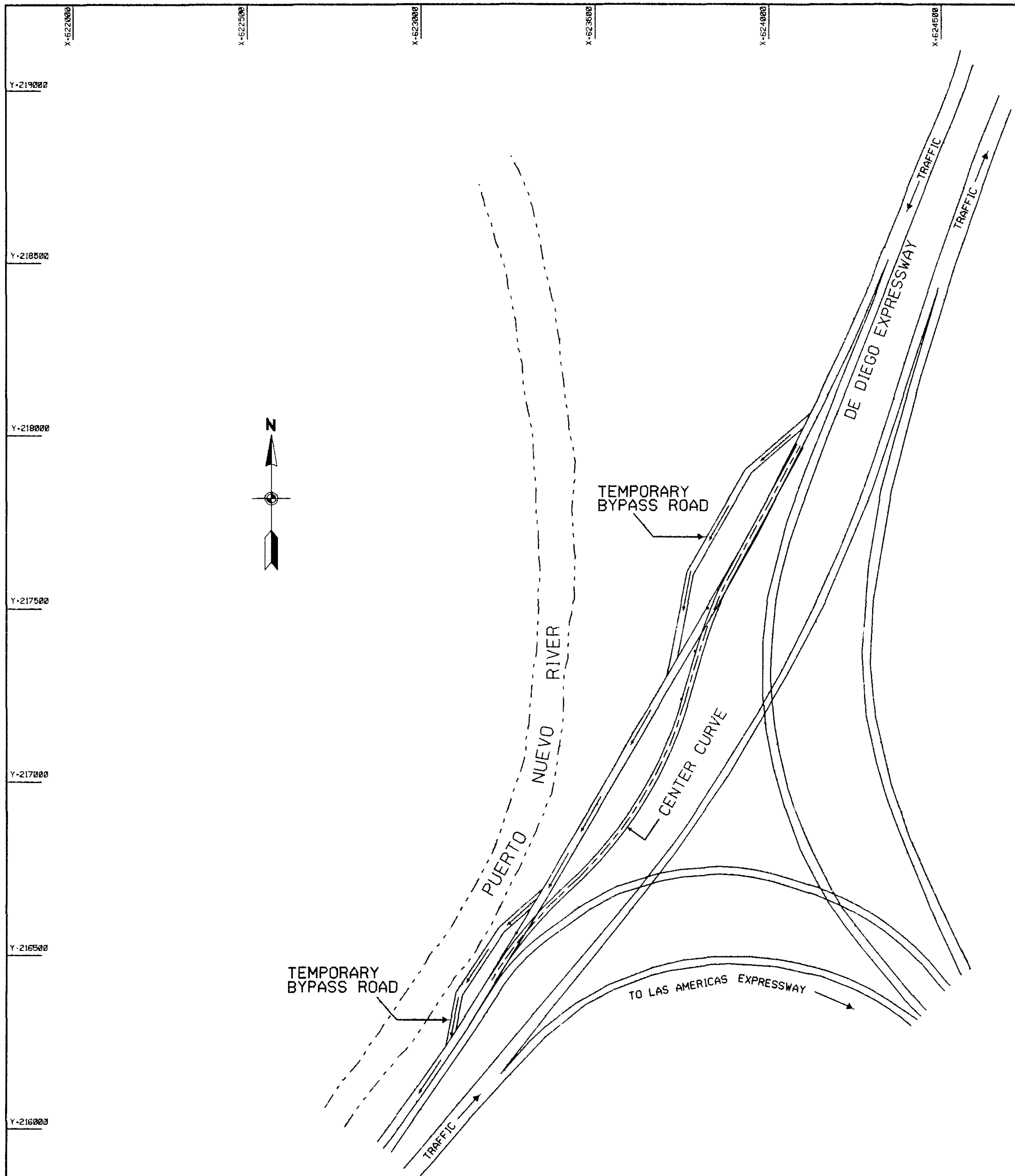
CROSS SECTIONS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-117




# CONSTRUCTION SEQUENCE

1) CONSTRUCT CENTER CURVE.
2) CONSTRUCT TEMPORARY BYPASS ROADS.
3) ROUTE TRAFFIC TO BYPASS ROADS.
4) CONSTRUCT TIE IN TO EXISTING ROAD.

GRAPHIC SCALE

-200' 0 200' 400' 600'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

DE DIEGO EXPRESSWAY RELOCATION
CONSTRUCTION SEQUENCE

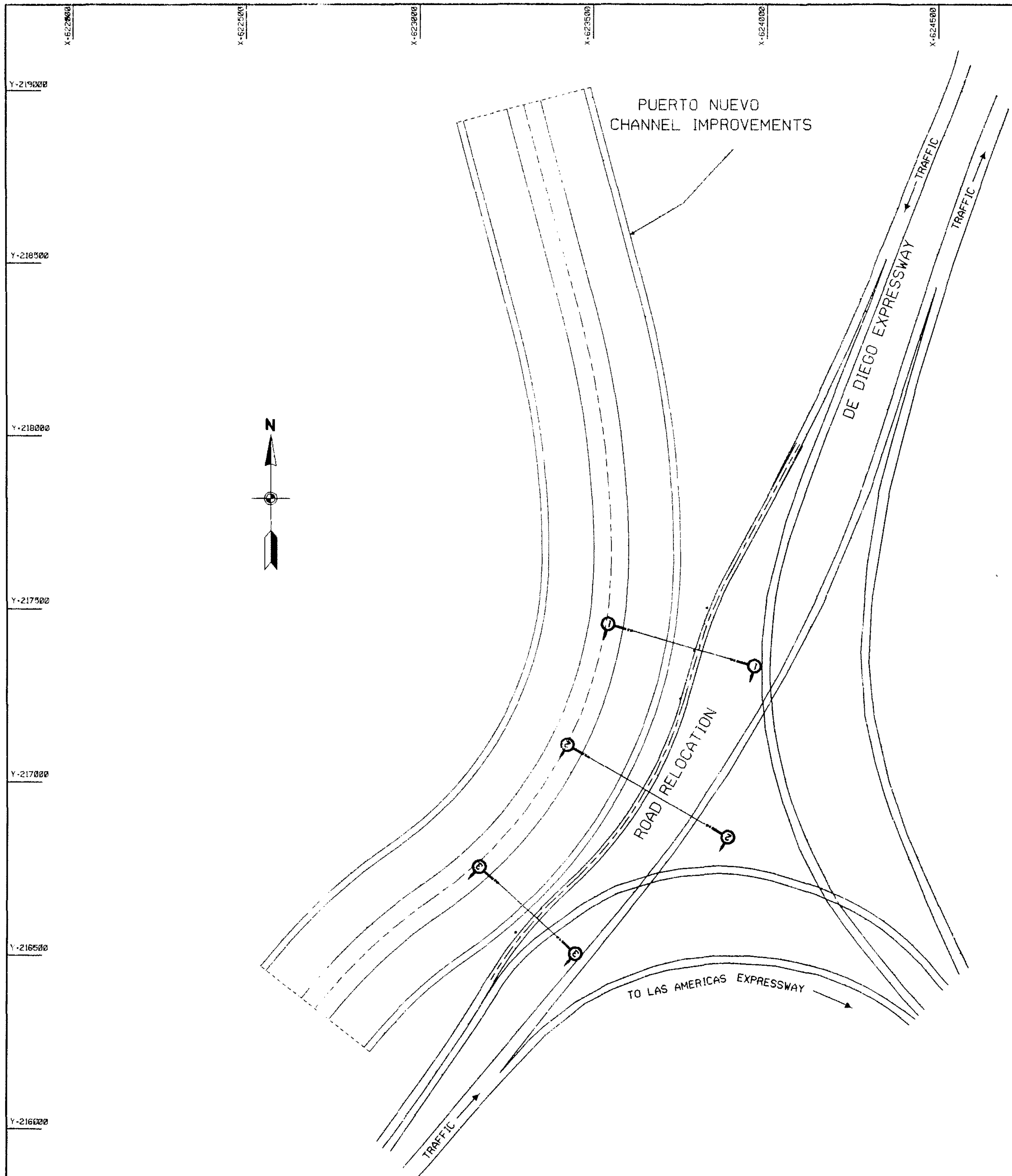
PLAN

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO 102-35,578 DECEMBER 1990

PLATE S-118




NOTE:

FOR CROSS-SECTIONS
SEE PLATE S-120.

GRAPHIC SCALE

-200' 0 200' 400' 600'

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM

DE DIEGO EXPRESSWAY RELOCATION
FINISHED CONSTRUCTION

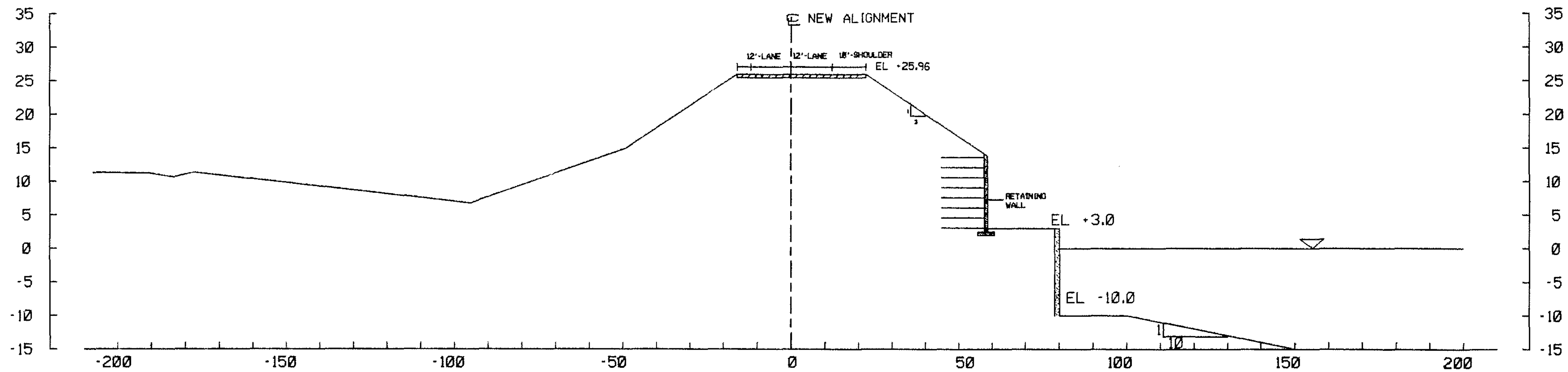
PLAN

STRUCTURAL

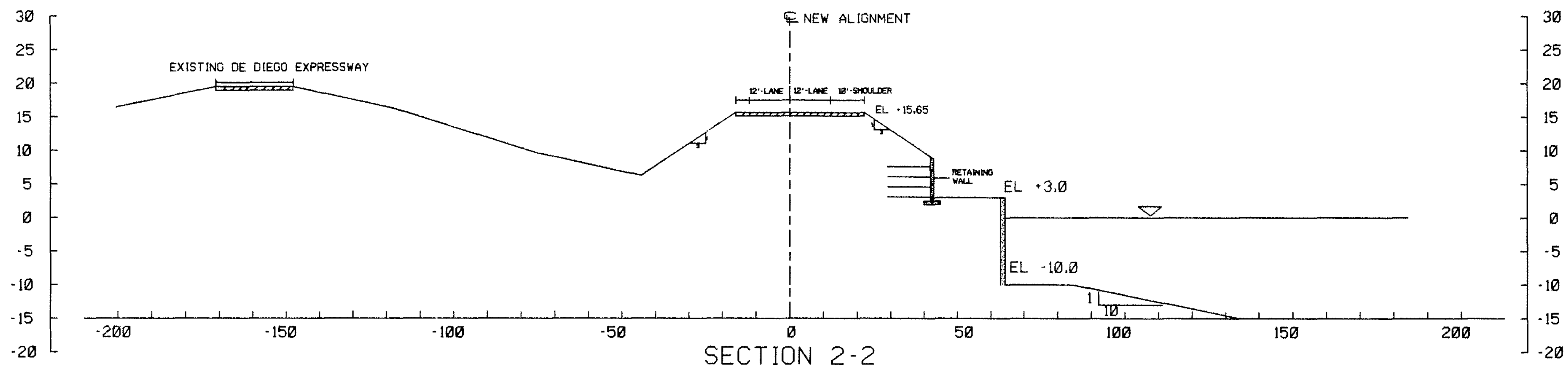
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

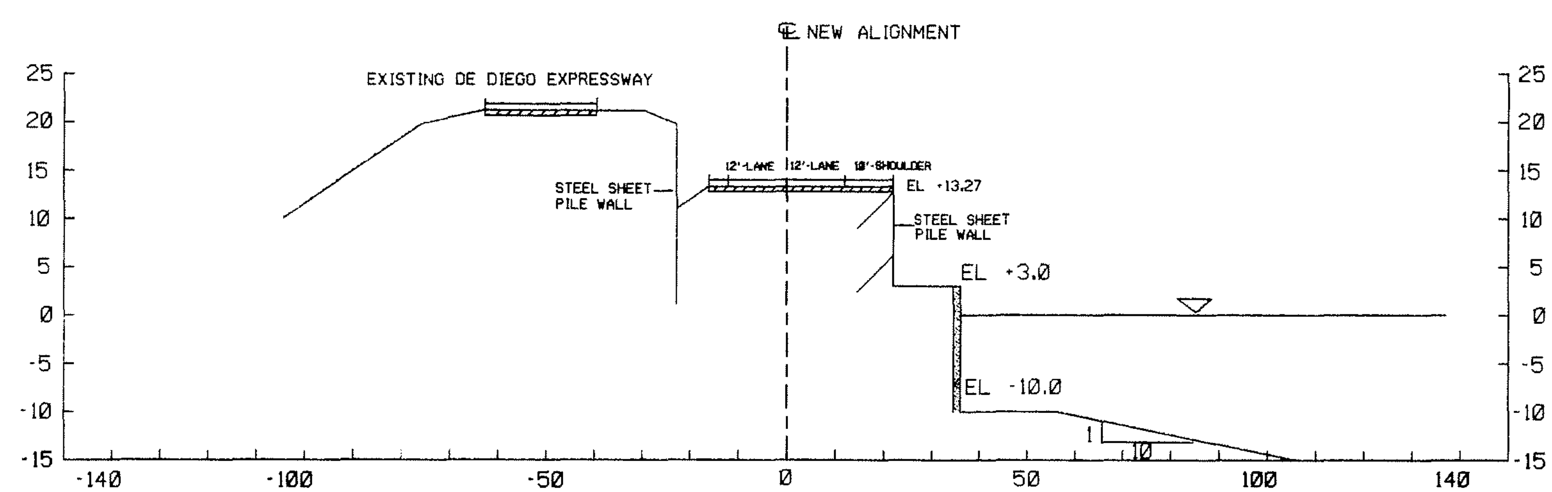
PLATE S-119




SECTION 1-1

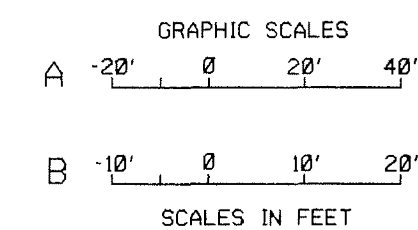



SECTION 2-2




SECTION 3-3

SCALE:
A - HORIZONTAL
B - VERTICAL




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

DE DIEGO EXPRESSWAY RELOCATION
FINISHED CONSTRUCTION

CROSS SECTIONS

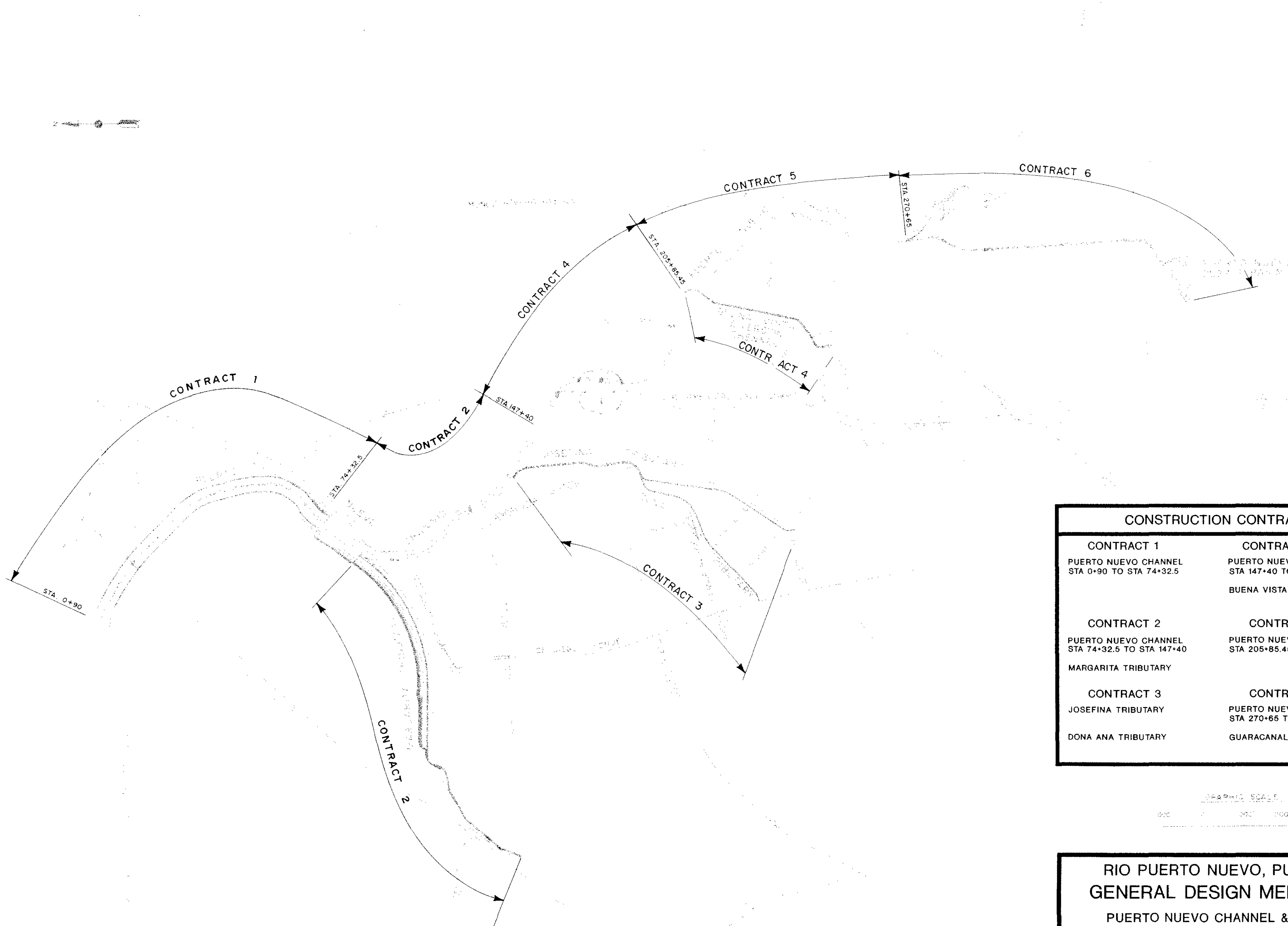
STRUCTURAL

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE S-12(




## CONSTRUCTION CONTRACTS

| | |
|---|---|
| CONTRACT 1<br>PUERTO NUEVO CHANNEL<br>STA 0+90 TO STA 74+32.5 | CONTRACT 4<br>PUERTO NUEVO CHANNEL<br>STA 147+40 TO STA 205+85.45<br>BUENA VISTA DIVERSION CHANNEL |
| CONTRACT 2<br>PUERTO NUEVO CHANNEL<br>STA 74+32.5 TO STA 147+40<br>MARGARITA TRIBUTARY | CONTRACT 5<br>PUERTO NUEVO CHANNEL<br>STA 205+85.45 TO STA 270+65 |
| CONTRACT 3<br>JOSEFINA TRIBUTARY<br>DONA ANA TRIBUTARY | CONTRACT 6<br>PUERTO NUEVO CHANNEL<br>STA 270+65 TO DEBRIS BASIN<br>GUARACANAL |

RIO PUERTO NUEVO, PUERTO RICO
# GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL & TRIBUTARIES

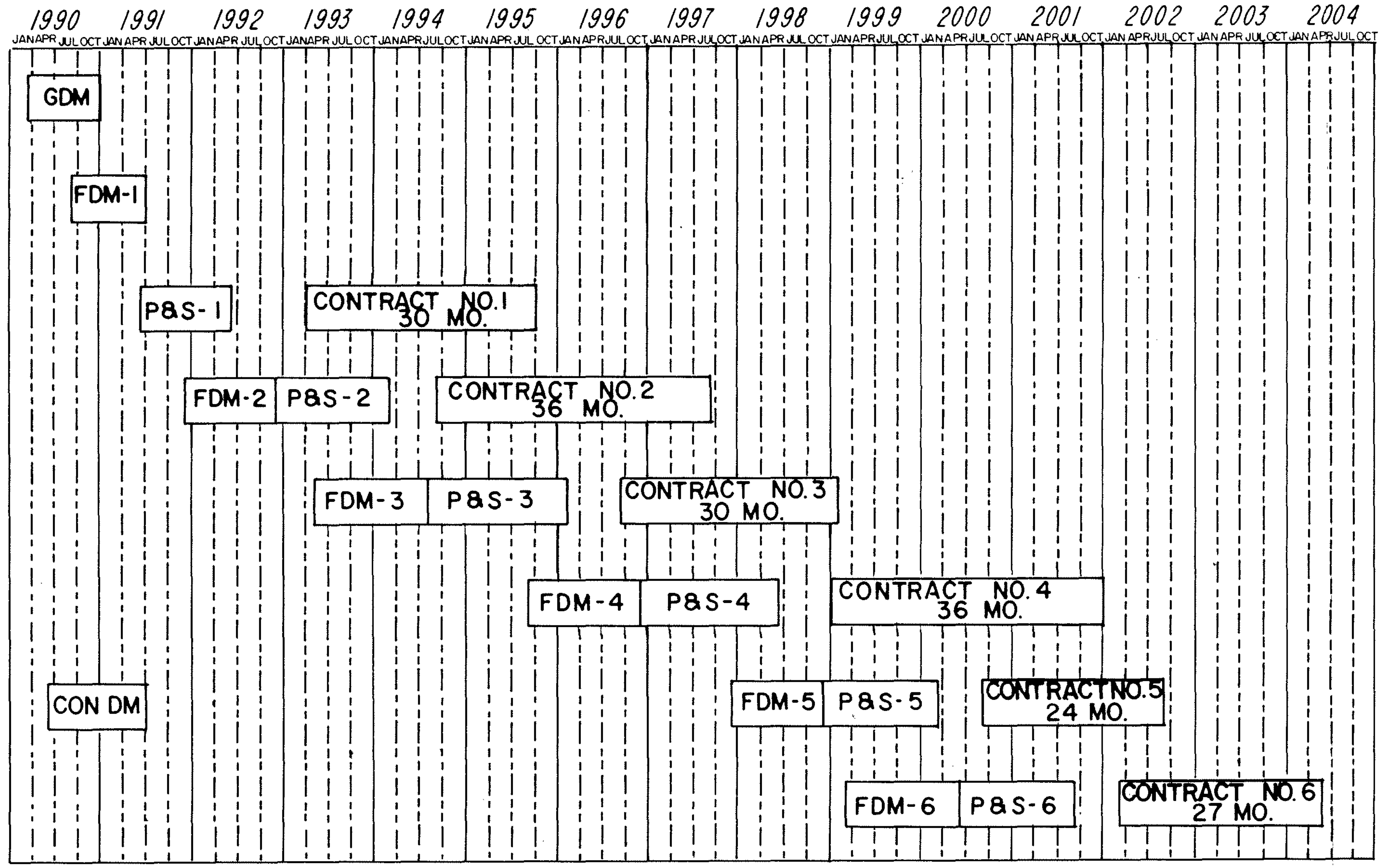
## CONSTRUCTION CONTRACTS

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

## RIO PUERTO NUEVO




NOTE:
SCHEDULE IS SUBJECT TO CHANGE AND IS DEPENDANT UPON GDM APPROVAL AND AVAILABILITY OF FUNDS. REVISED SCHEDULE WILL BE PROVIDED IN FEATURE DESIGN MEMORANDUM 1.

RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL & TRIBUTARIES

SCHEDULE

STRUCTURAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578 DECEMBER 1990

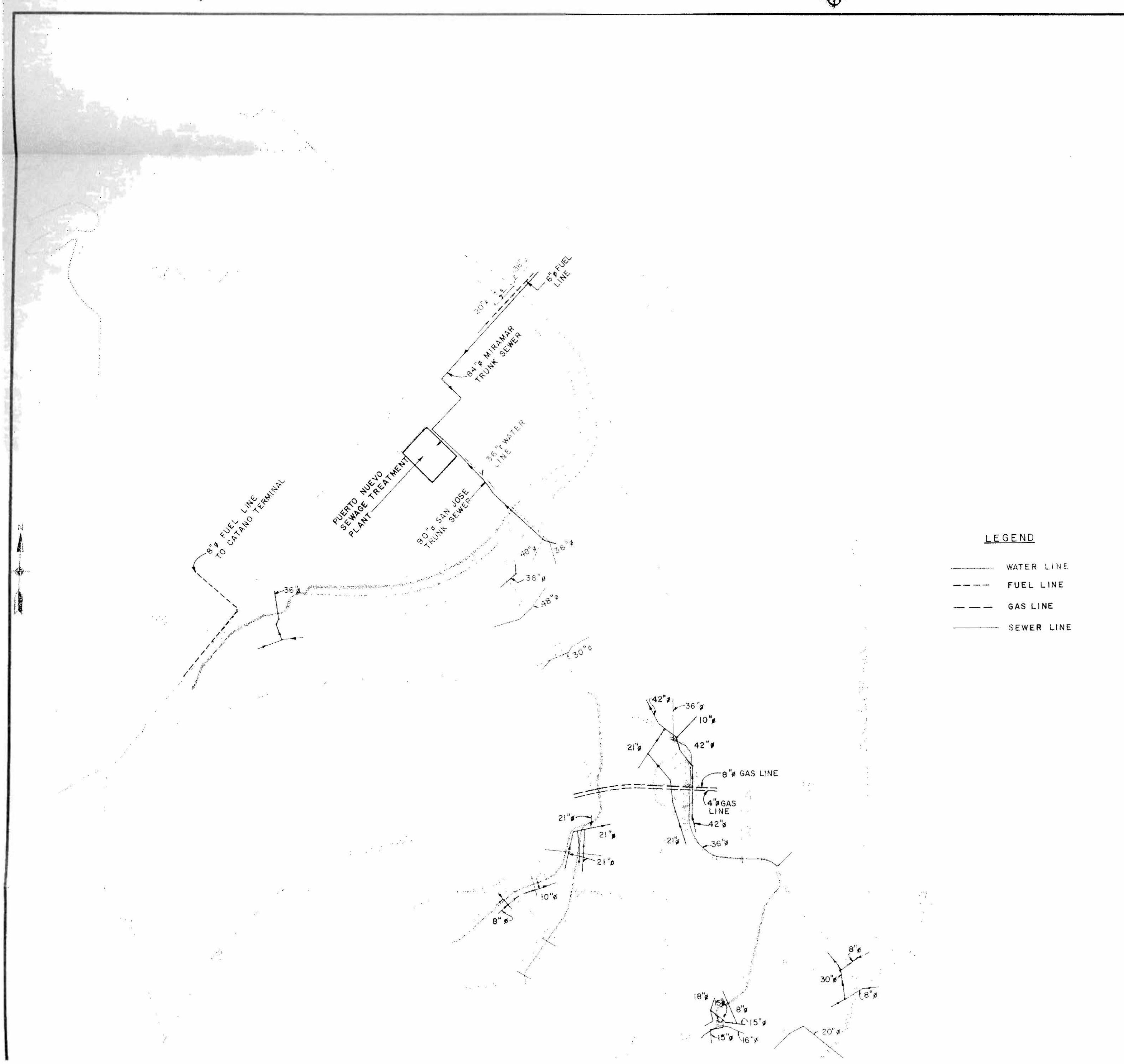

Channel Limits
Soil Sample Locations
Water Sample Locations
Scale: 1" = 430' ±
Kennedy Avenue
De Diego Expressway
Rio Puerto Nuevo
RIO PUERTO NUEVO, PUERTO RICO
GENERAL DESIGN MEMORANDUM
PUERTO NUEVO CHANNEL AND TRIBUTARIES
CORROSION MITIGATION INVESTIGATION
SOIL & WATER SAMPLE LOCATIONS
STRUCTURAL
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
D.O. FILE NO. 102-35,578
DECEMBER 1990

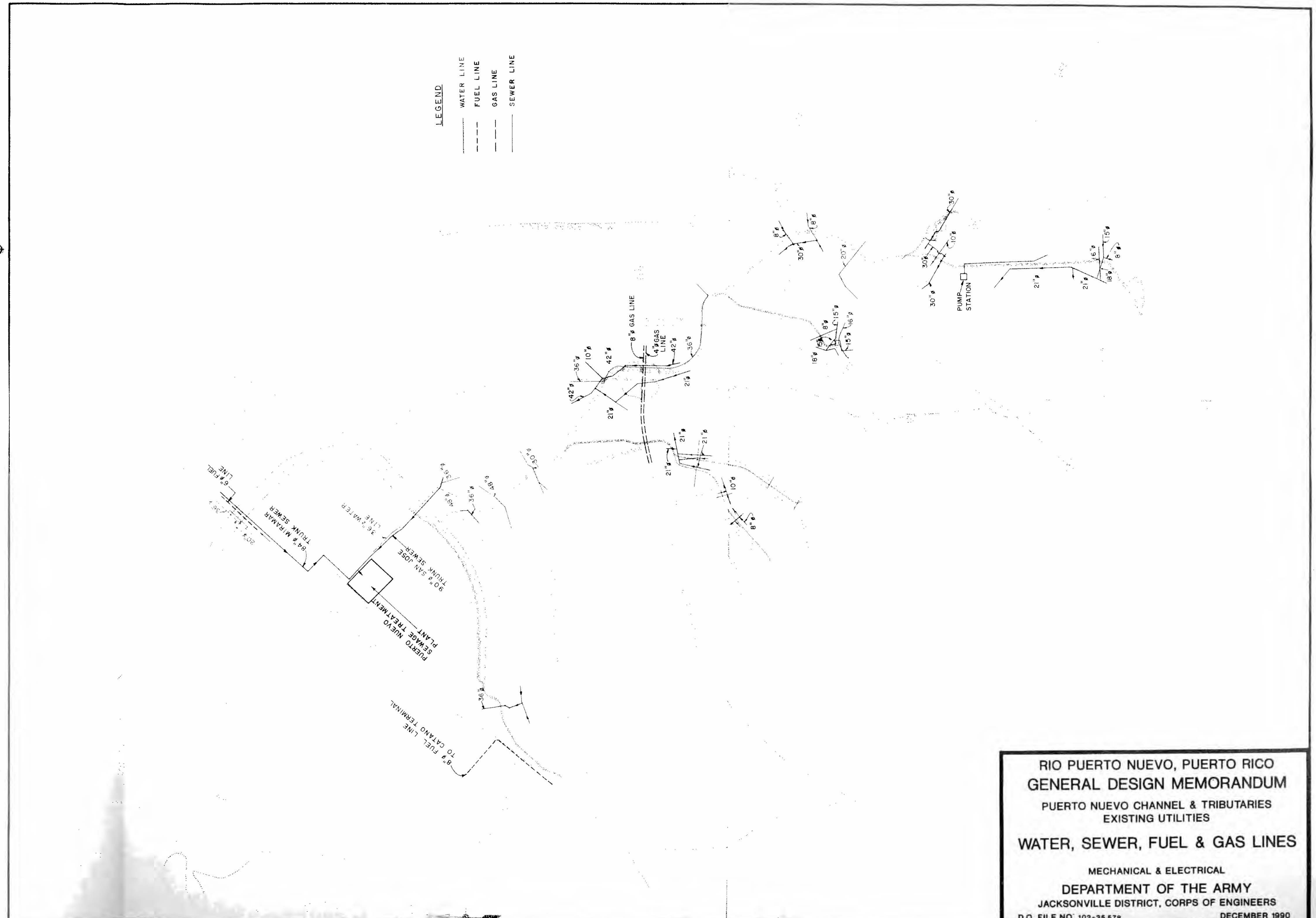
PLATE S-123

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**EXISTING UTILITIES**

PLATES


LEGEND
WATER LINE
FUEL LINE
GAS LINE
SEWER LINE
PUERTO NUEVO SEWAGE TREATMENT PLANT
84"ø MIRAMAR TRUNK SEWER
90"ø SAN JOSE TRUNK SEWER
36"ø WATER LINE
6"ø FUEL LINE
8"ø FUEL LINE TO CATANO TERMINAL
8"ø GAS LINE
4"ø GAS LINE
N




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

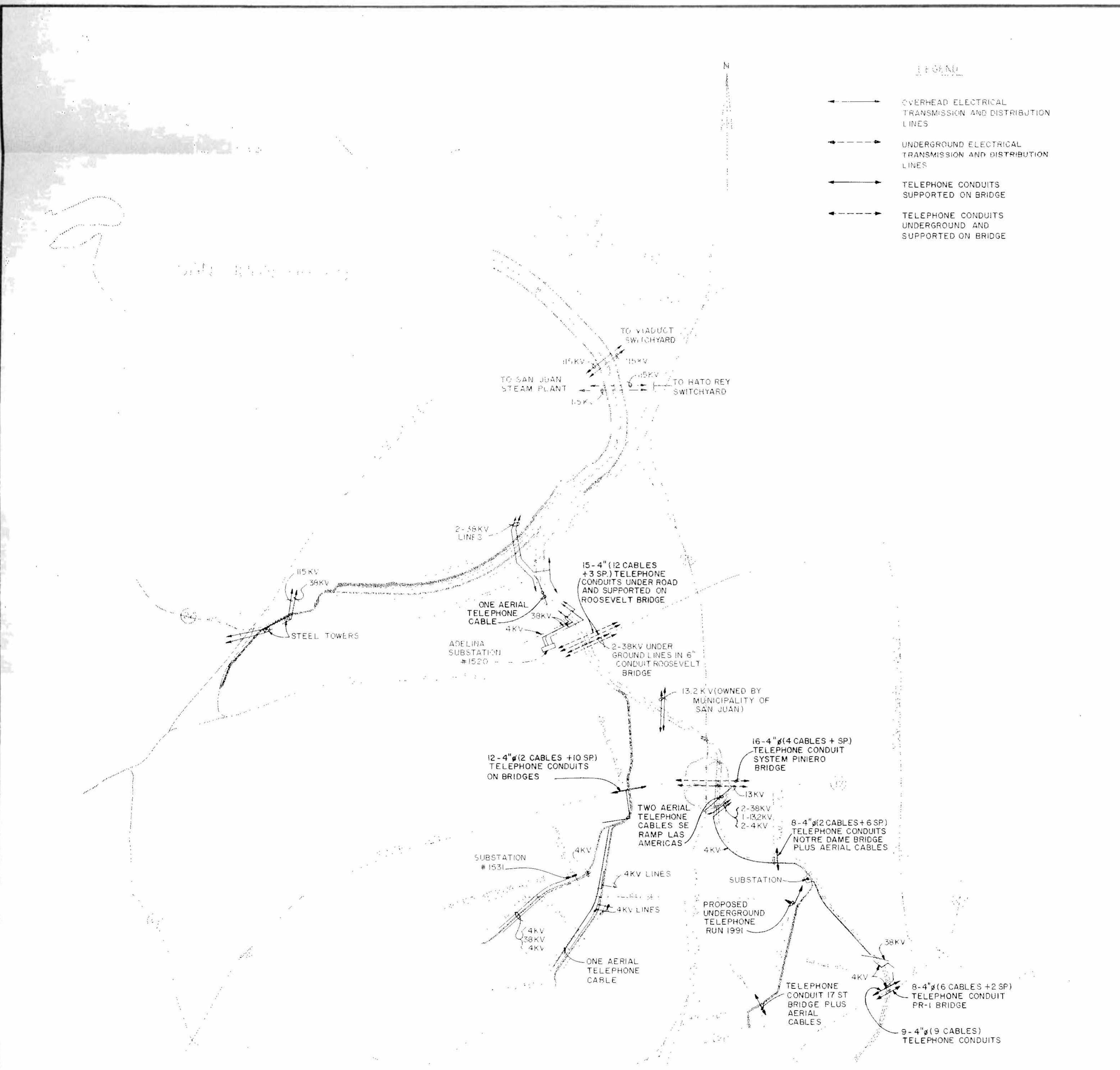
PUERTO NUEVO CHANNEL & TRIBUTARIES
EXISTING UTILITIES

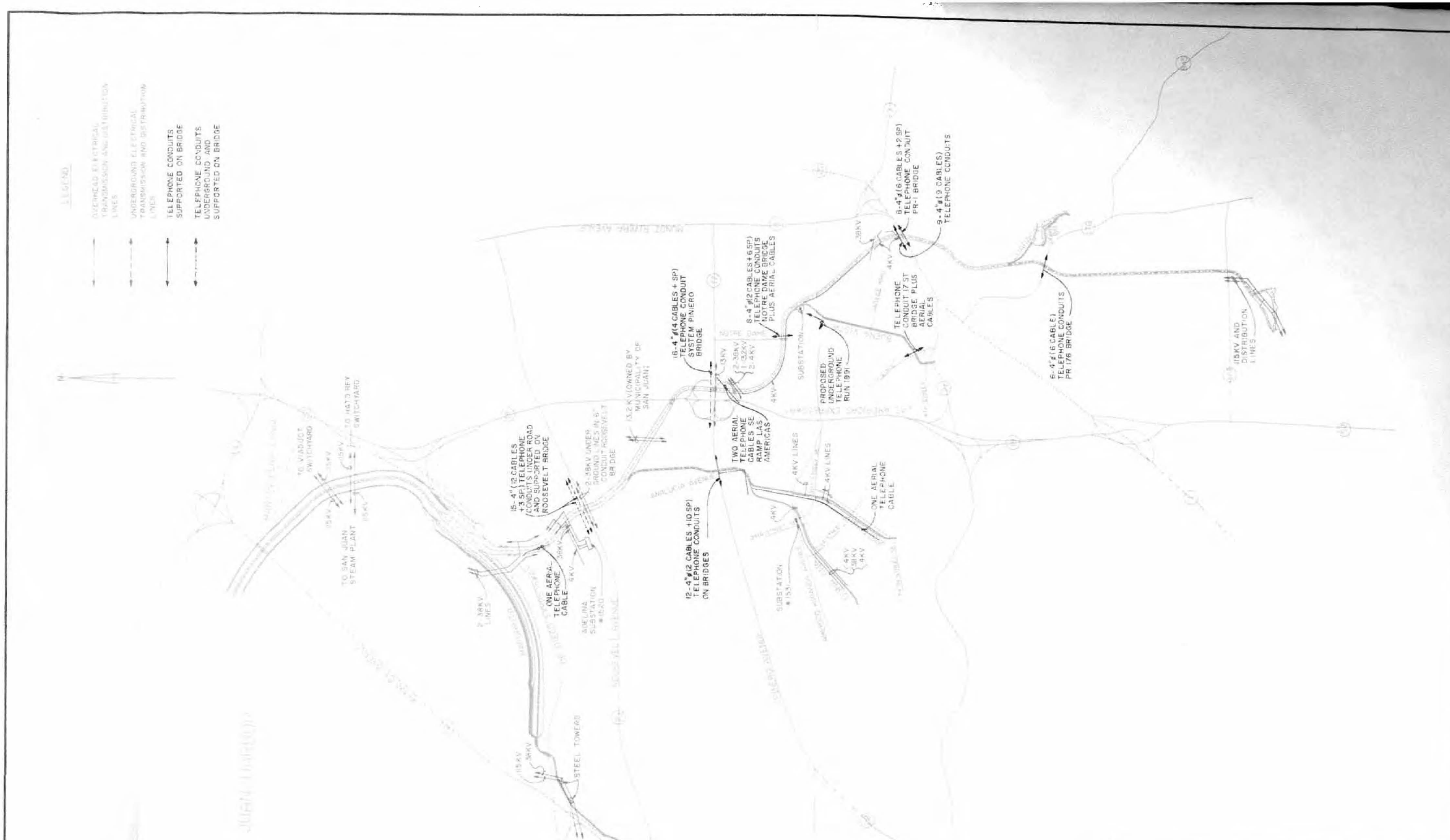
WATER, SEWER, FUEL & GAS LINES

MECHANICAL & ELECTRICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990


N
LEGEND
OVERHEAD ELECTRICAL TRANSMISSION AND DISTRIBUTION LINES
UNDERGROUND ELECTRICAL TRANSMISSION AND DISTRIBUTION LINES
TELEPHONE CONDUITS SUPPORTED ON BRIDGE
TELEPHONE CONDUITS UNDERGROUND AND SUPPORTED ON BRIDGE
TO VIADUCT SWITCHYARD
115KV
115KV
TO SAN JUAN STEAM PLANT
115KV
TO HATO REY SWITCHYARD
2-38KV LINES
115KV
38KV
STEEL TOWERS
15-4" (12 CABLES +3 SP.) TELEPHONE CONDUITS UNDER ROAD AND SUPPORTED ON ROOSEVELT BRIDGE
ONE AERIAL TELEPHONE CABLE
38KV
4KV
ADELINA SUBSTATION #1520
2-38KV UNDER GROUND LINES IN 6" CONDUIT ROOSEVELT BRIDGE
13.2 KV (OWNED BY MUNICIPALITY OF SAN JUAN)
16-4"ø(4 CABLES + SP) TELEPHONE CONDUIT SYSTEM PINIERO BRIDGE
12-4"ø(2 CABLES +10 SP) TELEPHONE CONDUITS ON BRIDGES
13KV
2-38KV
1-13.2KV
2-4KV
TWO AERIAL TELEPHONE CABLES SE RAMP LAS AMERICAS
8-4"ø(2 CABLES + 6 SP.) TELEPHONE CONDUITS NOTRE DAME BRIDGE PLUS AERIAL CABLES
4KV
SUBSTATION #1531
4KV
4KV LINES
SUBSTATION
4KV LINES
PROPOSED UNDERGROUND TELEPHONE RUN 1991
4KV
38KV
4KV
38KV
ONE AERIAL TELEPHONE CABLE
4KV
TELEPHONE CONDUIT 17 ST BRIDGE PLUS AERIAL CABLES
8-4"ø(6 CABLES +2 SP) TELEPHONE CONDUIT PR-1 BRIDGE
9-4"ø(9 CABLES) TELEPHONE CONDUITS




RIO PUERTO NUEVO, PUERTO RICO

# GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL & TRIBUTARIES
EXISTING UTILITIES

## ELECTRICAL & TELEPHONE LINES

MECHANICAL & ELECTRICAL

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

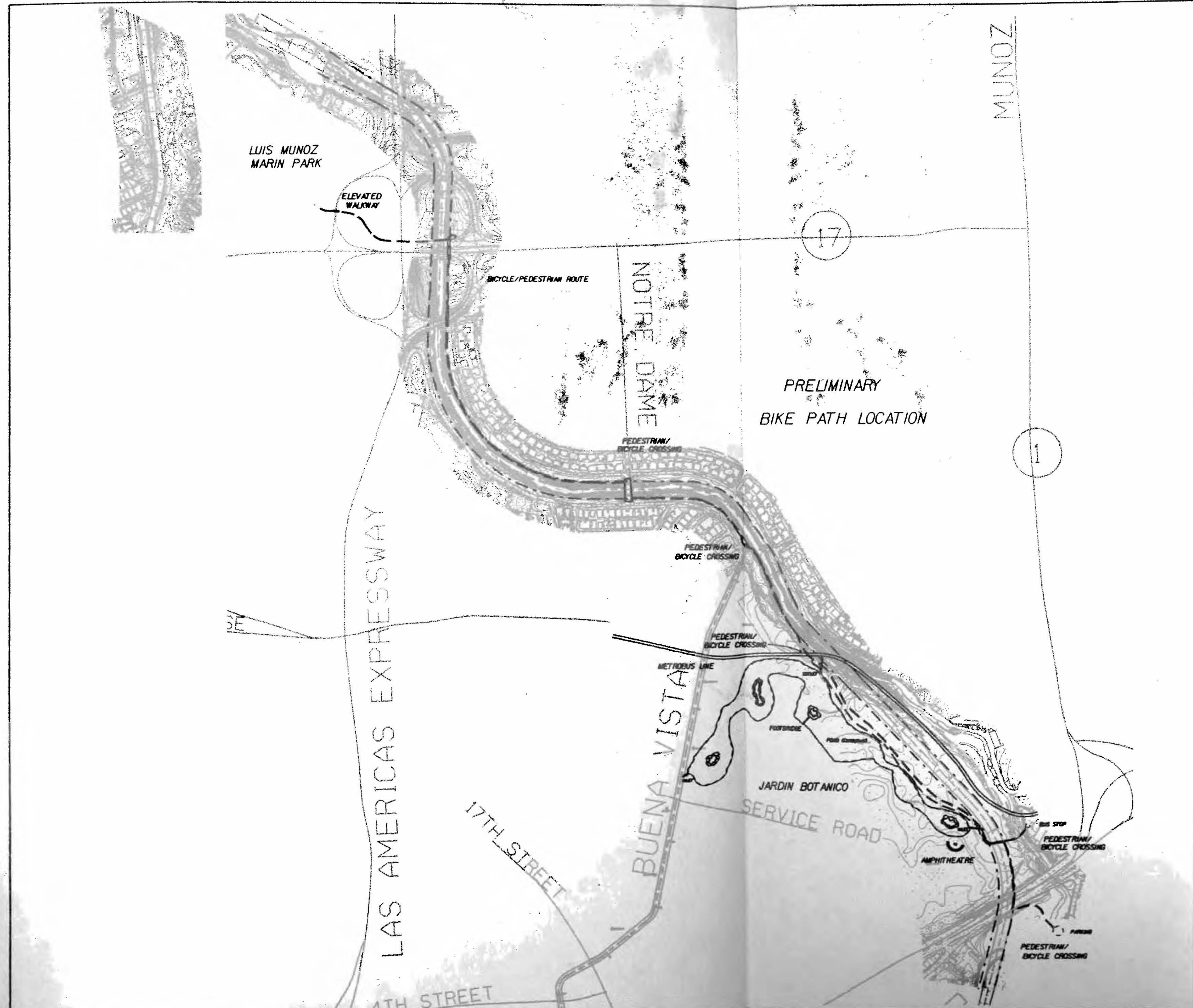
D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE ME-2

RIO PUERTO NUEVO
GENERAL DESIGN MEMORANDUM

**RECREATIONAL**

PLATES




RIO PUERTO NUEVO, PUERTO RICO

GENERAL DESIGN MEMORANDUM

PUERTO NUEVO CHANNEL

BIKE PATH & LINEAR PARK ALIGNMENT

RECREATION

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

D.O. FILE NO. 102-35,578 DECEMBER 1990

PLATE R-1