

technical appendices

APPENDIX TA-1

QUALHYMO MODEL AND ENHANCEMENTS

. Discussion
. Model

APPENDIX 1.0 QUALHYMO MODEL AND ENHANCEMENTS

In generating runoff from pervious land segments, the QUALHYMO model uses the U.S. Soil Conservation Service (1969) procedure to determine the excess moisture input from the pervious area. The soil moisture deficit of soils and the initial abstraction are updated by the model for each event to provide an accounting of initial moisture conditions. The initial abstraction is reduced by the antecedent precipitation over the preceding twenty-four hours and will recover to its user-specified maximum in the absence of precipitation over the foregoing period of time. In the case of the soil moisture deficit, current values preceding an event are computed as a function of a variable Antecedent Precipitation Index (API). This index is based on daily rainfall totals weighted by a recession coefficient (having a system memory of approximately thirty days).

Runoff volume computations for impervious areas are carried out by reducing precipitation with a small initial abstraction and subsequently applying a runoff coefficient (i.e. 0.95). Inter-event updating of the initial abstraction is similar to the technique for pervious areas.

The QUALHYMO model calculates flow rates from flow volume by convolution of excess precipitation, with two unit hydrograph shapes proposed by Nash (1957) and Williams (1973). Since runoff from pervious areas is convoluted separately from impervious areas, the same or different unit hydrograph shapes can be used at the discretion of the modeller. Herein, the Williams and Nash approaches were used for the pervious and impervious areas, respectively.

A flow path connected to an outlet is determined for both pervious and impervious areas. The flow path for the impervious areas may be overland, channel and pipe flow or combinations of these. The flow path for pervious areas can be calculated or left to the model to compute based on physical characteristics of the drainage area.

A kinematic approximation is used within QUALHYMO to route flows along river reaches. Hydraulics in the reach are represented either by a Manning flow equation or specified rating curve. Depth-flow velocity and depth-section area relationships for the channel are calculated by the model and used subsequently for flow routing purposes.

Calculation of base flow in the model is carried out with a single reservoir representing groundwater storage. A net inflow and outflow from the reservoir is calculated for each model time step with inflow taken as the difference between precipitation and runoff minus any losses to initial abstraction. Outflow is expressed as a function of a baseflow recession constant times the groundwater reservoir storage. Losses to deep groundwater storage are estimated as a constant proportion of the outflow from the groundwater storage reservoir and effectively reduce the contribution to base flow.

A.1.1 Model Enhancements

In order to accommodate the flow travel and attenuation process within water courses of the Waterford River basin, the kinematic approximation employed in the original QUALHYMO model for streamflow routing was replaced by a hydrologic Muskingum method which incorporates the variable storage coefficient (VSC) method (Williams and Haan, 1973). The latter technique accounts for the variation in water surface slope and has been tested successfully on Ontario streams (Waterloo Research Institute, 1984).

Another enhancement was the addition of the U.S. National Weather Service (NWS) River Forecast System snowmelt model (1973) in order to improve the computational accuracy of melt and moisture totals in the watershed during rainfall and snowmelt occurrences. The NWS snowmelt model employs a temperature index procedure in which melt rates are proportional to the difference between the mean air temperature and a base temperature (typically 0°C) during periods without precipitation. A seasonal variation in the melt factor can be simulated to reflect the increase in solar radiation and the decrease in the albedo of a snow cover as the winter period

progresses. During periods of precipitation, a semi-empirical energy balance approach takes into account the net long wave radiation transfer to a snow cover, the latent heat transfer or sublimation of water vapour, sensible heat transfer due to the heat content of the air, and heat transfer to the snow cover caused by precipitation. Short wave radiation is considered to be zero during the occurrence of precipitation due to the presence of cloud cover. Meteorologic data required for computation is limited to air temperature and precipitation intensity during the snowmelt period.

Outflow of liquid water from the snowpack is differentiated from snowmelt in the NWS computational approach by a snowpack heat accounting technique, which indicates whether water will be in a liquid or solid phase. Liquid water is retained in the snowpack against gravity drainage and the portion which exceeds a specified capacity is transmitted as outflow after a time lag which represents routing of meltwater through the snowpack.

The runoff which occurs within small urban catchments can be quite sensitive to short duration intensities. As a final enhancement, QUALHYMO was also modified to allow either 15 minute duration rainfall amounts to be read into the model, or rainfall amounts for any time fraction of hourly inputs. The latter is particularly useful for simulating runoff from design rainfall storms.

A.1.2 CN Transformation for QUALHYMO Input

Rainfall runoff in pervious areas is calculated by the QUALHYMO model using the SCS relation:

$$Q = \frac{(P - ABSPER)^2}{(P - ABSPER + S^*)}$$

where:

Q = cumulative depth of runoff (m)
 P = cumulative depth of precipitation (mm)
 ABSPER = initial abstraction (mm)
 S^* = loss parameter (mm)

In the QUALHYMO Model, S^* and ABSPER are updated by the model with each precipitation occurrence in order to provide a continuous accounting of initial moisture conditions prior to runoff events. In the case of S^* , this is accomplished by expressing S^* as a function of a variable Antecedent Precipitation Index, the API.

The API is determined from the following relation:

$$\text{API2} = \text{APIK} * \text{API1} + P_1$$

where:

APIK is a coefficient (typically taken as 0.9)
 P_1 is precipitation within time step 1, and the
 API subscripts refer to conditions at the beginning of time step 1 and
 time step 2.

The relationship which relate S^* and API is:

$$S^* = S_{\text{MIN}} + (S_{\text{MAX}} - S_{\text{MIN}}) * \exp(-SK * \text{API})$$

where:

S_{MIN} and S_{MAX} represent the range in S^* , and SK is a calibration parameter which defines the slope of soil moisture between the maximum and minimum values. These relationships are shown graphically in the following figure and their development is described below.

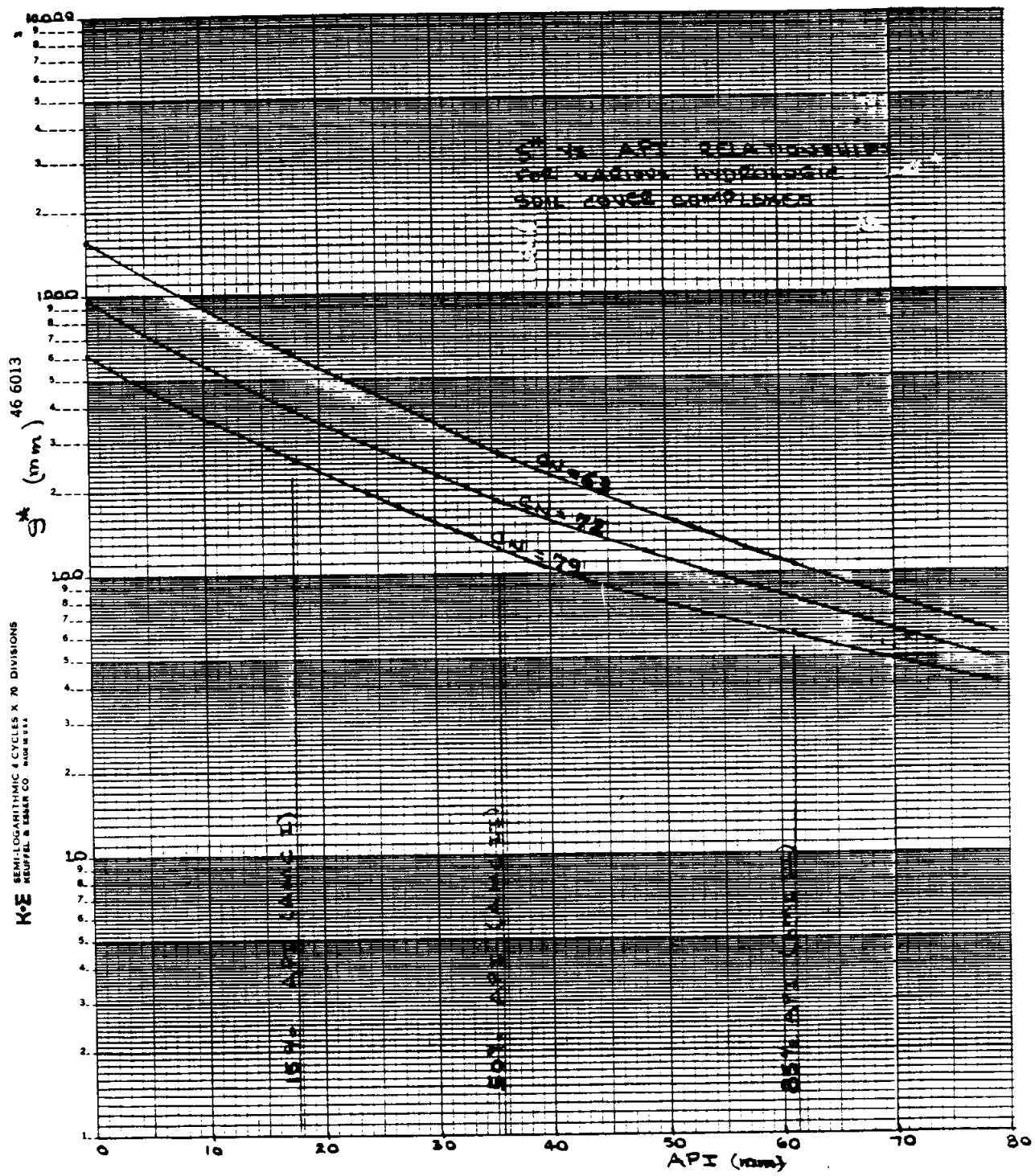


Figure A1-1

In order to apply the QUALHYMO model, the following steps were taken:

- i) Hydrologic soil-cover complexes (CN) were computed for the large catchments shown in Figure 5-1. A weighted average hydrologic soil-cover complex (CN) was calculated for each subcatchment to correspond to the Soil Conservation Service Antecedent Moisture Condition I, II and III (AMC condition).
- ii) The API sub-routine of the QUALHYMO model was then used in an analysis of the hourly precipitation records between June 1962 and December 1987 for the Stephenville Airport station to calculate continuous API (Antecedent Precipitation Index) values. With these values, it is possible to initiate model simulations on any date with the knowledge that the API value for that date integrates all of the precipitation that precedes that date.
- iii) In order to develop API values for use in design storm runoff simulations (Section 5.7.2), an API duration analysis was carried out to determine the API values corresponding to the 15, 50 and 85 percent time of exceedance. It was established that the API values of 17.8 mm, 35.8 mm and 61.6 mm corresponded to the foregoing percentage exceedances, respectively.
- iv) An S* versus API curve was established for each subcatchment in Figure 4-1. In order to obtain the general shape of this curve, the hydrologic soil cover (CN) for each subcatchment corresponding to the antecedent moisture conditions, I, II and III (point i) above) was converted to the equivalent S* loss parameter by the relationship following the Soil Conservation Service procedure (1969).

$$S^* = \frac{100 - 10}{CN}$$

Based on the experience of the model's author, the foregoing S^* magnitudes were plotted at the API values corresponding to the 15, 50 and 85 percent points. Values of SMIN and SMAX were subsequently established by graphical curve extension, and SK (the curve slope) was computed from the exponential equation relating this parameter to S^* , SMIN and SMAX.

PREVIOUS DATA***

AA=2 KORH=.84 TPORL=3.91 HRS

SMIN=3. SMAX=250. MM SK=0.068

APIK=0.9 APII=30.

ABSER=15. MM SVOL=0.1 MM SLOSK1=0.000005

SLOSK=1.0 BASIN=5.0 CMS

BASET=0.0 SNDFAC=-1 PACDEP=0

ID=3 NPK=5

ID= 4 ISER= 101 IDI= 2 IDII= 3

ID=6 NPEAK=5

PRINT PEAK

ADD SERIES

PRINT PEAK

**

***** BASIN NO. 340 *****

START

***** RAIN RECORDS ON FILE 20

WATER SURVEY FLOW RECORDS ON FILE 10

CASE=1 (API METHOD)

RAIN FACTOR = 1.7

***** SOUTH BRANCH *****

GENERATE

IDOUT=3 ISER=340 DT= 1.0 HR

DA=22700. HA AB=0 FRIMP=0

PREVIOUS DATA***

AA=2 KORH=-1.22 TPORL=-4.96 HRS

SMIN=3. SMAX=250. MM SK=0.068

APIK=0.9 APII=48.

ABSER=15. MM SVOL=0.1 MM SLOSK1=0.000005

SLOSK=1.0 BASIN=8.0 CMS

BASET=0.0 SNDFAC=-1 PACDEP=0

ID=3 NPK=5

PRINT PEAK

ADD SERIES

PRINT PEAK

**

*FIELD SURVEYED SECTION NO. 24

COMPUTE RATING CURVE ID=1 VALLEY SECTION= 1 DIVIDED INTO 3 SECTIONS

ELEVATION > MIN= 34.711 M MAX= 40.00 M

SLOPE > CHANNEL= 0.0009 FLOODPLAIN=0.0009

N= 0.07 DIST= 1031.0 M=.04 DIST= 1132.17 M=0.07

DIST= 1409.0

DIST ELEV DIST ELEV DIST ELEV

968.45 36.36 989.67 36.98 1000.0 37.062

***** CONFLUENCE OF THE NORTH & SOUTH BRANCHES *****

ID= 6 ISER= 103 IDI= 4 IDII= 5
ID=6 NPK=5

***** ROUTING REACH 3 *****

*FIELD SURVEYED SECTION NO. 12
 COMPUTE RATING CURVE ID=1 VALLEY SECTION= 1 DIVIDED INTO 3 SECTIONS
 ELEVATION > MIN= 10.383 M MAX= 22.774 M
 SLOPE > CHANNEL= 0.0018 FLOODPLAIN=0.0018
 N= 0.07 DIST= 52.4 M=.04 DIST= 149.167
 N=0.07 DIST= 154.523

DIST	ELEV	DIST	ELEV	DIST	ELEV
0.0	19.145	40.0	13.145	52.4	12.117
56.85	13.051	66.0	12.009	70.188	11.422
87.490	10.383	102.46	11.109	106.126	11.109
108.126	10.959	110.126	11.009	113.13	11.009
116.130	11.159	118.927	11.359	119.061	11.711
130.402	10.644	144.410	10.597	149.170	10.803
152.523	12.774	154.523	22.774		

COMPUTE TRAVEL TIME ID=2 REACH NO= 3 NUMBER OF VALLEY SECTIONS= 1
 LENGTH= 8500. M SLOPE= 0.0018 M/M
 ROUTE NC ID=2 HYD NO= 1003 INFLOW HYD ID=6
 LENGTH=8500. SLOPE= 0.0018 RATING CURVE ID=1
 SECTIONS= 1 PCODE= 0
 PRINT PEAK ID=2 NPEAK=5

LENGTH= 8500. M SLOPE= 0.0018 M/M
 ID=2 HYD NO= 1003 INFLOW HYD ID=6
 LENGTH=8500. SLOPE= 0.0018 RATING CURVE ID=1
 SECTIONS= 1 PCODE= 0
 PRINT PEAK ID=2 NPEAK=5

SIMULATE FROM 99 6 1 TO 99 6 6
 RAIN RECORDS ON FILE 18
 WATER SURVEY FLOW RECORDS ON FILE 10
 CASE=1 (API METHOD)
 RAIN FACTOR = 1.2

GENERATE IDOUT=3 ISER=320 DT= 1.0 HR
 DA=7653. HA AB=0 FRIMP=0
 PREVIOUS DATA***
 AA=2 KORH=.50 TPORL=2.68 HRS
 SHIN=15. SHAX=500. MM SK=0.076
 APIK=0.9 APII=36.

ABSER=15. MM SVOL=0.1 MM SLOSS1=0.000005
 BASET=1.0 BASHN=3.0 CMS
 BASET=0.0 SNOFAC=-1 PADDEP=0

PRINT PEAK ID=3 NPK=5
 ID= 4 ISER= 104 ID1= 2 IDII= 3
 ADD SERIES
 PRINT PEAK ID=4 NPK=5

APIK=0.9 APII=30.
ABER=15. MM SVOL=0.1 MM SLOSSK1=0.000005
SLOSSK=1.0 BASIN=2.0 CMS
BASET=0.0 SNOFAC=-1 PACOEP=0
ID= 3 MPK=5
ID= 4 ISER= 105 IDI= 2 IDII= 3
ID=4 MPK=5
**

PRINT PEAK
ADD SERIES
PRINT PEAK
PRINT PEAK
**

START
SIMULATE FROM 99 6 1 TO 99 6 6
RAIN RECORDS ON FILE 17
WATER SURVEY FLOW RECORDS ON FILE 10
CASE=1 (API METHOD)
RAIN FACTOR = 1.0
**

***** BASIN NO. 370 *****
**
GENERATE IDOUT=3 ISER=370 DT= 1.0 HR
DA=4259. MA AB=0 FRIMP=0
PREVIOUS DATA***
AA=2 KORN=-.59 TPORL=-2.38 HRS
SPIN=11. SPMAX=460. MM SK=0.074
APIK=0.9 APII=30.
ABER=15. MM SVOL=0.1 MM SLOSSK1=0.000005
SLOSSK=1.0 BASIN=1.5 CMS
BASET=0.0 SNOFAC=-1 PACOEP=0
ID=3 MPK=5
**

***** UPPER FERRY BRIDGE *****
**
ADD SERIES ID= 5 ISER= 106 IDI= 4 IDII= 3
PRINT PEAK
FINISH

APPENDIX TA-2

CODROY RIVER AREA
FREQUENCY ANALYSES - 26 YEARS

- . Little Codroy River**
- . North Branch at Confluence**
- . South Branch at Confluence**
- . North and South Combined**
- . Upper Ferry Bridge**
- . Upper South Branch @ TCH**
- . Upper North Branch**

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 All-Sim Little Codroy - Codroy Valley

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	151.683	49.217	0.324	0.019	2.274
LN X SERIES	4.966	0.351	0.071	-0.464	2.591
LN(X-A) SERIES	7.820	0.020	0.003	-0.008	2.273

X(MIN)=	70.290	TOTAL SAMPLE SIZE=	26
X(MAX)=	232.070	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	59.524	NO. OF ZERO FLOWS=	0

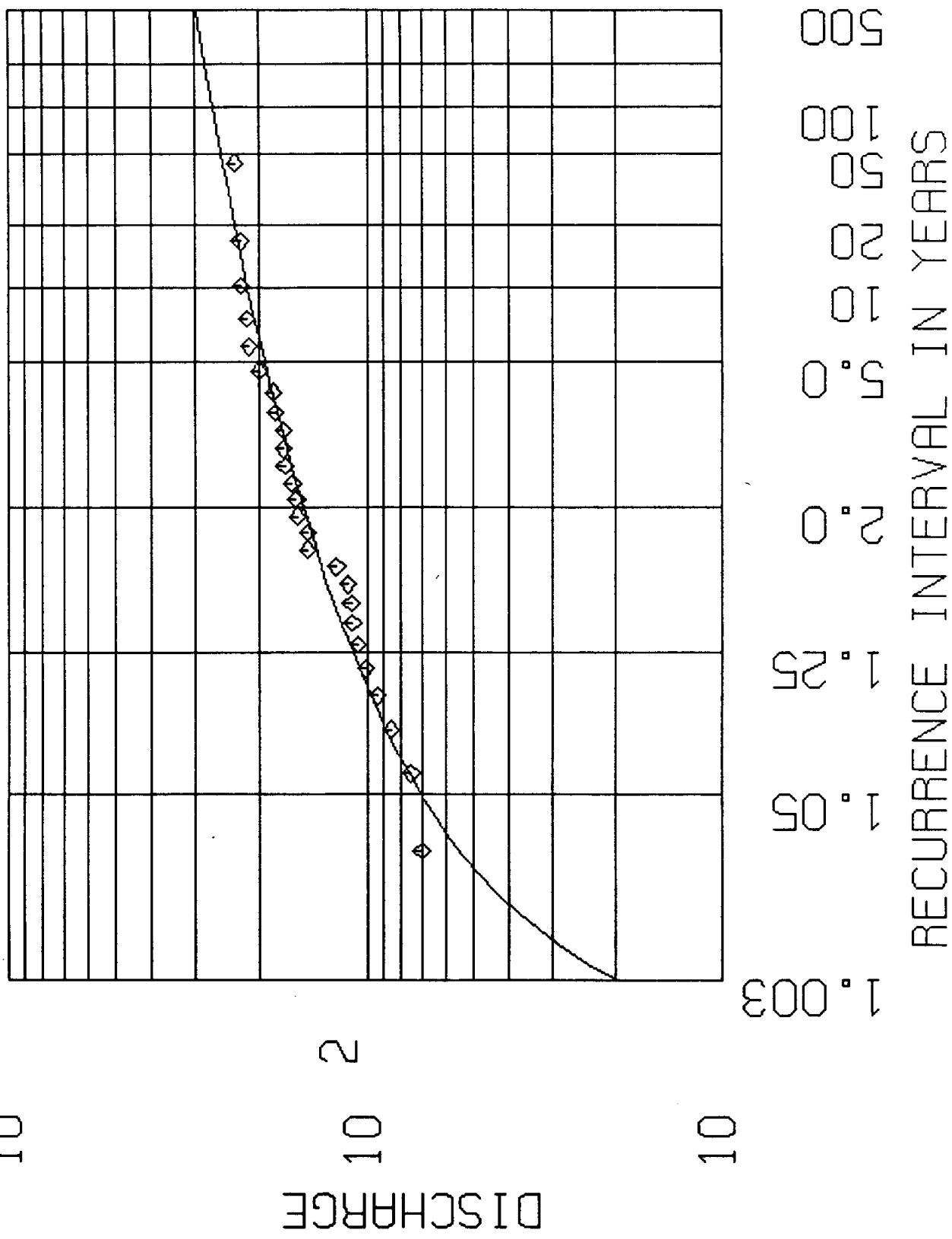
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

3LN PARAMETERS: A= -2339.902 M= 7.820 S= 0.020

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	19.50
1.050	0.952	70.40
1.250	0.800	110.00
2.000	0.500	151.00
5.000	0.200	193.00
10.000	0.100	215.00
20.000	0.050	234.00
50.000	0.020	254.00
100.000	0.010	268.00
200.000	0.005	281.00
500.000	0.002	297.00

FREQUENCY ANALYSIS - ALL-SIM
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 101 CODROY RIVER - NORTH BRANCH

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	299.799	102.477	0.342	0.017	2.919
LN X SERIES	5.639	0.381	0.068	-0.615	2.746
LN(X-A) SERIES	9.344	0.009	0.001	-0.002	2.896

X(MIN)=	141.190	TOTAL SAMPLE SIZE=	26
X(MAX)=	526.870	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	108.378	NO. OF ZERO FLOWS=	0

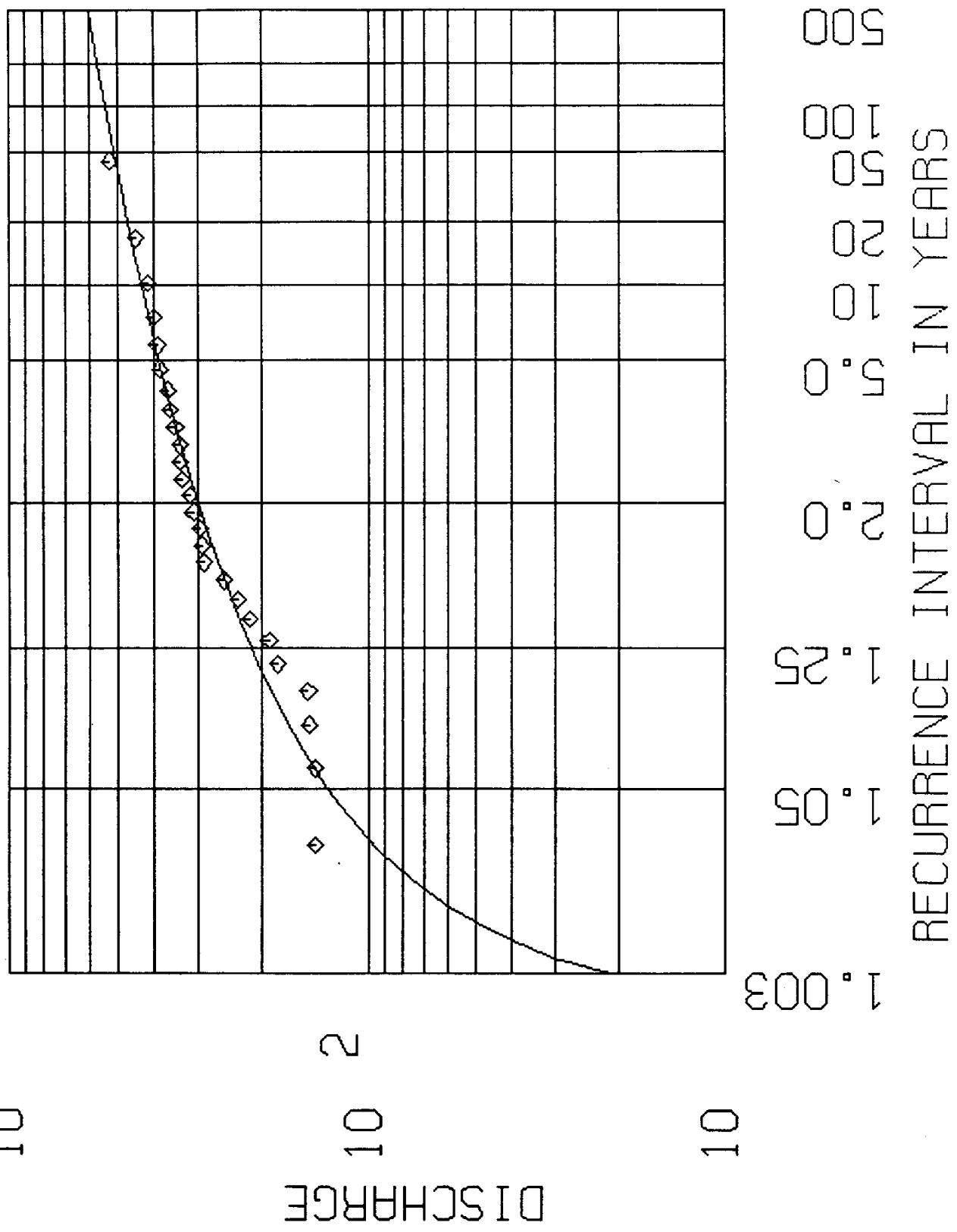
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

3LN PARAMETERS: A=-11135.595 M= 9.344 S= 0.009

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	21.10
1.050	0.952	130.00
1.250	0.800	213.00
2.000	0.500	299.00
5.000	0.200	386.00
10.000	0.100	431.00
20.000	0.050	469.00
50.000	0.020	512.00
100.000	0.010	540.00
200.000	0.005	566.00
500.000	0.002	598.00

FREQUENCY ANALYSIS - 101
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 102 CODROY RIVER - SOUTH BRANCH

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	260.957	84.903	0.325	-0.024	2.729
LN X SERIES	5.506	0.361	0.066	-0.645	2.978
LN(A-X) SERIES	8.706	0.014	0.002	-0.004	2.744

X(MIN)=	111.060	TOTAL SAMPLE SIZE=	26
X(MAX)=	426.250	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	99.782	NO. OF ZERO FLOWS=	0

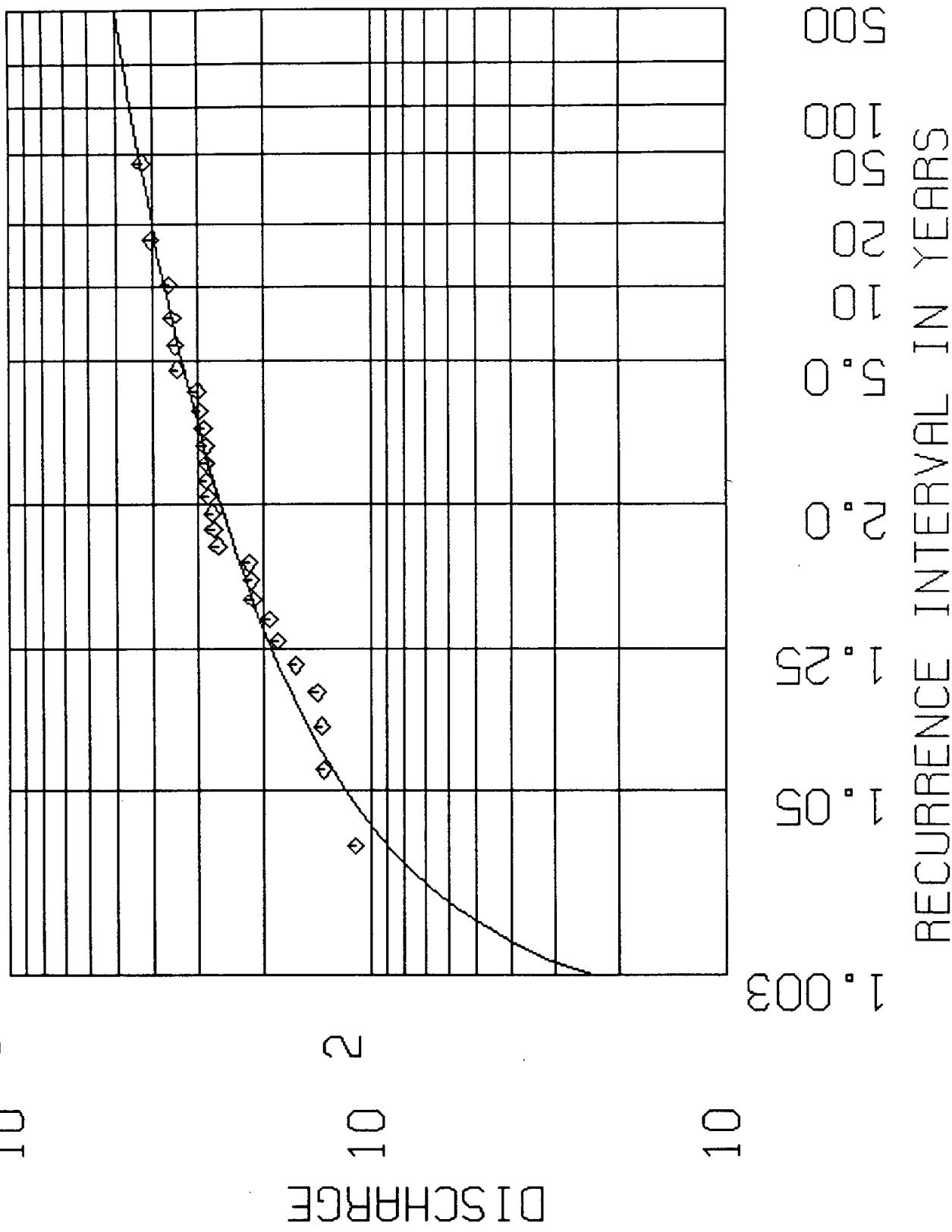
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

DISTRIBUTION IS UPPER BOUNDED AT A= 0.6298E+04
 3LN PARAMETERS: A= 6297.682 M= 8.706 S= 0.014

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	23.60
1.050	0.952	118.00
1.250	0.800	190.00
2.000	0.500	262.00
5.000	0.200	333.00
10.000	0.100	369.00
20.000	0.050	400.00
50.000	0.020	433.00
100.000	0.010	456.00
200.000	0.005	476.00
500.000	0.002	501.00

FREQUENCY ANALYSIS - 102
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 103 CODROY RIVER - NORTH & SOUTH CONFLUENCE

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	538.617	185.404	0.344	0.081	2.865
LN X SERIES	6.225	0.379	0.061	-0.554	2.722
LN(X-A) SERIES	8.294	0.046	0.006	-0.012	2.766

X(MIN)= 244.350	TOTAL SAMPLE SIZE= 26
X(MAX)= 946.480	NO. OF LOW OUTLIERS= 0
LOWER OUTLIER LIMIT OF X= 195.582	NO. OF ZERO FLOWS= 0

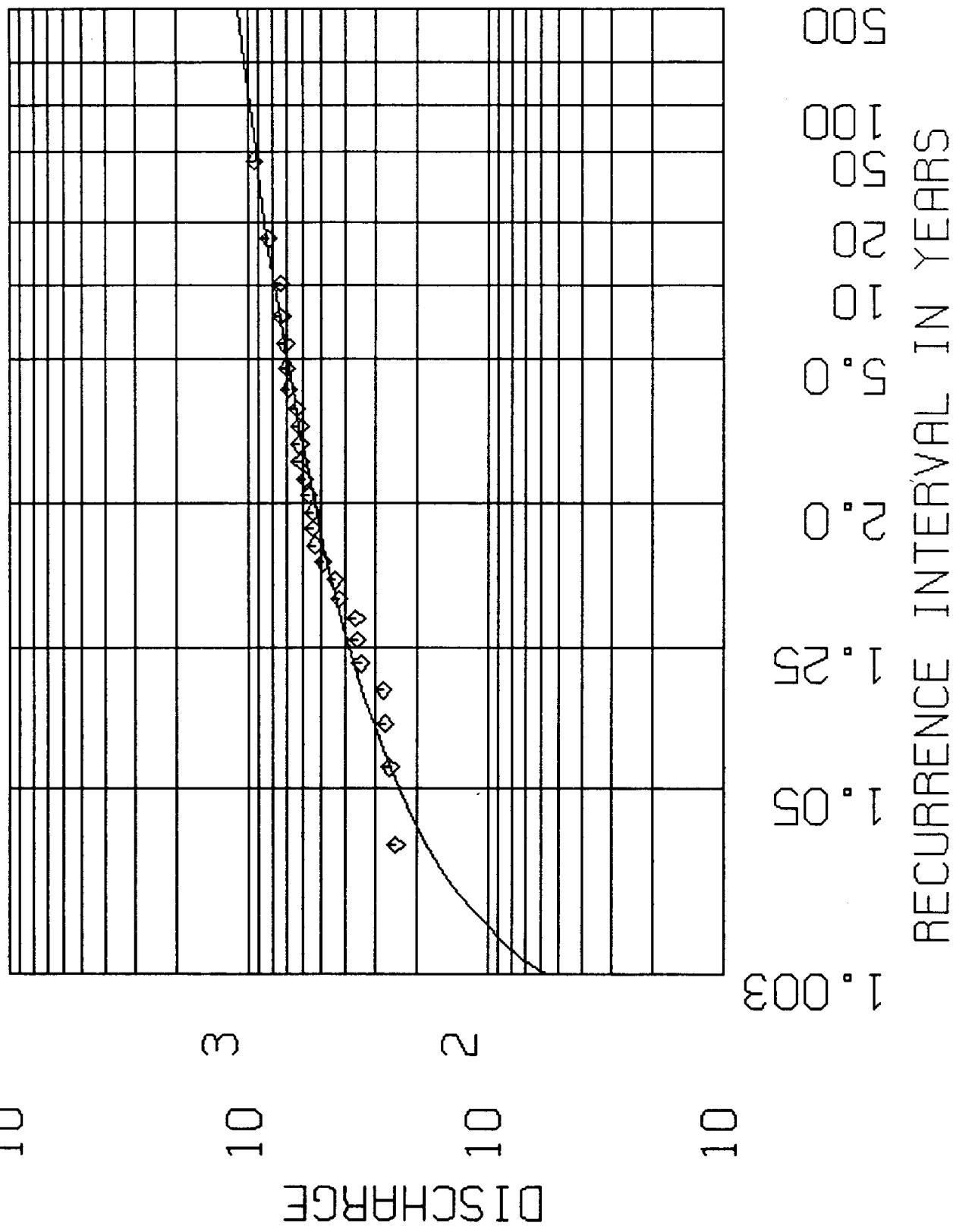
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

3LN PARAMETERS: A= -3464.206 M= 8.294 S= 0.046

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	56.30
1.050	0.952	237.00
1.250	0.800	382.00
2.000	0.500	534.00
5.000	0.200	693.00
10.000	0.100	779.00
20.000	0.050	851.00
50.000	0.020	934.00
100.000	0.010	990.00
200.000	0.005	1040.00
500.000	0.002	1100.00

FREQUENCY ANALYSIS - 103
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 106 CODROY RIVER - FERRY BRIDGE

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	593.647	202.670	0.341	0.017	2.685
LN X SERIES	6.322	0.379	0.060	-0.593	2.767
LN(X-A) SERIES	9.865	0.011	0.001	-0.003	2.672

X(MIN)= 276.880	TOTAL SAMPLE SIZE= 26
X(MAX)= 1012.850	NO. OF LOW OUTLIERS= 0
LOWER OUTLIER LIMIT OF X= 215.910	NO. OF ZERO FLOWS= 0

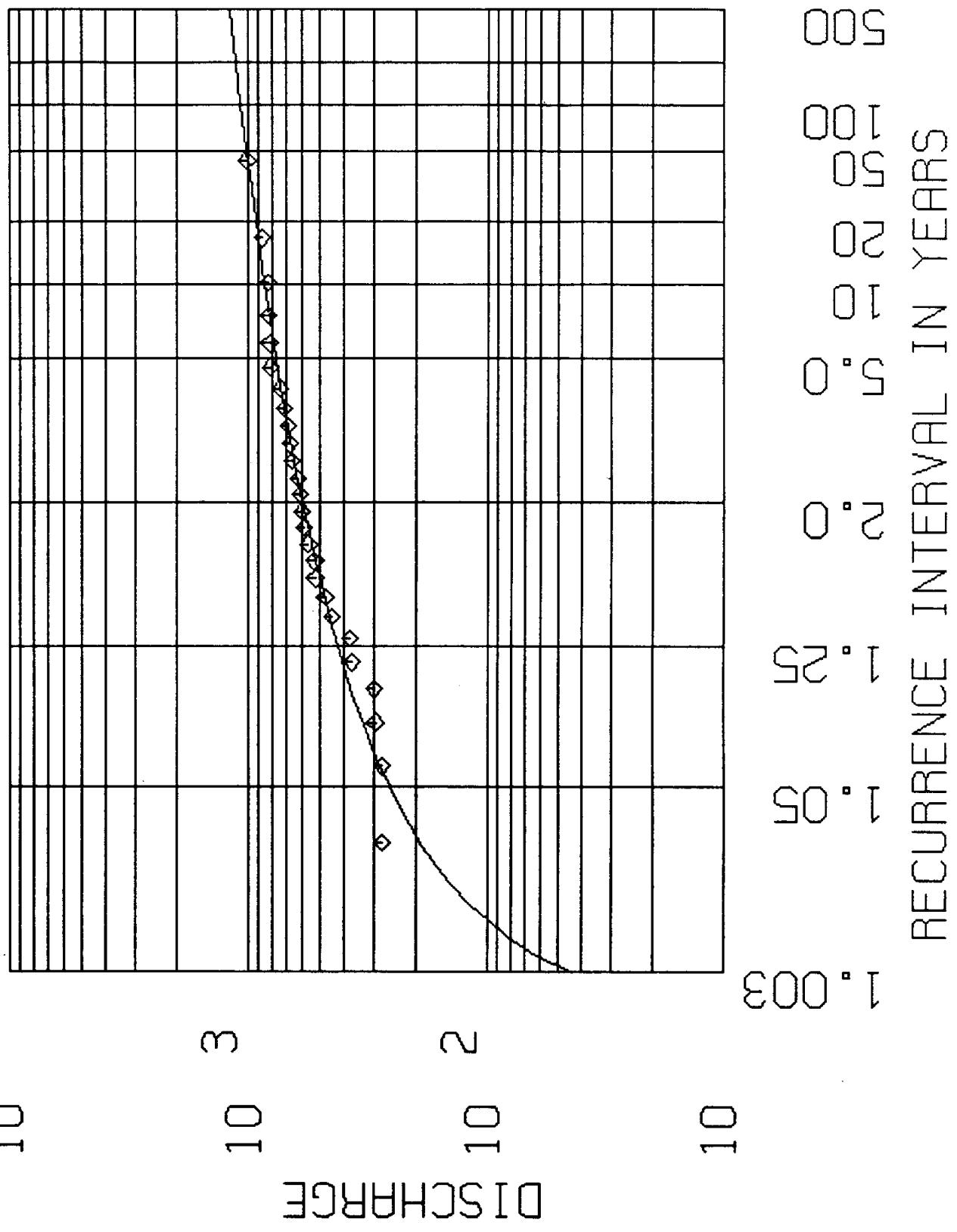
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

3LN PARAMETERS: A=-18645.561 M= 9.865 S= 0.011

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	43.50
1.050	0.952	257.00
1.250	0.800	423.00
2.000	0.500	593.00
5.000	0.200	764.00
10.000	0.100	854.00
20.000	0.050	929.00
50.000	0.020	1010.00
100.000	0.010	1070.00
200.000	0.005	1120.00
500.000	0.002	1180.00

FREQUENCY ANALYSIS - 106
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 340 = ID NUMBER UPPER SOUTH BRANCH @ TCH

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	250.636	83.940	0.335	0.009	2.765
LN X SERIES	5.462	0.373	0.068	-0.646	3.001
LN(X-A) SERIES	9.648	0.005	0.001	-0.001	2.759

X(MIN)= 102.970
 X(MAX)= 412.410
 LOWER OUTLIER LIMIT OF X= 92.781

TOTAL SAMPLE SIZE= 26
 NO. OF LOW OUTLIERS= 0
 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

3LN PARAMETERS: A=-15246.855 M= 9.648 S= 0.005

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	21.40
1.050	0.952	111.00
1.250	0.800	180.00
2.000	0.500	250.00
5.000	0.200	321.00
10.000	0.100	358.00
20.000	0.050	389.00
50.000	0.020	424.00
100.000	0.010	447.00
200.000	0.005	468.00
500.000	0.002	494.00

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 360 = ID NUMBER UPPER NORTH BRANCH

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	176.238	59.650	0.338	-0.079	2.562
LN X SERIES	5.108	0.379	0.074	-0.610	2.618
LN(A-X) SERIES	7.020	0.053	0.008	-0.015	2.643

X(MIN)=	82.640	TOTAL SAMPLE SIZE=	26
X(MAX)=	295.300	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	64.153	NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

DISTRIBUTION IS UPPER BOUNDED AT A= 0.1296E+04
 3LN PARAMETERS: A= 1296.372 M= 7.020 S= 0.053

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	1.33
1.050	0.952	73.80
1.250	0.800	126.00
2.000	0.500	178.00
5.000	0.200	227.00
10.000	0.100	252.00
20.000	0.050	272.00
50.000	0.020	294.00
100.000	0.010	308.00
200.000	0.005	321.00
500.000	0.002	337.00

APPENDIX TA-3

**LITTLE CODROY RIVER
FREQUENCY ANALYSIS**

- . 6 Years Observed Data**
- . 6 Years Simulated Data**

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 Cod-Obs Codroy Valley

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	170.167	45.354	0.267	-0.272	5.263
LN X SERIES	5.104	0.285	0.056	-0.644	5.468
LN(A-X) SERIES	5.195	0.248	0.048	-0.115	5.509

X(MIN)= 107.000
 X(MAX)= 229.000
 LOWER OUTLIER LIMIT OF X= 99.974

TOTAL SAMPLE SIZE= 6
 NO. OF LOW OUTLIERS= 0
 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

DISTRIBUTION IS UPPER BOUNDED AT A= 0.3552E+03
 3LN PARAMETERS: A= 355.205 M= 5.195 S= 0.248

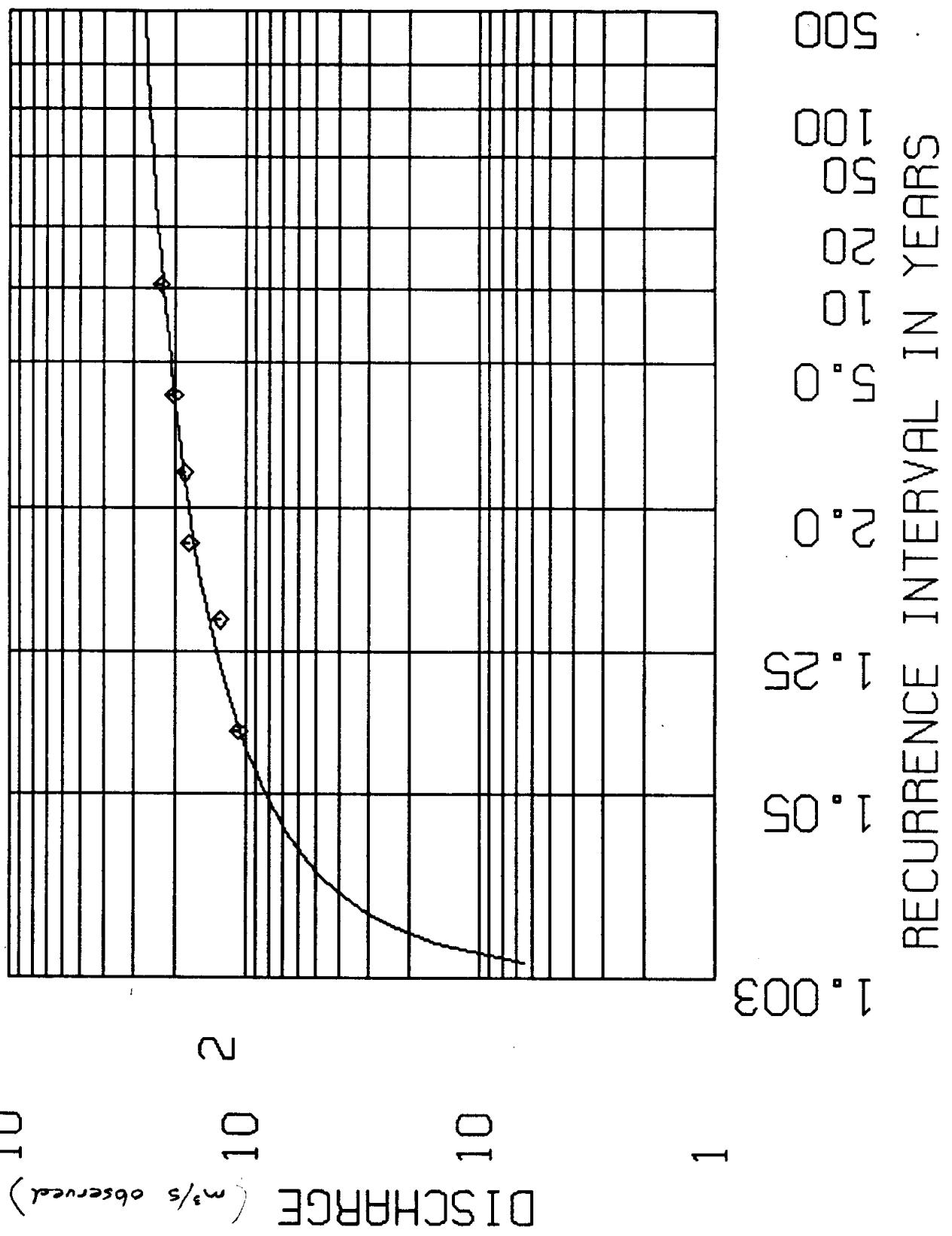
FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	-
1.050	0.952	82.10
1.250	0.800	133.00
2.000	0.500	175.00
5.000	0.200	209.00
10.000	0.100	224.00
20.000	0.050	235.00
50.000	0.020	247.00 -
100.000	0.010	254.00 -
200.000	0.005	260.00
500.000	0.002	267.00

WSC STATION NO=Cod-Obs
 WSC STATION NAME=Codroy Valley

MONTH	YEAR	DATA	ORDERED	RANK	PROB.	RET. PERIOD
(1)	(2)	(3) (CMS)	(4) (CMS)	(5)	(6) (%)	(7) (YEARS)
4	1982	229.000	229.000	1	9.68	10.333
1	1983	129.000	202.000	2	25.81	3.875
4	1984	107.000	181.000	3	41.94	2.385
6	1985	173.000	173.000	4	58.06	1.722
1	1986	202.000	129.000	5	74.19	1.348
10	1987	181.000	107.000	6	90.32	1.107

FREQUENCY ANALYSIS - Cod-Obs
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
 Cod-Sim Codroy Valley

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	148.273	50.183	0.338	-0.008	4.156
LN X SERIES	4.948	0.358	0.072	-0.303	4.432
LN(A-X) SERIES	6.884	0.051	0.007	-0.034	4.172

X(MIN)= 85.600
 X(MAX)= 211.870
 LOWER OUTLIER LIMIT OF X= 75.298

TOTAL SAMPLE SIZE= 6
 NO. OF LOW OUTLIERS= 0
 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

DISTRIBUTION IS UPPER BOUNDED AT A= 0.1125E+04
 3LN PARAMETERS: A= 1125.487 M= 6.884 S= 0.051

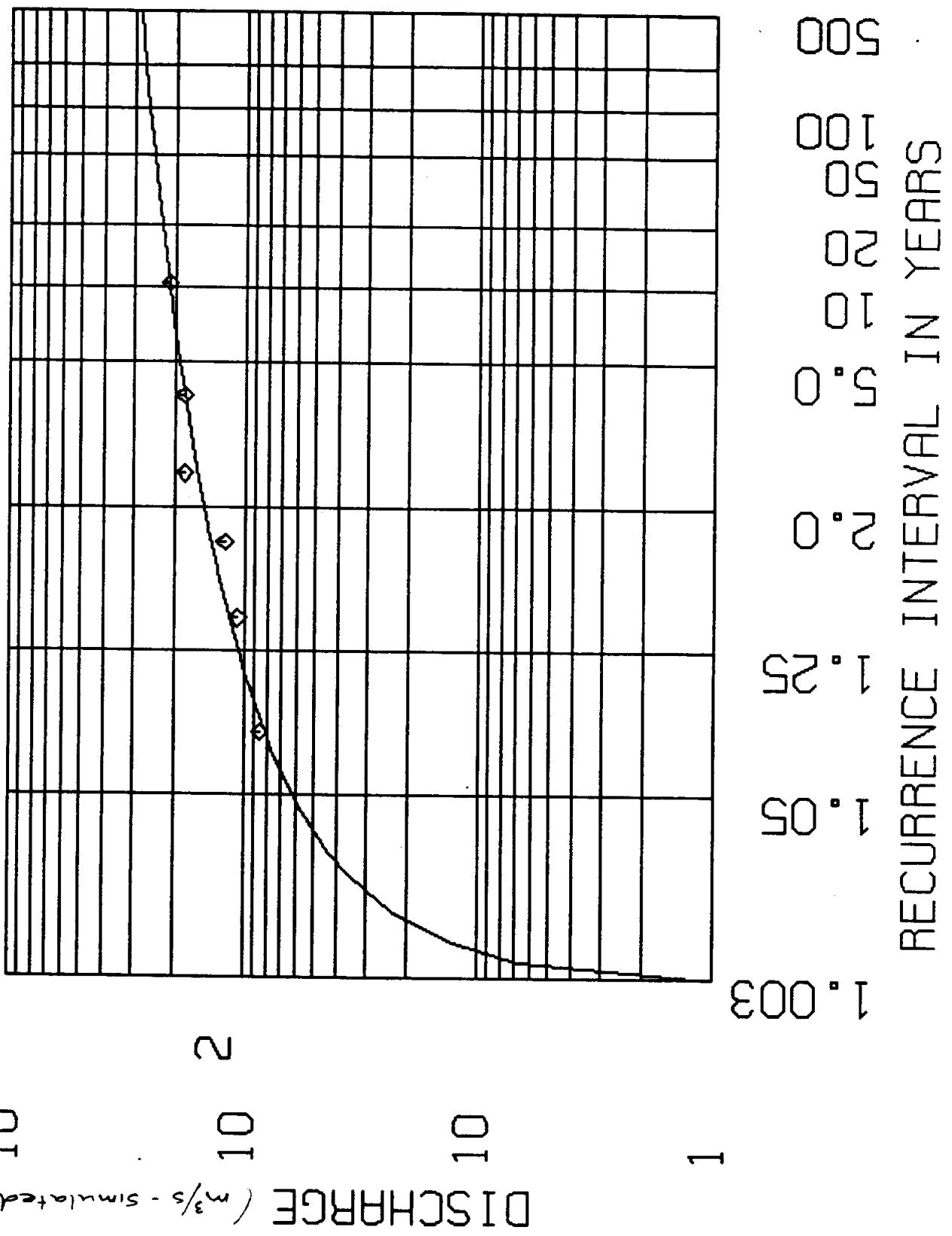
FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	1.17
1.050	0.952	61.90
1.250	0.800	106.00
2.000	0.500	149.00
5.000	0.200	191.00
10.000	0.100	212.00
20.000	0.050	229.00
50.000	0.020	247.00
100.000	0.010	259.00
200.000	0.005	270.00
500.000	0.002	284.00

WSC STATION NO=Cod-Sim
 WSC STATION NAME=Codroy Valley

MONTH	YEAR	DATA	ORDERED	RANK	PROB.	RET. PERIOD
(1)	(2)	(3) (CMS)	(4) (CMS)	(5)	(6) (%)	(7) (YEARS)
4	1982	182.700	211.870	1	9.68	10.333
1	1983	85.600	182.700	2	25.81	3.875
4	1984	107.000	180.500	3	41.94	2.385
6	1985	121.970	121.970	4	58.06	1.722
1	1986	211.870	107.000	5	74.19	1.348
10	1987	180.500	85.600	6	90.32	1.107

FREQUENCY ANALYSIS - Cod-Sim
THREE PARAMETER LOGNORMAL-MAX LIKELIHOOD



APPENDIX TA-4

REGIONAL FLOOD FREQUENCY ANALYSIS

- Canada-Newfoundland Flood Frequency Analysis (1984)**
- Canada-Newfoundland Flood Frequency Analysis (1989)**

1984 REGIONAL ANALYSIS

Form of Flood Flow Equations

Entire Island:

$$\log_{10} QP_t = K + a \log_{10} DA + b \log_{10} MAR + c \log_{10} ACLS + d \log_{10} SHAPE$$

South Region:

$$\log_{10} QP_t = K + a \log_{10} DA + b \log_{10} MAR + c \log_{10} ACLS + d \log_{10} SHAPE$$

where: DA = watershed area (km^2)

SHAPE = watershed shape factor

ACLS = watershed area controlled by lakes and swamps (%)

MAR = mean annual runoff (mm)

Limitations

	<u>Island</u>	<u>South Region</u>
DA	4-4400 km^2	4-2640 km^2
SHAPE	1.24-2.45	1.24-2.45
ACLS	55-100	55-100
MAR	788-2124	929-2124

Application to Codroy Valley

<u>Location</u>	<u>DA</u>	<u>SHAPE</u>	<u>ACLS</u>	<u>MAR</u>	<u>Island Equation</u>	
					<u>Q20***</u>	<u>Q100***</u>
N. Branch	365.6	2.15	40**	1655	411	536
S. Branch	276.0	1.26	54*	2250**	143-683	176-947
Confluence	641.6	1.65	44.6**	1910	902	1192
Upper Ferry	813.9	1.65	38.2**	1820	971	1265

* at limit of range of application of analysis

** outside range of application of primary analysis

*** approximate results only (all limited by * and ** constraints above)

1989 REGIONAL ANALYSIS (SW NEWFOUNDLAND)

First Form of Flood Flow Equation

$$Q_{20} = 20.654 \text{ (DA)}^{0.821} \text{ (LSF)}^{-3.623} \quad \text{Equation 1}$$

$$Q_{100} = 29.174 \text{ (DA)}^{0.821} \text{ (LSF)}^{-3.816} \quad \text{Equation 2}$$

where: DA = drainage area (km^2) - range 72 to 640 km^2

LSF = $1.0 + \text{FACLS} - (\text{FALS}/1.0 + \text{FACLS})$

FACLS = fraction of DA controlled by lakes and swamps - range 0.34 to 0.83

FALS = fraction of DA covered by lakes and swamps - range 0.04 to 0.14

Application to Codroy Valley Area

<u>Location</u>	<u>DA</u>	<u>FACLS</u>	<u>FALS</u>	<u>LSF</u>	<u>Q_{20}</u>	<u>Q_{100}</u>
N. Branch	365.6	0.40	0.15**	1.29	--	--
S. Branch	276.0	0.54	0.20**	1.41	--	--
Confluence	641.6*	0.446	0.17	1.33	--	--
Upper Ferry	813.9**	--	--	--	--	--

Second Form of Equations

$$Q_{20} = 1.416 \text{ (DA)}^{0.998} \quad \text{Equation 3}$$

$$Q_{100} = 1.734 \text{ (DA)}^{0.998} \quad \text{Equation 4}$$

<u>Location</u>	<u>Q_{20}</u>	<u>Q_{100}</u>
N. Branch	512 m^3/s	611 m^3/s
S. Branch	386 m^3/s	473 m^3/s

* results at limit of range of application of all regional analysis equations

** outside range of application of regional analysis equations 1 and 2

APPENDIX TA-5

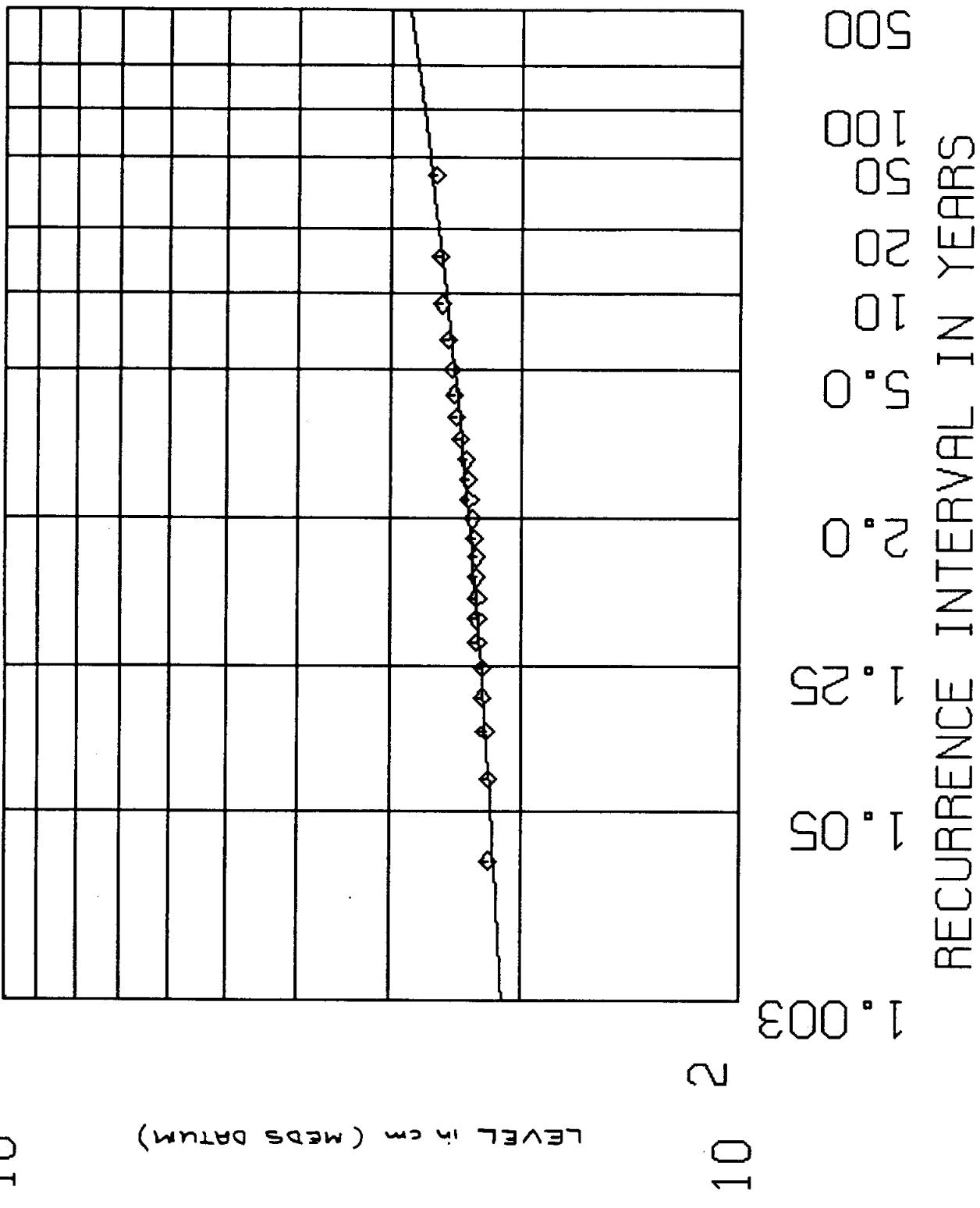
**INSTANTANEOUS PEAK
TIDE LEVEL
FREQUENCY ANALYSIS**

Port Aux Basques

WSC STATION NO=ITIDE
 WSC STATION NAME=PORT AUX BASQUES

MONTH (1)	YEAR (2)	DATA (3) (CM)	ORDERED (4) (CMS)	RANK (5)	PROB. (6) (%)	RET. PERIOD (7) (YEARS)
12	1961	231.000	261.000	1	2.59	38.667
10	1962	229.000	258.000	2	6.90	14.500
3	1963	229.000	256.000	3	11.21	8.923
11	1965	221.000	251.000	4	15.52	6.444
1	1966	245.000	248.000	5	19.83	5.043
2	1967	230.000	246.000	6	24.14	4.143
3	1968	235.000	245.000	7	28.45	3.515
2	1969	261.000	242.000	8	32.76	3.053
12	1970	258.000	237.000	9	37.07	2.698
1	1971	251.000	236.000	10	41.38	2.417
10	1972	225.000	235.000	11	45.69	2.189
1	1973	225.000	233.000	12	50.00	2.000
12	1974	242.000	231.000	13	54.31	1.841
1	1975	233.000	230.000	14	58.62	1.706
3	1976	248.000	230.000	15	62.93	1.589
11	1977	236.000	229.000	16	67.24	1.487
12	1981	230.000	229.000	17	71.55	1.398
1	1982	256.000	229.000	18	75.86	1.318
12	1983	229.000	225.000	19	80.17	1.247
11	1984	221.000	225.000	20	84.48	1.184
1	1985	237.000	223.000	21	88.79	1.126
1	1986	246.000	221.000	22	93.10	1.074
2	1987	223.000	221.000	23	97.41	1.027

FREQUENCY ANALYSIS - ITIDE
LOG PEARSON TYPE III-MOMENT



FREQUENCY ANALYSIS - LOG PEARSON TYPE III DISTRIBUTION
 ITIDE PORT AUX BASQUES

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	236.565	12.067	0.051	0.642	2.779
LN X SERIES	5.465	0.050	0.009	0.575	2.692
X(MIN)=	221.000			TOTAL SAMPLE SIZE=	23
X(MAX)=	261.000			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	208.876			NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MOMENTS

LP3 PARAMETERS: A= 0.1447E-01 B= 12.11 LOG(M)= 5.290
 M = 198.3

FREQUENCY REGIME

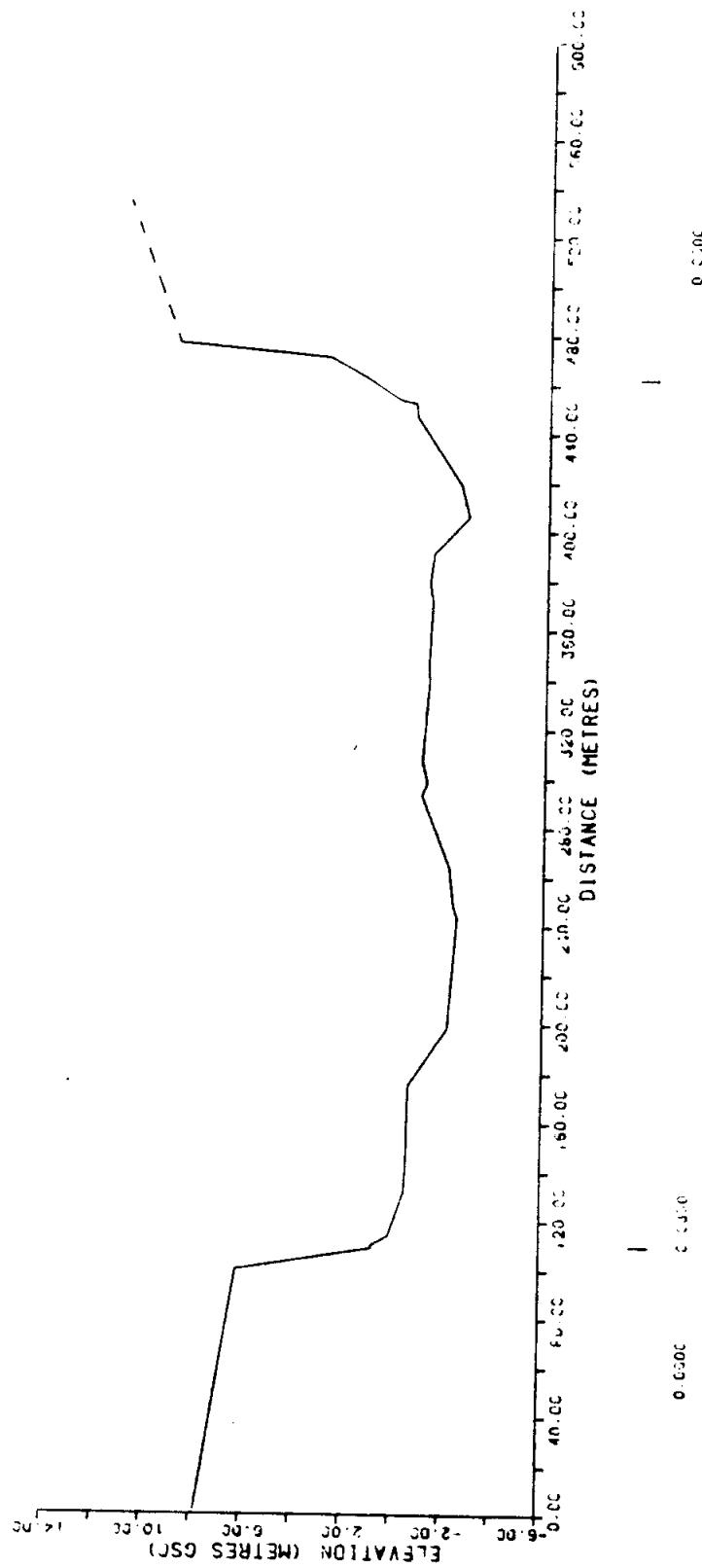
RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD LEVEL (cm)
1.003	0.997	212.00
1.050	0.952	219.00
1.250	0.800	226.00
2.000	0.500	235.00
5.000	0.200	246.00
10.000	0.100	253.00
20.000	0.050	259.00 -
50.000	0.020	266.00
100.000	0.010	271.00 -
200.000	0.005	276.00
500.000	0.002	283.00

APPENDIX TA-6
HEC-2 CROSS SECTION PLOTS

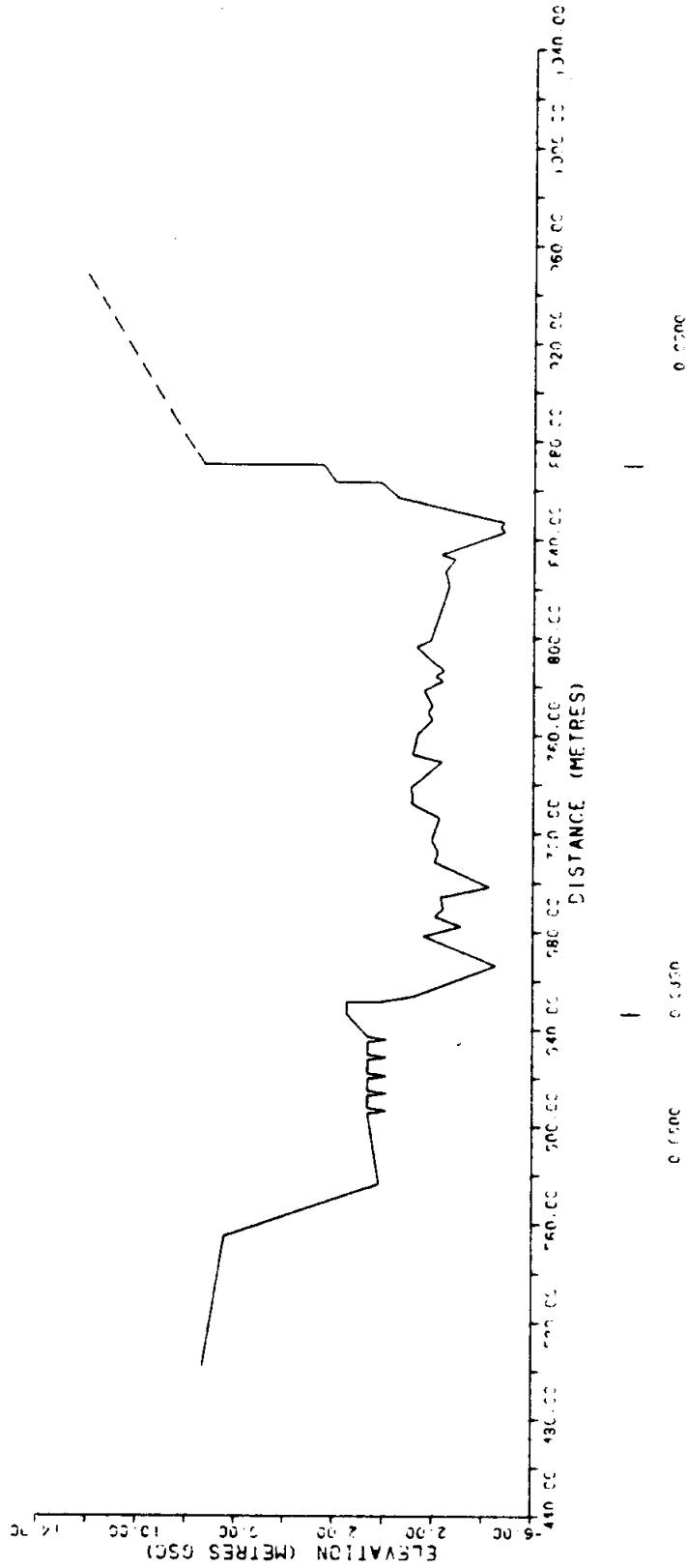
Notes:

- all sections are drawn from upstream looking downstream
- field measured data described by continuous lines _____
- topographic data from mapping described by dashed lines - - -
- roughness values for left and right banks and channel are summarized in Appendix TA-7

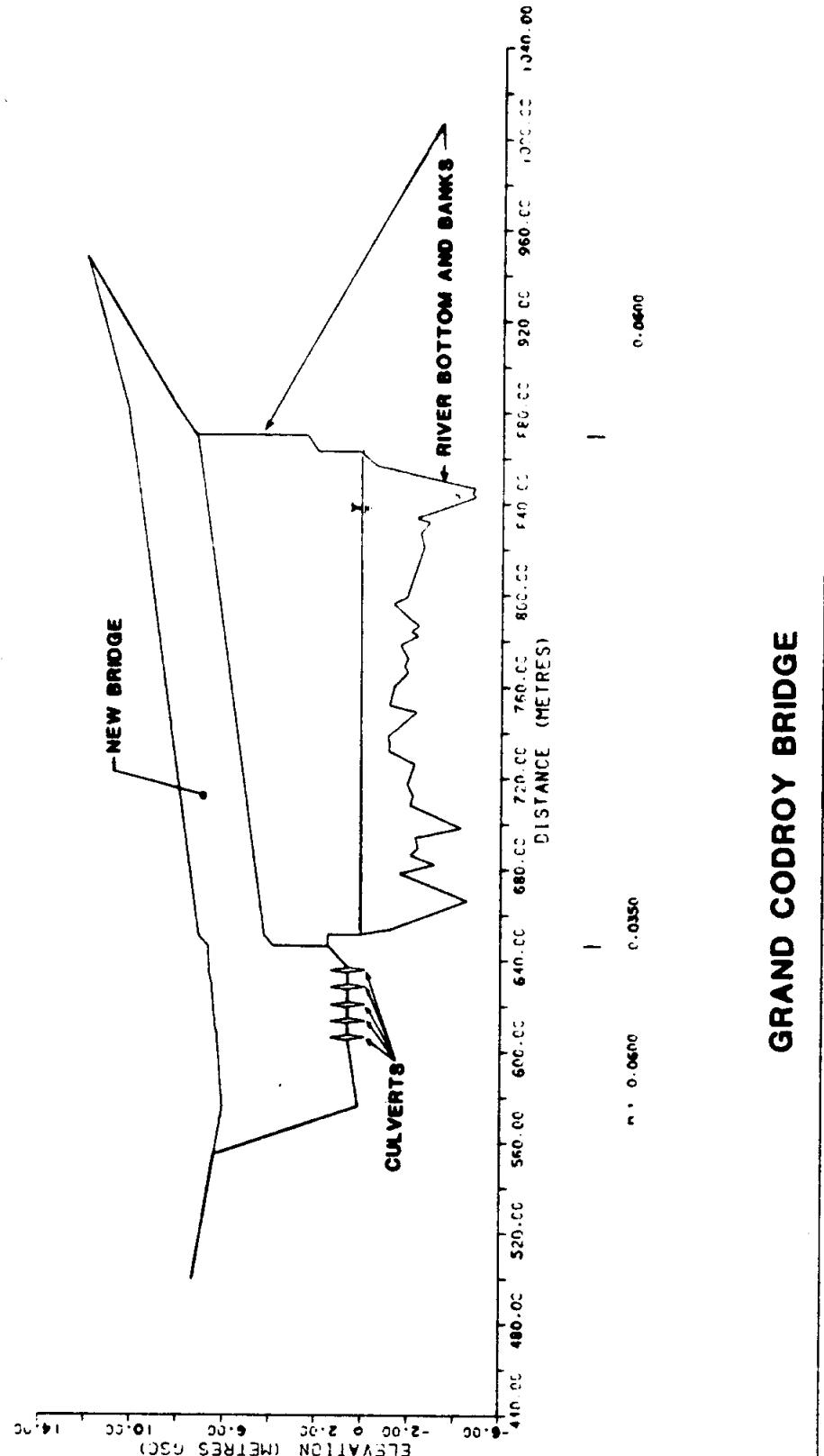
CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 1.0



CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 2.0

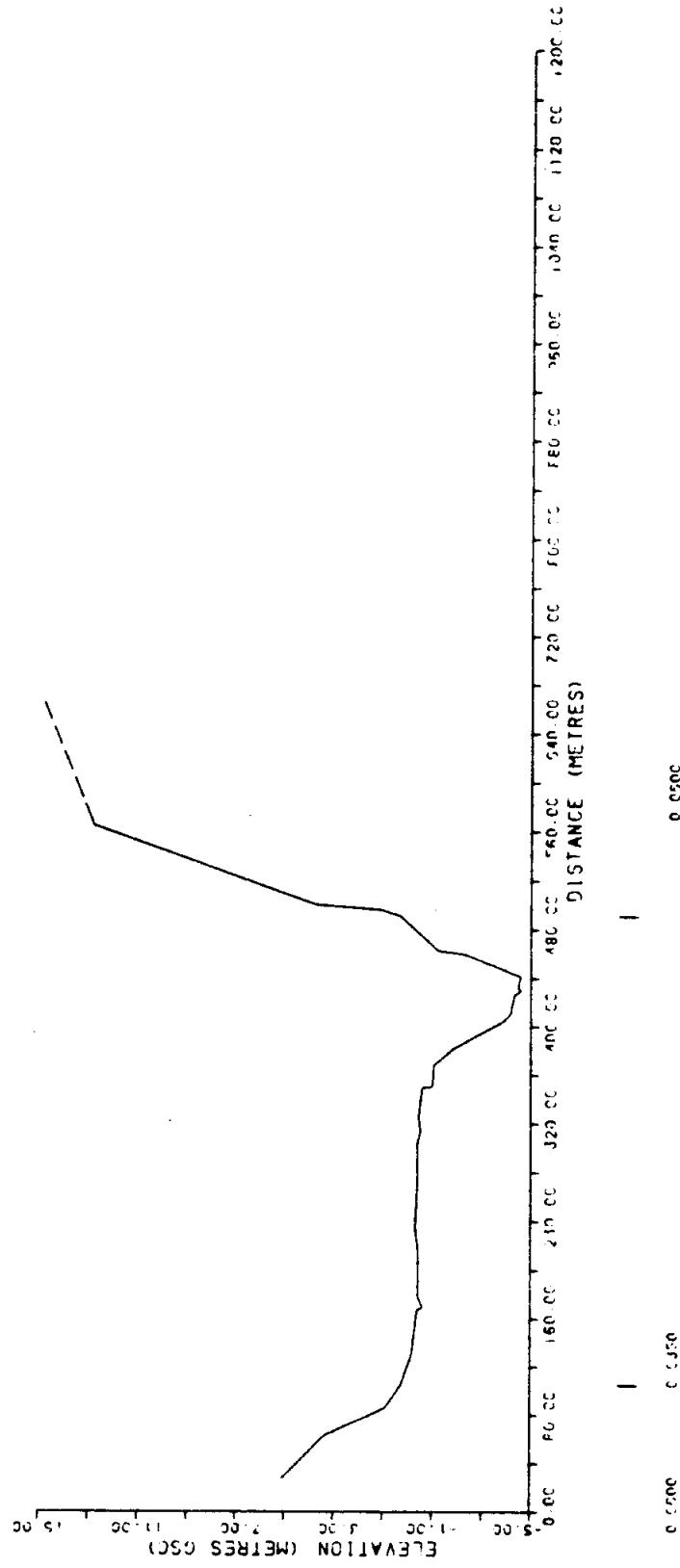


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CROSS SECTION NUMBER 2.1

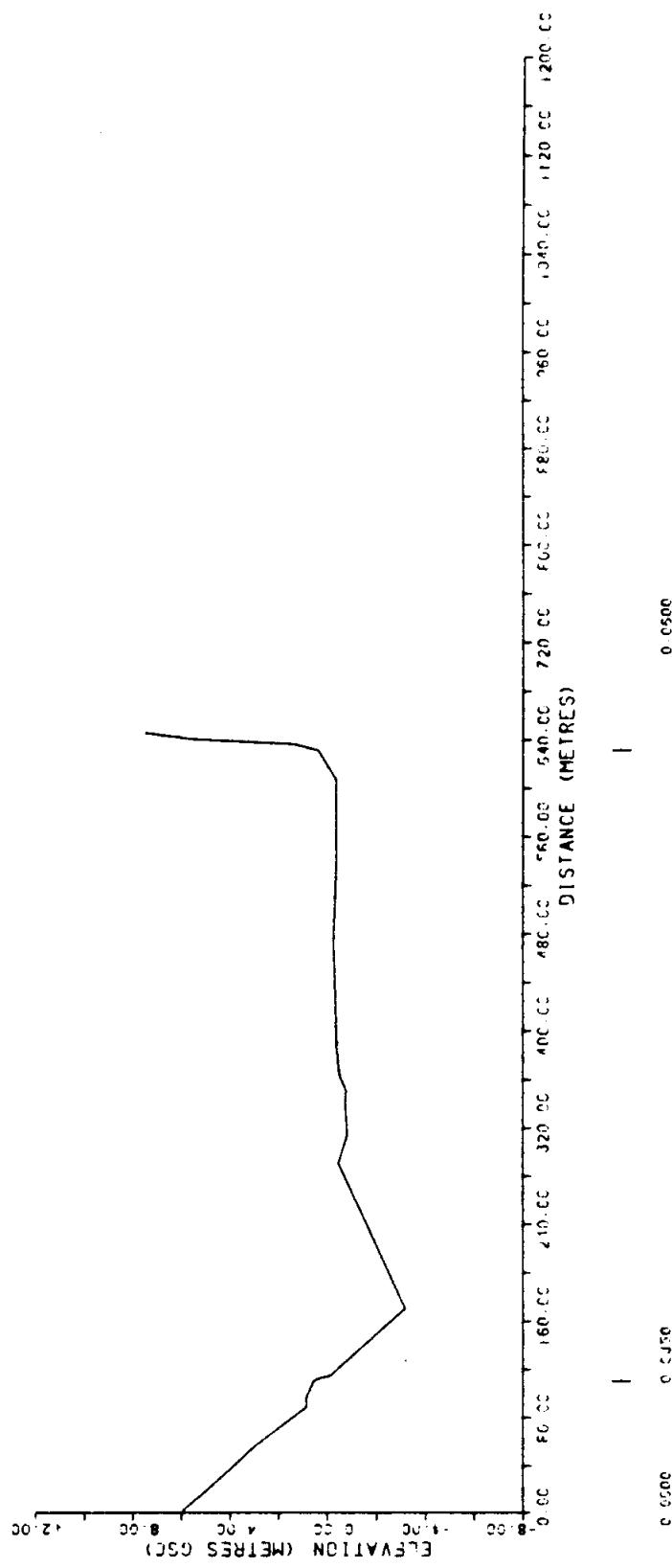


GRAND CODROY BRIDGE
VIEW LOOKING DOWNSTREAM

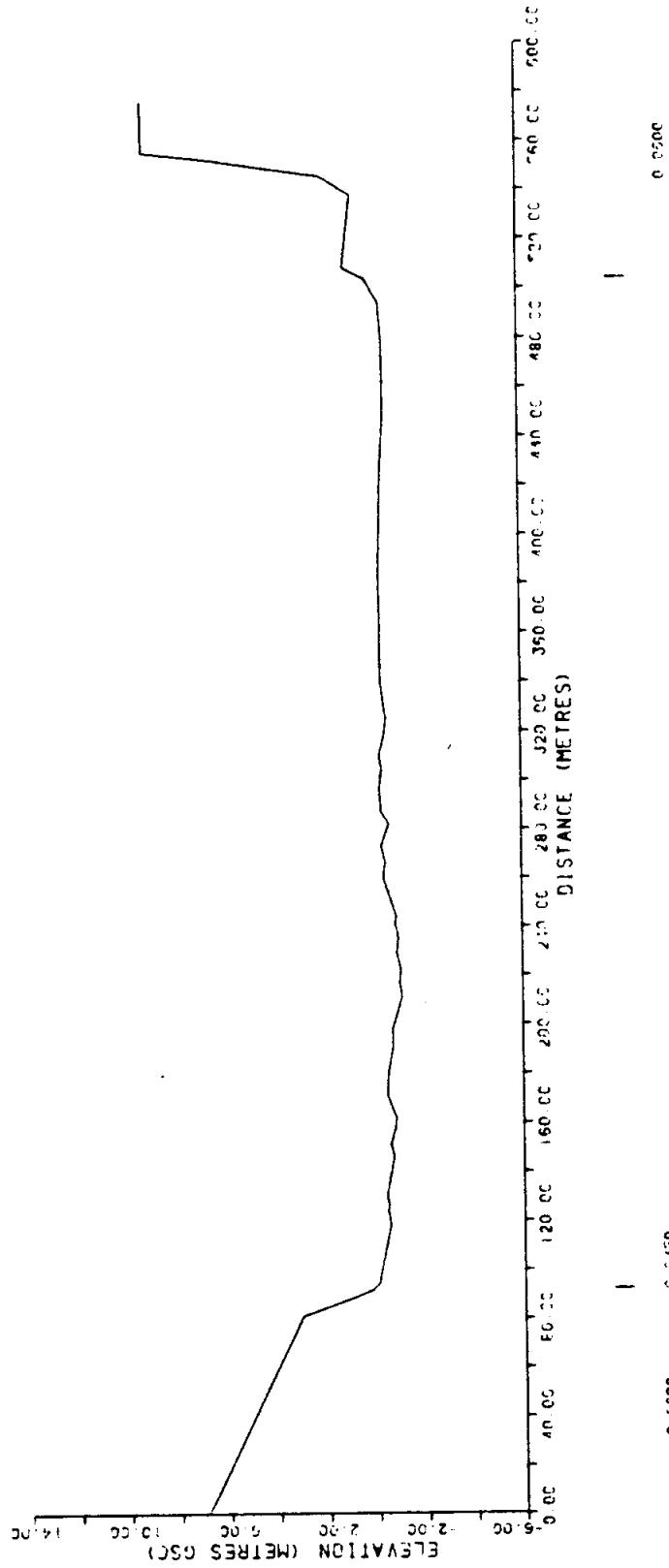
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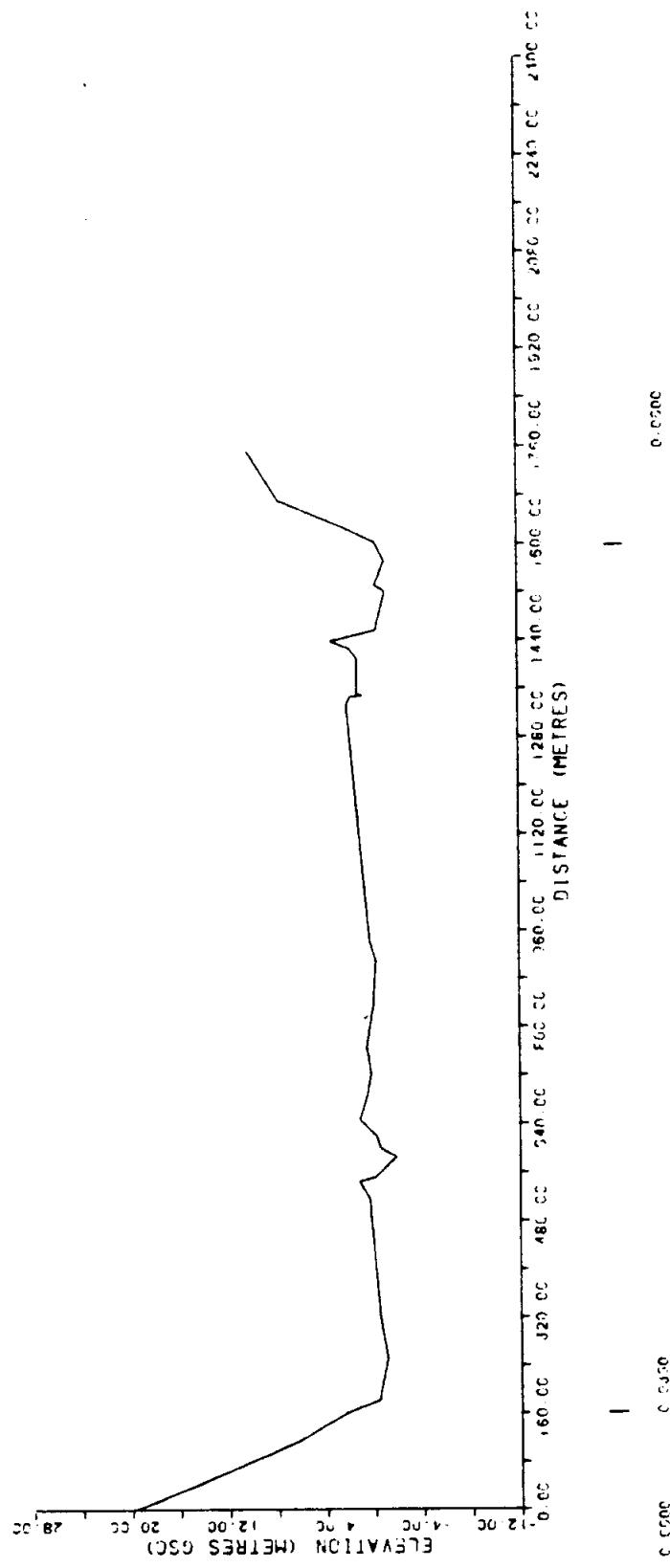
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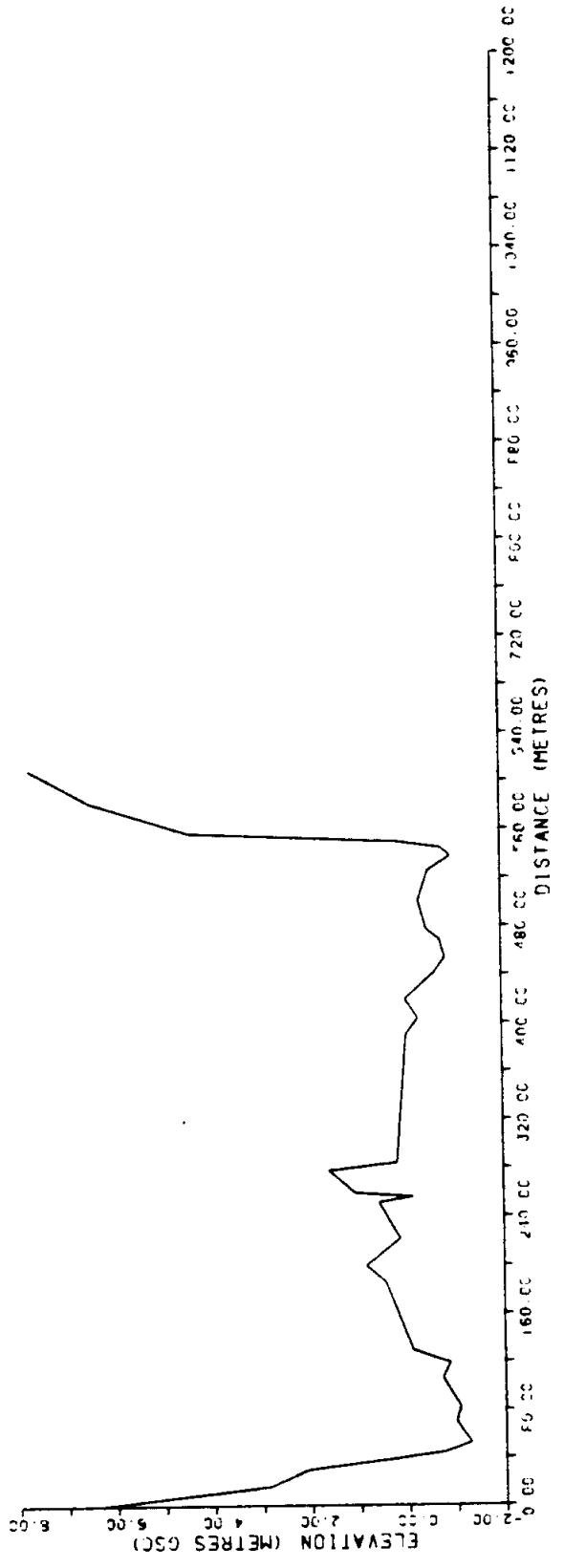
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5.



CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 6.0



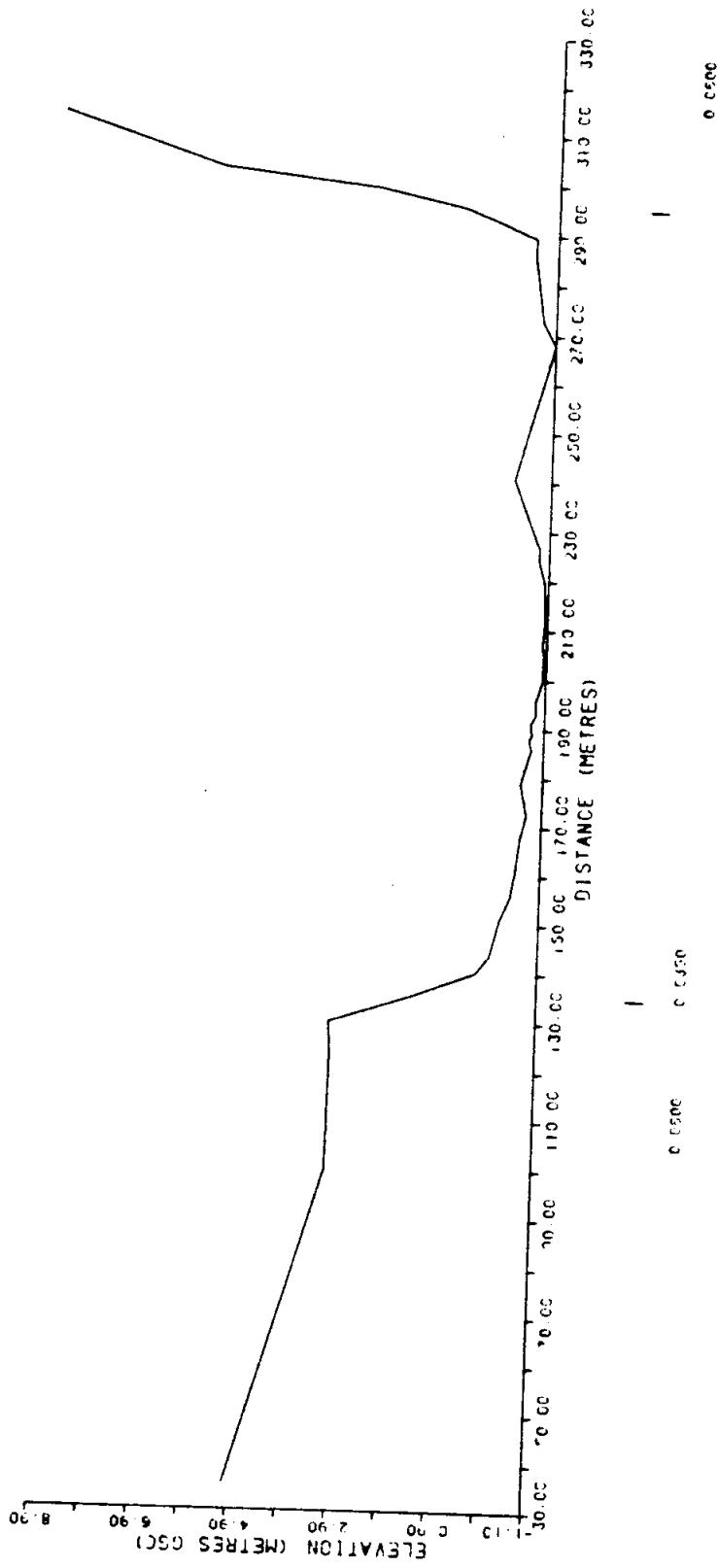
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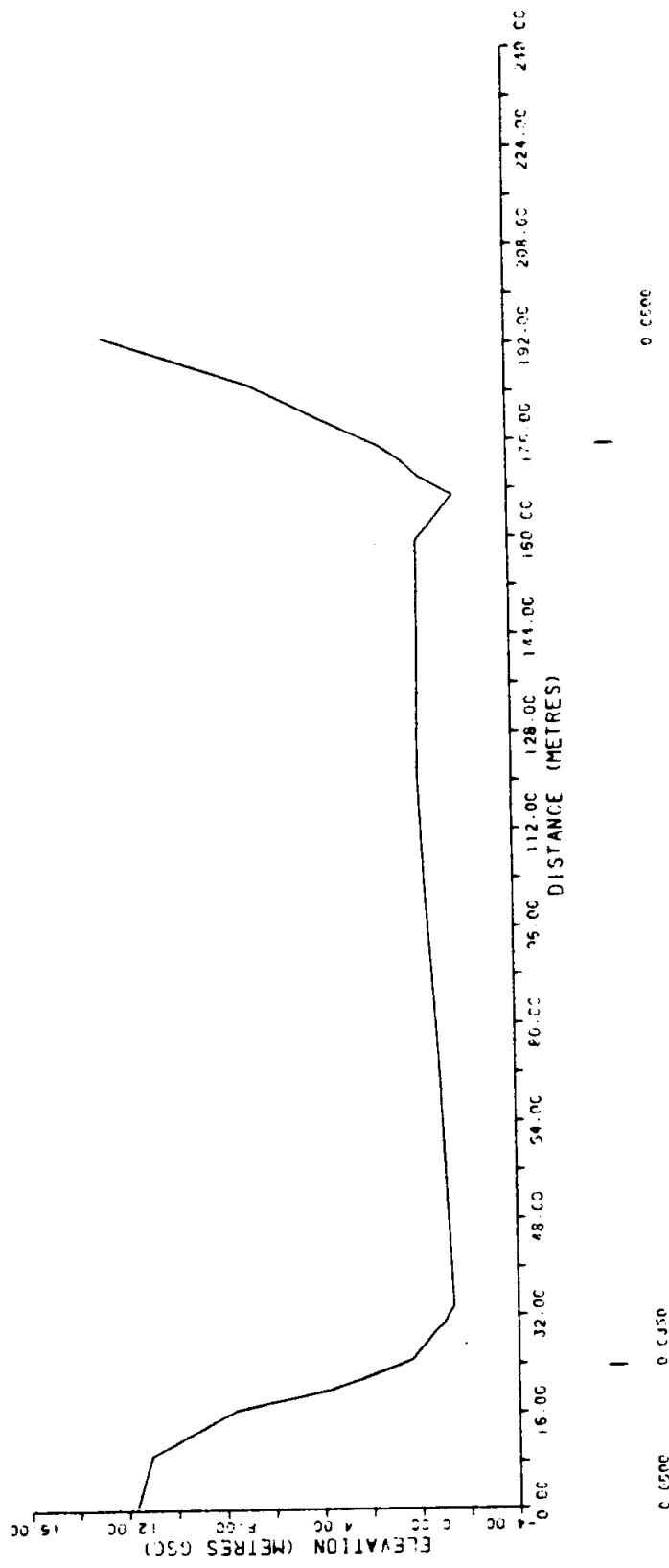
0 0500

0 0700 0 0750

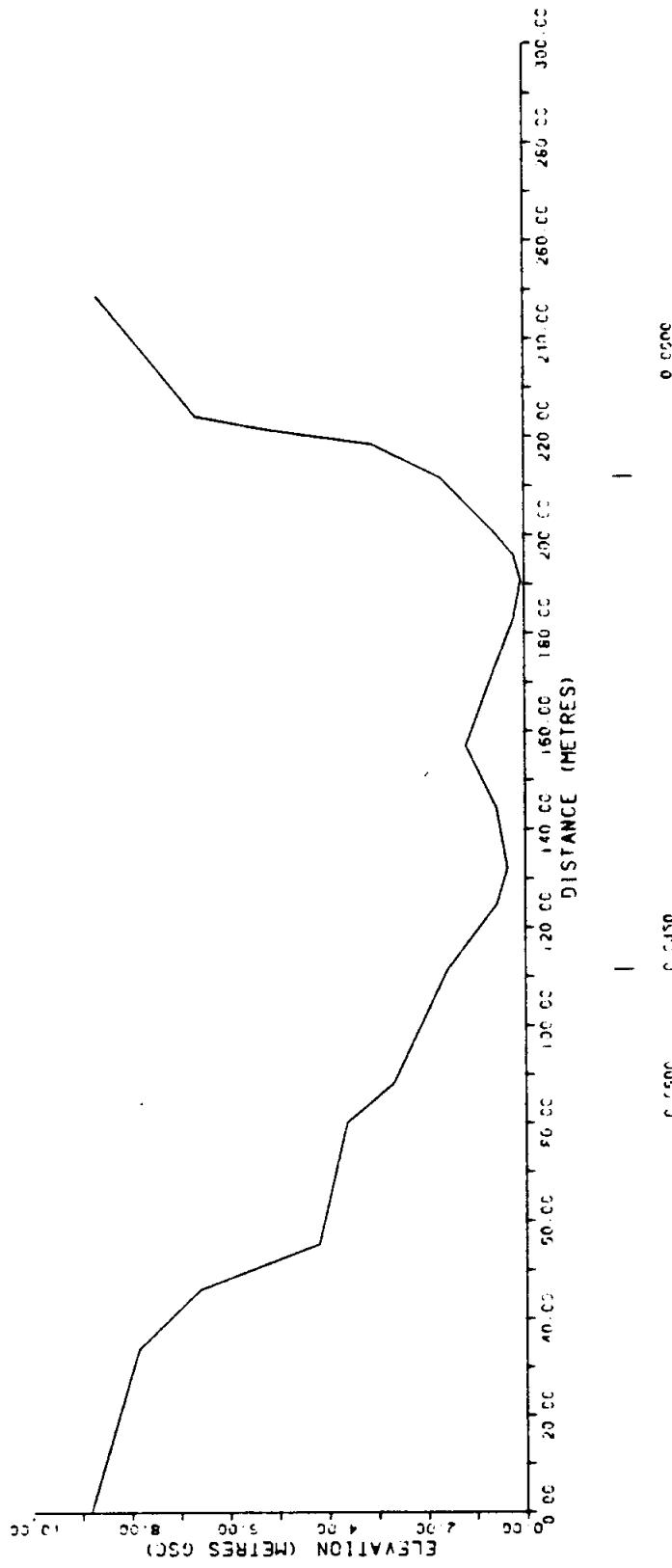
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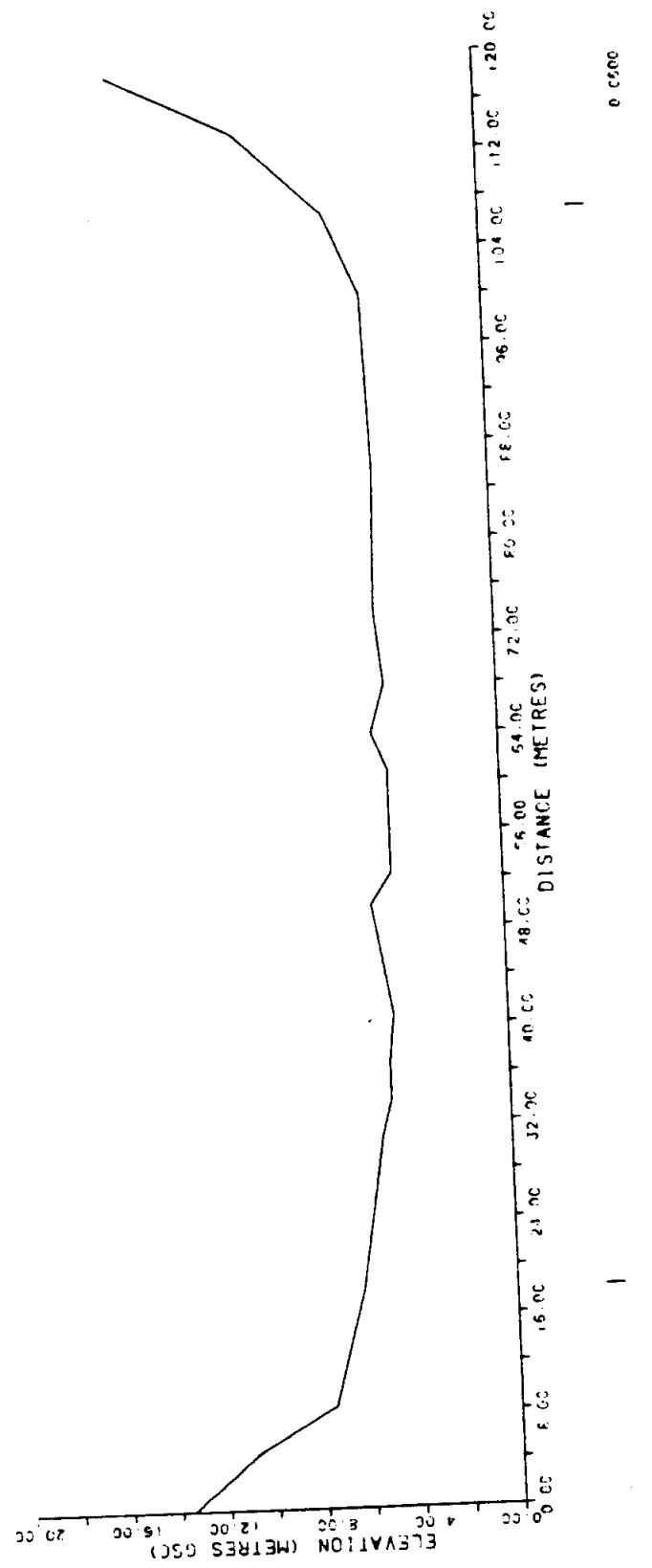
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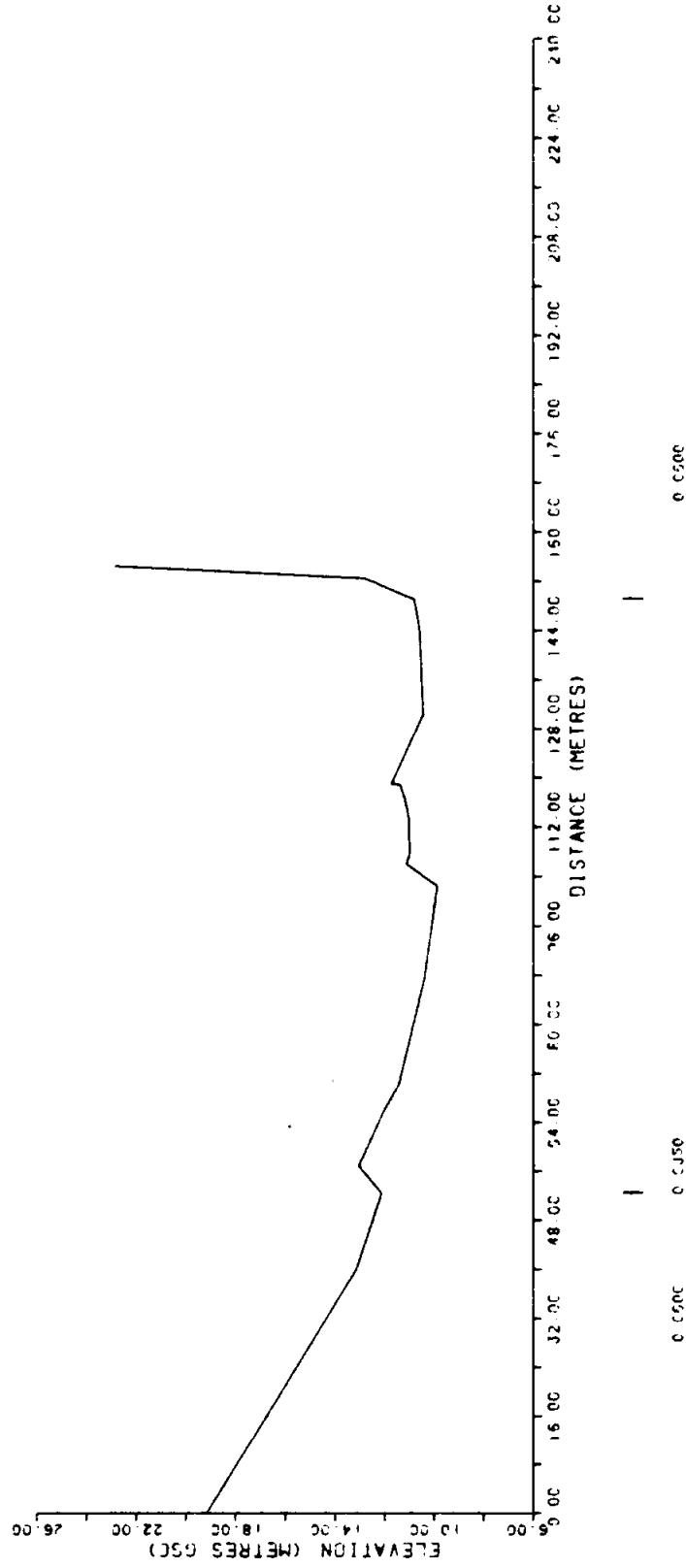
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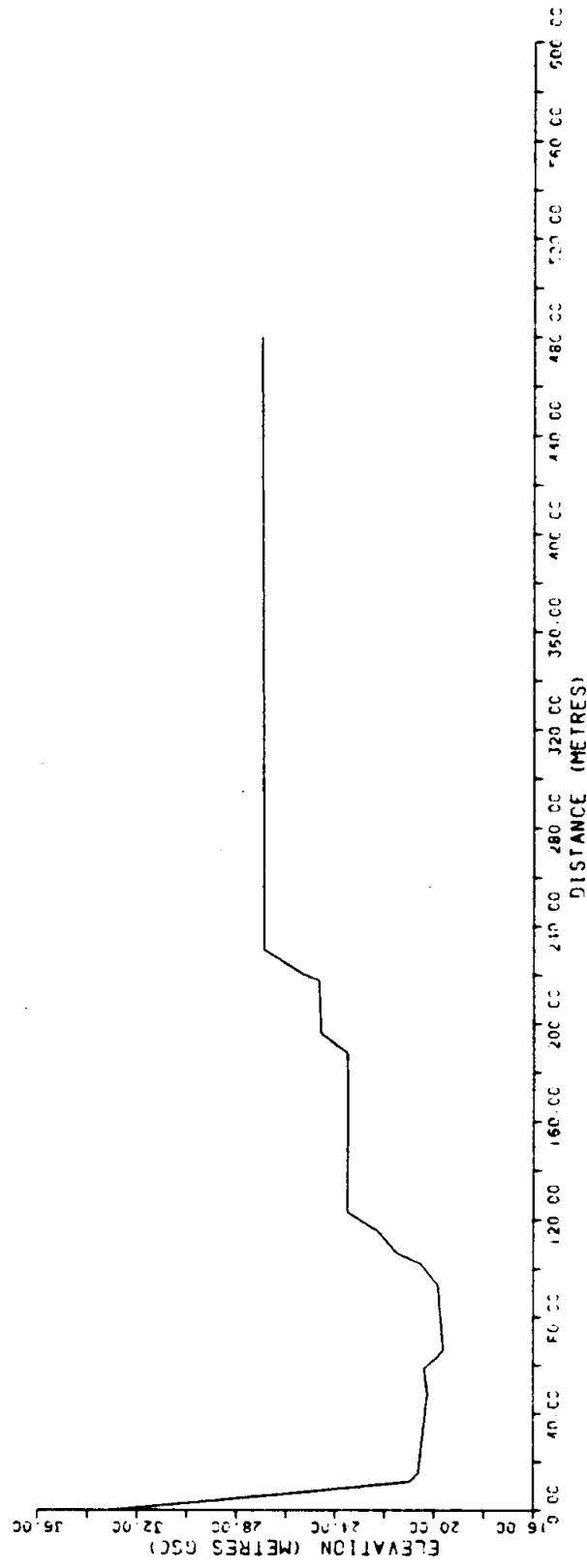
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CROSS SECTION NUMBER 11.0



CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 12.0



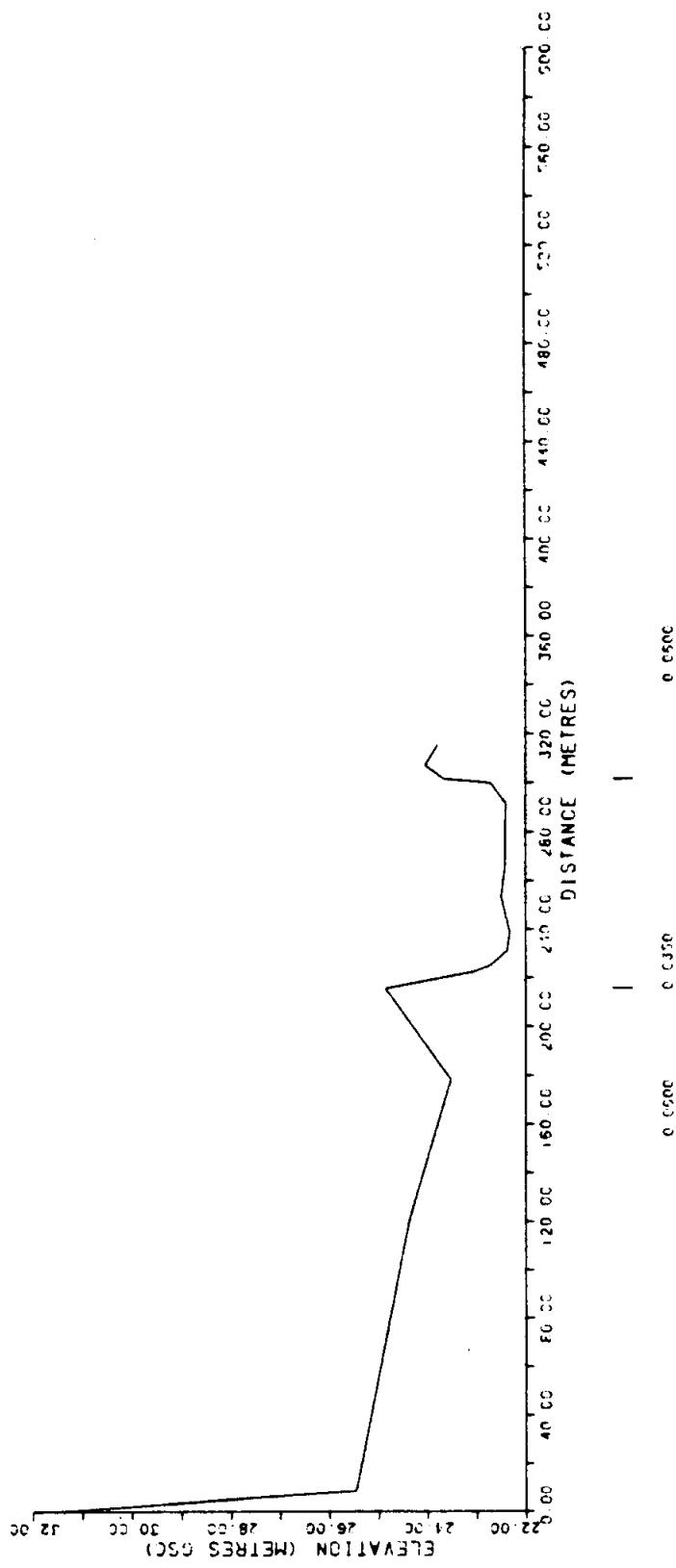
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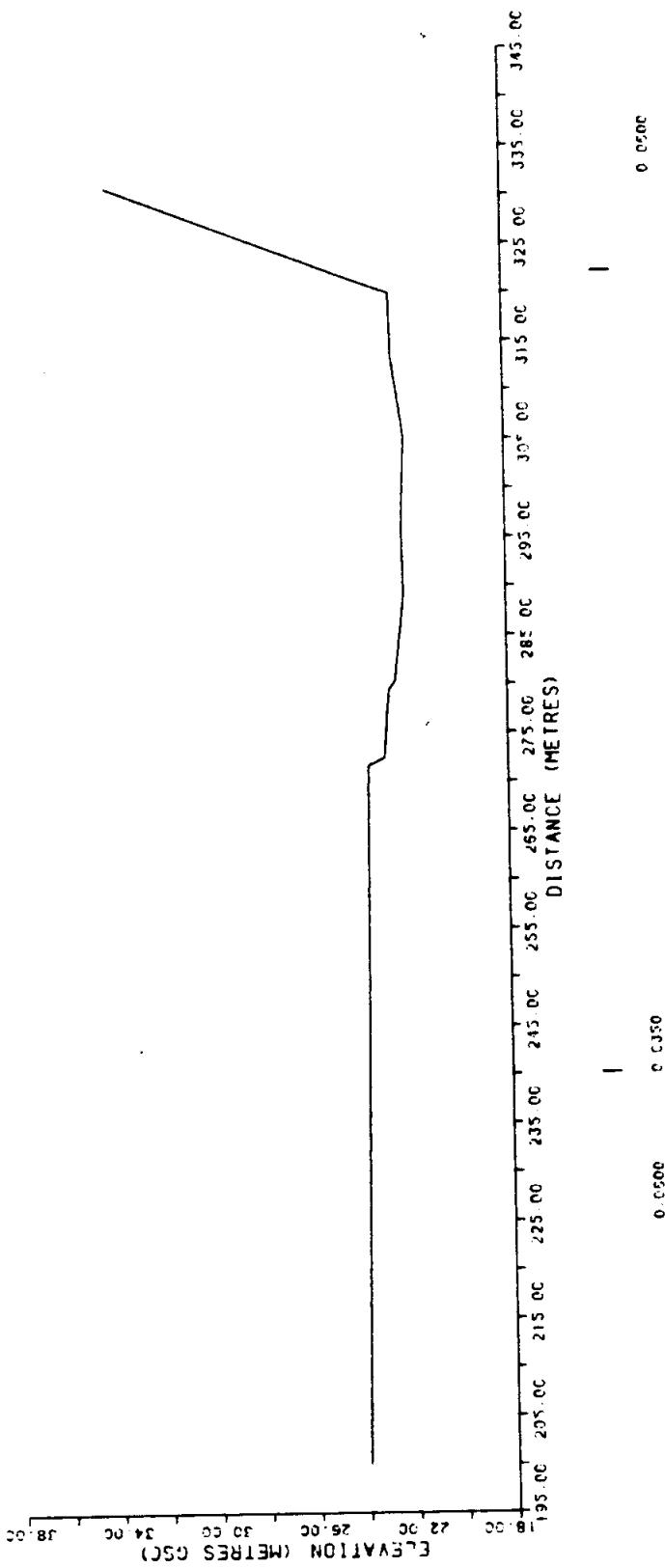
0.0500

0.0500

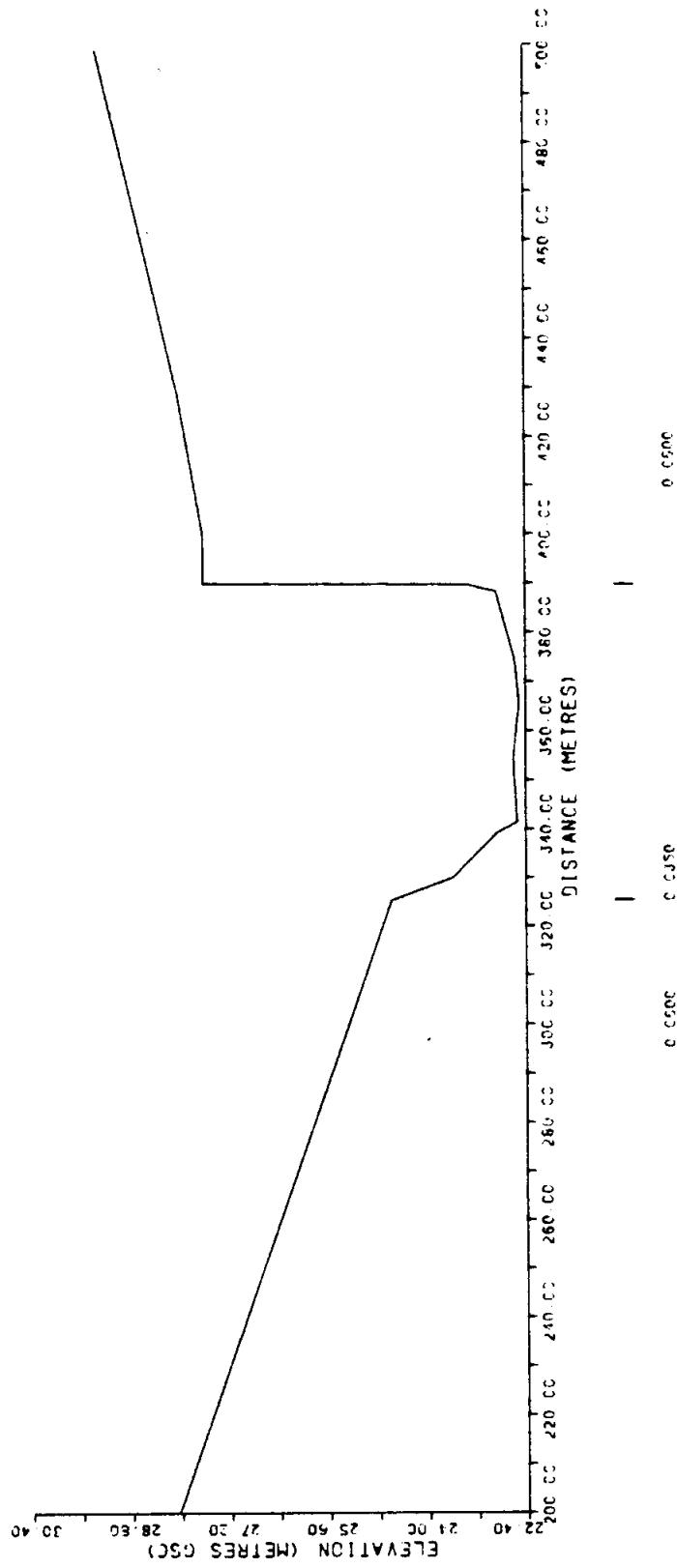
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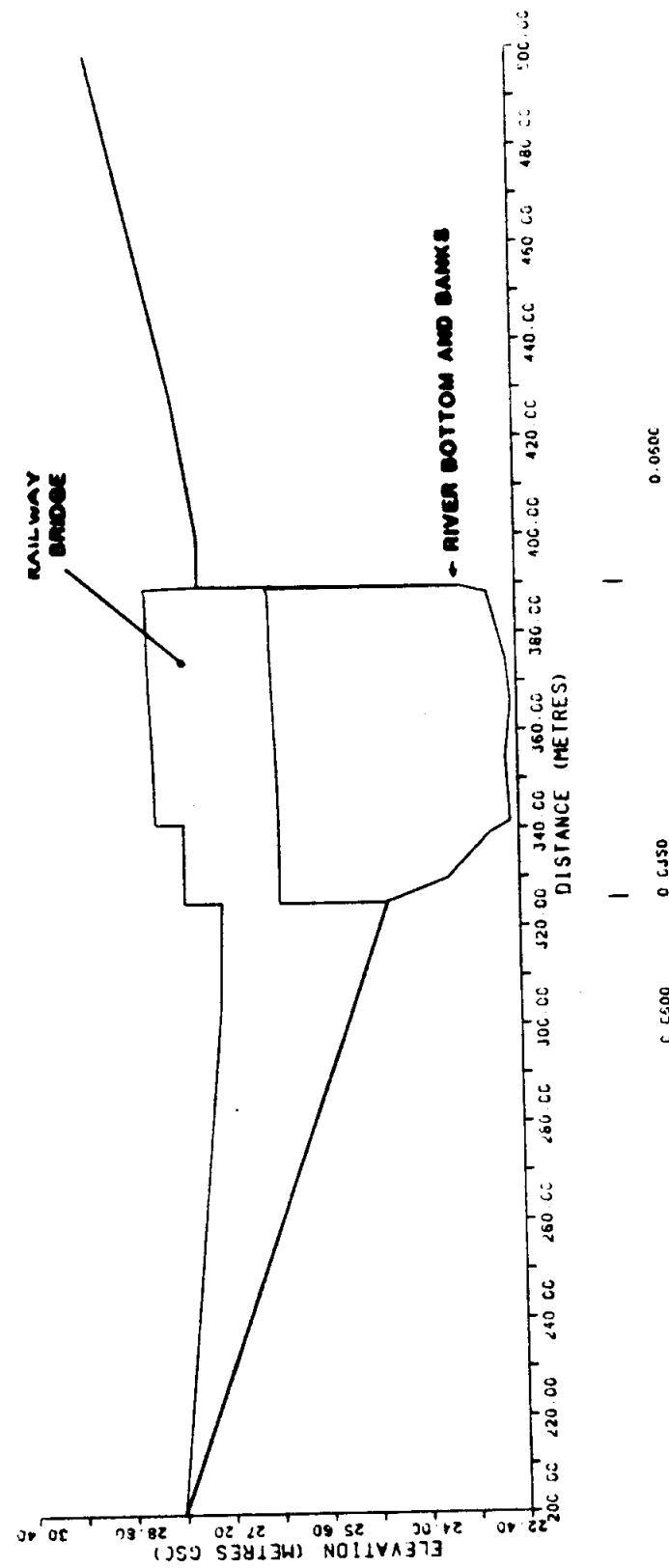
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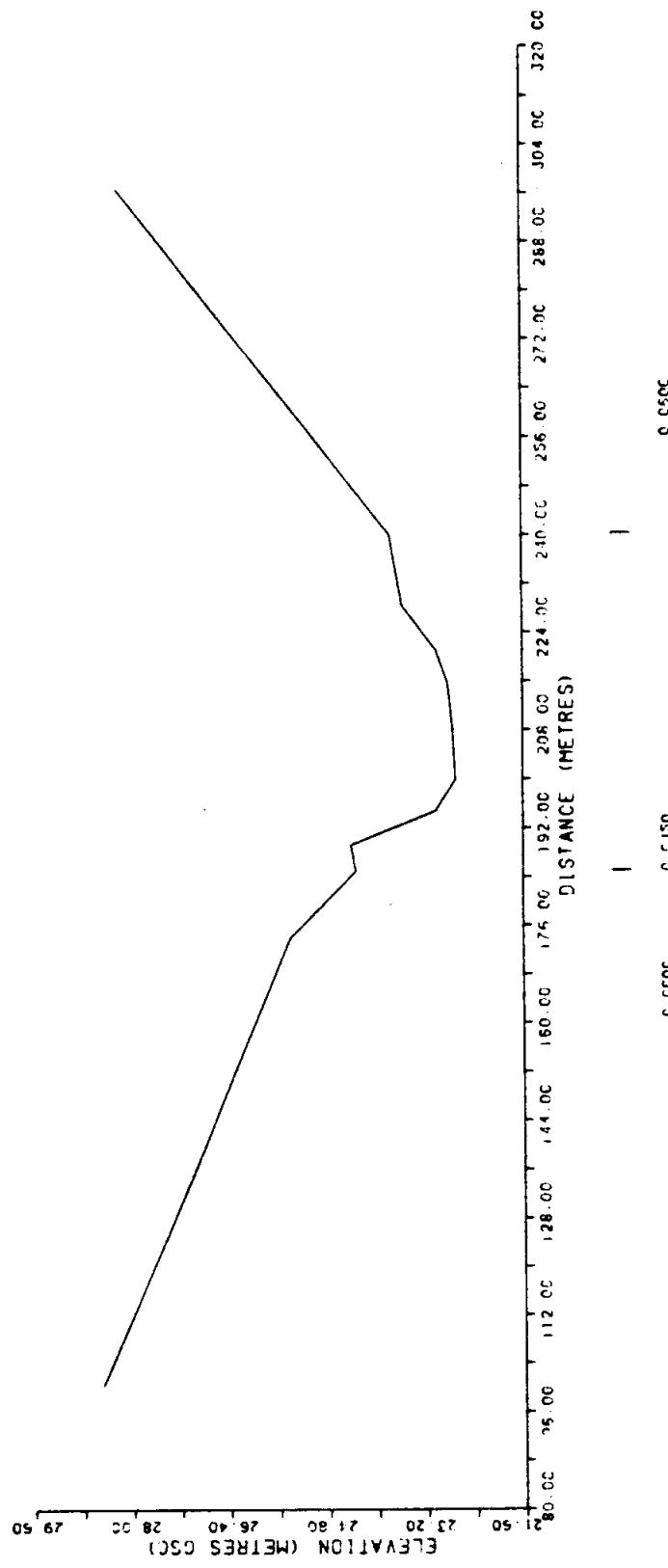
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CROSS SECTION NUMBER 16.0



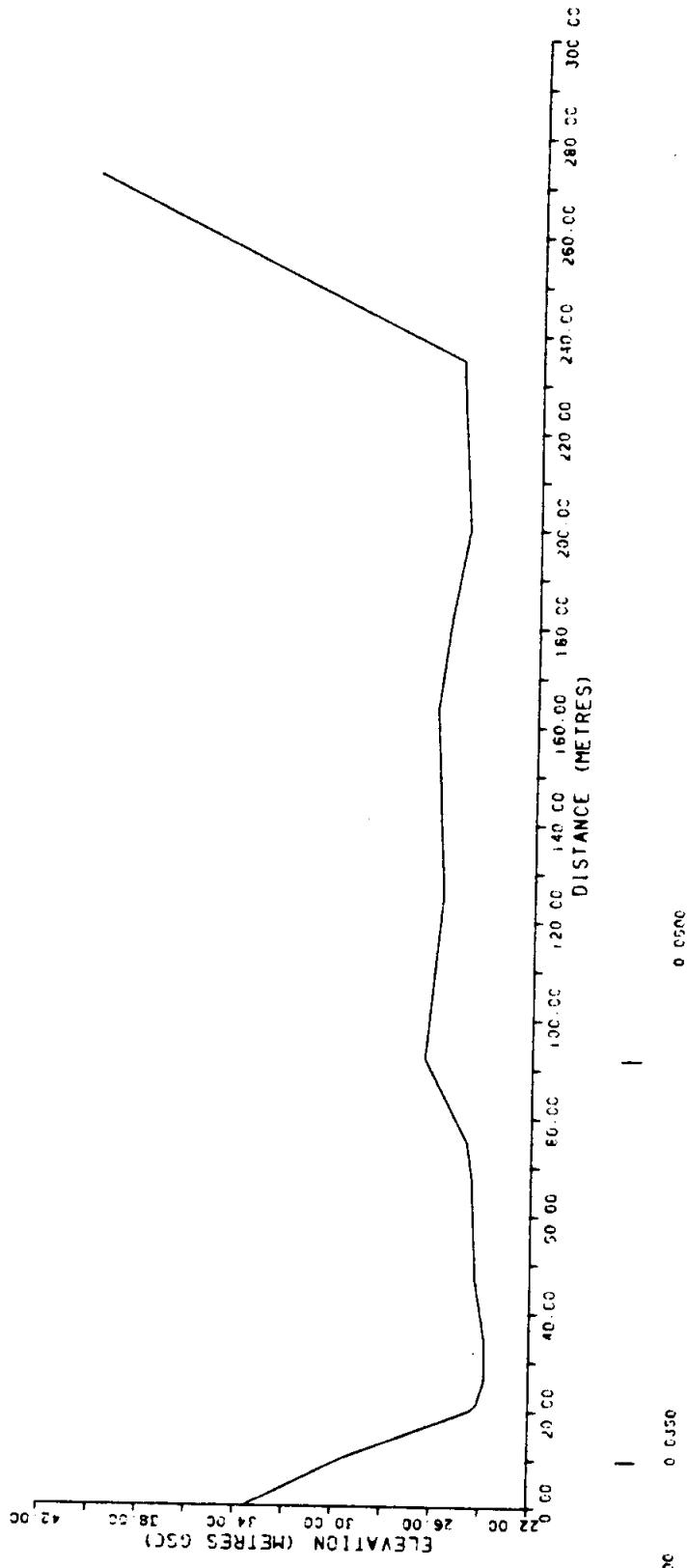
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CROSS SECTION NUMBER 16.1



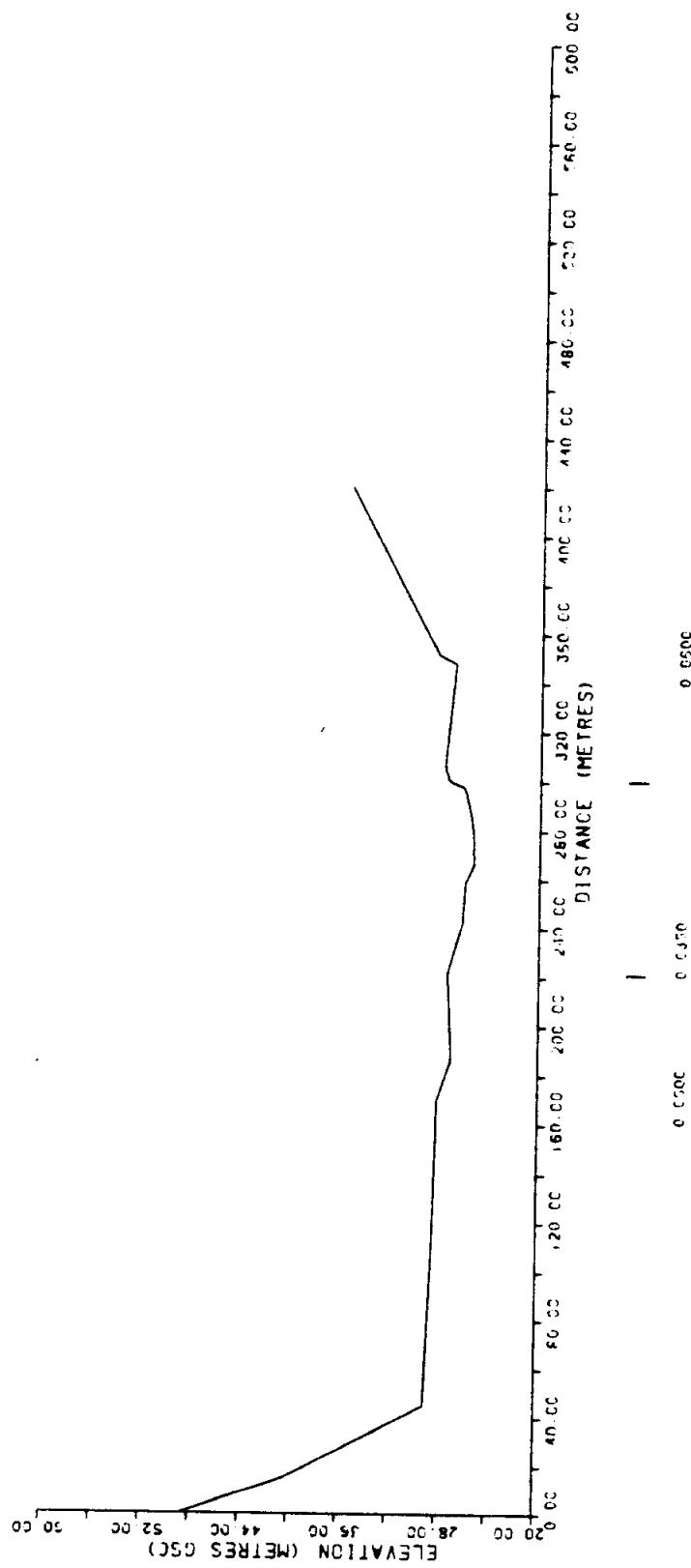
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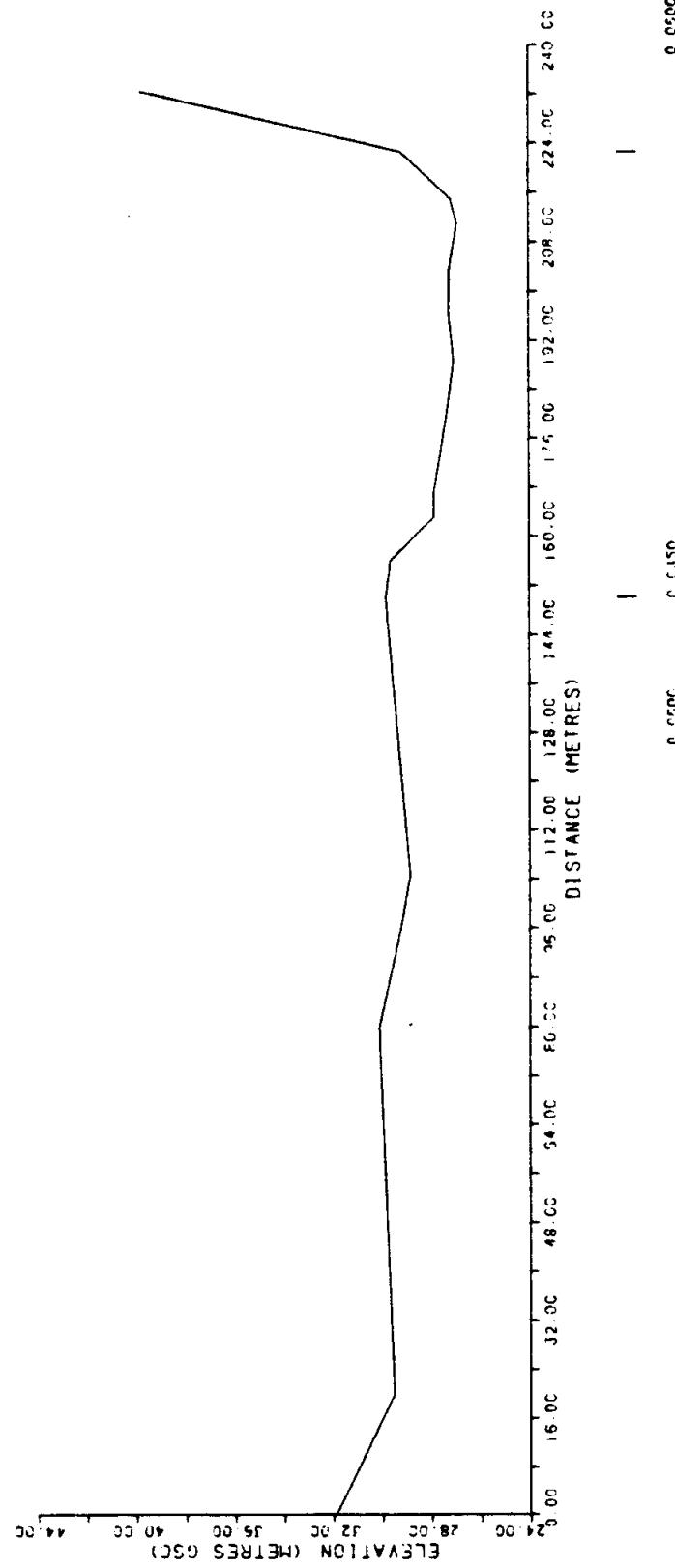
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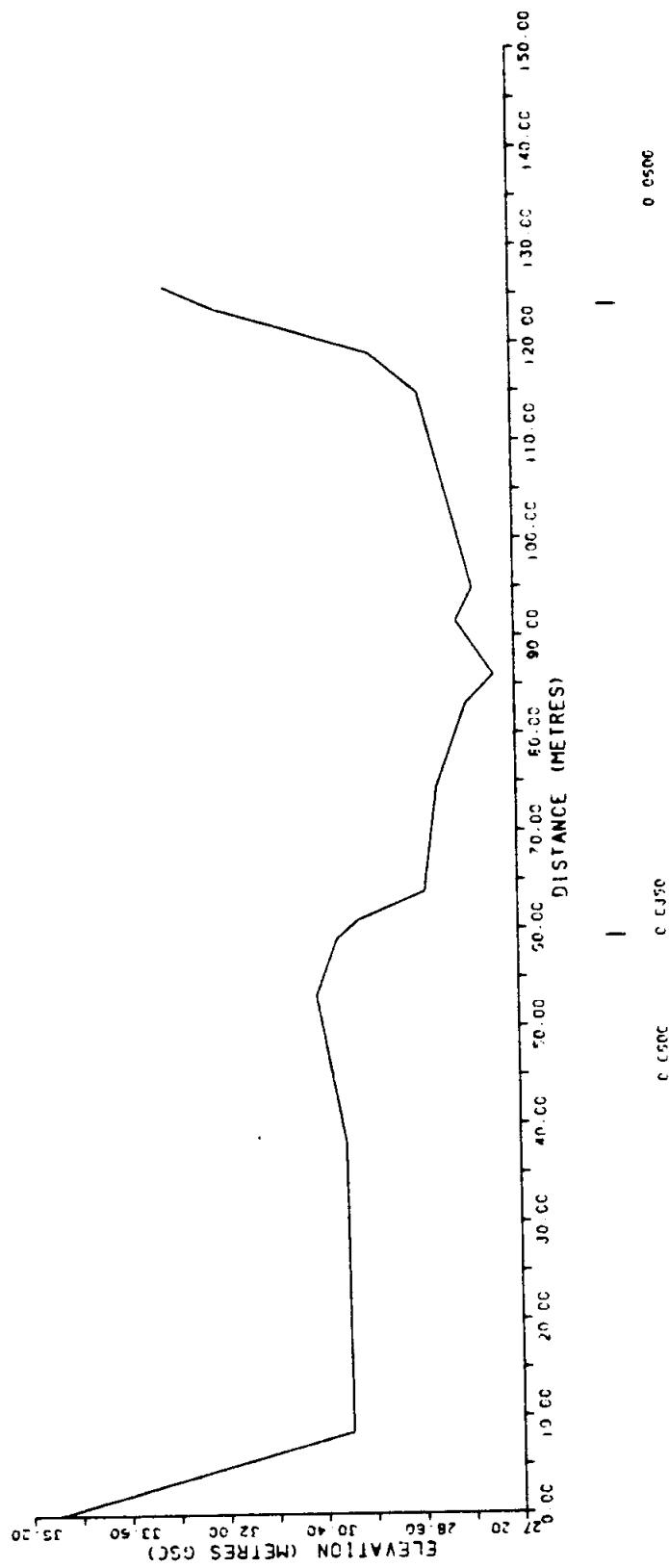
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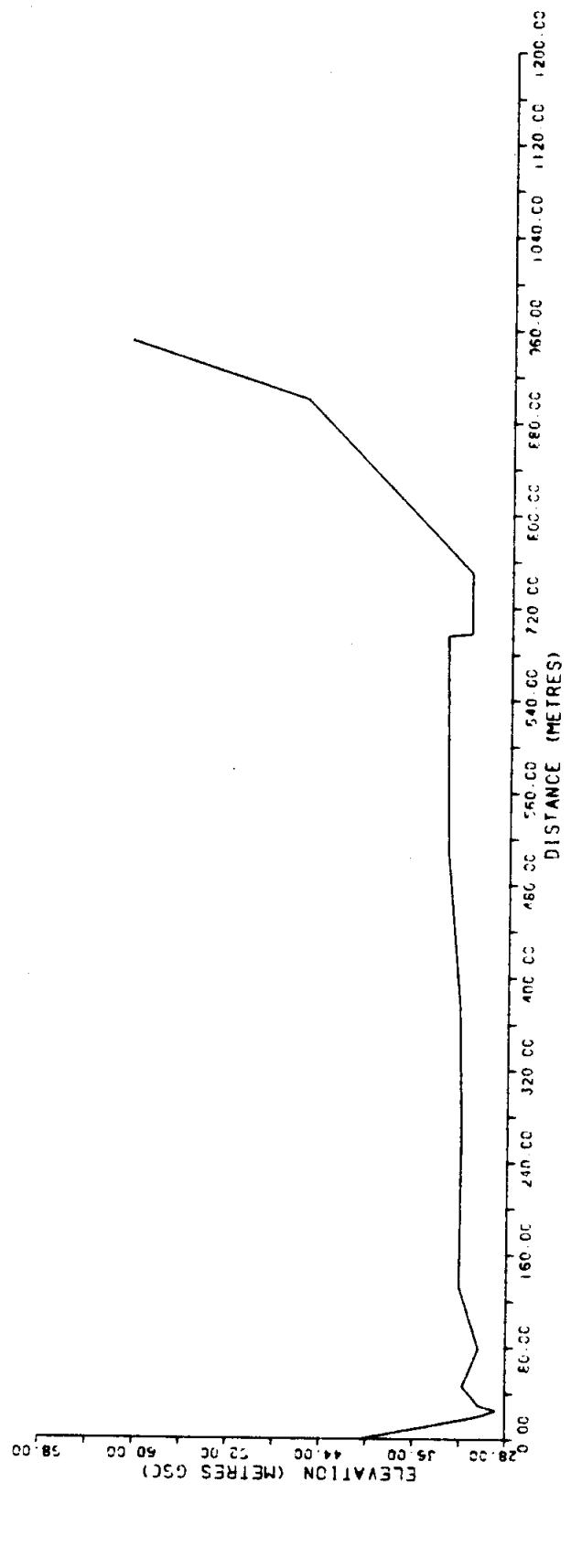
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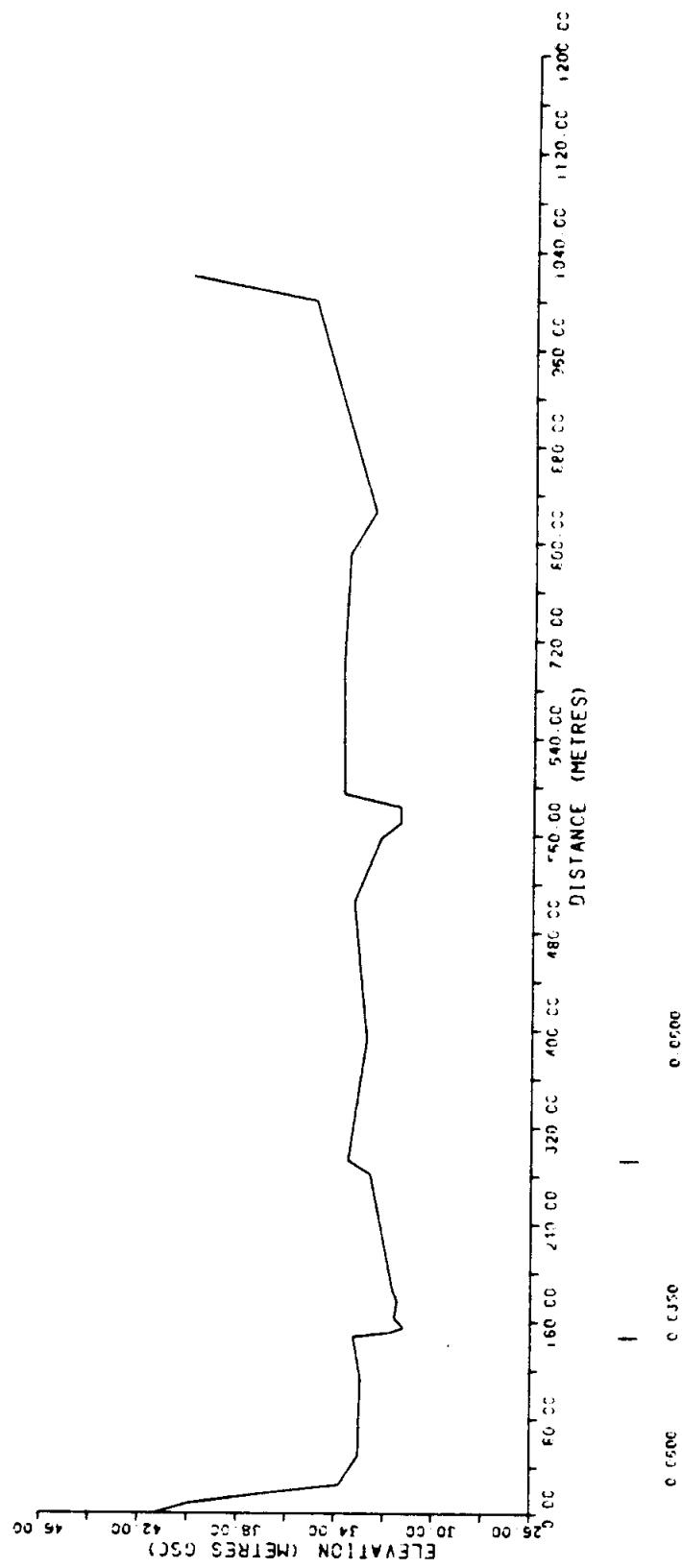
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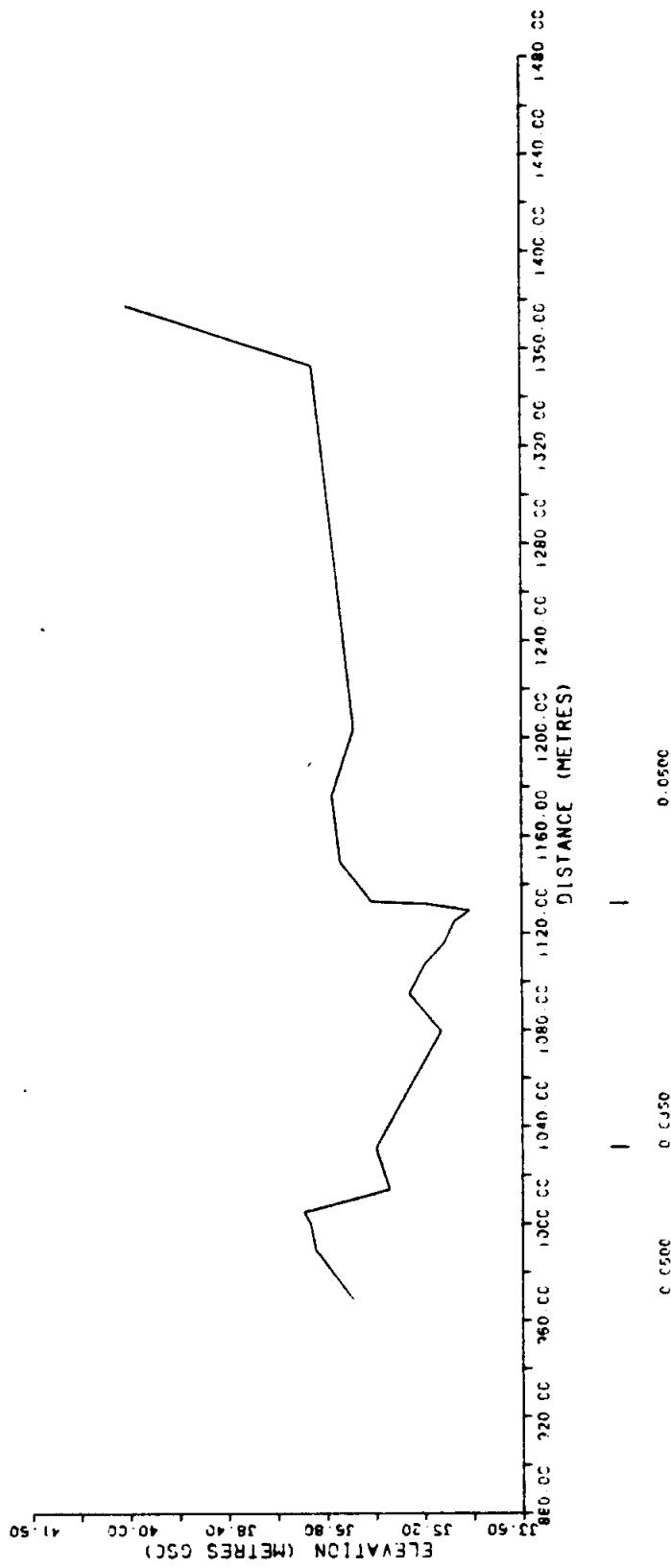
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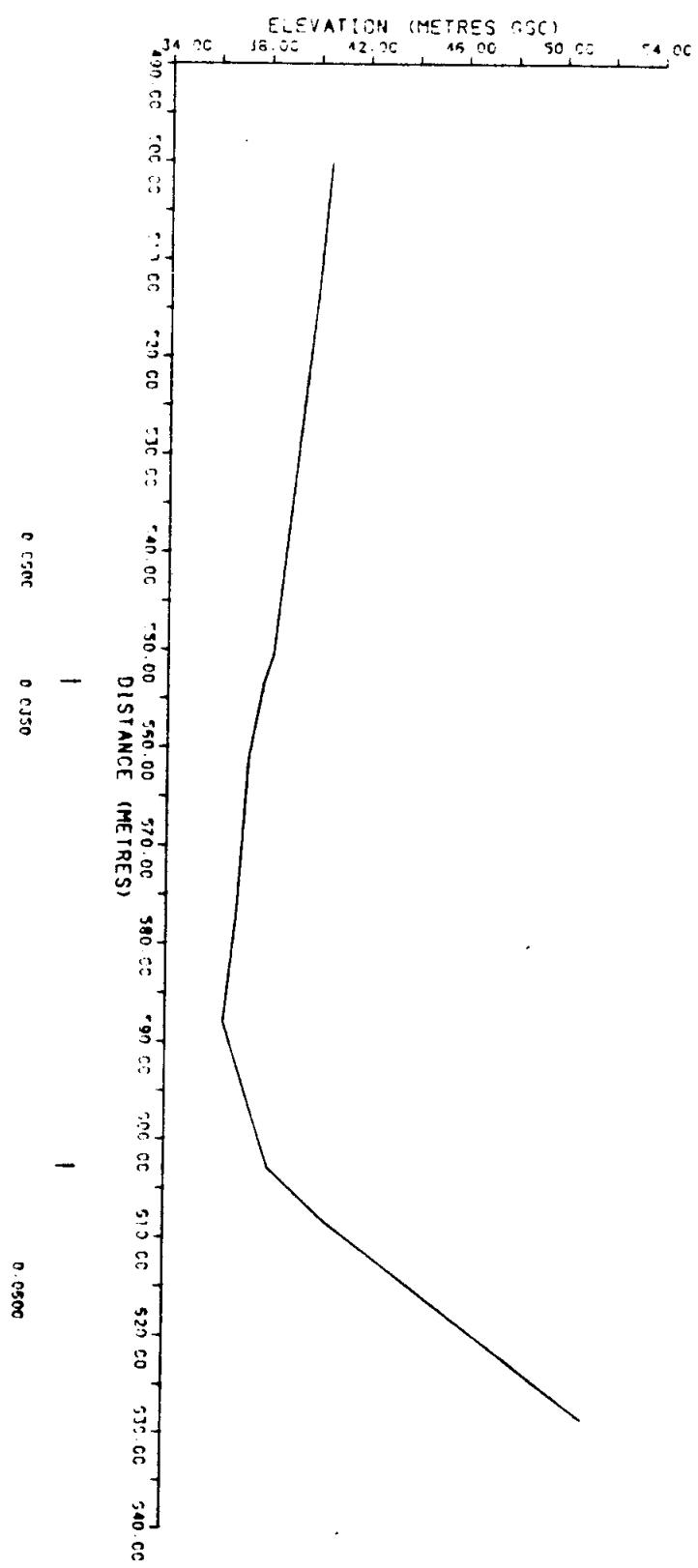
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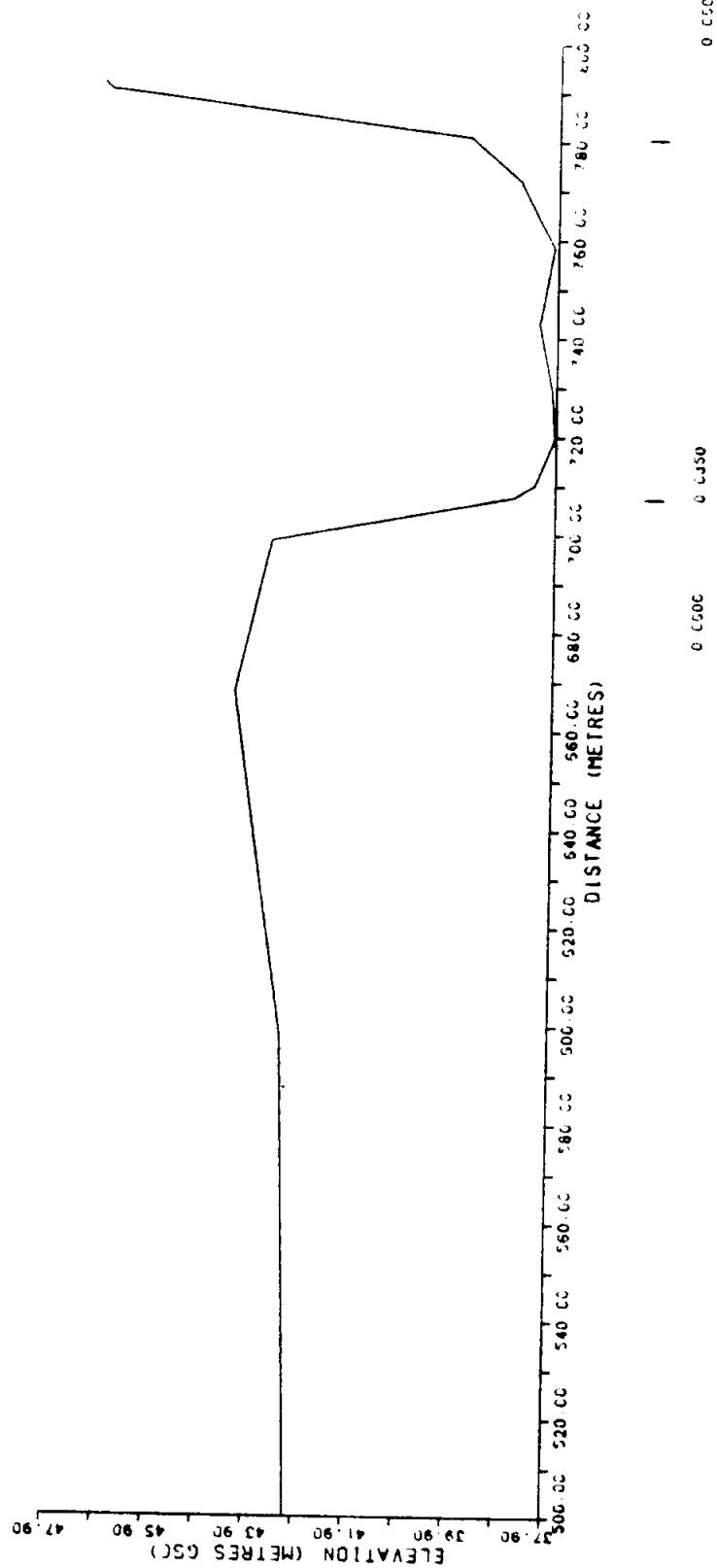
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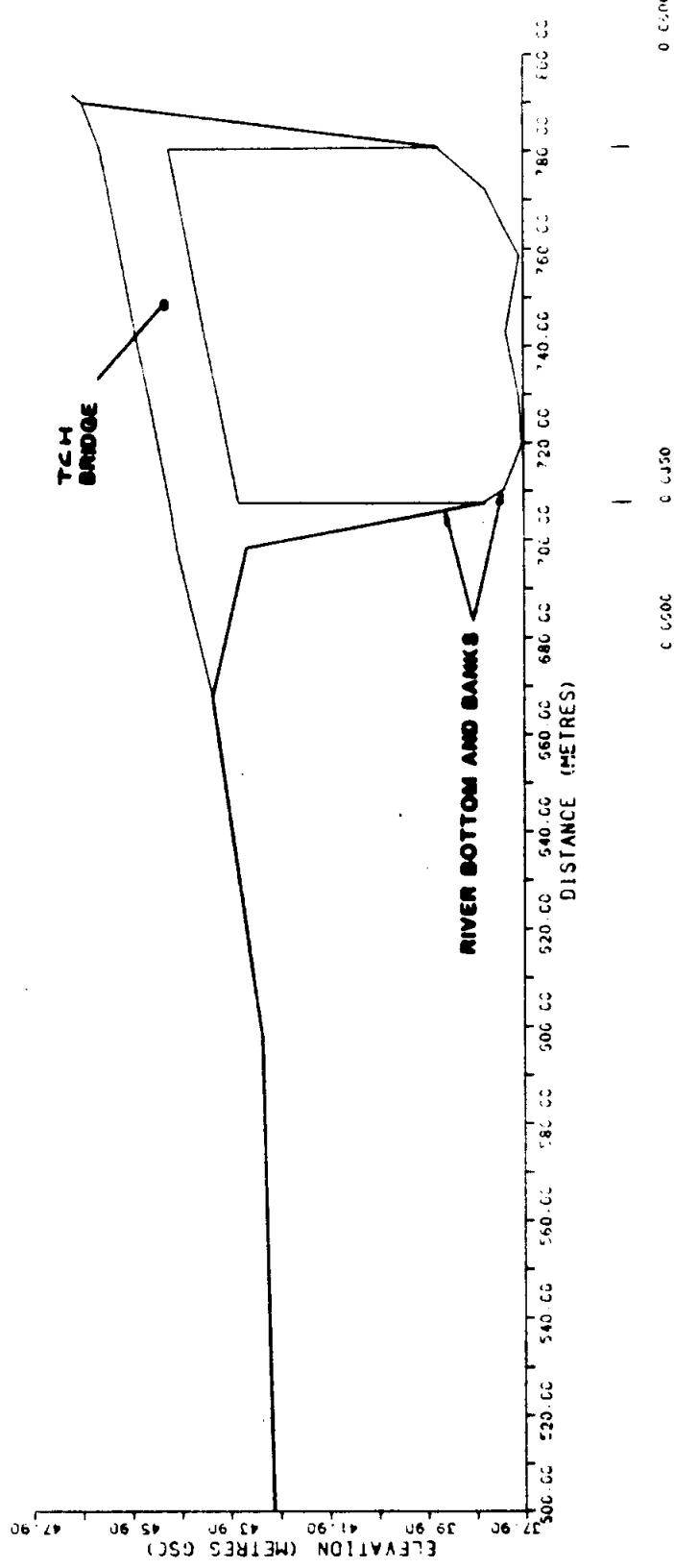
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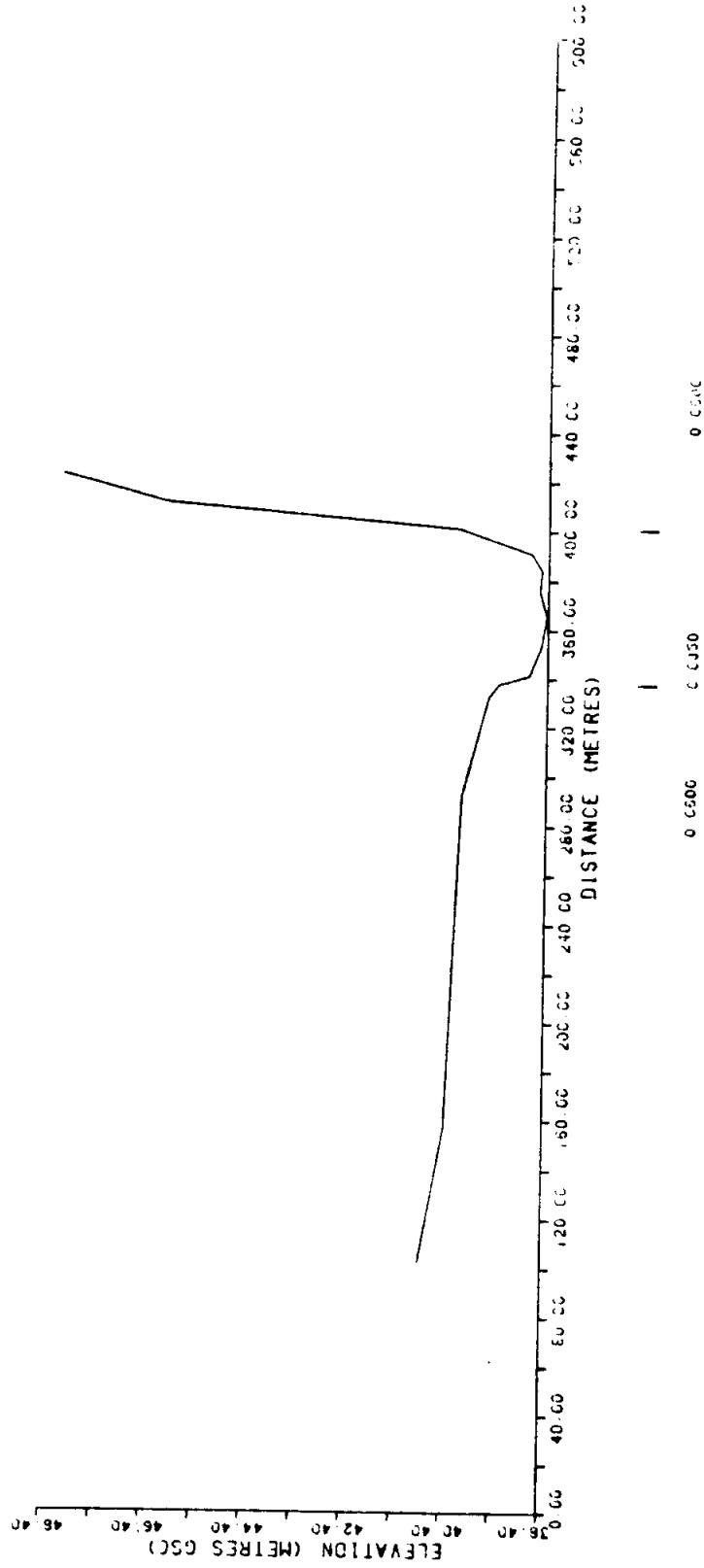
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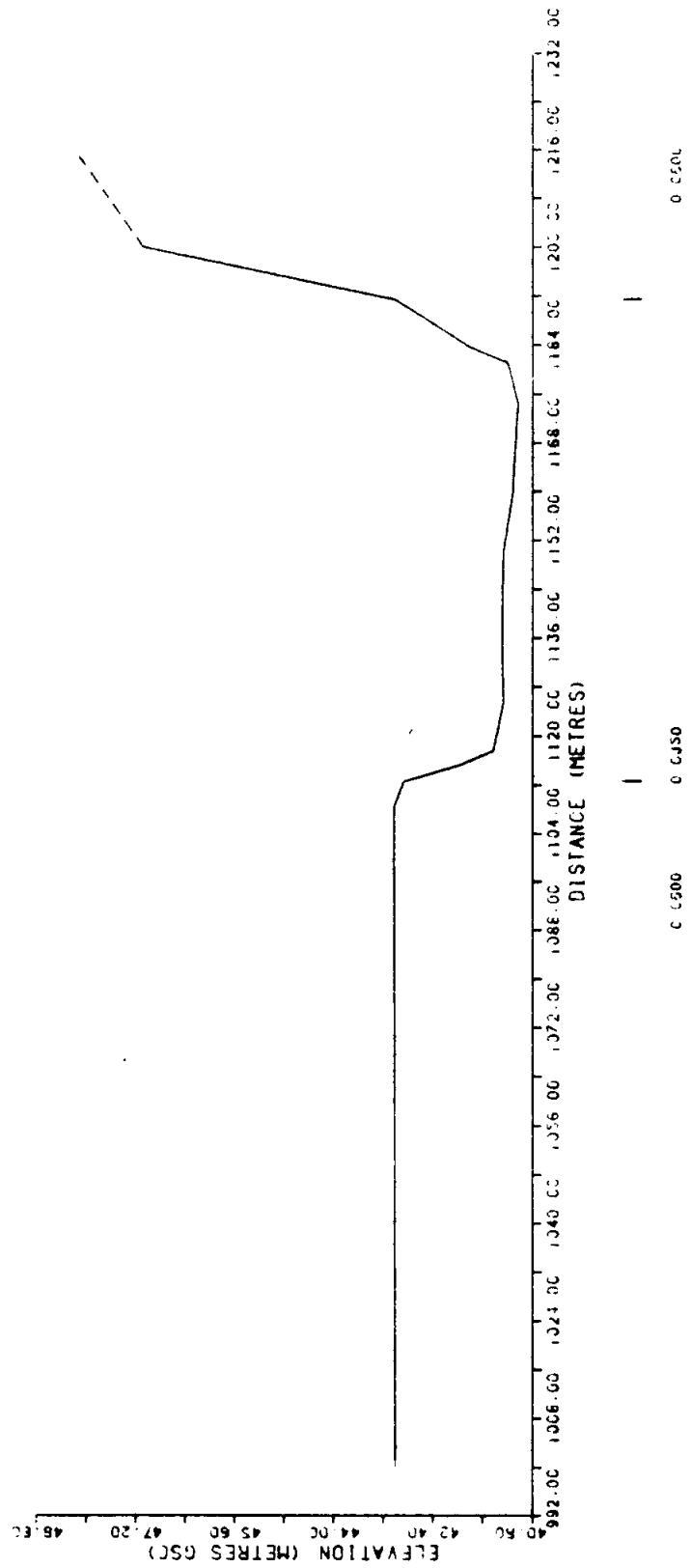
CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 26.1



CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 27.0



CODROY RIVER X-SECTIONS HEC-2 MODEL
CROSS SECTION NUMBER 28.0



APPENDIX TA-7
CALIBRATED HEC-2 COEFFICIENTS

CALIBRATED X-SECTION COEFFICIENTS

X-SECTION #	MANNINGS (n) LEFT BANK	ROUGHNESS COEFFICIENT RIGHT BANK	CHANNEL	EXPANSION COEFFICIENT	CONTRACTION COEFFICIENT
1.0	0.080	0.080	0.040	0.1	0.3
2.0	0.100	0.100	0.040	0.3	0.5
4.0	0.080	0.080	0.040	0.1	0.3
6.0	0.080	0.080	0.040	0.3	0.5
8.0	0.080	0.080	0.050	0.1	0.3
13.0	0.090	0.060	0.045	0.1	0.3
14.0	0.080	0.060	0.045	0.2	0.4
15.0	0.080	0.060	0.045	0.1	0.3
16.0	0.080	0.080	0.050	0.3	0.5
18.0	0.050	0.050	0.055	0.1	0.3
19.0	0.050	0.050	0.055	0.1	0.3
20.0	0.080	0.080	0.060	0.1	0.3
21.0	0.080	0.080	0.060	0.2	0.4
25.0	0.070	0.080	0.060	0.1	0.3
26.0	0.100	0.100	0.060	0.3	0.5
28.0	0.080	0.080	0.060	0.1	0.3

CALIBRATED BRIDGE COEFFICIENTS

X-SECTION #	PIER COEFFICIENT (XK)	LOSS COEFFICIENT (XKOR)	DISCHARGE COEFFICIENT (COFQ)
2.1	1.05	1.5	1.50
16.1	1.05	1.6	1.56
26.1	1.05	1.5	1.50

APPENDIX TA-8
HYDRAULIC MODEL (HEC-2)
Input Data Set

8745.557	44.155	742.970	45.842	44.440	758.66	46.126	44.724	780.790	46.551
8745.149	780.80	46.551	39.667	790.20	46.907	46.907	792.00	47.090	47.090
X1	27.0	16.	337.95	401.210	110.0	30.00	60.00		
GR	44.0	20.	43.0	70.0	40.9	100.0	40.393	157.279	40.103
GR39.565	332.375	39.388	337.95	38.768	341.440	38.560	353.517	38.441	365.71
GR38.564	375.930	38.539	384.11	38.742	391.160	40.192	401.210	46.065	611.01
GR48.170	422.210								
NC	0.080	0.080	0.080	0.1	0.3				
X1	28.0	17.	1112.51	1191.31	440.0	440.0	440.0		
GR	45.0	880.0	43.008	1000.00	43.034	1108.20	42.880	1112.51	41.947 1115.25
GR41.4291117.510	41.272	1125.26	41.298	1135.34	41.270	1149.86	41.122	1159.69	
GR41.108	1162.46	41.035	1174.27	41.201	1180.97	41.031	1183.63	43.026	1191.31
GR47.1081200.000	48.148	1214.90							

EJ

T1 CODROY RIVER NEC-2 BACKWATER MODEL

T2 MACLAREN PLANSEARCH INC 1989

T3 100 YEAR DESIGN EVENT - PROJECT NO. 52766-C1-00-00-00
 J1 0 3 1 1098. 0.93
 J2 15

ER

T1 OODRUY RIVER NEC-2 BACKWATER MODEL

T2 MACLAREN PLANSEARCH INC 1989

T3 20 YEAR DESIGN EVENT - PROJECT NO. 52766-C1-00-00-00

J1	0	2	1	1	929.0	0.93
J2	1					
MC	0.080	0.080	0.060	0.1	0.3	
X1	1.0	29.	110.	462.8		
Q1	7.811	0.	6.24	100.	.811	109.
Q2	-4.86	132.	-564	143.53	-569	175.
Q3	-2.311	248.	-2.129	264.0	-1.001	293.0
Q4	-1.245	339.	-1.214	346.0	-1.336	371.0
Q5	-2.753	406.	-2.453	419.0	-0.605	447.0
Q6	1.446	462.80	2.911	470.9	8.966	476.4
MC	0.100	0.100	0.040	0.3	0.5	1.040
X1	2.0	65.	646.26	870.16	250.0	250.0
X3	10					
Q1	7.331	500.	6.437	555.0	0.20	576.3
Q2	0.650	607.7	0.650	612.5	-0.10	613.7
Q3	-0.10	620.80	0.650	622.0	0.65	627.3
Q4	0.65	634.50	-0.10	635.7	0.65	636.9
Q5	1.50	651.00	0.200	651.1	-1.187	653.3
Q6	-3.077	682.00	-2.04	686.0	-2.345	689.0
Q7	-2.710	705.00	-2.01	708.0	-2.132	712.0
Q8	-1.096	732.00	-1.126	735.0	-1.035	738.0
Q9	-1.309	760.00	-1.888	766.0	-1.736	769.0
Q10	-2.103	781.00	-2.315	782.0	-2.041	784.0
Q11	-1.827	799.00	-2.559	821.0	-2.406	827.0
Q12	-4.784	843.00	-4.631	845.0	-4.784	847.0
Q13	2.00	863.10	2.500	870.15	7.312	870.16
Q14	1.050	1.5	1.50	190.0	6.000	2200.
X1	2.1					
X2			1	7.18	6.088	
X3	10.					
Q1	28.	500.	7.331	7.331	555.0	6.437
Q2	605.3	6.300	0.65	606.5	6.30	1.40
Q3	6.42	0.650	613.7	6.42	1.40	614.9
Q4	0.650	620.80	6.48	1.40	622.0	6.480
Q5	628.5	6.550	1.40	629.7	6.550	0.65
Q6	6.670	1.40	636.9	6.670	0.65	646.26
Q7	3.907	651.0	7.120	4.32	651.1	7.120
Q8	863.1	9.980	7.180	870.15	10.112	870.16
Q9	10.279	8.130	948.0	12.06	12.06	
X1	3.0	36.	104.67	490.18	90.	90.
Q2	5.202	25.141	3.355	63.041	.8950	85.800
Q3	-3950	167.00	-669	169.0	-427	178.0

X1	3.0	36.	104.67	490.18	90.	90.	90.	90.
Q2	5.202	25.141	3.355	63.041	.8950	85.800	0.265	104.67
Q3	-3950	167.00	-669	169.0	-427	178.0	-427	214.0

6.088
10.112
0.200
612.50
6.480
0.650
635.7
6.707
7.18
882.2
130.55
234.0

GR - .396	274.0	- .396	304.0	- .518	314.0	- .427	324.0	- .579	349.0
GR - .975	350.0	- 1.006	356.0	- 1.036	360.0	- 1.036	367.0	- 1.798	381.0
GR - 2.865	393.0	- 3.871	406.0	- 4.145	410.0	- 4.297	425.0	- 4.572	429.0
GR - 4.450	432.0	- 4.572	441.0	- 3.474	450.0	- 2.286	459.0	- 1.219	462.0
GR - 0.183	461.18	.301	490.18	1.064	495.88	3.7360	500.0	12.784	564.61
GR 16.784	665.0	NC 0.000	0.080	0.040	0.1	0.3	Q1 2	908.0	1085.
X1 4.	24.	X1 10.	630.766	240.	300.0	260.0	GR 6.050	0.000	3.965
GR 0.560	110.000	0.319	112.837	- 0.133	114.840	- 3.150	170.000	- 0.453	290.000
GR - 0.819	314.000	- 0.727	339.000	- 0.773	350.000	- 0.499	363.000	- 0.377	365.000
GR - 0.255	471.000	- 0.377	537.000	- 0.375	567.500	- 0.370	592.326	- 0.375	606.300
GR 0.348	630.766	1.294	636.131	5.434	639.870	7.450	645.000	X1 5.	48.
GR 6.936	0.000	3.265	76.062	3.038	80.920	0.853	89.042	0.226	91.677
GR - 0.033	96.170	- 0.521	118.000	- 0.429	124.000	- 0.460	126.000	- 0.386	130.000
GR - 0.688	146.000	- 0.566	151.000	- 0.765	158.000	- 0.795	162.000	- 0.445	171.000
GR - 0.505	181.000	- 0.688	191.000	- 0.688	198.000	- 1.054	211.000	- 0.963	217.000
GR - 1.024	222.000	- 0.871	229.000	- 0.932	235.000	- 0.810	241.000	- 0.871	244.000
GR - 0.353	260.000	- 0.445	266.000	- 0.292	273.000	- 0.597	282.000	- 0.292	287.000
GR - 0.231	296.000	- 0.323	304.000	- 0.231	310.000	- 0.414	317.000	- 0.512	324.200
GR - 0.301	339.258	- 0.280	352.426	- 0.360	422.579	- 0.513	447.423	- 0.487	470.255
GR - 0.370	493.990	0.160	503.546	1.050	508.198	0.717	537.720	1.905	545.562
GR 6.250	552.177	9.095	555.559	9.115	576.062	NC 0.000	0.000	0.000	0.5
X1 6.0	36.	159.4	1625.0	1640.	980.0	1200.	GR 19.806	0.	17.611
GR 0.444	195.0	- 1.044	250.0	- 0.444	317.00	0.390	517.0	1.214	544.00
GR - 0.162	552.0	- 1.844	585.0	- 0.556	600.00	- 0.226	619.0	1.136	646.00
GR 0.463	691.0	.206	722.0	.556	765.00	- 0.055	836.0	- 0.2540	909.00
GR - 2.360	941.0	2.056	1330.0	1.756	1345.0	.736	1348.0	1.140	1350.0
GR 1.160	1408.0	1.800	1425.0	3.300	1437.0	- 400	1455.0	- 1.220	1520.0
GR - 3.795	1530.0	- 1.14	1570.0	- 379	1602.	2.00	1625.0	7.50	1670.0
GR 10.0	1750.0	X1 7.0	34.	29.755	557.521	1500.	750.0	1060.0	GR 6.372
GR 1.272	52.128	- 0.975	69.633	- 1.059	82.221	- 0.158	41.310	- 0.723	44.174
GR - 0.089	129.756	0.454	186.191	0.840	199.273	0.154	221.665	- 0.856	118.876
GR 0.122	256.174	1.060	259.248	1.588	277.842	0.197	284.023	- 0.014	389.725
GR - 0.262	403.201	- 0.008	419.486	- 0.611	441.261	- 0.835	453.830	- 0.726	468.835
GR 0.455	478.144	- 0.293	500.824	- 0.502	525.395	- 0.964	537.705	- 0.789	544.655
GR 0.110	549.655	4.392	557.521	6.441	583.441	7.656	610.581	NC 0.000	0.080
X1 8.0	39.	135.296	295.513	590.0	490.0	510.0	X1 8.0	39.	135.296

GR 5.000	35.000	3.101	100.000	3.070	123.993	3.101	130.000	1.478	135.296
GR 0.167	140.235	-0.109	143.700	-0.289	151.000	-0.499	156.000	-0.599	162.000
GR -0.669	168.000	-0.779	172.500	-0.649	179.000	-0.839	186.000	-0.789	188.000
GR -0.869	189.000	-0.809	191.000	-0.909	193.000	-0.909	196.000	-1.029	200.000
GR -1.049	205.000	-0.999	207.000	-1.039	210.000	-1.029	215.000	-0.999	220.000
GR -0.879	224.500	-0.899	226.500	-0.339	240.500	-0.709	254.000	-0.879	260.000
GR -1.099	248.000	-0.829	273.000	-0.639	286.000	-0.649	289.650	0.191	293.145
GR 0.793	295.513	2.519	299.230	5.687	302.779	8.867	313.427		
X1 9.0	23.	23.393	175.00	910.0	880.00	900.0			
GR 11.710	0.000	11.063	9.200	7.621	16.000	3.623	20.017	1.219	21.393
GR 0.345	24.812	-0.71	29.845	-0.950	30.598	-1.361	33.598	-0.930	70.886
GR -0.830	76.886	-0.642	88.711	-0.407	101.702	-0.173	120.749	-0.230	141.467
GR -0.244	159.345	-1.768	166.828	-0.361	170.000	0.339	172.646	1.210	175.000
GR 3.715	179.663	6.482	185.207	12.482	193.297				
X1 10.0	21.	111.168	211.706	1860.0	1700.0	1880.0			
GR 6.822	0.000	7.855	33.758	6.608	46.005	4.189	55.255	3.622	80.000
GR 2.674	88.043	1.586	111.188	0.576	124.601	0.354	131.863	0.577	144.183
GR 1.189	156.890	0.611	172.676	0.228	182.596	0.075	190.637	0.223	195.914
GR 0.610	200.600	1.695	211.706	3.067	218.469	5.227	221.556	6.640	224.300
GR 8.622	249.000								
Q1 2	886.0	1071.0							
X1 11.0	19.	17.960	106.737	4000.	4000.0	4000.0			
GR 13.516	0.000	10.809	4.690	7.542	8.530	6.263	17.960	5.250	30.796
GR 4.850	33.796	4.850	36.796	4.643	40.730	5.400	49.863	4.527	52.444
GR 4.530	60.974	5.151	64.001	4.562	67.945	4.869	73.816	4.717	85.602
GR 4.971	100.000	6.400	106.737	9.931	113.515	15.000	118.515		
X1 12.0	20.0	52.40	152.523	3400.0	3400.0	3400.0			
GR 19.145	0.0	13.145	40.00	12.117	52.40	13.051	56.85	12.009	66.00
GR 11.422	70.188	10.383	87.49	9.860	102.44	11.109	106.126	10.959	108.126
GR 11.009	110.126	11.009	113.13	11.159	116.13	11.359	118.927	11.711	119.061
GR 10.444	130.402	10.597	144.41	10.803	149.17	12.774	152.523	22.774	154.523
Q1 2	851.0	1045.0							
X1 12.50	12.	10.0	155.	4000.0	4000.	4000.			
GR 25.00	0	23.0	5.	20.	10.	19.5	40.0	20.0	70.0
GR 20.50	90.	20.0	105.0	19.5	125.0	20.00	155.0	21.0	162.
GR 22.00	170.	22.5	190.0	22.5	240.	25.0	275.		
NC .0600		.0450	.100	.300					
X1 13.0	19.	12.00	106.730	600.0	600.0	600.0			
GR 32.958	0.000	20.958	12.000	20.619	15.405	20.258	47.945	20.392	58.536
GR 19.901	63.114	19.622	66.115	19.849	93.122	20.522	102.025	21.522	106.730
GR 22.263	115.365	23.522	123.115	23.480	159.067	23.522	187.890	24.588	196.111
GR 24.683	217.661	25.314	220.335	26.911	230.395	27.000	400.000		
NC .080	.06	.045	.2	.40					
Q1 2	451.	578.							
X1 14.0	17.	215.23	301.432	860.0	750.00	850.00			

6231.440	0.000	25.441	8.623	24.373	120.578	23.519	178.110	24.840	215.230
6223.040	222.230	22.703	225.009	22.379	231.134	22.329	238.938	22.498	253.502
6222.426	265.317	22.409	291.518	22.709	299.673	23.652	301.432	24.033	306.976
6223.760	315.230	30.000	380.000						
MC 0.08	0.0600	0.045	.	.30					
X1 15.0	15.	240.0	322.0	350.0	380.00	370.0			
6228.052	200.	25.192	302.795	24.577	325.29	24.577	325.30	23.587	330.01
6222.873	339.138	22.562	361.620	22.563	361.45	22.605	354.35	22.509	365.50
6222.582	374.583	22.876	368.250	23.368	389.59	23.308	389.60	27.600	390.00
6227.600	400.000	27.991	428.800	29.287	499.1				
SB 1.050	1.6	1.56	.	.30	64.30	3.700	240.0		
X1 16.1	.				6.0	6.00	6.0		
X2		1	26.4	27.2					
X3 10.								27.284	27.600
B1 18.	200.0	28.052	26.052	302.795	27.333	25.192	325.290	27.284	24.577
61325.30	27.892	26.340	330.01	27.890	26.340	339.138	27.890	26.340	341.42
6127.890	26.340	341.45	28.347	26.340	354.35	28.370	26.370	345.500	26.414
6126.410	374.583	28.440	26.440	308.250	28.460	26.460	389.590	28.4930	26.500
61309.40	28.4930	23.308	390.00	27.600	400.0	27.600	27.600	428.80	
6127.991	27.991	499.10	29.287	29.287					
X1 17.0	14.	184.968	240.19	40.00	40.00	40.00			
62 28.0	0.	27.000	100.0	26.788	139.97	25.404	173.987	24.342	184.968
6226.415	189.304	23.032	194.821	22.711	199.878	22.756	208.995	22.830	215.640
6223.012	221.070	23.565	228.560	23.761	240.190	30.000	360.000		
MC 0.050	0.050	0.055	0.1	0.3					
X1 18.0	17.	10.0	92.102	600.00	450.0	540.0			
6233.568	0.000	29.618	10.000	24.418	20.000	24.125	21.300	23.815	26.120
6223.819	33.714	26.264	47.267	24.420	67.045	24.661	75.006	26.391	92.102
6225.748	125.080	26.074	163.486	25.597	181.307	24.897	199.828	25.218	231.705
6225.218	235.000	40.118	272.000						
MC 0.050	0.050	0.055	0.1	0.3					
X1 19.0	18.	221.534	300.600	104.0.0	1015.0	1110.			
6248.793	0.000	40.343	15.206	28.593	45.000	28.393	112.920	28.143	170.000
6227.073	186.414	27.369	221.534	26.207	242.450	26.020	258.634	25.370	266.000
6225.438	279.220	25.638	286.760	26.027	295.350	26.198	297.902	27.393	300.460
6227.755	305.900	30.000	330.00	40.00	360.00				
MC 0.080	0.080	0.060	0.1	0.3					
X1 20.0	17.	150.06	222.559	870.00	940.00	930.0			
6231.893	0.000	29.520	20.000	30.109	79.960	29.226	95.813	28.831	104.802

G29.799	150.060	29.600	155.940	27.849	163.059	27.851	166.954	27.335	179.482
G227.030	188.786	27.222	196.610	27.216	203.390	26.892	211.047	27.151	214.820
G229.151	222.559	39.749	232.559						
NC .08	.080	.0600	.200	.400					
X1 21.0	19.	59.0	123.665	650.0	500.00	670.0			
G34.796	0.000	29.990	8.400	30.036	38.100	30.483	53.210	30.146	59.000
G29.796	61.000	26.713	63.870	28.500	74.487	28.014	83.000	27.546	86.000
G228.146	91.500	27.877	94.872	28.170	101.832	28.719	114.900	29.491	118.991
G31.969	123.665	32.798	126.000	33.000	190.00	35.000	240.000		
X1 22.0	15.	20.0	132.317	1200.0	1442.5	1425.0			
G40.448	0.000	30.348	20.000	28.800	25.000	30.348	30.040	31.707	45.990
G30.352	78.815	32.080	132.317	31.970	261.100	32.179	374.920	33.300	507.700
G33.491	695.740	31.448	698.000	31.448	750.000	33.000	860.00	45.648	930.000
X1 23.0	23.	147.19	292.830	550.00	550.000	660.00			
X3 10						33.248	33.462		
G41.336	0.000	39.919	9.100	33.786	25.000	33.022	49.160	32.946	112.895
G33.248	147.190	31.690	150.970	31.192	154.550	31.587	162.690	31.454	176.290
G31.654	186.340	32.592	281.350	33.482	292.830	32.761	391.250	33.303	504.430
G32.226	557.300	31.426	526.570.000	31.426	583.300	33.730	594.300	33.701	606.200
G33.548	790.410	32.510	824.700	40.000	965.000				
X1 24.0	21.	1031.0	1132.17	1150.0	1050.00	1175.0			
G38.000	750.00	37.000	796.000	36.360	968.450	36.980	989.670	37.062	1000.000
G37.162	1005.000	35.770	1016.200	35.990	031.000	36.924	1079.330	35.634	1095.220
G35.185	1107.05	36.866	1115.840	34.711	1124.54	34.446	1129.390	35.136	1132.170
G36.047	1133.21	36.564	1169.590	36.604	1176.19	36.337	1203.420	37.000	1390.000
G40.000	1469.00								
NC 0.070	0.080	0.080	0.1	0.3					
X1 25.0	14.	553.664	602.962	580.00	950.000	910.00			
G2 43.00	410.0	40.500	430.00	40.454	500.0	39.951	513.50	38.254	550.433
G337.883	553.464	37.295	561.265	36.997	571.436	36.847	576.743	36.350	587.981
G337.298	595.773	38.191	602.962	40.460	608.337	50.983	628.444		
NC 0.100	0.100	0.060	0.3	0.5					
Q1 2	438.0	562.0							
X1 26.0	17.	707.671	780.80	100.0	200.0	150.0	0.860		
X3 10						43.000	46.00		
G43.042	500.0	43.269	597.883	44.269	667.956	43.573	698.460	38.707	707.671
G33.707	707.70	38.313	710.246	37.931	719.781	37.994	729.310	38.264	742.970
G337.983	758.600	38.322	764.918	38.672	771.966	39.677	780.790	39.677	780.800
G44.907	790.200	47.080	792.000						
S8 1.050	1.5	1.50		62.2	4.70	420.			
X1 26.1				7.0	7.0	7.0			
X2		1	45.149	43.042			0.840		
X3 10							43.042	46.551	
S1 13.0	500.00	43.042	43.042	597.883	43.269	43.269	667.956	44.269	44.269
S1690.46	44.999	43.573	707.671	45.143	38.707	407.70	45.143	45.740	729.310

* WATER SURFACE PROFILES *
* VERSION OF SEPTEMBER 1988 *
* *
* *
* RUN DATE 11/23/89 TIME 10:46: 3 *

* U.S. ARMY CORPS OF ENGINEERS *
* THE HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET, SUITE D *
* DAVIS, CALIFORNIA 95616 *
* (916) 756-1104 *

X	X	XXXXXX	XXXX	XXXX
X	X	X	X	X
X	X	X	X	X
XXXXXX	XXXX	X	XXXX	XXXX
X	X	X	X	X
X	X	X	X	X
X	X	XXXXXX	XXXX	XXXXXX

ICE OPTION

END OF BANNER

THIS RUN EXECUTED 11/23/89 10:46: 3

HEC2 RELEASE DATED SEPT 88

T1 CODROY RIVER HEC-2 BACKWATER MODEL
 T2 MACLAREN PLANSEARCH INC 1989
 T3 20 YEAR DESIGN EVENT - PROJECT NO. 52766-C1-00-00-00

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2				1		929.0	0.93	

J2	NPROF	IPILOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNM	ITRACE
						-1				

NC	0.080	0.080	0.040	0.1	0.3					
IC	0.46	0.46	0.46	0.04	0.80					
X1	1.0	29.	110.	462.8						
GR	7.811	0.	6.24	100.	.811	109.	.811	110.0	.114	114.0
GR	-.486	132.	-.544	143.53	-.589	175.	-2.129	198.0	-2.479	243.0
GR	-2.311	248.	-2.129	264.0	-1.001	293.0	-1.214	298.0	-1.005	307.0
GR	-1.245	339.	-1.214	346.0	-1.336	371.0	-1.214	379.0	-1.367	391.0
GR	-2.753	406.	-2.433	419.0	-0.605	447.0	-0.544	452.4	0.096	454.0
GR	1.446	462.80	2.911	470.9	8.966	476.4	11.040	534.0		
NC	0.100	0.100	0.040	0.3	0.5					
X1	2.0	65.	646.26	870.16	250.0	250.00	250.0			
X3	10							6.000	7.000	
GR	7.331	500.	6.437	555.0	0.20	576.3	0.650	605.30	-0.1	606.5
GR	0.650	607.7	0.650	612.5	-0.10	613.7	0.650	614.90	0.65	619.60
GR	-0.10	620.80	0.650	622.0	0.65	627.3	-0.10	628.50	0.65	629.70
GR	0.65	634.50	-0.10	635.7	0.65	636.9	1.50	646.26	1.50	646.30
GR	1.50	651.00	0.200	651.1	-1.187	653.3	-4.509	666.00	-1.584	678.00
GR	-3.077	682.00	-2.04	686.0	-2.345	689.0	-2.254	693.80	-4.235	698.00
GR	-2.710	705.00	-2.01	708.0	-2.132	712.0	-1.888	717.00	-2.193	726.00
GR	-1.096	732.00	-1.126	735.0	-1.035	738.0	-2.284	749.00	-1.126	752.00
GR	-1.309	760.00	-1.888	766.0	-1.736	769.0	-1.888	772.00	-1.583	778.00
GR	-2.103	781.00	-2.315	782.0	-2.041	784.0	-2.345	786.00	-1.279	796.00
GR	-1.827	799.00	-2.559	821.0	-2.406	827.0	-2.803	832.00	-2.254	834.00
GR	-4.784	843.00	-4.631	845.0	-4.784	847.0	-0.517	857.00	0.20	863.0
GR	2.00	863.10	2.500	870.15	7.312	870.16	8.130	882.20	12.06	948.0
SB	1.050	1.5	1.50		190.0	6.000	2200.			
X1	2.1				8.80	8.8	8.8			
X2			1	7.18	6.088					
X3	10.							6.088	10.112	
BT	28.	500.	7.331	7.331	555.0	6.437	6.437	576.30	6.088	0.200
BT	605.3	6.300	0.65	606.3	6.30	1.40	607.7	6.300	0.650	612.50

BT	6.42	0.650	613.7	6.42	1.40	614.9	6.420	0.650	619.6	6.480
BT	0.650	620.80	6.48	1.40	622.0	6.480	0.650	627.3	6.550	0.650
BT	628.5	6.550	1.40	629.7	6.550	0.65	634.5	6.670	0.65	635.7
BT	6.670	1.40	636.9	6.670	0.65	646.26	6.707	1.500	646.3	6.707
BT	3.907	651.0	7.120	4.32	651.1	7.120	4.320	863.0	9.98	7.18
BT	863.1	9.980	7.180	870.15	10.112	7.310	870.16	10.112	7.310	882.2
BT	10.279	8.130	948.0	12.06	12.06					
X1	3.0	36.	104.67	490.18	90.	90.	90.			
GR	5.202	25.141	3.355	63.041	.8950	85.800	0.265	104.67	-0.183	130.55
GR	-3960	167.00	-.609	169.0	-.427	178.0	-.427	214.0	-.305	234.0
GR	-.396	274.0	-.396	304.0	-.518	314.0	-.427	324.0	-.579	349.0
GR	-.975	350.0	-1.006	356.0	-1.036	360.0	-1.036	367.0	-1.798	381.0
GR	-2.865	393.0	-3.871	404.0	-4.145	410.0	-4.297	425.0	-4.572	429.0
GR	-4.450	432.0	-4.572	441.0	-3.474	450.0	-2.286	459.0	-1.219	462.0
GR	-0.183	481.18	.301	490.18	1.064	495.88	3.7360	500.0	12.784	564.41
GR	14.784	665.0								
NC	0.080	0.080	0.040	0.1	0.3					
QT	2	908.0	1085.							
X1	4.	24.	110.	630.766	240.	300.0	260.0			
GR	6.050	0.000	3.965	37.562	2.982	56.218	0.864	88.357	0.849	97.049
GR	0.560	110.000	0.319	112.837	-0.133	114.840	-3.150	170.000	-0.453	290.000
GR	-0.819	314.000	-0.727	339.000	-0.773	350.000	-0.499	363.000	-0.377	385.000
GR	-0.255	471.000	-0.377	537.000	-0.375	567.500	-0.370	592.325	-0.375	606.300
GR	0.348	630.766	1.294	636.131	5.434	639.870	7.450	645.000		
X1	5.	48.	91.677	503.546	1300.	1723.0	1550.	0		
GR	6.936	0.000	3.265	76.062	3.038	80.920	0.853	89.042	0.226	91.677
GR	-0.033	94.170	-0.521	118.000	-0.429	124.000	-0.460	126.000	-0.384	130.000
GR	-0.688	146.000	-0.566	151.000	-0.765	158.000	-0.795	162.000	-0.445	171.000
GR	-0.505	181.000	-0.688	191.000	-0.688	198.000	-1.054	211.000	-0.963	217.000
GR	-1.024	222.000	-0.871	229.000	-0.932	235.000	-0.810	241.000	-0.871	244.000
GR	-0.353	260.000	-0.445	266.000	-0.292	273.000	-0.597	282.000	-0.292	287.000
GR	-0.231	296.000	-0.323	304.000	-0.231	310.000	-0.414	317.000	-0.512	324.200
GR	-0.301	339.238	-0.280	382.426	-0.360	422.579	-0.513	447.423	-0.487	478.255
GR	-0.370	493.998	0.160	503.546	1.050	508.198	0.717	537.720	1.905	545.562
GR	6.250	552.177	9.095	555.559	9.115	576.062				

IC

0.01

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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

0

CCHV= .100 CEHV= .300

*SECNO 1.000

4478 FLOATING ICE COVER, ICE THICKNESS LOB= .5 CH= .5 ROB= .5

SPGR	ICE N	B-S N	C	B	H	T/H	X*K
.800	.0400	.0399	25.	346.	3.7	.12	*****

3370 NORMAL BRIDGE, NRD= 0 MIN ELTRD= 1.02 MAX ELLC= .56

1.00	3.68	.93	.00	.93	1.03	.10	.00	.00	.81
929.	0.	929.	0.	0.	676.	0.	0.	0.	1.45
.00	.00	1.38	.00	.000	.040	.000	.000	-2.75	108.80
.003112	0.	0.	0.	0	0	0	-128.10	350.63	459.44

0

CCHV= .300 CEHV= .500

*SECNO 2.000

4478 FLOATING ICE COVER, ICE THICKNESS LOB= .5 CH= .5 ROB= .5

SPGR	ICE N	B-S N	C	B	H	T/H	X*K
.800	.0400	.0399	25.	212.	6.4	.07	3.744

3370 NORMAL BRIDGE, NRD= 0 MIN ELTRD= 1.02 MAX ELLC= .56

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 6.00 ELREA= 7.00

2.00	6.40	1.61	.00	.00	1.70	.09	.67	.00	1.50
929.	0.	929.	0.	0.	717.	0.	174.	71.	7.31
.05	.00	1.30	.00	.000	.040	.000	.040	-4.78	646.26
.002336	250.	250.	250.	2	0	0	-97.51	216.82	863.08

0

SPECIAL BRIDGE

5070, VARIABLE ELCHU OR ELCHO ON SB CARD NOT SPECIFIED

1

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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

1.05 1.50 1.50 .00 190.00 6.00 2200.00 .00 -4.78 -4.78

*SECNO 2.100

ERROR ELTRD .LT. MIN ROAD ELEV, ELTRD SET EQUAL TO MIN ROAD ELEV ✓

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE ✓

4478 FLOATING ICE COVER, ICE THICKNESS LOB=.5 CH=.5 ROB=.5

SPGR	ICE N	B-S N	C	B	H	T/H	X*K
.800	.0400	.0399	31.	212.	6.4	.07	2.510

3420 BRIDGE W.S.= 1.61 BRIDGE VELOCITY= .79 CALCULATED CHANNEL AREA= 1177.

EGPRS	EGLWC	H3	QWEIR	GLOW	BAREA	TRAPEZOID AREA	ELLC	ELTRD	WEIRLN
1.63	1.70	.01	0.	1434.	2200.	984.	.56	6.09	0.

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 6.09 ELREA= 10.11

2.10	6.40	1.62	.00	.00	1.70	.07	.00	.00	1.50
929.	0.	929.	0.	0.	815.	0.	181.	73.	7.31
.06	.00	1.14	.00	.000	.040	.000	.040	-4.78	646.26
.000369	9.	9.	9.	0	0	0	.00	216.82	863.08

0

*SECNO 3.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE

4478 FLOATING ICE COVER, ICE THICKNESS LOB=.5 CH=.5 ROB=.5

SPGR	ICE N	B-S N	C	B	H	T/H	X*K
.800	.0400	.0399	26.	386.	6.3	.07	2.114

3370 NORMAL BRIDGE, NRD= 0 MIN ELTRD= 1.81 MAX ELLC= 1.35

3.00	6.29	1.71	.00	.00	1.76	.05	.05	.01	.26
929.	4.	925.	1.	15.	947.	4.	261.	101.	.30
.08	.24	.98	.22	.100	.040	.100	.040	-4.57	78.22
.001156	90.	90.	90.	2	0	0	-153.34	418.67	496.88

0

1

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SECNO	DEPTH	CWSEL	CRIVS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

CCHV=.100 CENV=.300

*SECNO 4.000

4478 FLOATING ICE COVER, ICE THICKNESS LOB=.5 CH=.5 ROB=.5

.800 .0400 .0399 26. 521. 5.1 .09 3.439

3370 NORMAL BRIDGE, NRD= 0 MIN ELTRD= 2.05 MAX ELLC= 1.59

4.00	5.11	1.96	.00	.00	1.98	.03	.22	.00	.56
908.	5.	903.	1.	22.	1267.	4.	554.	229.	.35
.18	.21	.71	.21	.080	.040	.080	.040	-3.15	71.79
.000623	240.	260.	300.	2	0	0	-206.81	564.94	636.73

0

*SECNO 5.000

4478 FLOATING ICE COVER, ICE THICKNESS LOB=.5 CH=.5 ROB=.5

SPGR	ICE N	B-S N	C	B	H	T/H	X*K
.800	.0400	.0399	27.	412.	3.9	.12	*****

3370 NORMAL BRIDGE, NRD= 0 MIN ELTRD= 2.92 MAX ELLC= 2.46

5.00	3.89	2.83	.00	.00	2.86	.03	.88	.00	.23
908.	3.	885.	20.	10.	1208.	65.	2552.	1026.	.16
.78	.28	.73	.31	.080	.040	.080	.040	-1.05	81.69
.000515	1300.	1550.	1723.	3	0	0	-170.87	465.29	546.97

0

CCHV=.300 CEHV=.500

THIS RUN EXECUTED 11/23/89 10:48:56

HEC2 RELEASE DATED SEPT 88

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

20 YEAR DESIGN EVENT -

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
1.000	.00	1.02	.56	-2.75	929.00	.93	.00	1.03	31.12	1.38	675.59	166.54
2.000	250.00	1.02	.56	-4.78	929.00	1.61	.00	1.70	23.36	1.30	716.80	192.21
* 2.100	8.80	6.09	.56	-4.78	929.00	1.62	.00	1.70	3.69	1.14	815.08	483.31
* 3.000	90.00	1.81	1.35	-4.57	929.00	1.71	.00	1.76	11.56	.98	966.52	273.27
4.000	260.00	2.05	1.59	-3.15	908.00	1.96	.00	1.98	6.23	.71	1293.08	363.73
5.000	1550.00	2.92	2.46	-1.05	908.00	2.83	.00	2.86	5.15	.73	1282.00	400.21

20 YEAR DESIGN EVENT -

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
1.000	929.00	.93	.00	.00	.00	350.63	.00
2.000	929.00	1.61	.00	.68	.00	216.82	250.00
* 2.100	929.00	1.62	.00	.00	.00	216.82	8.80
* 3.000	929.00	1.71	.00	.10	.00	418.67	90.00
4.000	908.00	1.96	.00	.24	.00	564.94	260.00
5.000	908.00	2.83	.00	.88	.00	465.29	1550.00

SUMMARY OF ERRORS AND SPECIAL NOTES