REPORT
ON
HYDRAULIC DESIGN
OF
JUNCTION VETERANS BOULEVARD CANAL
AND
SUBURBAN CANAL

by:

BROWN, CUNNINGHAM & GANNUCH, INC.

Authorized under:

JEFFERSON PARISH
DRAINAGE CAPITAL IMPROVEMENTS PROGRAM

15 January 1999
(Revised 2 MAR 1999)

HYDRAULIC DESIGN
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1. Introduction. The purpose of this design analysis is to develop a culvert junction at Veterans Boulevard Canal with Suburban Canal which minimizes form losses and friction losses within the 467 foot reach. This reach lies within the limits between a 58-foot wide flume on the upstream end at station 89+50 and a 58-foot wide flume on the downstream end at station 94+17. See enclosure 1 for a layout of the junction superimposed upon the existing facilities at the project location. The drawing of existing facilities was provided by the A-E Firm of N-Y Associates of Metairie, Louisiana.

2. Basic Data. The invert elevation at station 89+50 is 1.29 feet Cairo Datum and at station 94+17 it is 0.99 feet Cairo Datum. The design slope of the invert is 0.00064 feet per foot. The Manning's n-value is 0.015 and the flows entering the junction are, 2700 cfs from the Suburban Canal, 500 cfs from the east side on Veterans Canal, and 500 from the west side for the 10-YR design. The total flow exiting the junction is 3700 cfs. Based upon previous hydraulic analysis, the depth at the downstream end of this reach is 11.81 feet, which produces a flowline of 12.8 feet Cairo Datum. The basic conveyance is a three barrel box culvert having a total width equaling 58 feet at its entrance and a total width of 58 feet at its exit into an existing flume. Upstream of the box culvert is a 58-foot wide concrete flume which begins at station 89+50 and flows into the 54 foot wide box culvert at station 90+10 (the width is determined by the 4' due to the internal walls of the triple culvert). The lateral canals are brought into the junction as

gradually contracting curves at a rate of 1-foot per 9-degrees of curvature over 80° and 100° of direction change respectively, for the purpose of minimizing the form losses by accelerating the flow velocity to the same speed as the main channel flow.

3. Design Analysis. A. See the layout on enclosure 1. The basic friction losses along the channel centerline are computed by applying the Manning Equation to the junction in two parts according to the flow distribution and length of channel conveyance:

$$H_L = \frac{(V_1 n)^2 L_1}{2.22(R_1)^{4/3}} + \frac{(V_2 n)^2 L_2}{2.22(R_2)^{4/3}}$$

Where V_1 is velocity between station 92+84 and 94+17;

L_1 is the length in that reach = 133 feet;

R_1 is the Hydraulic Radius in that reach;

V_2 is velocity between station 90+10 and 92+84;

L_2 is the length in that reach = 274 feet;

R_2 is the Hydraulic Radius in the second reach, for the three box culverts.

$Q_1 = 3700$ cfs | $Q_2 = 2700$ cfs

$A_1 = 58'X11.81'$ | $A_2 = 58'X(11.81+h_L)$

Where h_L is head loss in first reach

$R_1 = A_1/P_1$ | $R_2 = A_2/P_2$

Where P is Wetted perimeter

$P_1 = (2X11.81')+58'$ | $P_2 = 6X(11.81'+h_L)+54'$

Assume trial $h_L = 0.05'$

Then

$R_1 = 684.98/81.62 = 8.39'$ $R_2 = 687.88/125.16 = 5.49'$

$V_1 = Q_1/A_1 = 5.40$ fps $V_2 = 3.93$ fps

$$H_L = \frac{133'(0.015X5.4)^2}{2.22(8.39)^{1.33}} + \frac{274'(0.015X3.93)^2}{2.22(5.49)^{1.33}}$$

$= 0.023' + 0.044'$

$= 0.067$ feet

Since $h_L \approx 0.05'$, OK no further trials required.

depth = 11.81'+0.02' = 11.83 feet at station 92+84

depth = 11.83+0.04 = 11.87 feet at station 89+50

Flow line at station 89+50 = 13.16 ft. C.D. This design elevation is 0.64 feet lower than the design value of 13.8 ft. C.D. provided by the U.S. Army Corps of Engineers.

B. The basic friction loss into the lateral channels along Veterans Canal is computed similarly but because velocities change in the reach as the culvert converges from 24 feet of bottom width to 10.5 feet of bottom width, averaging of the velocity and Hydraulic Radius is required:

$$H_L = \frac{L(nVavg)^2}{2.22(Ravg)^{4/3}}$$

Where Vavg is average velocity in feet per second.

Ravg is average Hydraulic Radius

L is length of reach in feet = 185 feet

Q in lateral is 500 cfs

Velocity at exit = $\frac{500cfs}{10.5'X11.83'} = 4.02fps$

Velocity at entrance, assume $h_L = 0.05'$ =

$$\frac{4.02fps + 1.75fps}{2} = 2.89fps$$

Vavg = $$\frac{500cfs}{24'X(11.83 + h_L)} = 1.75fps$$

Wetted perimeter at exit = ((11.83X2)+10.5) = 34.16'

Wetted perimeter at entrance = ((11.88X2)+24) = 47.76'

Hydraulic radius at exit = (10.5'X11.83)/34.16 = 3.64 feet

Hydraulic radius at entrance = (11.88X24)/47.7 = 6.00 feet

Ravg = $$\frac{(3.64' + 6.00')}{2} = 4.82feet$$

H_L = $$\frac{185'x(0.015X2.89)^2}{2.22(4.82)^{1.333}} = 0.034feet$$

$h_L \approx H_L$ OK no further trails needed.

Total loss = first part of 3.a above plus

Part 3.b. = 0.023+ 0.019

= 0.042 feet

Depth = 11.83+0.019 = 11.85 feet

185 feet upstream of EXIT.

Flow Line at entrance assuming slope equal to 0.00064ft/ft. = 12.93 ft.C.D.

4. Momentum Change. In the design of flood control channels, one of the more important hydraulic problems is the analysis of the flow conditions at open channel junctions. A box culvert not running full is an open channel. The momentum design approach as described in Appendix E of the U.S. Army EM-1110-2-1601 dated July 1990, has been verified for small angles by physical model tests. The theory and assumptions given in paragraph E-2, for Tranquil Flow have been applied to this hydraulic junction. Because the Veterans-Suburban junction is a combination of

box culverts of different widths upstream and downstream of the flow-junction, the derivation and application of the momentum equation for a rectangular channel with unequal widths was followed as given in paragraph E-4 of the referenced EM. Further, since the box culverts split the flows equally upstream and downstream, and equal flows enter the junction from the east and west, only one side of the junction will be analyzed using equation E-11 in EM-1110-2-1601:

$$\frac{Q_3^2}{gA_3}+\frac{b_3y_3^2}{2}=\frac{Q_1^2}{gA_1}+\frac{Q_2^2}{gA_2}COS\theta+\frac{b_3y_1^2}{2}$$

See layout and explanation of terms, definition sketches, Plate E-1, enclosure 2.

Based upon water surface/depth calculations in 3.a. and b. above, Y_1 = 11.83 ft.

Other givens are: Q_1 = 2700/4 = 675 cfs

Q_2 = 500 cfs

Q_3 = 675 cfs + 500 cfs = 1175 cfs

A_1 = 11.83X13.83' = 163.61 sq. ft.

A_2 = 11.83X10.5' = 124.22 sq. ft.

A_3 = 11.83X24.33' = 287.82 sq. ft.

b_3 = 24.33'

g = 32.2

ϴ = 0 degrees

Cos ϴ = 1

148.97+1702.47=86.49+62.50+1702.49

Sum of Momentum: 1851.45= 1851.47: OK Stop

Therefore, water depth will not rise due to momentum loss at design flows described.

5. Conclusions. The configuration developed during the analysis is acceptable because the total loss through the reach is no more than 0.10 feet and is due primarily to friction. Form losses have been held to a minimum as a direct result of the layout and cross-sections shown on enclosure 3. This is supported by zero change in momentum across the junction as demonstrated by the calculations is paragraph 4 above.

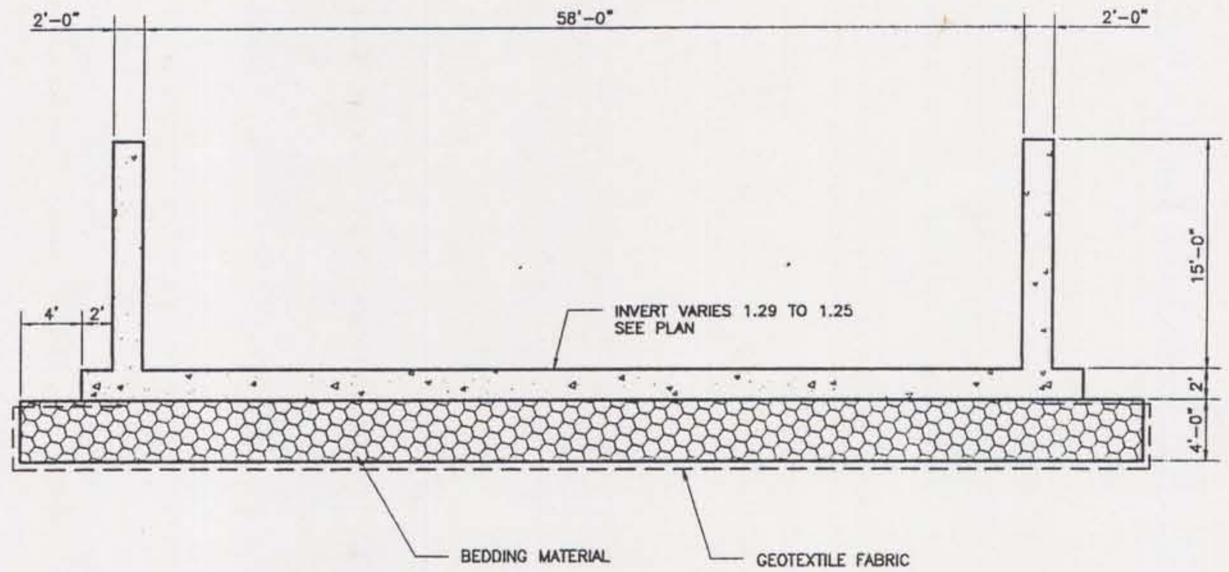
BROWN, CUNNINGHAM & GANNUCH, INC.

Cecil W. Soileau

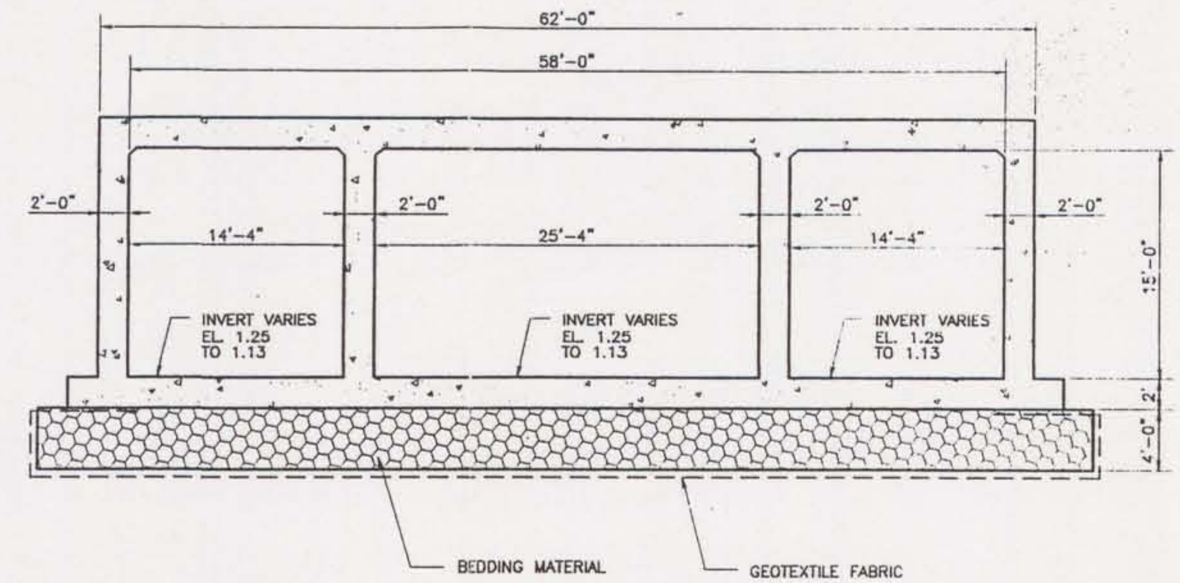
Cecil Soileau, P.E.
Senior Hydraulic Engineer

CS:mar
Enclosures 1.Layout, 2. Definition Sketches, 3. Plan and Design Sections

Safety is a Part of Your Contract



SECTION A-A



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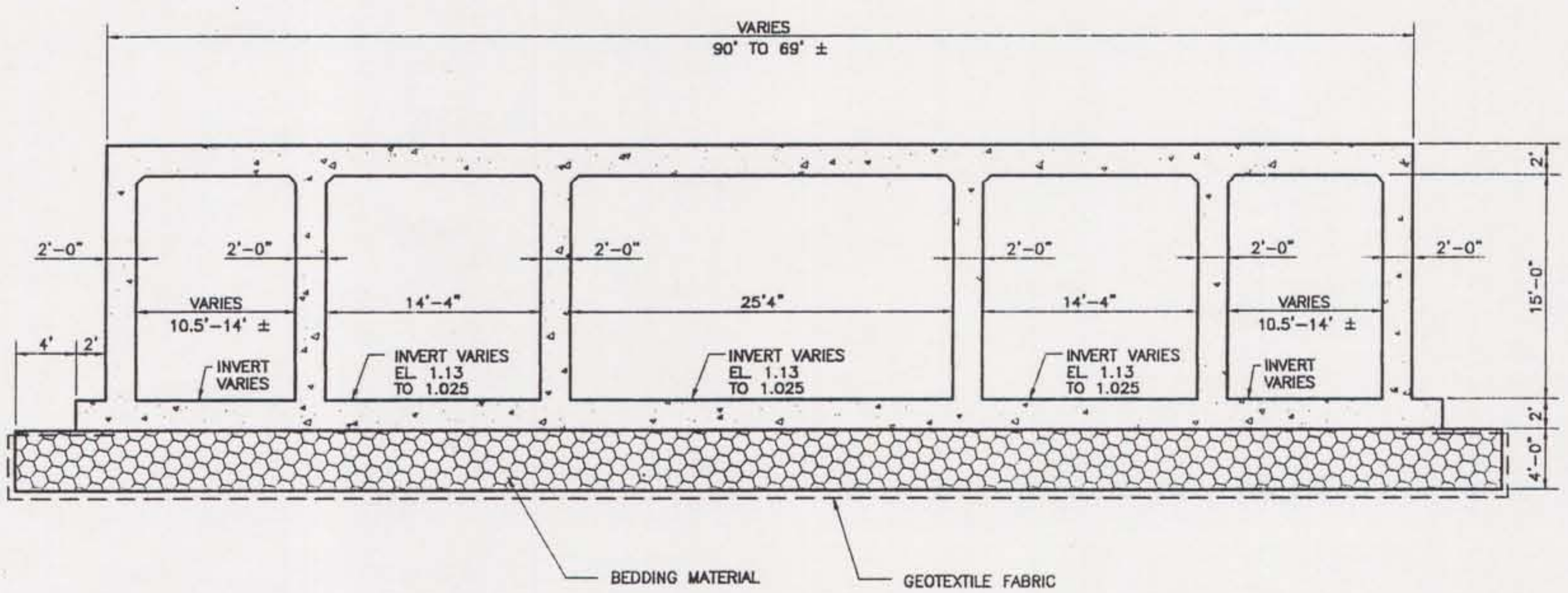
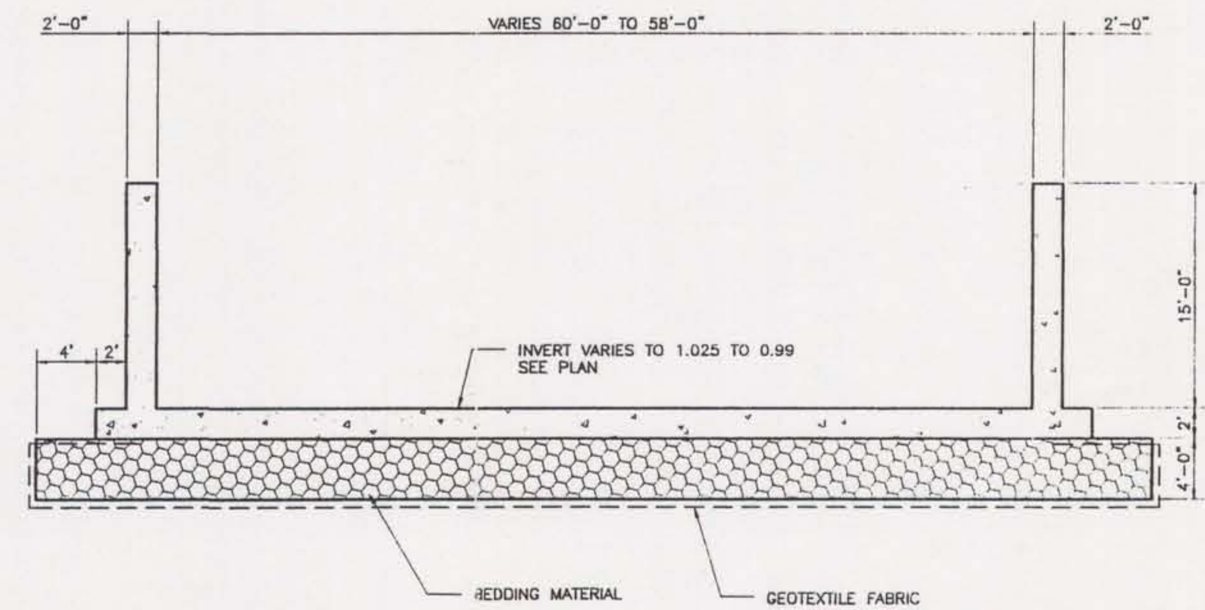


SECTION C-C



SECTION D-D

VALUE INCENTIVE CLAUSES ENGINEERING — YOUR KEY TO HIGHER PROFITS

SCALE: 1" = 5'

5 0 5 10 15 20

C•A•D

SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

JEFFERSON PARISH
DEPT. OF PUBLIC WORKS
DPW NO.91-058D-DR(SELA)

N-Y ASSOCIATES, INC.
CONSULTING ENGINEERS
METAIRIE,LA.

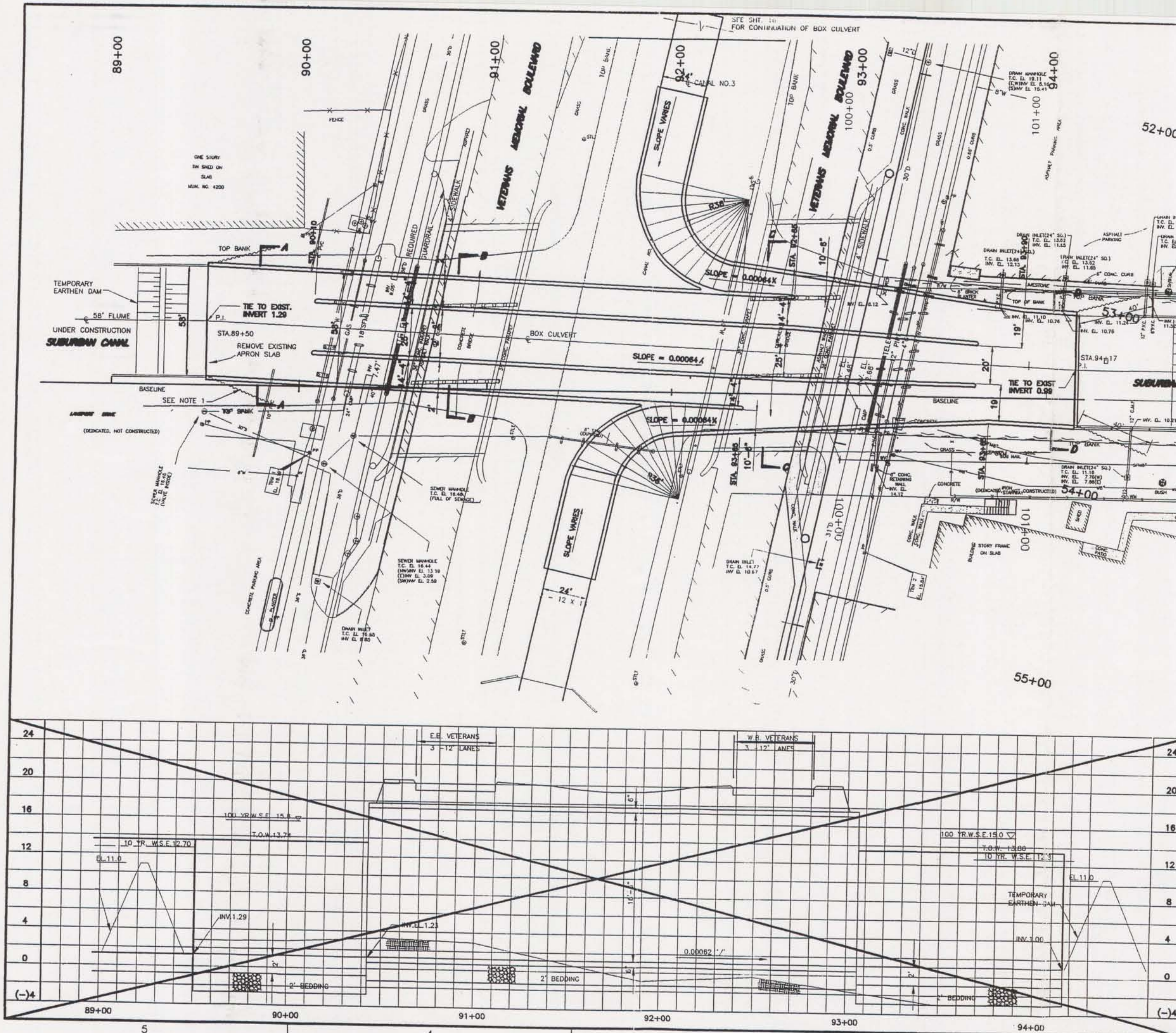
SOUTHEAST LOUISIANA, LOUISIANA
SUBURBAN CANAL IMPROVEMENTS
AT VETERANS BLVD.
JEFFERSON PARISH, LOUISIANA

TYPICAL SECTIONS

DESIGNED BY: M.A.C.
DRAWN BY: J.W.M.
CHECKED BY: T.M.S.
DATE: 1-7-98
PLOT SCALE: 1=5
PLOT DATE: 5-7-98
CADD FILE: SENPLAN.DWG
FILE NO. H-8-45010
SUBMITTED BY:
X
DESIGN ENGINEER
SOLICITATION NO. DACW29-98-B
DWG X OF X

5 4 3 2 1

ENCLOSURE 1



SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

U.S.ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS,LOUISIANA

JEFFERSON PARISH
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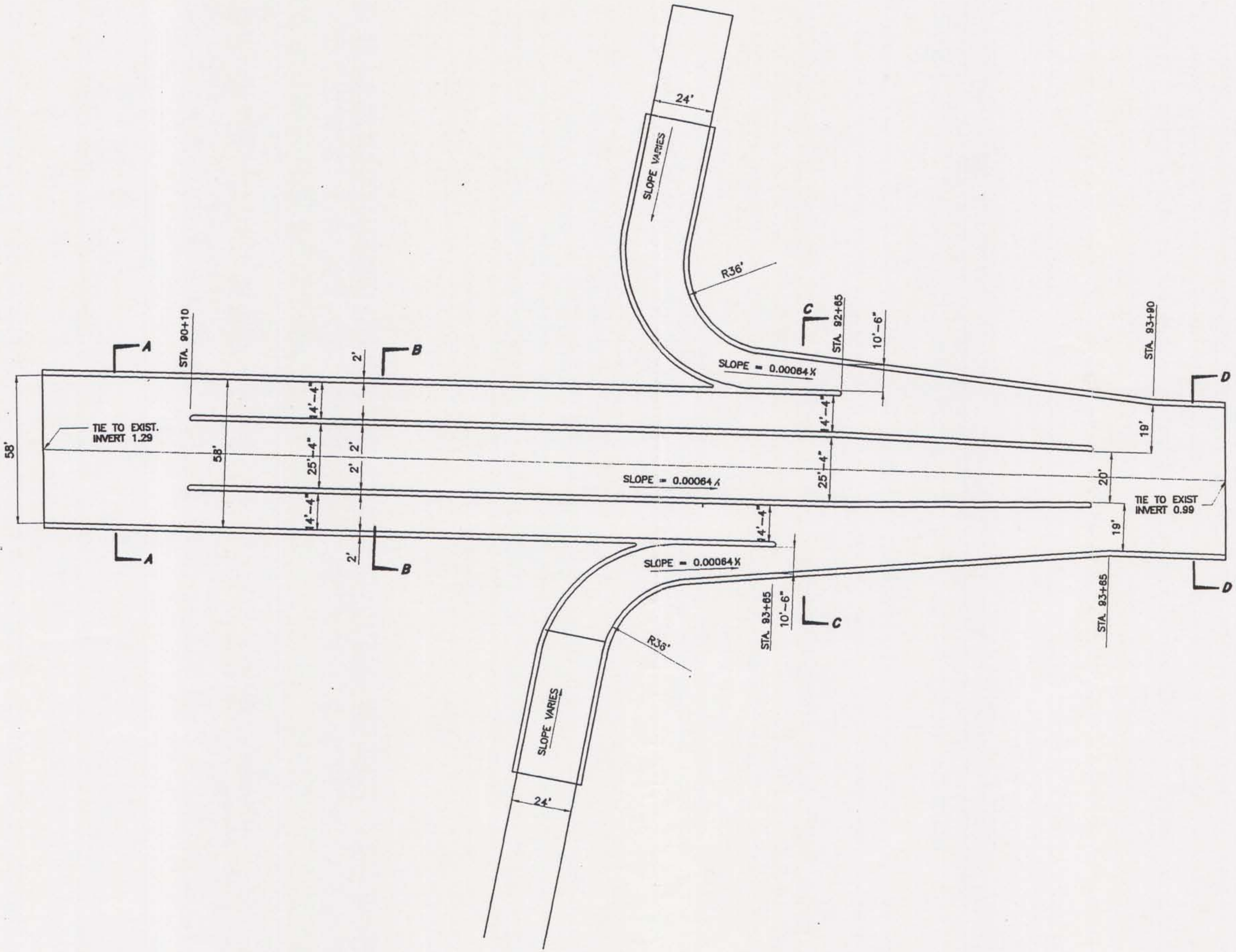
SUBURBAN CANAL IMPROVEMENTS
AT VETERANS BLVD.
JEFFERSON PARISH, LOUISIANA

PLAN & PROFILE
STA. 89+50 TO STA. 93+90

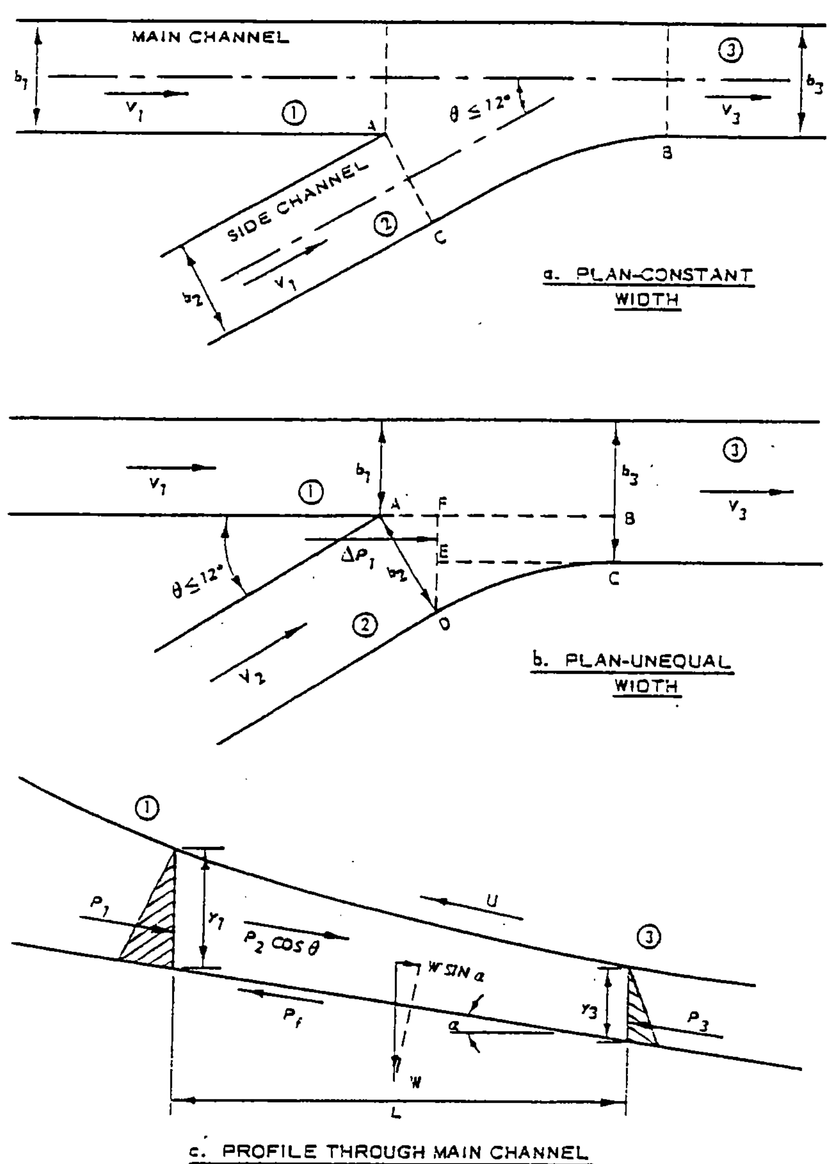
DESIGNED BY:	J.E.S.	DATE: 5-12-98	PLOT SCALE: 1=20	PLOT DATE: 5-12-98
DRAWN BY:	M.J.M.			FILE NO. H-8-45010
CHECKED BY:	J.E.S.	CADD FILE: PP_SHT.DWG		
SUBMITTED BY: X	DESIGN ENGINEER	SOLICITATION NO. DACW29-98-B		DWG 15 OF 29

ENCLOSURE 1



24'
SLOPE VARIES
R36'
C
STA. 92+65
10'-6"
STA. 93+90
A
STA. 90+10
2'
B
SLOPE = 0.00064%
D
58'
TIE TO EXIST. INVERT 1.29
58'
4'-4"
25'-4"
2'
2'
4'-4"
4'-4"
25'-4"
19'
20'
SLOPE = 0.00064%
TIE TO EXIST INVERT 0.99
4'-4"
19'
A
2'
B
SLOPE = 0.00064%
D
STA. 93+65
10'-6"
C
STA. 93+65
R36'
SLOPE VARIES
24'

ENCLOSURE 3



RECTANGULAR CHANNEL JUNCTION
DEFINITION SKETCHES

PLATE E-1

ENCL 2