APPENDIX
E

APPENDIX E

SURFACE WATER HYDROLOGY AND HYDRAULIC CALCULATIONS

APPENDIX E

TABLE OF CONTENTS

			Page No.
E.1	Pipeline Arroyo Hydraulic Calculations		
	a.	PMF Calculation for the Pipeline Arroyo	E-3
	b.	Printout of HEC-2 Computer Model Reaches #1, #2, and #3 to Determine the Limits of the PMF	E-6
	c.	HEC-2 Analysis for Low Flow Channel at the Buried Jetty	E-49
	d.	Nickpoint Stability - Riprap Design for Jetty	E-65
E.2	North and South Diversion Ditch Hydraulic Calculations:		
	a.	PMF Calculation for Watersheds A_1, A_2, and B	E-71
	b.	100 Year Flood Calculations for Watersheds A_1, A_2, and B	E-79
	c.	Flow Depth Calculations - North Diversion Ditch, Sections K, L, M, N, and O	E-86
	d.	North Diversion Ditch - Confluence Stability	E-92
	e.	PMF Calculations for the South Diversion Ditch and Flow Depth Calculations for Limiting Sections 1 and 2	E-104
	f.	Flow Depth Calculations for the North Diversion Ditch Inward Curves	E-109
	g.	Riprap Calculations for the North Diversion Ditch Inward Curves	E-112

APPENDIX E

TABLE OF CONTENTS
(Continued)

		Page No.
E.3	Tailings Embankment Hydraulic Calculations	
	a. Runoff Control Ditch Design	E-119
	b. Scour Along Protective Bench	E-131
	c. Rock Mulch Design for Embankment	E-140
E.4	Tailings Embankment Slope Stability Calculation	E-143
E.5	Tailings Top Hydraulic Calculations	
	a. Hydraulic Analyses for Swales	E-205
	b. Soil/Rock Matrix Stability Calculations	E-230
E.6	South Cell Drainage Channel Hydraulic Calculations	E-248
E.7	North Cell Drainage Channel Hydraulic Calculations	E-258
E.8	Riprap and Bedding Calculations	E-268

E.1(a)

PMF Arroyo Hydraulic Calculation

HYDROGRAPH CALCULATION FOR ONE-HOUR PMP EVENTS USING THE SCS CURVE NUMBER METHOD
HMR 49 RAINFALL DISTRIBUTION USED

Design of Small Dams - Revised Watershed
PIPELINE ARROYO UNC PROJECT RM86-060-01
13-May-88 14:59

ONE-HOUR RAINFALL AMOUNT	9.4 INCHES		
SCS CURVE NUMBER	79	S =	2.66
MEAN BASIN ELEV.	7275 FEET		
DURATION (D)	0.25 HOURS		
WATER COURSE LENGTH (L)	6.98 MILES	0.880681818	
WATERSHED AREA (A)	18.22 SQ. MILES		
MAXIMUM RELIEF (H)	819.00 FEET		
ELEV ADJUSTMENT	0.88625 ADJ. RAINFAL	8.33 INCHES	
AREAL ADJUSTMENT (DSD)	0.75 ADJ. RAINFAL	6.25 INCHES	
WATERSHED ADJUSTMENT (DSD. TABLE 5. PG 67)	1.04		

ITEM	TIME PERIOD. HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
PERCENT OF 1-HOUR RAINFALL (DSD.TABLE 2. PG 52)	74	89	95	100
ULATIVE RAINFALL	4.62	5.56	5.94	6.25
INCREMENTAL RAINFALL	4.62	0.94	0.37	0.31
SEQUENCE	0.37	0.94	4.62	0.31
P - CUMULATIVE DESIGN RAINFALL	0.37	1.31	5.94	6.25
Q - CUMULATIVE RUNOFF	0.01	0.18	3.62	3.90
INCREMENTAL RUNOFF OR EXCESS RAINFALL	0.01	0.17	3.45	0.28

TIME OF CONCENTRATION (Tc)	1.86 HOURS
ADJUSTED Tc	1.92 HOURS
TIME TO PEAK (Tp)	1.28 HOURS
BASE PERIOD (Tb)	3.42 HOURS
T PEAK DISCHARGE	6893 CFS

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		67.72	1153.31	23748.32	1928.13	
	0.00	0.00				0.00
	0.16	8.46				8.46
	0.32	16.93	0.00			16.93
	0.48	25.39	144.16	0.00		169.56
	0.64	33.86	288.33	2968.54		3290.73
	0.80	42.32	432.49	5937.08	0.00	6411.90
	0.96	50.79	576.66	8905.62	241.02	9774.08
	1.12	59.25	720.82	11874.16	482.03	13136.27
	1.28	67.72	864.98	14842.70	723.05	16498.45
	1.44	62.65	1009.15	17811.24	964.06	19847.10
	1.60	57.58	1153.31	20779.78	1205.08	23195.75
	1.76	52.51	1066.98	23748.32	1446.10	26313.92
	1.92	47.44	980.66	21970.75	1687.11	24685.97
	2.08	42.38	894.33	20193.18	1928.13	23058.02
	2.24	37.31	808.01	18415.61	1783.81	21044.74
	2.40	32.24	721.68	16638.05	1639.49	19031.45
	2.56	27.17	635.36	14860.48	1495.16	17018.17
	2.72	22.10	549.03	13082.91	1350.84	15004.88
	2.88	17.03	462.71	11305.34	1206.52	12991.60
	3.04	11.96	376.38	9527.77	1062.20	10978.31
	3.20	6.89	290.05	7750.20	917.88	8965.03
	3.36	1.82	203.73	5972.63	773.56	6951.75
	3.52	0.00	117.40	4195.06	629.24	4941.70
	3.68		31.08	2417.49	484.92	2933.49
	3.84		0.00	639.92	340.60	980.52
	4.00			0.00	196.28	196.28
	4.16				51.96	51.96
	4.32				0.00	0.00
	4.48					

E.1(b)

HEC-2 Calculations to Determine Limits of the PMF For:

- Subcritical Reaches #1 and #2
  (Flatter slopes)

- Supercritical Reach #3
  (Steeper slopes)

By: SWM Date: 11-29-90 Subject: UNC Gallup, New Mexico
Pipeline Arroyo Redesign

Checked By: GS/12-03-90 Project #: 86-060-24 Page 1 of 40

Purpose:

This calculation brief presents a description and HEC-2 analysis of Alternative #7 (recommended redesign alternative for Pipeline Arroyo). More specifically, the design assumptions, summary, and HEC-2 input/output for Alterative #7 are included.

The HEC-2 analysis for Alternative #7 involved two separate runs of the HEC-2 program. The first HEC-2 run represents subcritical flow in Reaches #1 &#2 (flatter slopes) of the reconfigured channel. The second HEC-2 run represents supercritical flow in Reach #3 (steeper slopes) of the reconfigured channel.

The cross sections used in the HEC-2 analysis are shown on the enclosed maps (Figures J-1 & J-2).

Method:

The U.S. Army Corps of Engineers' HEC-2 computer model for open channel flow was utilized to analyze the reconfigured channel.

Results:

- See the HEC-2 output that is included at the end of this calculation brief.
- See Figure #2 on page #4 for relationship (profile view) between the following elevations:

  1) Bench Top

  2) Embankment Top

  3) Bench Toe

  4) Channel Bottom

  5) PMF Maximum Water Surface Elevation

Assumptions: The following assumptions were made in the design process:

- o the reference line used in all alternatives is the centerline for the present channel design under the existing reclamation plan. All station numbers refer to stations along this line. which is plotted on the enclosed maps.
- o The sandstone outcrop located at @Sta 62+70 is known as the Nickpoint.
- o Reach #1 is defined as that part of the channel that is located between Sta 0+00 to Sta 40+00.
- o Reach #2 is defined as that part of the channel that is located between Sta 40+00 to Nickpoint.
- o Reach #3 is defined as that part of the channel that is located between the Nickpoint and Sta 85+70 (end of channel).

Summary of Alternative #7:

In Alternative #7, the channel is modified only slightly from the existing configuration as follows:

- o ensure a 30' wide, 2' deep channel bottom from Sta 5+00 to Sta 61+70 (i.e. low-flow channel)
- o Fill existing depressions and headcuts
- o a stone filled trench (jetty) will be installed at Sta 59+50 to reinforce the Nickpoint and maintain shallow upstream slopes.
- o a 40' wide protective bench will be constructed at the tailings embankment toe which would protect the embankment and tailings during the PMF.

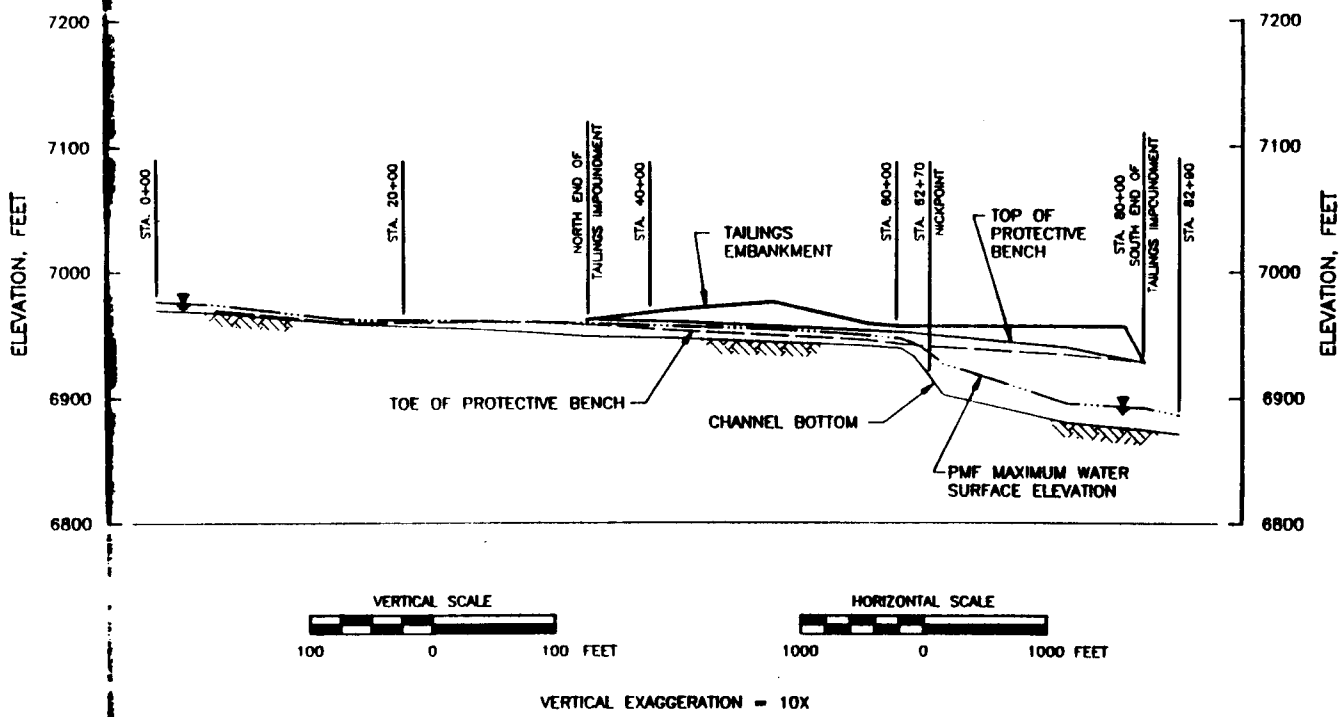
DRAWING NUMBER 86-060-8420

E-10

PAGE #4 OF 40

FIGURE #2

ALTERNATIVE #7



[redacted]

PIPELINE ARROYO PROFILE

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

No	DATE	ISSUE / REVISION	DWN BY	CKD BY	APD BY
1			RHP		

DATE: 11-9-90	FIGURE 4-3	DRAWING NUMBER
SCALE: AS SHOWN		86-060-8420

[redacted]

```
*****************************************************
*  WATER SURFACE PROFILES                           *
*  VERSION OF SEPTEMBER 1988                        *
   ERROR: 01,02,03,04                               *
   UPDATED:  JUNE 1990                              *
*  RUN DATE    11/23/90      TIME   23:03:22        *
*****************************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*                                   *
*************************************
```

BY: SNM
12/3/90
Chkd. By: GS
12/3/90

p. 5 of 40

```
X     X  XXXXXXX   XXXXX             XXXXX
X     X  X       X     X           X     X
X     X  X       X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X       X                 X
X     X  X       X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

```
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
:::                                       :::
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
```

REACHES #1 + #2

```
============================
M A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

END OF BANNER

Run Date: 11/26/90 Run Time: 18:20:33 HMVersion: 5.30 Data File: alt7.hc2

THIS RUN EXECUTED 11/26/90 18:20:33

```
*************************************************
 HEC2 RELEASE DATED SEP 88 UPDATED JUN  1990

 ERROR CORR -  01.02.03.04
 MODIFICATION -
*************************************************
```

p. 6 of 40

T1 ALTERNATIVE #7--REACH 1&2--Q=26300 CFS
T2 UNC PROJECT NO. 86-060-24 RESP. TO NRC COMMENTS 11/7/90
T3 PIPELINE ARROYO SUBCRITICAL FLOW

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	0	0	0	0.04	0	0	26300	6950	0

NC	0.035	0.035	0.03							
X1	61.40	17	250	676	0	0	0			
GR	6960	0	6955	55	6950	127	6945	250	6940	260
GR	6935	270	6933	275	6933	300	6937	310	6937	480
GR	6942	600	6942	650	6942	660	6942	676	6951.5	727.5
GR	6951.5	767.5	6957	792						
X1	60.40	10	110	515	160	130	100			
GR	6960	0	6950	110	6939	115	6939	140	6941.5	145
GR	6943	515	6943	530	6952	572.5	6952	612.5	6957	632
X1	57.75	16	145	543	270	295	262			
GR	6960	0	6955	35	6950	90	6945.5	145	6941	155
GR	6941	185	6945	195	6945	230	6945	270	6945	295
GR	6945	330	6945	375	6945	543	6953.5	587.5	6953.5	627.5
GR	6960	660								
X1	50.00	14	455	712	750	850	775			
GR	6975	0	6970	10	6965	30	6960	100	6950	140
GR	6950	320	6950	455	6944	532	6944	562	6950	650
GR	6950	712	6957	745	6957	785	6976	880		
X1	41.95	12	535	772	820	800	805			
GR	6970	0	6965	70	6960	165	6955	235	6950	535
GR	6947	557	6947	587	6953.5	700	6953.5	772	6960.5	810
GR	6960.5	850	6970	905						
X1	35.00	9	215	780	700	700	705			
GR	6970	0	6960	145	6955	215	6948.7	583	6948.7	613
GR	6958	710	6958.5	780	6962.5	800	6962.5	840		
X1	30.10	21	135	980	495	1140	490			
GR	6970	0	6960	135	6955	565	6952	575	6952	605
GR	6955	615	6955	660	6955	765	6955	800	6955	850
GR	6955	880	6956	980	6958	990	6960	1000	6960	1070
GR	6962	1422	6962.4	1510	6964.5	1680	6966.5	1795	6968	1900
GR	6970	1910								

Run Date: 11/23/90 Run Time: 23: 3:22 HMVersion: 5.30 Data File: ALT7.HC2

X1	24.95	26	795	1800	560	540	520			
GR	7000	0	6990	45	6980	140	6970	275	6960	545
GR	6960	615	6960	795	6955	865	6953	865	6953	895
GR	6955	895	6955	1175	6955	1295	6955	1385	6955	1715
GR	6958	1770	6960	1800	6960	1970	6962	2060	6964	2070
GR	6966	2080	6968	2090	6970	2100	6980	2150	6990	2165
GR	7000	2230								

p. 7/40

X1	15.05	15	690	795	910	1180	990			
GR	7000	0	6990	35	6980	105	6970	210	6960	690
GR	6959	710	6959	740	6960	795	6960	1520	6975	1575
GR	6980	1600	6985	1620	6990	1645	6995	1660	7000	1690

X1	4.85	14	820	1155	1035	1070	1022			
GR	6980	0	6970	820	6970	890	6968	890	6968	920
GR	6970	920	6970	930	6970	950	6970	1000	6970	1030
GR	6970	1060	6970	1105	6970	1155	6980	1540		

Run Date: 11/23/90 Run Time: 23: 3:22 HNVersion: 5.30 Data File: ALT7.HC2

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

*PROF 1

p. 8/40

*SECNO 61.400
3720 CRITICAL DEPTH ASSUMED

61.400	10.32	6943.32	6943.32	6950.00	6945.77	2.45	.00	.00	6945.00
26300.0	.0	26286.8	13.2	.0	2090.3	4.7	.0	.0	6942.00
.00	.00	12.58	2.80	.000	.030	.035	.000	6933.00	253.36
.007727	0.	0.	0.	0	18	0	.00	429.80	683.16

*SECNO 60.400
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

60.400	7.99	6946.99	6946.99	.00	6949.47	2.48	.79	.00	6950.00
26300.0	.0	25507.0	793.0	.0	2000.7	97.3	4.8	1.0	6943.00
.00	.00	12.75	8.15	.000	.030	.035	.000	6939.00	111.37
.007987	160.	100.	130.	20	15	0	.00	437.46	548.83

*SECNO 57.750
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

57.750	8.64	6949.64	6949.64	.00	6952.05	2.41	2.05	.00	6945.50
26300.0	626.4	25313.3	360.3	104.5	2002.5	56.3	17.7	3.8	6945.00
.01	5.99	12.64	6.40	.035	.030	.035	.000	6941.00	94.45
.007597	270.	262.	295.	20	8	0	.00	472.82	567.27

*SECNO 50.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.60

50.000	10.33	6954.33	.00	.00	6955.52	1.20	3.48	.00	6950.00
26300.0	8537.4	17593.8	168.8	1401.0	1787.5	44.2	65.4	13.3	6950.00
.03	6.09	9.84	3.82	.035	.030	.035	.000	6944.00	122.69
.002981	750.	775.	850.	3	0	0	.00	609.72	732.41

Run Date: 11/23/90 Run Time: 23: 3:22 HMVersion: 5.30 Data File: ALT7.HC2

P. 9/40

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

*SECNO 41.950

41.950	9.92	6956.92	.00	.00	6958.39	1.47	2.86	.00	6950.00
26300.0	9943.8	16232.2	123.9	1350.5	1481.8	31.7	122.2	24.5	6953.50
.06	7.36	10.95	3.91	.035	.030	.035	.000	6947.00	208.18
.004254	820.	805.	800.	3	0	0	.00	582.37	790.54

*SECNO 35.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.62

35.000	10.68	6959.38	.00	.00	6960.13	.75	1.74	.00	6955.00
26300.0	386.5	25911.6	1.9	134.4	3709.7	1.9	176.4	34.3	6958.50
.08	2.88	6.98	.98	.035	.030	.035	.000	6948.70	153.66
.001619	700.	705.	700.	2	0	0	.00	630.75	784.41

*SECNO 30.100

30.100	8.40	6960.40	.00	.00	6961.22	.82	1.09	.00	6960.00
26300.0	.9	26026.9	272.2	1.1	3557.5	90.0	219.2	44.7	6956.00
.10	.82	7.32	3.02	.035	.030	.035	.000	6952.00	129.61
.003213	495.	490.	1140.	3	0	0	.00	1010.69	1140.30

*SECNO 24.950

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.36

24.950	8.57	6961.57	.00	.00	6961.81	.24	.59	.00	6960.00
26300.0	570.0	25313.9	416.1	426.0	6286.2	322.6	283.3	60.2	6960.00
.14	1.34	4.03	1.29	.035	.030	.035	.000	6953.00	502.59
.000577	560.	520.	540.	2	0	0	.00	1538.10	2040.69

*SECNO 15.050

Run Date: 11/23/90 Run Time: 23: 3:22 HNVersion: 5.30 Data File: ALT7.HC2

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

p. 10/40

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

15.050	4.03	6963.03	6963.03	.00	6964.48	1.45	1.61	.00	6960.00
26300.0	1277.3	4707.3	20315.4	220.3	385.6	2213.4	400.2	90.6	6960.00
.17	5.80	12.21	9.18	.035	.030	.035	.000	6959.00	544.57
.010721	910.	990.	1180.	20	14	0	.00	986.54	1531.11

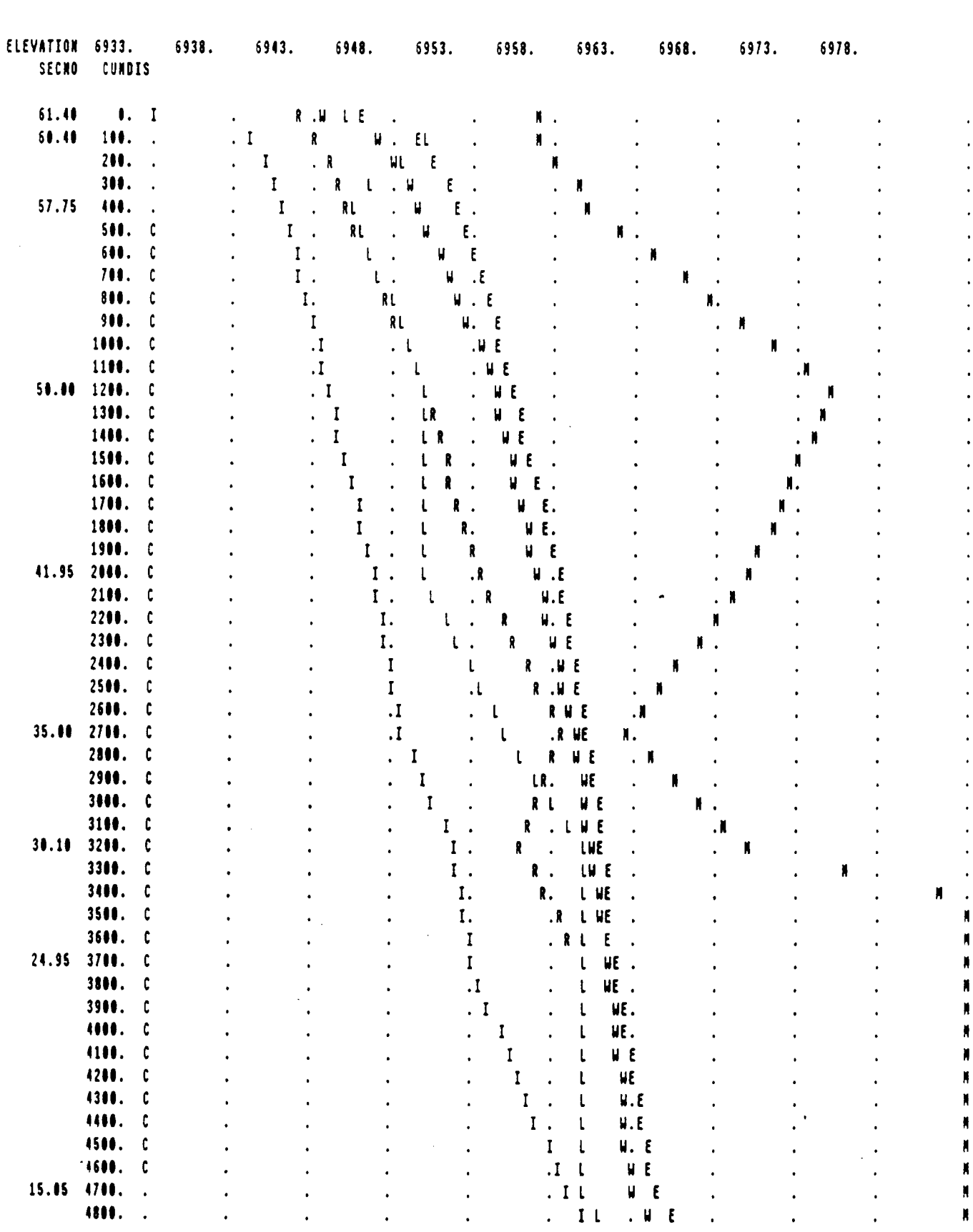
*SECNO 4.850
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

4.850	6.56	6974.56	6974.56	.00	6976.23	1.67	9.03	.00	6970.00
26300.0	5277.9	18544.5	2477.6	851.3	1586.5	399.7	468.2	113.1	6970.00
.20	6.20	11.69	6.20	.035	.030	.035	.000	6968.00	446.36
.007113	1035.	1022.	1070.	3	14	0	.00	884.08	1330.43

PROFILE FOR STREAM INE ARROYO SUBCRITICAL F

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,N-LOWER END STA

p. 11/40



```
      5100.  .         .         .         .         .         .        ..  .        E           .         .        M
      5200.  .         .         .         .         .         .        .I  L       .W  E        .         .        M
      5300.  .         .         .         .         .         .        .  I  L   .    W  E  .             .        M   E-18
      5400.  .         .         .         .         .         .        .    I   L .     W  E.             .        M
      5500.  .         .         .         .         .         .        .      I   L        W .E           .        M
      5600.  .         .         .         .         .         .        .        I . L        W    E      .       M.
4.85  5700.  .         .         .         .         .         .        .          I   L      . W   E  .    M      .
```

p.12/40

Run Date: 11/23/90 Run Time: 23: 3:22 HMVersion: 5.30 Data File: ALT7.HC2

THIS RUN EXECUTED 11/23/90 23: 3:31

****
HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

p. 13/40

ERROR CORR - 01,02,03,04
MODIFICATION -
****

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

INE ARROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	61.400	.00	.00	.00	6933.00	26300.00	6943.32	6943.32	6945.77	77.27	12.58	2095.00	2992.01
*	60.400	100.00	.00	.00	6939.00	26300.00	6946.99	6946.99	6949.47	79.87	12.75	2098.02	2942.85
*	57.750	262.00	.00	.00	6941.00	26300.00	6949.64	6949.64	6952.05	75.97	12.64	2163.31	3017.47
*	50.000	775.00	.00	.00	6944.00	26300.00	6954.33	.00	6955.52	29.81	9.84	3232.61	4817.25
	41.950	805.00	.00	.00	6947.00	26300.00	6956.92	.00	6958.39	42.54	10.95	2864.02	4032.10
*	35.000	705.00	.00	.00	6948.70	26300.00	6959.38	.00	6960.13	16.19	6.98	3845.98	6536.47
	30.100	490.00	.00	.00	6952.00	26300.00	6960.40	.00	6961.22	32.13	7.32	3648.57	4639.55
*	24.950	520.00	.00	.00	6953.00	26300.00	6961.57	.00	6961.81	5.77	4.03	7034.72	10951.51
*	15.050	990.00	.00	.00	6959.00	26300.00	6963.03	6963.03	6964.48	107.21	12.21	2819.36	2539.98
*	4.850	1022.00	.00	.00	6968.00	26300.00	6974.56	6974.56	6976.23	71.13	11.69	2837.44	3118.29

Run Date: 11/23/90 Run Time: 23: 3:22 HNVersion: 5.30 Data File: ALT7.HC2

:NE ARROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

p. 14/40

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	61.400	26300.00	6943.32	.00	.00	-6.68	429.80	.00
*	60.400	26300.00	6946.99	.00	3.67	.00	437.46	100.00
*	57.750	26300.00	6949.64	.00	2.65	.00	472.82	262.00
*	50.000	26300.00	6954.33	.00	4.69	.00	609.72	775.00
	41.950	26300.00	6956.92	.00	2.59	.00	582.37	805.00
*	35.000	26300.00	6959.38	.00	2.46	.00	630.75	705.00
	30.100	26300.00	6960.40	.00	1.02	.00	1010.69	490.00
*	24.950	26300.00	6961.57	.00	1.17	.00	1538.10	520.00
*	15.050	26300.00	6963.03	.00	1.46	.00	986.54	990.00
	4.850	26300.00	6974.56	.00	11.53	.00	884.08	1022.00

```
*************************************************
*  WATER SURFACE PROFILES                       *
*  VERSION OF SEPTEMBER 1988                    *
*  ERROR: 01,02,03,04                           *
*  UPDATED:  JUNE 1990                          *
*  RUN DATE    11/26/90      TIME   15:58:57    *
*************************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*                                   *
*************************************
```

/ Sw-21
12-3-90
Chkd. By: GS.
12-03-90

p. 15/40

```
X     X  XXXXXXX   XXXXX            XXXXX
X     X  X        X    X           X    X
X     X  X        X                     X
XXXXXXX  XXXX     X         XXXXX   XXXXX
X     X  X        X                X
X     X  X        X    X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

```
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER INPLEMENTATION   :::
:::                                       :::
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
```

REACH #3

```
============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

END OF BANNER

Run Date: 11/26/90 Run Time: 18:30:52 HMVersion: 5.30 Data File: reach3.hc2

THIS RUN EXECUTED 11/26/90 18:30:52

****

HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

Chkd. By: GS
12-03-90

ERROR CORR - 01.02.03.04
MODIFICATION -

****

p. 16/40

T1 ALTERNATIVE #7-RECONFIGURED REACH #3 Q(PMF)=26300 CFS
T2 UNC PROJECT NO. 86-060-24 RESP. TO NRC COMMENTS 10/17/90
T3 REACH 3 - SUPERCRITICAL FLOW

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	0	0	1	0.015	0	0	26300	6956	

NC	0.035	0.035	0.03							
X1	57.75	16	145	543	275	285	262			
GR	6960	0	6955	35	6950	90	6945.5	145	6941	155
GR	6941	185	6945	195	6945	230	6945	270	6945	295
GR	6945	330	6945	375	6945	543	6953.5	587.5	6953.5	627.5
GR	6960	660								
X1	60.40	10	110	515	160	130	100			
GR	6960	0	6950	110	6939	115	6939	140	6941.5	145
GR	6943	515	6943	530	6952	572.5	6952	612.5	6957	632
X1	61.40	17	250	660	60	165	95			
GR	6960	0	6955	55	6950	127	6945	250	6940	260
GR	6935	270	6933	275	6933	300	6937	310	6937	480
GR	6942	600	6942	650	6942	660	6942	676	6951.9	727.5
GR	6951.5	767.5	6957	792						
X1	62.30	22	250	330	265	75	150			
GR	6960	0	6955	35	6950	85	6945	155	6945	175
GR	6940	250	6935	260	6930	265	6922	280	6922	300
GR	6930	320	6935	330	6935	395	6935	435	6939	476
GR	6939	595	6940	620	6940	655	6940.7	717	6950.5	769.9
GR	6950.5	809.9	6957	845						
X1	63.80	20	300	335	1000	945	1005			
GR	6960	0	6955	80	6950	90	6945	105	6940	180
GR	6935	245	6925	250	6920	270	6925	300	6902	305
GR	6902	325	6925	330	6930	335	6935	375	6939	575
GR	6940	655	6940.7	728.5	6950.5	777.5	6950.5	817.5	6957	850
X1	73.80	20	650	735	850	520	630			
GR	6960	0	6955	40	6950	105	6945	240	6945	340
GR	6945	350	6940	450	6930	605	6925	625	6900	650
GR	6880	670	6880	690	6900	735	6925	757	6925	995
GR	6934	1075	6934	1180	6940	1210	6940	1250	6957	1335

Run Date: 11/26/90 Run Time: 15:58:57 HMVersion: 5.30 Data File: reach3.hc2

X1	80.10	15	325	440	290	330	280			
GR	6925	0	6920	140	6920	270	6915	280	6910	290
GR	6905	310	6900	325	6874.3	380	6874.3	400	6900	440
GR	5912	480	6925	790	6928	900	6928	1072	6957	1275
X1	82.90	19	480	645	0	0	0			
GR	6925	0	6920	115	6915	200	6910	460	6905	470
GR	6900	480	6871	510	6871	530	6900	645	6905	655
GR	6905	705	6905	860	6899	900	6899	935	6926	1100
GR	6930	1180	6940	1195	6950	1205	6960	1215		

p. 17/40

Run Date: 11/26/90 Run Time: 15:58:57 HNVersion: 5.30 Data File: reach3.hc2

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

*PROF 1

*SECNO 57.750

57.750	7.76	6948.76	6949.66	6956.00	6952.43	3.67	.00	.00	6945.50
26300.0	465.8	25545.1	289.1	64.9	1642.2	37.0	.0	.0	6945.00
.00	7.18	15.55	7.82	.035	.030	.035	.000	6941.00	105.17
.014971	0.	0.	0.	0	14	6	.00	457.51	562.68

10.13/40

*SECNO 60.400

3301 HV CHANGED MORE THAN HVINS

60.400	7.85	6946.85	6946.99	.00	6949.47	2.63	2.96	.00	6950.00
26300.0	.0	25523.5	776.5	.0	1944.7	92.7	11.4	2.7	6943.00
.01	.00	13.12	8.38	.000	.030	.035	.000	6939.00	111.43
.008786	275.	262.	285.	2	8	0	.00	436.74	548.17

ECNO 61.400

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.84

61.400	8.15	6941.15	6943.30	.00	6947.99	6.84	1.48	.00	6945.00
26300.0	.0	26300.0	.0	.0	1253.2	.0	15.2	3.6	6942.00
.01	.00	20.99	.00	.000	.030	.000	.000	6933.00	257.69
.029659	160.	100.	130.	7	11	0	.00	322.08	579.76

*SECNO 62.300

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .58

62.300	16.91	6938.91	6941.60	.00	6946.37	7.46	1.62	.00	6940.00
26300.0	.0	21460.3	4839.7	.0	901.3	488.6	18.5	4.3	6935.00
.01	.00	23.81	9.91	.000	.030	.035	.000	6922.00	252.18
.010000	60.	95.	165.	8	17	0	.00	222.87	475.05

Run Date: 11/26/90 Run Time: 15:58:57 HNVersion: 5.30 Data File: reach3.hc2

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

*SECNO 63.800

3301 HV CHANGED MORE THAN HVINS

p 19/40

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.64

63.800	24.85	6926.85	6932.13	.00	6944.03	17.18	2.34	.00	6925.00
26300.0	3988.3	22311.7	.0	218.7	632.4	.0	22.2	4.8	6930.00
.01	18.24	35.28	.00	.035	.030	.000	.000	6902.00	249.07
.026800	265.	150.	75.	7	14	0	.00	82.79	331.86

*SECNO 73.800

3301 HV CHANGED MORE THAN HVINS

73.800	15.92	6895.92	6901.95	.00	6916.08	20.16	27.95	.00	6900.00
26300.0	.0	26300.0	.0	.0	729.8	.0	40.7	6.6	6900.00
.02	.00	36.04	.00	.000	.030	.000	.000	6880.00	654.09
.028546	1080.	1005.	945.	6	15	0	.00	71.72	725.81

*SECNO 80.100

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .70

80.100	18.08	6892.38	6895.78	.00	6903.90	11.52	12.18	.00	6900.00
26300.0	.0	26300.0	.0	.0	965.5	.0	52.9	7.7	6900.00
.02	.00	27.24	.00	.000	.030	.000	.000	6874.30	341.31
.013957	850.	630.	520.	6	11	0	.00	86.82	428.13

*SECNO 82.900

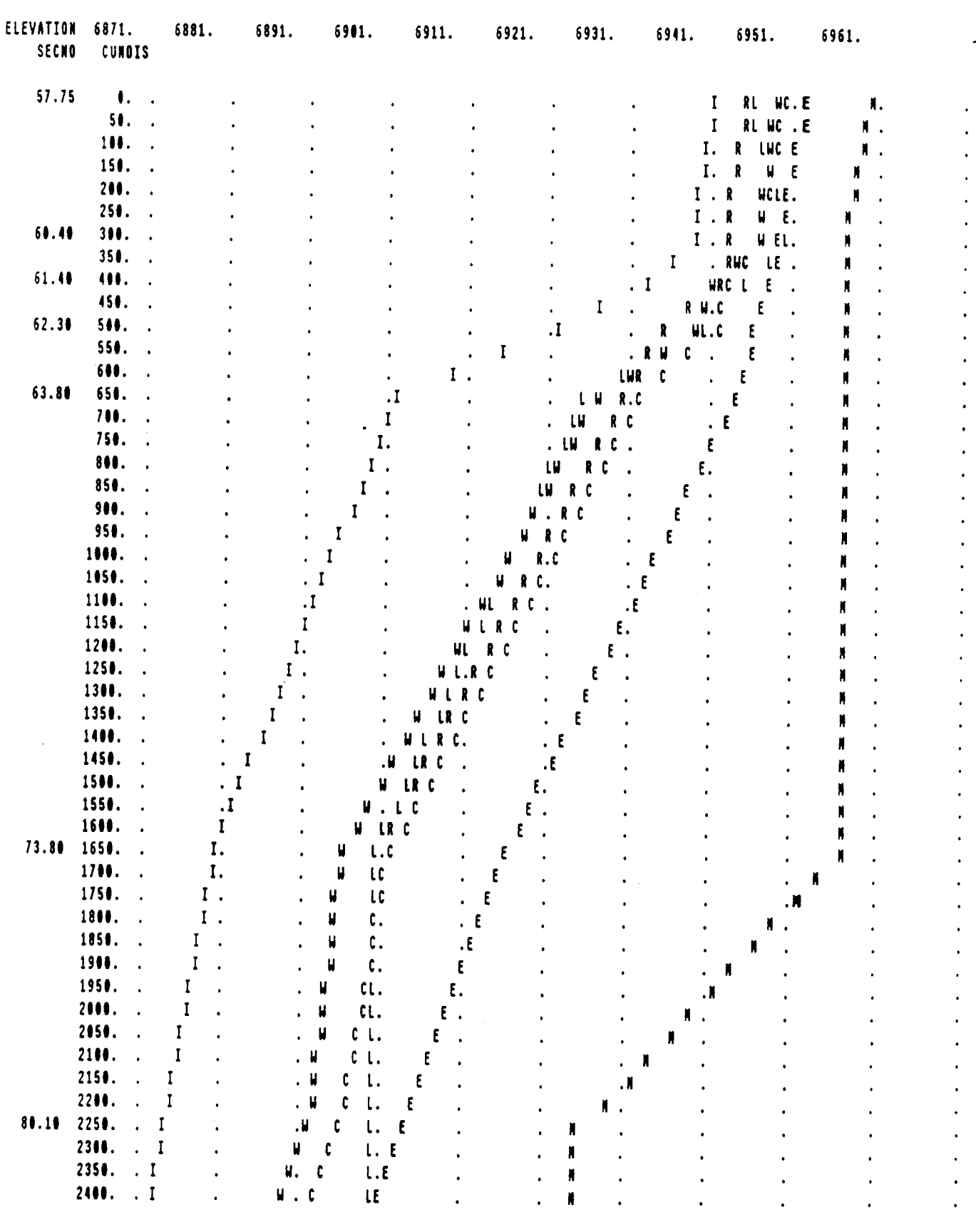
3301 HV CHANGED MORE THAN HVINS

82.900	15.55	6886.55	6890.63	.00	6899.37	12.82	4.53	.00	6900.00
26300.0	.0	26300.0	.0	.0	915.2	.0	59.0	8.3	6900.00
.03	.00	28.74	.00	.000	.030	.000	.000	6871.00	493.92
.018988	290.	280.	330.	7	8	0	.00	97.73	591.65

PROFILE FOR STREAM 3 - SUPERCRITICAL FLOW

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,N-LOWER END STA

10.20/40



82.90 2550. I . W E. . . N . . .

Run Date: 11/26/90 Run Time: 15:58:57 HMVersion: 5.30 Data File: reach3.hc2

THIS RUN EXECUTED 11/26/90 15:59: 5

p. 21/46

****
HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

ERROR CORR - 01,02,03,04
MODIFICATION -
****

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

3 - SUPERCRITICAL FLOW

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	57.750	.00	.00	.00	6941.00	26300.00	6948.76	6949.66	6952.43	149.71	15.55	1744.13	2149.50
	60.400	262.00	.00	.00	6939.00	26300.00	6946.85	6946.99	6949.47	87.86	13.12	2037.41	2805.80
*	61.400	100.00	.00	.00	6933.00	26300.00	6941.15	6943.30	6947.99	296.59	20.99	1253.16	1527.14
*	62.300	95.00	.00	.00	6922.00	26300.00	6938.91	6941.60	6946.37	100.00	23.81	1389.88	2630.05
*	63.800	150.00	.00	.00	6902.00	26300.00	6926.85	6932.13	6944.03	268.00	35.28	851.14	1606.52
	73.800	1005.00	.00	.00	6880.00	26300.00	6895.92	6901.95	6916.08	285.46	36.04	729.82	1556.62
*	80.100	630.00	.00	.00	6874.30	26300.00	6892.38	6895.78	6903.90	139.57	27.24	965.47	2226.16
	82.900	280.00	.00	.00	6871.00	26300.00	6886.55	6890.63	6899.37	189.88	28.74	915.20	1908.63

Run Date: 11/26/90 Run Time: 15:58:57 HNVersion: 5.30 Data File: reach3.hc2

3 - SUPERCRITICAL FLOW

SUMMARY PRINTOUT TABLE 150

p.22/40

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	57.750	26300.00	6948.76	.00	.00	-7.24	457.51	.00
	60.400	26300.00	6946.85	.00	-1.91	.00	436.74	262.00
*	61.400	26300.00	6941.15	.00	-5.69	.00	322.08	100.00
*	62.300	26300.00	6938.91	.00	-2.25	.00	222.87	95.00
*	63.800	26300.00	6926.85	.00	-12.06	.00	82.79	150.00
	73.800	26300.00	6895.92	.00	-30.93	.00	71.72	1005.00
*	80.100	26300.00	6892.38	.00	-3.54	.00	86.82	630.00
	82.900	26300.00	6886.55	.00	-5.83	.00	97.73	280.00

```
*****************************************************
*  WATER SURFACE PROFILES                           *
*  VERSION OF SEPTEMBER 1988                        *
   ERROR: 01,02,03,04                               *
*  UPDATED:  JUNE 1990                              *
*  RUN DATE    11/12/90      TIME   17:45:06        *
*****************************************************
```

```
*********************************
*  U.S. ARMY CORPS OF ENGINEERS  *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D    *
*  DAVIS, CALIFORNIA 95616-4687  *
*                                *
*********************************
```

p.23/40

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX              XXXXXX
```

```
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
:::                                       :::
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
```

```
============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

END OF BANNER

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

THIS RUN EXECUTED 11/12/90 17:45: 6

****

HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

ERROR CORR - 01,02,03,04
MODIFICATION -

****

p.24/40

T1 ALTERNATIVE #7--REACH 1&2--Q=26300 CFS
T2 UNC PROJECT NO. 86-060-24 RESP. TO NRC COMMENTS 11/7/90
T3 PIPELINE ARROYO SUBCRITICAL FLOW

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	0	0	0	0.04	0	0	26300	6950	0

NC	0.035	0.035	0.03							
X1	61.40	17	250	676	0	0	0			
GR	6960	0	6955	55	6950	127	6945	250	6940	260
GR	6935	270	6933	270	6933	300	6937	310	6937	480
GR	6942	500	6942	650	6942	660	6942	676	6951.5	727.5
GR	6951.5	767.5	6957	792						
X1	60.40	10	110	515	160	130	100			
GR	6960	0	6950	110	6939	115	6939	145	6941.5	145
GR	6943	515	6943	530	6952	572.5	6952	612.5	6957	632
X1	57.75	16	145	543	270	295	262			
GR	6960	0	6955	35	6950	90	6945.5	145	6941	155
GR	6941	185	6945	195	6945	230	6945	270	6945	295
GR	6945	330	6945	375	6945	543	6953.5	587.5	6953.5	627.5
GR	6960	660								
X1	50.00	14	455	712	750	850	775			
GR	6975	0	6970	10	6965	30	6960	100	6950	140
GR	6950	320	6950	455	6944	532	6944	562	6950	650
GR	6950	712	6957	745	6957	785	6976	880		
X1	41.95	12	535	772	820	800	805			
GR	6970	0	6965	70	6960	165	6955	235	6950	535
GR	6947	557	6947	587	6953.5	700	6953.5	772	6960.5	810
GR	6960.5	850	6970	905						
X1	35.00	9	215	780	700	700	705			
GR	6970	0	6960	145	6955	215	6948.7	583	6948.7	603
GR	6958	710	6958.5	780	6962.5	900	6962.5	840		
X1	30.10	21	135	980	495	1140	490			
GR	6970	0	6960	135	6955	565	6952	575	6952	605
GR	6955	615	6955	660	6955	765	6955	800	6955	850
GR	6955	880	6956	980	6958	990	6960	1000	6960	1070
GR	6960	1422	6962	1510	6964	1680	6966	1795	6968	1900
GR	6970	1910								

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

X1	24.35	26	795	1800	560	540	520			
GP	7000	0	6990	45	6980	140	6970	275	6950	345
GR	6960	515	6960	795	6955	865	6953	965	6953	995
GP	6955	995	6955	1175	6955	1295	6955	1365	6955	1715
GR	6958	1770	6960	1800	6960	1970	6962	2060	6964	2070
GR	6966	2080	6968	2090	6970	2100	6980	2150	6990	2165
GR	7000	2230								
X1	15.05	15	690	795	910	1190	990			
GP	7000	0	6990	35	6980	105	6970	210	6960	690
GP	6959	735	6959	765	6960	795	6960	1520	6975	1575
GR	6980	1600	6985	1620	6990	1645	6995	1660	7000	1690
X1	4.85	14	820	1155	1035	1070	1022			
GP	6980	0	6970	820	6970	890	6968	890	6968	920
GR	6970	920	6970	930	6970	950	6970	1000	6970	1030
GR	6970	1060	6970	1105	6970	1155	6980	1540		

p. 25/40

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EI	HV	HL	DLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	ICC	ICONT	CORAR	TOPWID	ENDST

*PPOF 1

P. 26/40

*SECNO 61.400
3720 CRITICAL DEPTH ASSUMED

61.400	10.31	6943.31	6943.31	6950.00	6945.76	2.45	.00	.00	6945.00
26300.0	.0	26287.0	13.0	.0	2091.8	4.7	.0	.0	6942.00
.00	.00	12.57	2.79	.000	.030	.035	.000	6933.00	253.38
.007747	0.	0.	0.	0	18	0	.00	429.74	683.11

*SECNO 60.400
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

60.400	7.98	6946.98	6946.98	.00	6949.45	2.48	.79	.00	6950.00
26300.0	.0	25509.9	790.1	.0	2002.4	97.0	4.9	1.0	6943.00
.00	.00	12.74	8.15	.000	.030	.035	.000	6939.00	111.37
.008015	160.	100.	130.	20	19	0	.00	437.40	548.78

*SECNO 57.750
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

57.750	8.64	6949.64	6949.64	.00	6952.05	2.41	2.05	.00	6945.50
26300.0	626.7	25312.9	360.4	124.6	2003.1	56.3	17.7	3.8	6945.00
.01	5.99	12.64	6.40	.035	.030	.035	.000	6941.00	34.43
.007589	270.	262.	295.	20	8	0	.00	472.84	567.28

*SECNO 50.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. XRATIO = 1.60

50.000	10.33	6954.33	.00	.00	6955.52	1.20	3.48	.00	6950.00
26300.0	8537.0	17594.2	168.8	1400.8	1787.3	44.2	65.4	13.3	6950.00
.03	6.09	9.84	3.82	.035	.030	.035	.000	6944.00	122.69
.002982	750.	775.	850.	3	0	0	.00	609.72	732.40

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	BETA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IOC	ICONT	CORAR	TOPWID	ENDST

P.27/40

*SECNO 41.950

41.950	9.92	6956.92	.00	.00	6958.39	1.47	2.86	.00	6950.00
26300.0	9943.8	16232.2	123.9	1350.5	1481.8	31.7	122.2	24.5	6953.50
.06	7.36	10.95	3.91	.035	.030	.035	.000	6947.00	206.18
.004254	820.	805.	800.	3	0	0	.00	582.37	790.54

*SECNO 35.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.62

35.000	10.68	6959.38	.00	.00	6960.13	.75	1.74	.00	6955.00
26300.0	386.5	25911.6	1.9	134.3	3709.4	1.9	176.4	34.3	6958.50
.08	2.88	6.99	.98	.035	.030	.035	.000	6948.70	153.67
.001619	700.	705.	700.	2	0	0	.00	630.74	784.40

*SECNO 30.100

30.100	8.42	6960.42	.00	.00	6961.21	.80	1.09	.00	6960.00
26300.0	1.0	25839.4	459.7	1.2	3572.4	228.1	221.1	48.6	6956.00
.10	.83	7.23	2.01	.035	.030	.035	.000	6952.00	129.37
.003124	495.	490.	1140.	3	0	0	.00	1310.98	1440.35

*SECNO 24.950

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.32

24.950	8.56	6961.56	.00	.00	6961.81	.24	.59	.00	6960.00
26300.0	565.3	25322.2	412.5	423.0	6275.8	320.1	286.1	65.9	6960.00
.14	1.34	4.03	1.29	.035	.030	.035	.000	6953.00	502.87
.000580	560.	520.	540.	2	0	0	.00	1537.36	2040.22

*SECNO 15.050

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.90 Data File: A[illegible]7.HC2

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

p. 23/40

3301 HV CHANGED MORE THAN HVINS

3665 10 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

15.050	4.03	6963.03	6963.03	.00	6964.48	1.45	1.63	.00	6960.00
26300.0	1278.6	4706.1	20315.3	220.7	385.9	2215.6	403.1	96.5	6960.00
.17	5.79	12.19	9.17	.035	.030	.035	.000	6959.00	544.43
.010687	910.	990.	1190.	20	14	0	.00	986.69	1531.12

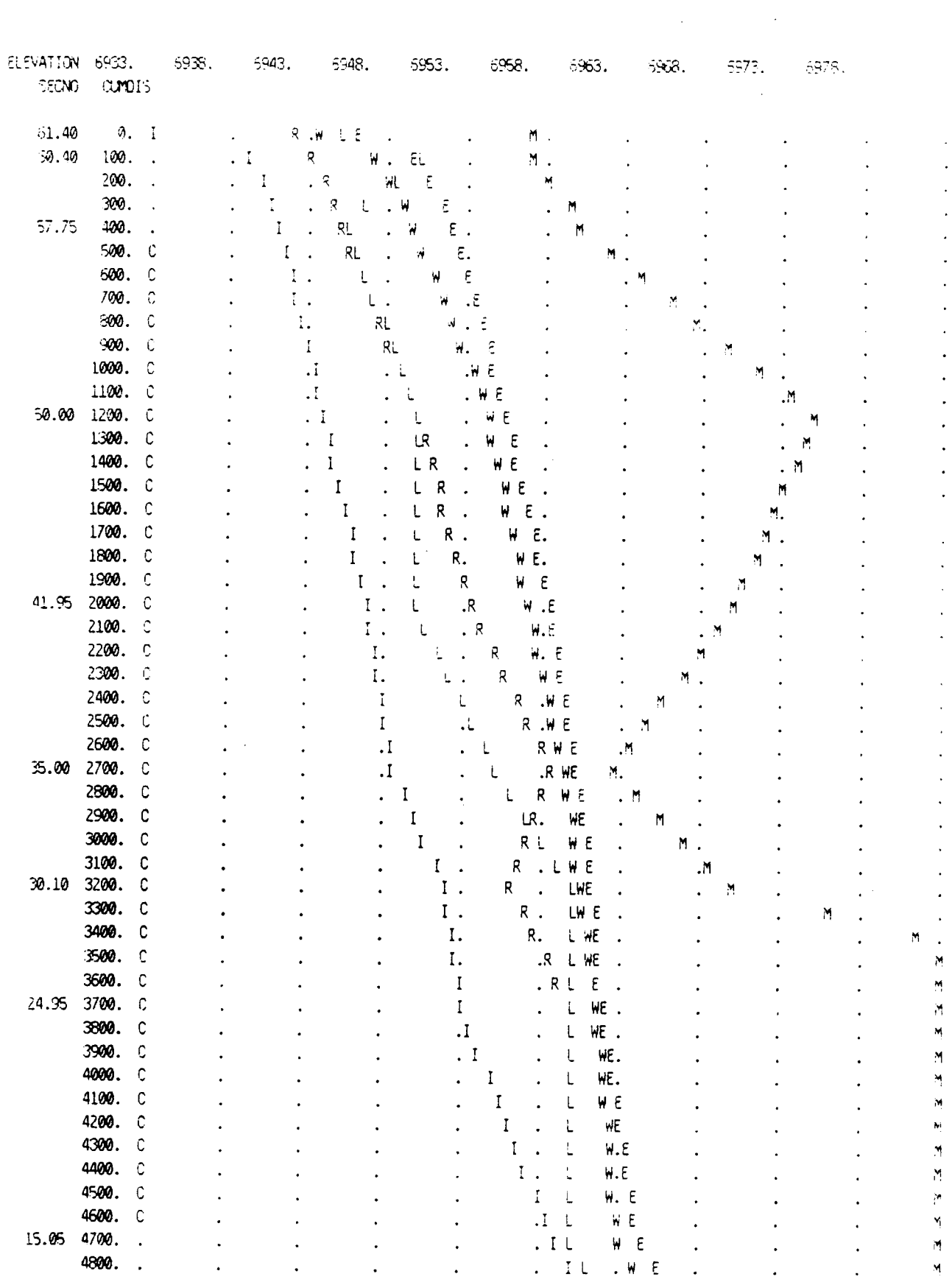
*SECNO 4.850
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

4.850	6.56	6974.56	6974.56	.00	6976.23	1.67	9.01	.00	6970.00
26300.0	5277.9	18544.5	2477.6	851.3	1586.5	399.7	471.1	119.0	6970.00
.20	6.20	11.69	6.20	.035	.030	.035	.000	6968.00	446.36
.007113	1035.	1022.	1070.	3	14	0	.00	884.08	1330.43

PROFILE FOR STREAM INE ARROYO SUBCRITICAL F

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

p.29/40



```
      5100.
      5200.
      5300.
      5400.
      5500.
      5600.
4.35  5700.
```

p. 30/40

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

THIS RUN EXECUTED 11/12/90 17:45:16

****

HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

p. 31/40

ERROR CORR - 01.02.03.04
MODIFICATION -

****

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

INE ARROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	61.400	.00	.00	.00	6933.00	26300.00	6943.31	6943.31	6945.76	77.47	12.57	2096.43	2988.09
	60.400	100.00	.00	.00	6939.00	26300.00	6946.98	6946.98	6949.45	80.15	12.74	2099.36	2937.65
*	57.750	262.00	.00	.00	6941.00	26300.00	6949.64	6949.64	6952.05	75.89	12.64	2164.00	3018.39
*	50.000	775.00	.00	.00	6944.00	26300.00	6954.33	.00	6955.52	29.82	9.84	3232.31	4616.56
	41.950	805.00	.00	.00	6947.00	26300.00	6956.92	.00	6958.39	42.54	10.95	2364.02	4032.10
*	35.000	705.00	.00	.00	6948.70	26300.00	6959.38	.00	6960.13	16.19	6.99	3645.67	[illegible]
	30.100	490.00	.00	.00	6952.00	26300.00	6960.42	.00	6961.21	31.24	7.23	3801.67	4705.80
*	24.950	520.00	.00	.00	6953.00	26300.00	6961.56	.00	6961.81	5.80	4.03	7018.95	10918.06
*	15.050	990.00	.00	.00	6959.00	26300.00	6963.03	6963.03	6964.48	106.87	12.19	2922.25	2544.09
*	4.850	1022.00	.00	.00	6968.00	26300.00	6974.56	6974.56	6976.23	71.13	11.69	2837.44	3118.29

Run Date: 11/12/90 Run Time: 17:45: 6 HMVersion: 5.30 Data File: ALT7.HC2

ARROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

p. 32/40

	SECNO	Q	WSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	61.400	26300.00	6943.31	.00	.00	-6.69	429.74	.00
*	60.400	26300.00	6946.98	.00	3.66	.00	437.40	100.00
*	57.750	26300.00	6949.64	.00	2.66	.00	472.84	262.00
*	50.000	26300.00	6954.33	.00	4.69	.00	609.72	775.00
	41.950	26300.00	6956.92	.00	2.59	.00	532.37	805.00
*	35.000	26300.00	6959.38	.00	2.46	.00	630.74	705.00
	30.100	26300.00	6960.42	.00	1.03	.00	1310.98	490.00
*	24.950	26300.00	6961.56	.00	1.15	.00	1537.36	520.00
*	15.050	26300.00	6963.03	.00	1.47	.00	986.69	990.00
	4.850	26300.00	6974.56	.00	11.52	.00	684.08	1022.00

```
*************************************************
*  WATER SURFACE PROFILES                       *
   VERSION OF SEPTEMBER 1988                    *
   ERROR: 01,02,03,04                           *
   UPDATED:  JUNE 1990                          *
*  RUN DATE    11/26/90      TIME   15:16:43    *
*************************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*                                   *
*************************************
```

P. 33/40

```
X     X  XXXXXXX   XXXXX             XXXXX
X     X  X       X     X           X     X
X     X  X       X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X       X                 X
X     X  X       X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

```
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
:::                                       :::
:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
```

```
============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

END OF BANNER

Run Date: 11/26/90 Run Time: 15:16:43 HMVersion: 5.30 Data File: re3old.hc2

THIS RUN EXECUTED 11/26/90 15:16:43

p.34/40

```
*********************************************
  HEC2 RELEASE DATED SEP 88 UPDATED JUN  1990

  ERROR CORR -  01,02,03,04
  MODIFICATION -
*********************************************
```

T1 ALTERNATIVE #8B-PRESENT REACH 3--Q=26300 CFS
T2 UNC PROJECT NO. 86-060-24 RESP. TO NRC COMMENTS 10/17/90
T3 REACH 3 - SUPERCRITICAL FLOW

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	0	0	1	0.015	0	0	26300	6956	

NC	0.035	0.035	0.03							
X1	57.75	17	145	540	270	285	262			
GR	6960	0	6955	35	6950	90	6945.5	145	6941	160
GR	6941	180	6945	195	6945	230	6945	270	6945	295
GR	6945	330	6945	375	6946	540	6953.5	580	6953.5	620
GR	6960	655	6960	755						
X1	60.40	9	110	520	160	130	100			
GR	6960	0	6950	110	6939	120	6939	140	6941.5	145
GR	6943	520	6952	560	6952	600	6962	640		
X1	61.40	16	250	660	60	200	95			
GR	6960	0	6955	55	6950	127	6945	250	6940	260
GR	6935	270	6933	275	6933	295	6937	297	6937	480
GR	6942	600	6942	650	6942	660	6951.9	710	6951.9	750
GR	6960	795								
X1	62.30	23	250	330	265	110	150			
GR	6960	0	6955	35	6950	85	6945	155	6945	175
GR	6940	250	6935	260	6930	265	6922	280	6922	300
GR	6930	320	6935	330	6935	395	6933.8	420	6935	435
GR	6939	476	6939	595	6940	620	6940	655	6940.7	717
GR	6950.5	769.9	6950.5	809.9	6957	845				
X1	63.80	20	300	335	1080	1015	1005			
GR	6960	0	6955	60	6950	90	6945	105	6940	180
GR	6935	245	6925	250	6920	270	6925	300	6902	305
GR	6902	325	6925	330	6930	335	6935	375	6939	575
GR	6940	655	6940.7	728.5	6950.5	777.5	6950.5	817.5	6957	850
X1	73.80	20	650	735	850	595	630			
GR	6960	0	6955	40	6950	105	6945	240	6945	340
GR	6945	350	6940	450	6930	605	6925	625	6900	650
GR	6880	670	6880	690	6900	735	6920	757	6925	960
GR	6935	1075	6934	1180	6940	1210	6940	1250	6957	1335

Run Date: 11/26/90 Run Time: 15:16:43 HMVersion: 5.30 Data File: re3old.hc2

X1	80.10	15	325	440	290	330	275			
GR	6925	0	6920	140	6920	270	6915	280	6910	290
GR	6905	310	6900	325	6874.3	380	6874.3	400	6900	440
GR	6912	480	6925	790	6928	900	6928	1072	6957	1275
X1	82.90	19	480	645	0	0	0			
GR	6925	0	6920	115	6915	200	6910	460	6905	470
GR	6900	480	6871	510	6871	530	6900	645	6905	655
GR	6905	705	6905	860	6899	900	6899	935	6926	1100
GR	6930	1180	6940	1195	6950	1205	6960	1215		

p. 35/40

Run Date: 11/26/90 Run Time: 15:16:43 HNVersion: 5.30 Data File: re3old.hc2

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

*PROF 1

p. 36/40

*SECNO 57.750

57.750	8.01	6949.01	6949.95	6956.00	6952.71	3.70	.00	.00	6945.50
26300.0	567.8	25569.2	162.9	75.3	1637.6	24.2	.0	.0	6946.00
.00	7.54	15.61	6.75	.035	.030	.035	.000	6941.00	102.10
.014977	0.	0.	0.	0	14	6	.00	453.95	556.05

*SECNO 60.400

3301 HV CHANGED MORE THAN HVINS

60.400	7.83	6946.83	6947.12	.00	6949.64	2.81	3.07	.00	6950.00
26300.0	.0	26096.7	203.3	.0	1933.5	32.5	11.2	2.7	6943.00
.01	.00	13.50	6.25	.000	.030	.035	.000	6939.00	112.88
.009423	270.	262.	285.	3	5	0	.00	424.12	537.01

*SECNO 61.400

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.79

61.400	8.27	6941.27	6943.38	.00	6948.09	6.82	1.55	.00	6945.00
26300.0	.0	26300.0	.0	.0	1255.1	.0	14.9	3.5	6942.00
.01	.00	20.95	.00	.000	.030	.000	.000	6933.00	257.45
.030088	160.	100.	130.	7	11	0	.00	325.12	582.57

*SECNO 62.300

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .59

62.300	16.70	6938.70	6941.51	.00	6946.35	7.65	1.73	.00	6940.00
26300.0	.0	21368.2	4931.8	.0	885.4	483.1	18.3	4.3	6935.00
.01	.00	24.13	10.21	.000	.030	.035	.000	6922.00	252.59
.010444	60.	95.	200.	8	17	0	.00	220.36	472.96

Run Date: 11/26/90 Run Time: 15:16:43 HNVersion: 5.30 Data File: re3old.hc2

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

*SECNO 63.800

3301 HV CHANGED MORE THAN HVINS

p.37/40

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, XRATIO = 1.59

63.800	24.89	6926.89	6931.98	.00	6943.91	17.01	2.45	.00	6925.00
26300.0	4035.3	22264.7	.0	221.0	633.8	.0	22.2	4.8	6930.00
.01	18.26	35.13	.00	.035	.030	.000	.000	6902.00	249.05
.026521	265.	150.	110.	7	14	0	.00	82.85	331.90

*SECNO 73.800

3301 HV CHANGED MORE THAN HVINS

73.800	15.91	6895.91	6901.95	.00	6916.09	20.18	27.82	.00	6900.00
26300.0	.0	26300.0	.0	.0	729.5	.0	40.7	6.6	6900.00
.02	.00	36.05	.00	.000	.030	.000	.000	6880.00	654.09
.028576	1080.	1005.	1015.	6	15	0	.00	71.71	725.80

*SECNO 80.100

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, XRATIO = .70

80.100	18.08	6892.38	6895.78	.00	6903.90	11.53	12.19	.00	6900.00
26300.0	.0	26300.0	.0	.0	965.3	.0	52.9	7.8	6900.00
.02	.00	27.25	.00	.000	.030	.000	.000	6874.30	341.32
.013964	850.	630.	595.	6	11	0	.00	86.81	428.13

*SECNO 82.900

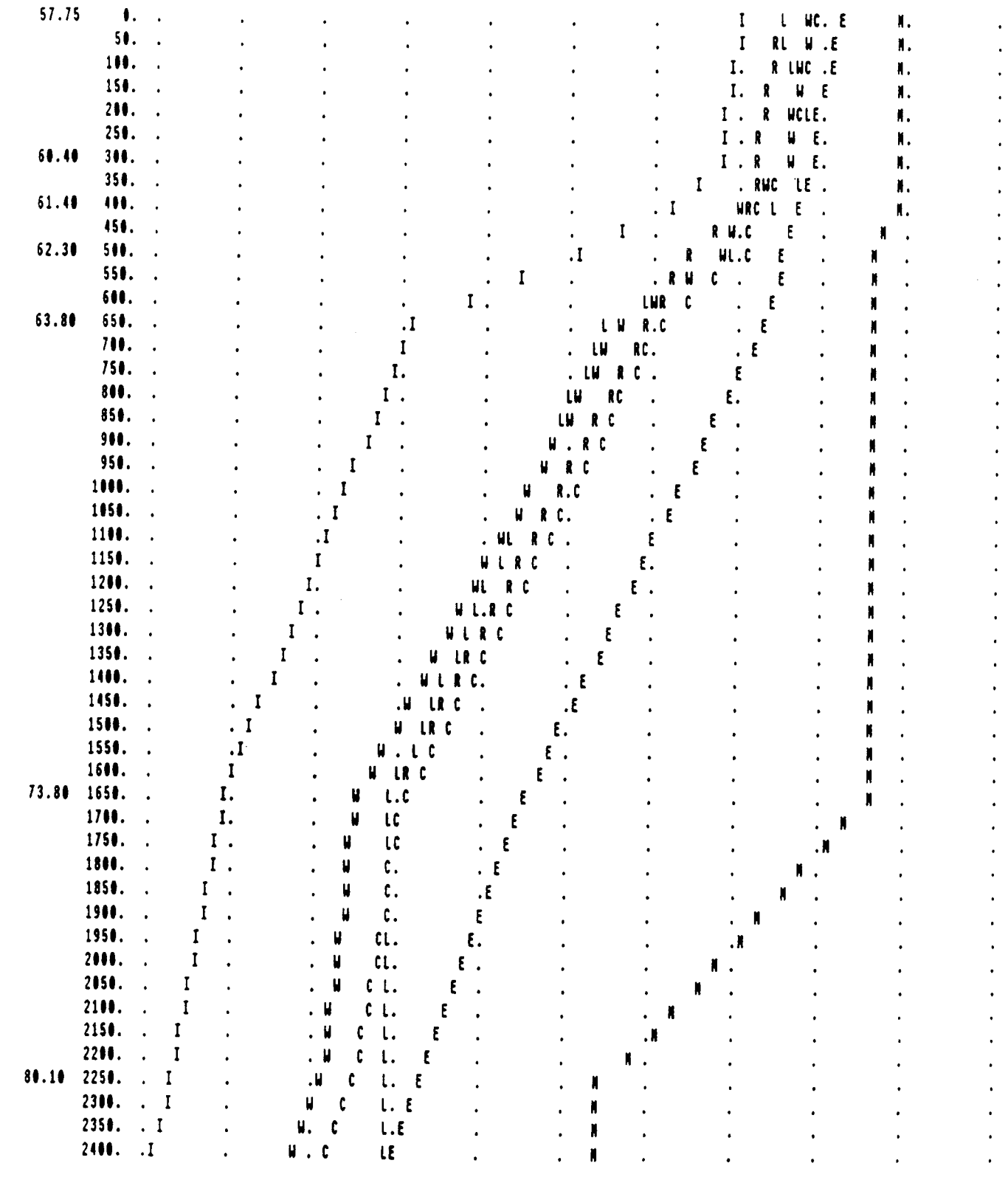
3301 HV CHANGED MORE THAN HVINS

82.900	15.51	6886.51	6890.63	.00	6899.43	12.92	4.47	.00	6900.00
26300.0	.0	26300.0	.0	.0	911.8	.0	58.9	8.4	6900.00
.03	.00	28.84	.00	.000	.030	.000	.000	6871.00	493.95
.019177	290.	275.	330.	7	8	0	.00	97.56	591.51

PROFILE FOR STREAM 3 - SUPERCRITICAL FLOW

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,N-LOWER END STA

p. 38/40



```
        2500.  .        .    W    .      C.        .        .    A    .        .        .        .
  82.90 2550.  I        .    W         EL.        .        .    N    .        .        .        .
```


Run Date: 11/26/90 Run Time: 15:16:43 HNVersion: 5.30 Data File: re3old.hc2

THIS RUN EXECUTED 11/26/90 15:16:50

****
HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

p. 39/40

ERROR CORR - 01,02,03,04
MODIFICATION -
****

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

3 - SUPERCRITICAL FLOW

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	57.750	.00	.00	.00	6941.00	26300.00	6949.01	6949.95	6952.71	149.77	15.61	1737.04	2149.01
	60.400	262.00	.00	.00	6939.00	26300.00	6946.83	6947.12	6949.64	94.23	13.50	1966.05	2709.27
*	61.400	100.00	.00	.00	6933.00	26300.00	6941.27	6943.38	6948.09	300.88	20.95	1255.08	1516.20
*	62.300	95.00	.00	.00	6922.00	26300.00	6938.70	6941.51	6946.35	104.44	24.13	1368.54	2573.47
*	63.800	150.00	.00	.00	6902.00	26300.00	6926.89	6931.98	6943.91	265.21	35.13	854.82	1614.95
	73.800	1005.00	.00	.00	6880.00	26300.00	6895.91	6901.95	6916.09	285.76	36.05	729.54	1555.81
*	80.100	630.00	.00	.00	6874.30	26300.00	6892.38	6895.78	6903.90	139.64	27.25	965.30	2225.64
	82.900	275.00	.00	.00	6871.00	26300.00	6886.51	6890.63	6899.43	191.77	28.84	911.82	1899.17

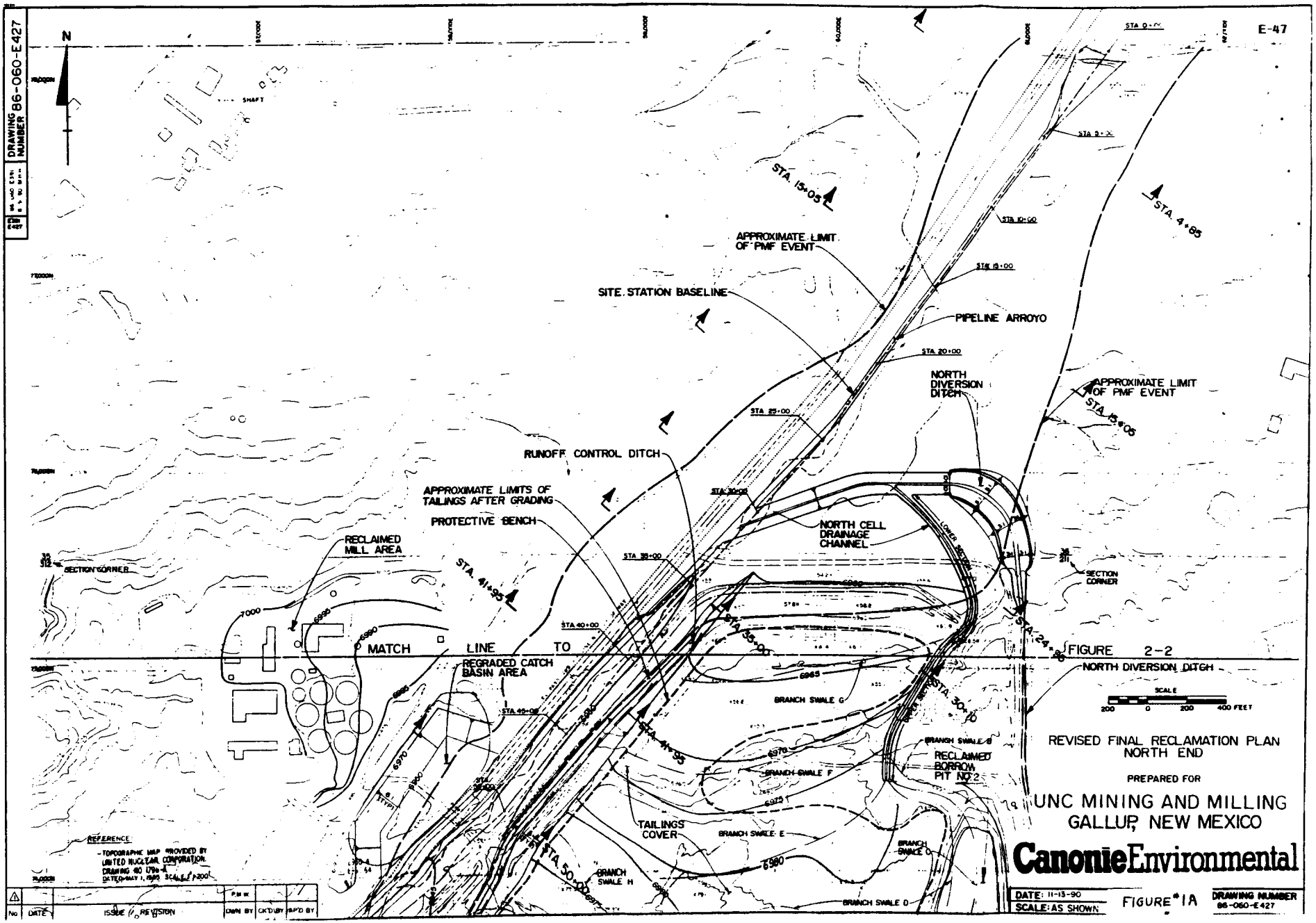
Run Date: 11/26/90 Run Time: 15:16:43 HMVersion: 5.30 Data File: re3old.hc2

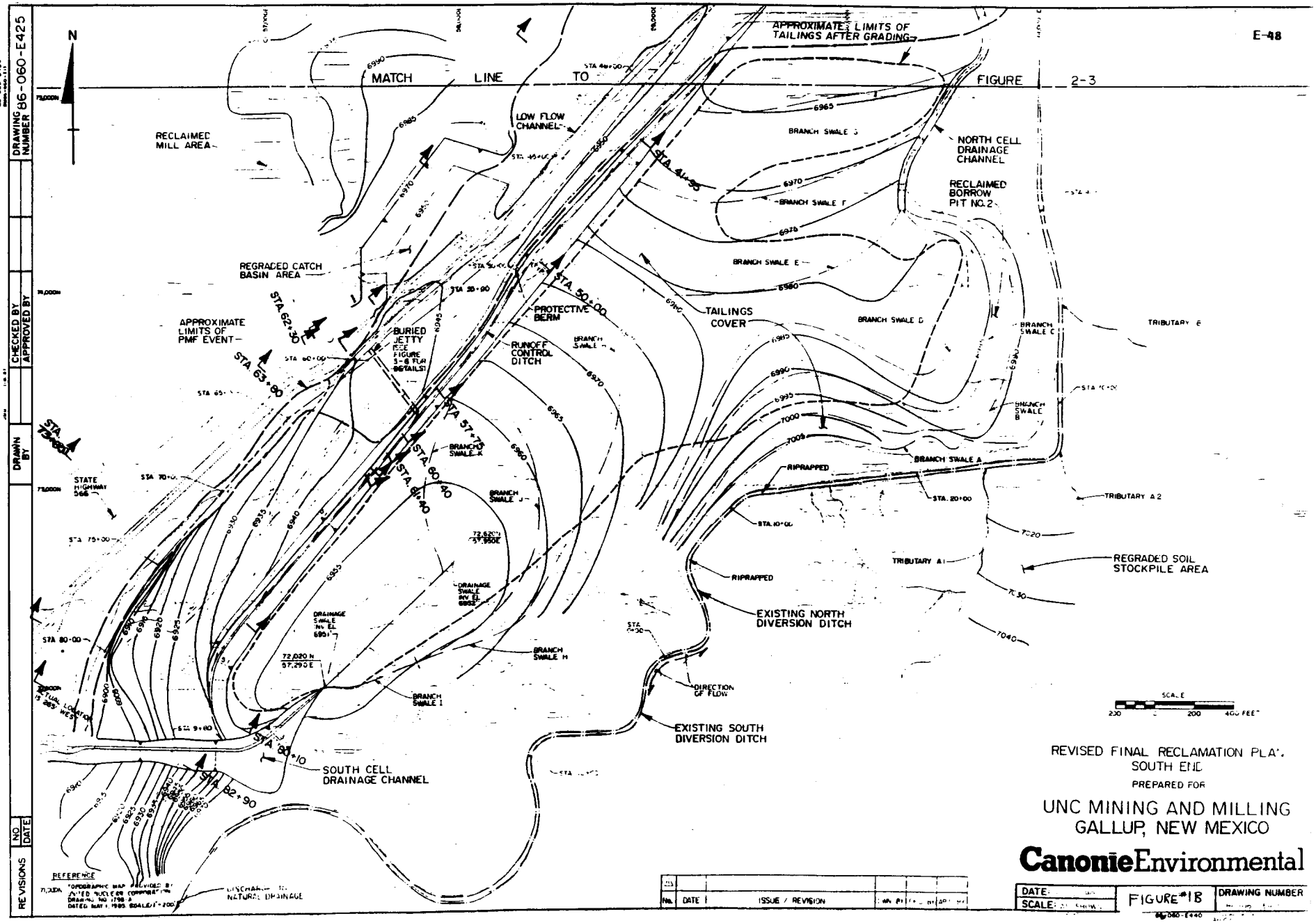
3 - SUPERCRITICAL FLOW

SUMMARY PRINTOUT TABLE 150

p. 40/40

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	57.750	26300.00	6949.01	.00	.00	-6.99	453.95	.00
	60.400	26300.00	6946.83	.00	-2.18	.00	424.12	262.00
*	61.400	26300.00	6941.27	.00	-5.56	.00	325.12	100.00
*	62.300	26300.00	6938.70	.00	-2.57	.00	220.36	95.00
*	63.800	26300.00	6926.89	.00	-11.81	.00	82.85	150.00
	73.800	26300.00	6895.91	.00	-30.98	.00	71.71	1005.00
*	80.100	26300.00	6892.38	.00	-3.54	.00	86.81	630.00
	82.900	26300.00	6886.51	.00	-5.86	.00	97.56	275.00


N
SHAFT
STA 15+05
APPROXIMATE LIMIT OF PMF EVENT
SITE STATION BASELINE
PIPELINE ARROYO
STA 20+00
NORTH DIVERSION DITCH
APPROXIMATE LIMIT OF PMF EVENT
STA 4+85
STA 15+05
STA 25+00
RUNOFF CONTROL DITCH
APPROXIMATE LIMITS OF TAILINGS AFTER GRADING
PROTECTIVE BENCH
NORTH CELL DRAINAGE CHANNEL
RECLAIMED MILL AREA
SECTION CORNER
STA 41+95
STA 35+00
STA 40+00
MATCH LINE TO
REGRADED CATCH BASIN AREA
STA 24+85
FIGURE 2-2
NORTH DIVERSION DITCH
SCALE
200 0 200 400 FEET
BRANCH SWALE G
STA 30+70
BRANCH SWALE B
RECLAIMED BORROW PIT NO. 2
BRANCH SWALE F
TAILINGS COVER
BRANCH SWALE E
BRANCH SWALE C
BRANCH SWALE H
BRANCH SWALE D
STA 50+00
REFERENCE
- TOPOGRAPHIC MAP PROVIDED BY UNITED NUCLEAR CORPORATION DRAWING NO 1796-4 DATED MAY 1, 1985 SCALE 1"=200'
DRAWING NUMBER 86-060-E427
REVISED FINAL RECLAMATION PLAN
NORTH END
PREPARED FOR
UNC MINING AND MILLING
GALLUP, NEW MEXICO
Canonie Environmental
DATE: 11-13-90
SCALE: AS SHOWN
FIGURE #1A
DRAWING NUMBER 86-060-E427
No DATE ISSUE / REVISION DWN BY CK'D BY APP'D BY



REVISED FINAL RECLAMATION PLAN
SOUTH END

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

E.1(c)

HEC-2 Analysis for Low Flow Channel at the Buried Jetty

Canonie Environmental

E-50

By SWM Date 11-8-90 Subject UNC Sheet No. 1 of

Chkd. By [illegible] Date 12/3/90 PIPELINE ARROYO HEC-2 ANALYSIS OF LOW FLOW CHANNEL AT BURIED JETTY Proj. No. 86-060-24

1/4" X 1/4"

PURPOSE: TO COMPUTE THE DISCHARGE (Q) AT WHICH THE STORMWATER WILL OVERTOP THE LOW-FLOW CHANNEL AND CONTACT THE BURIED JETTY (SEE FIGURE #1). THIS ANALYSIS WILL BE PERFORMED FOR THE RECOMMENDED REDESIGN ALTERNATIVE (i.e. HEC-2 ALTERNATIVE #7).

METHOD: PERFORM A TRIAL AND ERROR ANALYSIS USING THE HEC-2 DATA FILE THAT DESCRIBES THE ALTERNATIVE #7 CHANNEL CONFIGURATION (SEE PAGE 5 FOR SUMMARY OF ALTERNATIVE #7). THE INPUT DISCHARGE WILL BE VARIED TO PRODUCE A DISCHARGE VS. WATER SURFACE ELEVATION CURVE (SEE FIGURE 2)

NOTE: THE PROPOSED JETTY WILL BE LOCATED AT STATION 59+50. THIS IS IN CLOSE PROXIMITY TO THE HEC-2 CROSS-SECTION AT STATION 60+40. THEREFORE IT IS ASSUMED THAT THE WATER SURFACE ELEVATIONS AT THESE STATIONS ARE EQUIVALENT (i.e. THE HEC-2 DATA FOR STATION 60+40 IS REPRESENTATIVE OF STATION 59+50)

By SWM Date 11-8-90 Subject UNC Sheet No. ___ of 2

Chkd. By [illegible] Date 12/5/90 Proj. No. 86-060-29

1/4" X 1/4"

RESULTS:

THE CHANNEL IS OVERTOPPED AT ELEVATION 6993', WHICH OCCURS AT A DISCHARGE Q = 2250 CFS.

THE HEC-2 OUTPUT FOR Q_{INPUT} = 2250 CFS IS INCLUDED IN THIS CALC BRIEF.

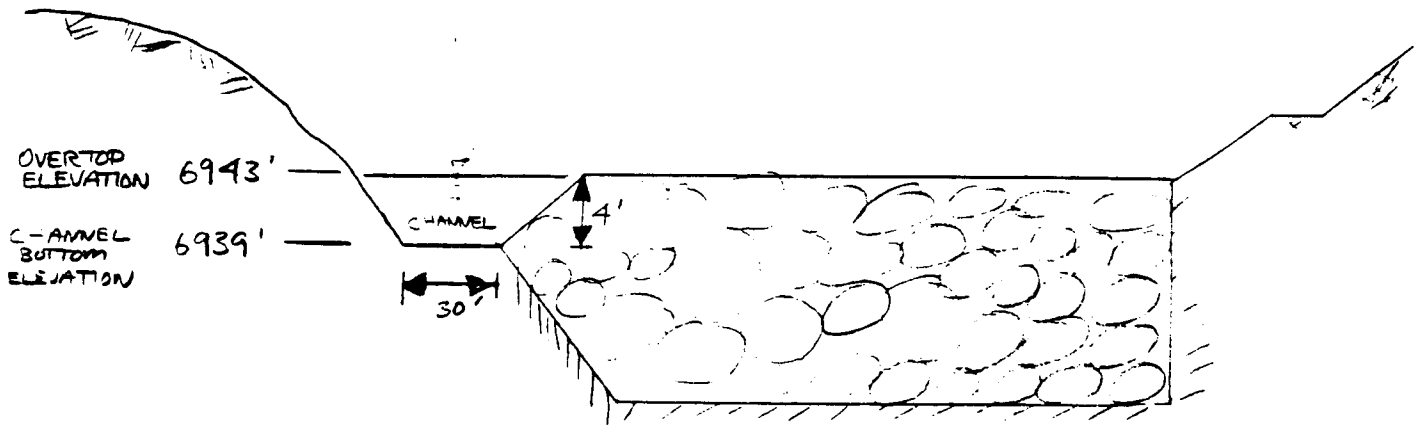
Canonie Environmental

E-52

By SWM Date 11-8-90 Subject UNC Sheet No. 3 of

Chkd. By mm Date 12/3/90 FIGURE # 1 Proj. No. 86-060-24

1/4" X 1/4"



STATION 5950'

FIGURE 1

Canonie Environmental

E-53

By SWM Date 11-8-90 Subject UNC Sheet No. 4 of

Chkd. By [illegible] Date 12/3/90 FIGURE 2 Proj. No. 86-060-29

1/4" X 1/4"

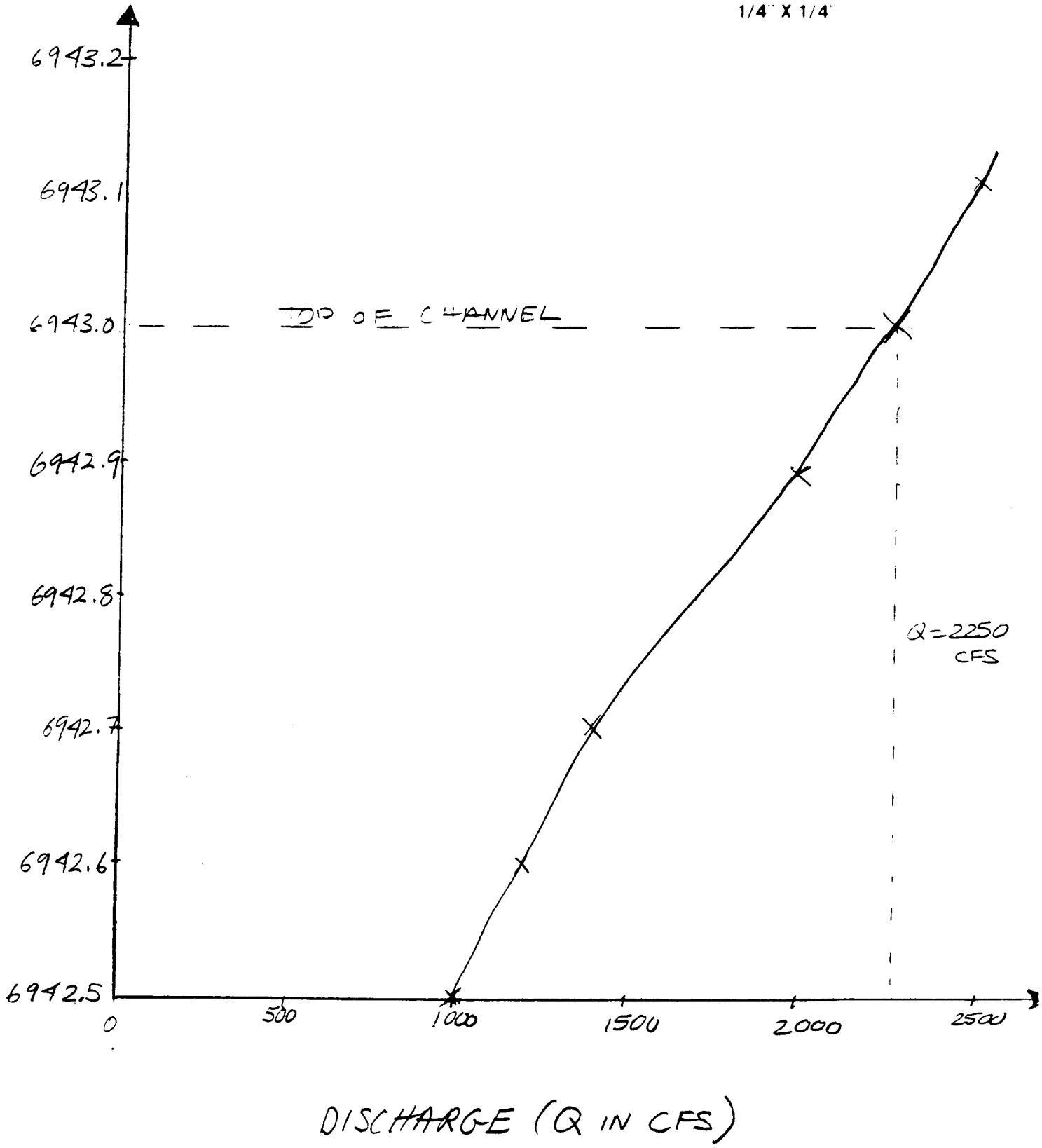


FIGURE 2

Canonie Environmental

E-50

By SWM Date 11-8-90 Subject UNC Sheet No. 1 of

Chkd. By mm Date 12/3/90 PIPELINE ARROYO HEC-2 ANALYSIS OF LOW FLOW CHANNEL AT BURIED JETTY Proj. No. 86-060-24

1/4" X 1/4"

PURPOSE: TO COMPUTE THE DISCHARGE (Q) AT WHICH THE STORMWATER WILL OVERTOP THE LOW-FLOW CHANNEL AND CONTACT THE BURIED JETTY (SEE FIGURE #1). THIS ANALYSIS WILL BE PERFORMED FOR THE RECOMMENDED REDESIGN ALTERNATIVE (i.e. HEC-2 ALTERNATIVE #7).

METHOD: PERFORM A TRIAL AND ERROR ANALYSIS USING THE HEC-2 DATA FILE THAT DESCRIBES THE ALTERNATIVE #7 CHANNEL CONFIGURATION (SEE PAGE 5 FOR SUMMARY OF ALTERNATIVE #7). THE INPUT DISCHARGE WILL BE VARIED TO PRODUCE A DISCHARGE VS. WATER SURFACE ELEVATION CURVE (SEE FIGURE 2)

NOTE: THE PROPOSED JETTY WILL BE LOCATED AT STATION 59+50. THIS IS IN CLOSE PROXIMITY TO THE HEC-2 CROSS-SECTION AT STATION 60+40. THEREFORE IT IS ASSUMED THAT THE WATER SURFACE ELEVATIONS AT THESE STATIONS ARE EQUIVALENT (i.e. THE HEC-2 DATA FOR STATION 60+40 IS REPRESENTATIVE OF STATION 59+50)

By SWM Date 11-8-90 Subject UNC Sheet No. ___ of 2

Chkd. By [illegible] Date 12/3/90 Proj. No. 86-060-27

1/4" X 1/4"

RESULTS:

THE CHANNEL IS OVERTOPPED AT ELEVATION 6943', WHICH OCCURS AT A DISCHARGE Q = 2250 CFS.

THE HEC-2 OUTPUT FOR Q_{INPUT} = 2250 CFS IS INCLUDED IN THIS CALC BRIEF.

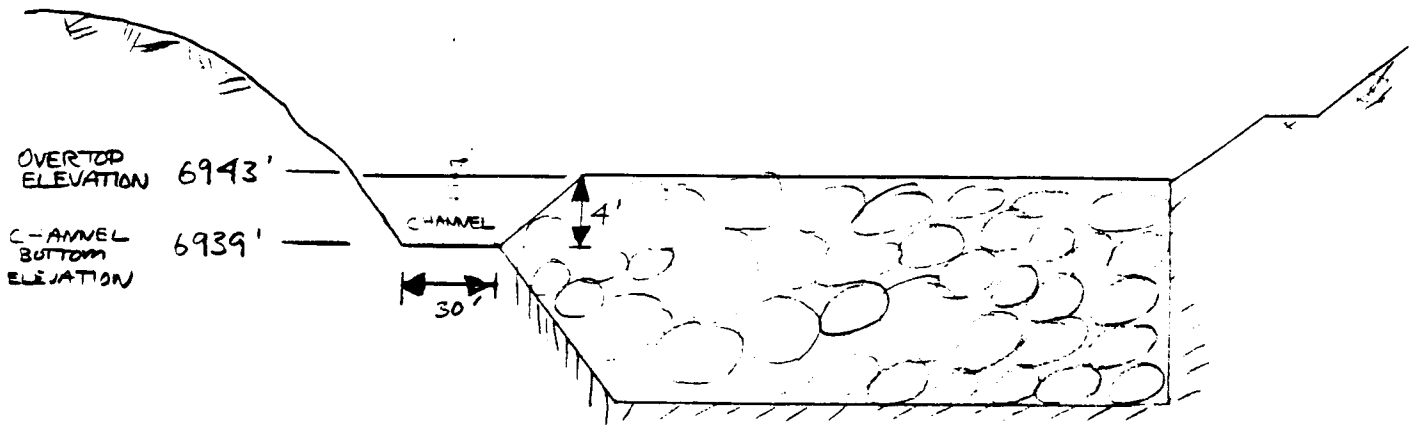
Canonie Environmental

E-52

By SWM Date 11-8-90 Subject UNC Sheet No. 3 of

Chkd. By mym Date 12/5/90 FIGURE # 1 Proj. No. 86-060-24

1/4" X 1/4"



STATION 5950'

FIGURE 1

Canonie Environmental

E-53

By SVM Date 11-8-90 Subject UNC Sheet No. 4 of

Chkd. By [illegible] Date 12/3/90 FIGURE 2 Proj. No. 86-060-29

1/4" X 1/4"

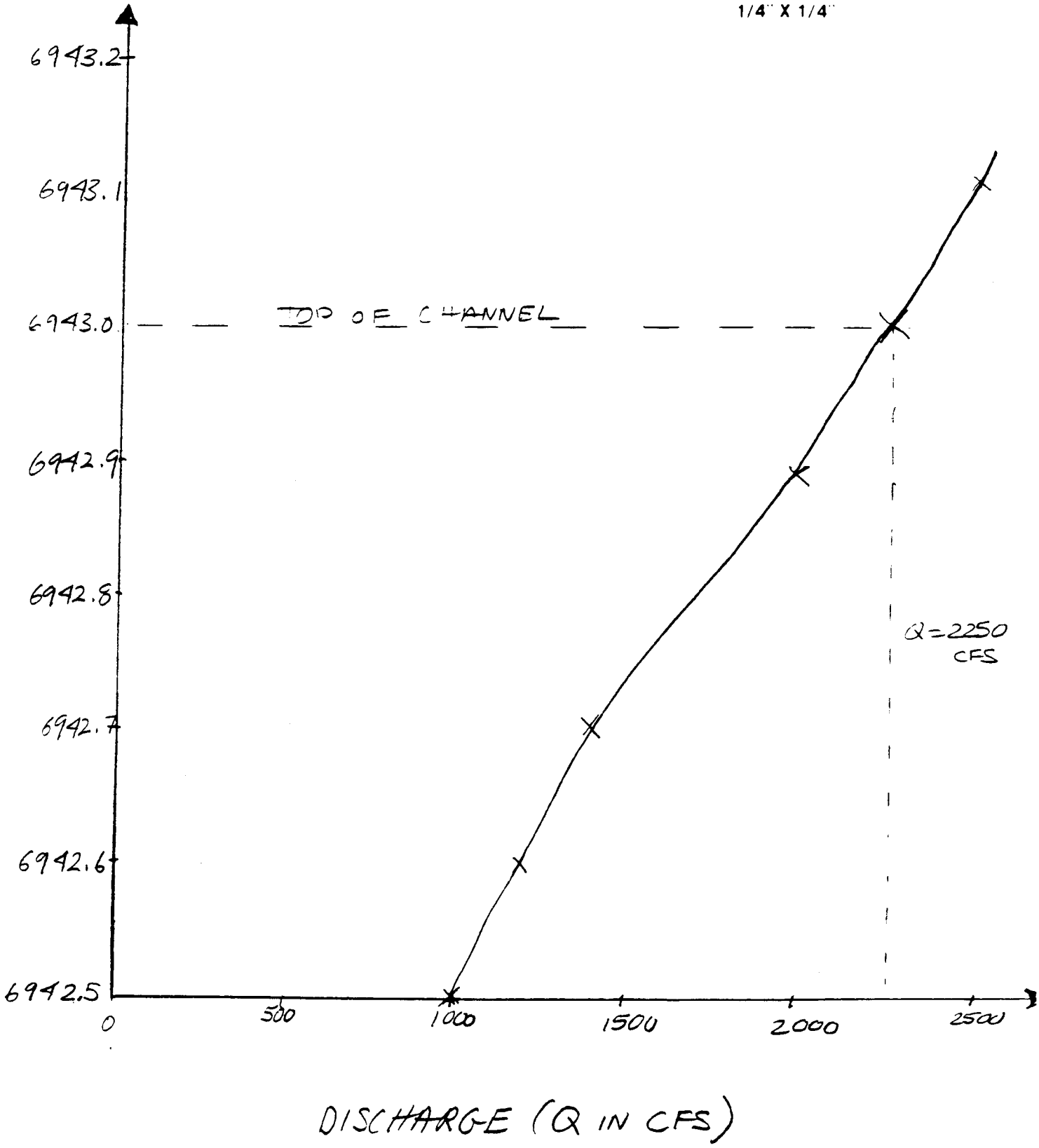


FIGURE 2

Summary of Alternative #7:

In Alternative #7, the channel is modified only slightly from the existing configuration as follows:

- ensure a 30' wide, 2' deep channel bottom from Sta 5+00 to Sta 61+70 (i.e. low-flow channel)
- Fill existing depressions and headcuts
- a stone filled trench (jetty) will be installed at Sta 59+50 to reinforce the Nickpoint and maintain shallow upstream slopes.
- a 40' wide protective bench will be constructed at the tailings embankment toe which would protect the embankment and tailings during the PMF.

2/3/92


```
*****************************************************
*  WATER SURFACE PROFILES                           *
*  VERSION OF SEPTEMBER 1988                        *
   ERROR: 01.02.03.04                               *
   UPDATED:  JUNE 1990                              *
*  RUN DATE    11/26/90      TIME   17:12:29        *
*****************************************************
```

```
*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*                                       *
*****************************************
```

```
X    X XXXXXXX  XXXXX          XXXXX
X    X X      X    X        X    X
X    X X      X                   X
XXXXXXX XXXX   X       XXXXX  XXXXX
X    X X      X              X
X    X X      X    X         X
X    X XXXXXXX  XXXXX         XXXXXXX
```

BY: SWM
11-8-90

p. 6

```
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  FULL MICRO-COMPUTER IMPLEMENTATION  :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

HAESTAD METHODS

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

END OF BANNER

ALTERNATIVE # 7
RUN FOR
Q = 2250 cfs

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

✓ 12/3/90

THIS RUN EXECUTED 11/26/90 17:12:29

****

HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

ERROR CORR - 01.02.03.04
MODIFICATION -

****

C. 7

T1 ALTERNATIVE #7--REACH 1&2-[redacted]
T2 UNC PROJECT NO. 86-060-24 RESP. TO NRC COMMENTS 11/7/90
T3 PIPELINE ARROYO SUBCRITICAL FLOW

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	0	0	0	0.04	0	0	2250	6950	0

NC	0.035	0.035	0.03							
X1	61.40	17	250	676	0	0	0			
GR	6960	0	6955	55	6950	127	6945	250	6940	260
GR	6935	270	6933	275	6933	300	6937	310	6937	480
GR	6942	600	6942	650	6942	660	6942	676	6951.5	727.5
GR	6951.5	767.5	6957	792						
X1	60.40	10	110	515	160	130	100			
GR	6960	0	6950	110	6939	115	6939	140	6941.5	145
GR	6943	515	6943	530	6952	572.5	6952	612.5	6957	632
X1	57.75	16	145	543	270	295	262			
GR	6960	0	6955	35	6950	90	6945.5	145	6941	155
GR	6941	185	6945	195	6945	230	6945	270	6945	295
GR	6945	330	6945	375	6945	543	6953.5	587.5	6953.5	627.5
GR	6960	660								
X1	50.00	14	455	712	750	850	775			
GR	6975	0	6970	10	6965	30	6960	100	6950	140
GR	6950	320	6950	455	6944	532	6944	562	6950	650
GR	6950	712	6957	745	6957	785	6976	880		
X1	41.95	12	535	772	820	800	805			
GR	6970	0	6965	70	6960	165	6955	235	6950	535
GR	6947	557	6947	587	6953.5	700	6953.5	772	6960.5	810
GR	6960.5	850	6970	905						
X1	35.00	9	215	780	700	700	705			
GR	6970	0	6960	145	6955	215	6948.7	583	6948.7	603
GR	6958	710	6958.5	780	6962.5	800	6962.5	840		
1	30.10	21	135	980	495	1140	490			
GR	6970	0	6960	135	6955	565	6952	575	6952	605
GR	6955	615	6955	660	6955	765	6955	800	6955	850
GR	6955	880	6956	980	6958	990	6960	1000	6960	1070
GR	6962	1422	6962.4	1510	6964.5	1680	6966.5	1795	6968	1900
GR	6970	1910								

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

✓ mgj 12/3/90

X1	24.95	26	795	1800	560	540	520			
GR	7000	0	6990	45	6980	140	6970	275	6960	545
GR	6960	615	6960	795	6955	865	6953	865	6953	895
GR	6955	895	6955	1175	6955	1295	6955	1385	6955	1715
GR	6958	1770	6960	1800	6960	1970	6962	2060	6964	2070
GR	6966	2080	6968	2090	6970	2100	6980	2150	6990	2165
GR	7000	2230								

p. 8

X1	15.05	15	690	795	910	1180	990			
GR	7000	0	6990	35	6980	105	6970	210	6960	690
GR	6959	710	6959	740	6960	795	6960	1520	6975	1575
GR	6980	1600	6985	1620	6990	1645	6995	1660	7000	1690

X1	4.85	14	820	1155	1035	1070	1022			
GR	6980	0	6970	820	6970	890	6968	890	6968	920
GR	6970	920	6970	930	6970	950	6970	1000	6970	1030
GR	6970	1060	6970	1105	6970	1155	6980	1540		

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

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

*PROF 1

*SECNO 61.400
3720 CRITICAL DEPTH ASSUMED

61.400	4.79	6937.79	6937.79	6950.00	6938.58	.78	.00	.00	6945.00
2250.0	.0	2250.0	.0	.0	317.2	.0	.0	.0	6942.00
.00	.00	7.09	.00	.000	.030	.000	.000	6933.00	264.41
.013861	0.	0.	0.	0	17	0	.00	234.66	499.07

p. 9

*SECNO 60.400
3685 20 TRIALS ATTEMPTED WSEL.CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

60.400	4.02	6943.02	6943.02	.00	6943.50	.49	1.34	.00	6950.00
2250.0	.0	2249.9	.1	.0	401.8	.3	.8	.8	6943.00
.00	.00	5.60	.32	.000	.030	.035	.000	6939.00	113.17
.012921	160.	100.	130.	20	10	0	.00	416.91	530.08

SECNO 57.750

57.750	4.76	6945.76	.00	.00	6946.13	.37	2.63	.00	6945.50
2250.0	.4	2246.6	3.0	.4	461.1	1.5	3.4	3.2	6946.00
.02	.98	4.87	1.97	.035	.030	.035	.000	6941.00	141.79
.008000	270.	262.	295.	5	0	0	.00	406.20	546.99

*SECNO 50.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. KRATIO = 1.85

50.000	4.83	6948.83	.00	.00	6949.19	.36	3.06	.00	6950.00
2250.0	.0	2250.0	.0	.0	465.8	.0	11.7	8.3	6950.00
.06	.00	4.83	.00	.000	.030	.000	.000	6944.00	470.01
.002349	750.	775.	850.	5	0	0	.00	162.84	632.85

*SECNO 41.950

41.950	4.15	6951.15	.00	.00	6951.79	.64	2.60	.00	6950.00
2250.0	79.4	2170.6	.0	39.5	332.2	.0	19.4	11.6	6953.50
.10	2.01	6.53	.00	.035	.030	.000	.000	6947.00	466.15
.004698	820.	805.	800.	3	0	0	.00	192.95	659.10

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

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

*SECNO 35.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. KRATIO = 2.02

35.000	4.40	6953.10	.00	.00	6953.24	.14	1.45	.00	6955.00
2250.0	.0	2250.0	.0	.0	763.0	.0	28.6	15.8	6958.50
.17	.00	2.95	.00	.000	.030	.000	.000	6948.70	326.30
.001147	700.	705.	700.	2	0	0	.00	327.27	653.56

*SECNO 30.100
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

30.100	3.74	6955.74	6955.74	.00	6956.22	.48	1.38	.00	6960.00
2250.0	.0	2250.0	.0	.0	403.5	.0	35.2	20.2	6956.00
.19	.00	5.58	.00	.000	.030	.000	.000	6952.00	501.47
.014804	495.	490.	1140.	20	9	0	.00	452.41	953.88

*SECNO 24.950

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. KRATIO = 6.30

24.950	3.77	6956.77	.00	.00	6956.80	.03	.58	.00	6960.00
2250.0	.0	2250.0	.0	.0	1609.9	.0	47.2	28.3	6960.00
.29	.00	1.40	.00	.000	.030	.000	.000	6953.00	840.30
.000373	560.	520.	540.	5	0	0	.00	907.04	1747.34

*SECNO 15.050
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

15.050	1.61	6960.61	6960.61	.00	6960.92	.31	1.12	.00	6960.00
2250.0	18.2	799.9	1431.8	9.0	131.7	444.3	73.1	50.0	6960.00
.36	2.03	6.07	3.22	.035	.030	.035	.000	6959.00	660.63
.011109	910.	990.	1180.	20	12	0	.00	861.61	1522.24

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

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

*SECNO 4.850

4.850	3.00	6971.00	.00	.00	6971.41	.41	10.49	.00	6970.00
2250.0	106.5	2093.5	50.0	41.3	396.3	19.4	85.6	65.8	6970.00
.42	2.58	5.28	2.58	.035	.030	.035	.000	6968.00	737.68
.009235	1035.	1022.	1070.	5	0	0	.00	455.97	1193.65

P. 11

/ mvp? 3.90

PROFILE FOR STREAM INE ARROYO SUBCRITICAL F

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

p. 12

```
ELEVATION  6933.    6938.    6943.    6948.    6953.    6958.    6963.    6968.    6973.    6978.
   SECNO   CUMDIS

   61.40      0.  I        WE     R .  L    .        .      M .        .        .        .        .        .
   60.40    100.  .        . I      WE       .  L    .      M .        .        .        .        .        .
            200.  C        .  I    . WE     .L       .        M        .        .        .        .        .
            300.  C        .   I   .  RWE L .        .        .  M     .        .        .        .        .
   57.75    400.  C        .    I  .  RLE  .        .        .   M    .        .        .        .        .
            500.  C        .     I .   RWE .        .        .      M .        .        .        .        .
            600.  C        .      I .     WE .        .        .        . M      .        .        .        .
            700.  C        .      I .      WE.        .        .        .    M   .        .        .        .
            800.  C        .       I.       EL        .        .        .       M.        .        .        .
            900.  C        .        I       WEL       .        .        .        . M      .        .        .
           1000.  C        .        .I       WEL      .        .        .        .     M  .        .        .
           1100.  C        .        .I       .WEL     .        .        .        .        .M       .        .
   50.00   1200.  C        .        . I      . E L    .        .        .        .        .  M     .        .
           1300.  C        .        .  I     . WELR   .        .        .        .        .  M     .        .
           1400.  C        .        .  I     .  WE R  .        .        .        .        . M      .        .
           1500.  C        .        .   I    .  WE  R .        .        .        .        M        .        .
           1600.  C        .        .    I   .   WE R .        .        .        .       M.        .        .
           1700.  C        .        .     I  .   LWE R .        .        .        .      M .        .        .
           1800.  C        .        .     I  .   LWE  R.        .        .        .     M  .        .        .
           1900.  C        .        .      I .   L WE  R        .        .        .    M   .        .        .
   41.95   2000.  C        .        .       I .   L W E .R       .        .        .   M    .        .        .
           2100.  C        .        .       I .    L WE . R      .        .        . M      .        .        .
           2200.  C        .        .        I.      WE .   R    .        .        M        .        .        .
           2300.  C        .        .        I.       WE.    R   .        .      M .        .        .        .
           2400.  C        .        .         I       EL     R .        .    M   .        .        .        .
           2500.  C        .        .         I       WEL     R .        .  M     .        .        .        .
           2600.  C        .        .        .I       E  L     R        .M       .        .        .        .
   35.00   2700.  C        .        .        .I       E   L    .R      M.        .        .        .        .
           2800.  C        .        .        .  I     .WE   L   R        . M      .        .        .        .
           2900.  C        .        .        .   I    . WE    LR.        .    M   .        .        .        .
           3000.  C        .        .        .    I   .  WE   R L        .      M .        .        .        .
           3100.  C        .        .        .      I .    E R  . L      .        .M       .        .        .
   30.10   3200.  .        .        .        .       I .    WE   .   L    .        .   M    .        .        .
           3300.  C        .        .        .       I .     WER .   L    .        .        .    M   .        .
           3400.  C        .        .        .        I.     WE R.   L    .        .        .        .     M  .
           3500.  C        .        .        .        I.      E  .R  L    .        .        .        .        M
           3600.  C        .        .        .         I      E  . R L    .        .        .        .        M
   24.95   3700.  C        .        .        .         I       E .   L    .        .        .        .        M
           3800.  C        .        .        .        .I      E .   L    .        .        .        .        M
           3900.  C        .        .        .        . I      E.   L    .        .        .        .        M
           4000.  C        .        .        .        .   I     E   L    .        .        .        .        M
           4100.  C        .        .        .        .    I    .E  L    .        .        .        .        M
           4200.  C        .        .        .        .     I   .WE L    .        .        .        .        M
           4300.  C        .        .        .        .      I  . WEL    .        .        .        .        M
           4400.  C        .        .        .        .       I .  EL    .        .        .        .        M
           4500.  C        .        .        .        .         I   E    .        .        .        .        M
           4600.  C        .        .        .        .         .I  LE   .        .        .        .        M
   15.05   4700.  .        .        .        .        .         . I LWE  .        .        .        .        M
           4800.  C        .        .        .        .         .   I LWE .        .        .        .        M
```

```
5100. C      .      .      .      .      .      I. LWE    .      .      .      M
5200. C      .      .      .      .      .      .I  LWE  .      .      .      M
5300. C      .      .      .      .      .      .  I  LWE .      .      .      M
5400. C      .      .      .      .      .      .  I   LWE      .      .      M
5500. C      .      .      .      .      .      .    I   LWE    .      .      M
5600. C      .      .      .      .      .      .      I . L E  .      .      M.
.85 5700. C      .      .      .      .      .      .       I   L WE .      .  M   .
```

E-62

✓ [illegible] 12/3/90

p.13

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

✓ mjj 12/3/90

THIS RUN EXECUTED 11/26/90 17:12:37

****

HEC2 RELEASE DATED SEP 88 UPDATED JUN 1990

ERROR CORR - 01,02,03,04
MODIFICATION -

****

p. 14

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

INE ARROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	61.400	.00	.00	.00	6933.00	2250.00	6937.79	6937.79	6938.58	138.61	7.09	317.21	191.11
*	[redacted]	100.00	.00	.00	6939.00	[redacted]		6943.02	6943.50	129.21	5.60	402.01	197.94
	57.750	262.00	.00	.00	6941.00	2250.00	6945.76	.00	6946.13	80.00	4.87	463.00	251.55
*	50.000	775.00	.00	.00	6944.00	2250.00	6948.83	.00	6949.19	23.49	4.83	465.76	464.22
	41.950	805.00	.00	.00	6947.00	2250.00	6951.15	.00	6951.79	46.98	6.53	371.69	328.25
*	35.000	705.00	.00	.00	6948.70	2250.00	6953.10	.00	6953.24	11.47	2.95	763.04	664.28
*	30.100	490.00	.00	.00	6952.00	2250.00	6955.74	6955.74	6956.22	148.04	5.58	403.47	184.92
*	24.950	520.00	.00	.00	6953.00	2250.00	6956.77	.00	6956.80	3.73	1.40	1609.85	1165.44
*	15.050	990.00	.00	.00	6959.00	2250.00	6960.61	6960.61	6960.92	111.09	6.07	584.98	213.48
	4.850	1022.00	.00	.00	6968.00	2250.00	6971.00	.00	6971.41	92.35	5.28	457.03	234.13

Run Date: 11/26/90 Run Time: 17:12:29 HMVersion: 5.30 Data File: alt7.hc2

✓ mjm 12/3/90

ROYO SUBCRITICAL F

SUMMARY PRINTOUT TABLE 150

p. 15

	SECND	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	61.400	2250.00	6937.79	.00	.00	-12.21	234.66	.00
*	60.400	2250.00	6943.02	.00	5.22	.00	416.91	100.00
	57.750	2250.00	6945.76	.00	2.74	.00	406.20	262.00
*	50.000	2250.00	6948.83	.00	3.07	.00	162.84	775.00
	41.950	2250.00	6951.15	.00	2.32	.00	192.95	805.00
*	35.000	2250.00	6953.10	.00	1.96	.00	327.27	705.00
*	30.100	2250.00	6955.74	.00	2.63	.00	452.41	490.00
*	24.950	2250.00	6956.77	.00	1.03	.00	907.04	520.00
*	15.050	2250.00	6960.61	.00	3.84	.00	861.61	990.00
	4.850	2250.00	6971.00	.00	10.39	.00	455.97	1022.00

E.1(d)

Nickpoint Stability - Riprap Design for Jetty

Canonie Environmental

E-66

By SWM Date 12-3-90 Subject UNC Sheet No. 1 of 3

Chkd. By mp Date 12/3/90 Proj. No. 86-060-24

1/4" X 1/4"

PURPOSE: TO DETERMINE THE RIPRAP d_{50} FOR THE BURIED JETTY AT STA 59+50 OF THE RECOMMENDED PIPELINE ARROYO REDESIGN ALTERNATIVE (HEC-2 ALTERNATIVE #7).

METHOD: USE RIPSFHEC.WR1 (LOTUS SYMPHONY SPREADSHEET) TO DETERMINE RIPRAP d_{50} BY MEANS OF THE SAFETY FACTOR METHOD. HEC-2 RESULTS FROM ALTERNATIVE #7 ARE USED AS INPUT FOR RIPSFHEC.WR1.

REFERENCES: "APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS", PAGES 185-194.

86-060-24 CALC. BRIEF - HEC-2 ANALYSIS OF THE RECOMMENDED REDESIGN ALTERNATIVE FOR PIPELINE ARROYO.

RESULTS: A RIPRAP d_{50} OF 6.4 INCHES WAS CALCULATED FOR THE BURIED JETTY. (SEE ATTACHED RIPSFHEC.WR1 PRINTOUT)

By SWM Date 12-3-90 Subject UNC Sheet No. 2 of 3

Chkd. By [illegible] Date 12/3/90 Proj. No. 86-060-24

1/4" X 1/4"

CALCULATIONS :

- SLOPE BETWEEN STA 59+50 AND STA 57+75 (ELEVATIONS WERE DERIVED FROM JIM FLETCHER'S SURVEY DATA OF PIPELINE ARROYO) :

$$m = \frac{\Delta \text{ elev.}}{\Delta \text{ dist}} = \frac{6941.4 - 6940.5}{|5775 - 5950|} = \underline{\underline{0.005}}$$

- ASSUME A SPECIFIC GRAVITY OF 2.6 FOR RIPRAP.

✓ mjj 12/3/90

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD USING HEC2 RESULTS RIPSFHEC.WR1
REF: "Applied Hydrology and Sedimentology
for Disturbed Areas", pages 185-194

LOCATION: CROSS-SECTION @ STA 60.40

Z (SIDE SLOPE)	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.005	Theta =	0.29 Degrees
RIPRAP S.G. =	2.6	Phi =	41.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM

D50 (ASSUM) =	0.53 FT	6.4 INCHES
n =	0.036	
DEPTH=	8 FT	
t =	2.50 PSF	
nb =	0.991	
SFb =	1.00	

CHANNEL SIDE SLOPES

D50 (ASSUM) =	0.53 FT	6.4 INCHES
n =	0.036	
DEPTH=	8 FT	
t =	1.87 PSF	
nb =	0.74	
Beta =	45.45	
n' =	0.64	
SFs =	1.06	

EMBANKMENT SIDESLOPES

D50 (ASSUM) =	NA FT	NA INCHES
n =	NA	
DEPTH=	NA FT	
t =	NA PSF	
nb =	NA	
Beta =	NA	
n' =	NA	
SFs =	NA	

UNC MINING AND MILLING

Division of United Nuclear Corporation
A UNC RESOURCES Company

Church Rock Operations
P.O. Drawer CQ

Gallup, New Mexico 87301
Telephone 505/722-6851

Memorandum

To: C. Johnson

Date: April 9, 1990

From: J. Fletcher

Subject: Pipeline Arroyo Profile

Station	Latitude	Departure	Elevation
0	73847.56	57678.51	6941.37
1+3	73788.83	57593.20	6939.73
1+14	73782.34	57585.59	6940.43
1+32	73770.67	57571.88	6940.69
1+69	73746.03	57542.96	6940.58
2+13	73717.63	57509.52	6938.44
2+37	73700.25	57493.06	6940.34
2+64	73679.98	57473.74	6939.48
3+13	73645.23	57440.63	6939.88
3+54	73615.19	57412.00	6939.61
3+62	73608.83	57405.74	6939.23
3+68	73604.24	57401.22	6938.53
3+78	73601.07	57398.09	6936.70
3+88	73594.01	57391.13	6936.23
3+99	73585.54	57382.79	6933.55
4+13	73575.65	57373.05	6932.73
4+33	73561.89	57359.49	6931.37
4+53.5	73547.41	57345.24	6930.16
4+54	73547.06	57344.89	6925.53
4+60	73542.36	57340.25	6925.30
4+84	73558.56	57323.21	6924.63
5+01	73548.52	57309.52	6922.25
5+47	73538.35	57263.91	6909.56
5+70	73525.86	57245.39	6908.77
5+85	73512.16	57239.49	6905.77
6+40	73477.88	57196.88	6901.02

Station	Latitude	Departure	Elevation
7+09	73431.33	57146.01	6902.68
7+92	73358.79	57105.69	6901.95
8+10	73342.24	57098.60	6900.57
9+11	73272.66	57025.03	6901.04
9+35	73254.66	57009.14	6901.54
10+33	73182.37	56942.97	6899.94
10+72	73160.12	56911.23	6899.92
10+81	73155.60	56903.00	6897.37
10+99	73143.01	56890.13	6897.03
11+07	73137.35	56884.48	6894.58
11+32	73113.96	56877.09	6897.84
11+75	73082.95	56846.17	6896.85
11+83	73075.49	56843.27	6889.91
12+36	73041.90	56802.52	6889.84
12+93	73019.42	56749.93	6886.93
13+25	72989.53	56738.58	6887.17
14+05	72957.42	56665.82	6884.52
14+82	72893.62	56620.82	6881.92
15+67	72837.58	56558.59	6880.91
16+54	72766.46	56508.04	6879.85
17+39	72707.64	56446.60	6879.84
18+30	72628.77	56399.89	6879.80
19+22	72553.61	56348.16	6878.01
19+97	72498.07	56297.93	6877.51
20+76	72429.84	56257.85	6876.75
21+32	72383.18	56226.09	6875.84
22+19	72307.06	56184.12	6875.07
23+04	72233.58	56141.40	6874.31
23+98	72146.88	56106.32	6874.29
24+94	72057.86	56069.97	6873.95
25+86	71968.17	56049.39	6872.66
27+41	71813.21	56041.22	6868.74
27+80	71776.55	56052.79	6871.27
28+86	71691.52	55988.75	6869.76
29+85	71721.69	55894.24	6869.07
29+99	71729.18	55882.32	6868.76

E.2(a)

PMF Calculation for Watersheds A_1, A_2, and B

HYDROGRAPH CALCULATION FOR ONE-HOUR PMP EVENTS USING THE SCS CURVE NUMBER ME

WATERSHED A1 UNC PROJECT RM86-060-01
20-Mar-97 13:54

ONE-HOUR RAINFALL AMOUNT	9.4	INCHES		
SCS CURVE NUMBER	80		S =	2.50
MEAN BASIN ELEV.	7080	FEET		
DURATION (D)	0.25	HOURS		
WATER COURSE LENGTH (L)	0.62	MILES	1.216856060	
WATERSHED AREA (A)	0.15	SQ. MILES		
MAXIMUM RELIEF (H)	200.00	FEET		
ELEV ADJUSTMENT	0.896	ADJ. RAINFAL	8.42	INCHES
AREAL ADJUSTMENT (DSD)	1	ADJ. RAINFAL	8.42	INCHES

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
PERCENT OF 1-HOUR RAINFALL (DSD,TABLE I, PG 52)	48	71	88	100
CUMULATIVE RAINFALL	4.04	5.98	7.41	8.42
INCREMENTAL RAINFALL	4.04	1.94	1.43	1.01
SEQUENCE	1.43	1.94	4.04	1.01
P - CUMULATIVE DESIGN RAINFALL	1.43	3.37	7.41	8.42
Q - CUMULATIVE RUNOFF	0.25	1.53	5.09	6.02
INCREMENTAL RUNOFF OR EXCESS RAINFALL	0.25	1.28	3.54	0.95

TIME OF CONCENTRATION (Tc)	0.19	HOURS
WATERSHED ADJUSTMENT (DSD, TABLE 5, PG 67)	1.00	
ADJUSTED Tc	0.19	HOURS
TIME TO PEAK (Tp)	0.24	HOURS
BASE PERIOD (Tb)	0.64	HOURS
UNIT PEAK DISCHARGE	301	CFS

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		76.04	384.71	1064.75	284.40	
	0.00	0.00				0.00
	0.06	19.01				19.01
	0.12	38.02				38.02
	0.18	57.03				57.03
	0.24	76.04	0.00			76.04
	0.30	54.66	96.18			150.83
	0.36	33.27	192.36			225.63
	0.42	11.89	288.54			300.43
	0.48	30.51	384.71	0.00		415.22
	0.54	19.12	327.12	266.19		612.43
	0.60	7.74	269.53	532.37		809.64
	0.66	0.00	211.94	798.56		1010.50
	0.72		154.35	1064.75	0.00	1219.09
	0.79		96.75	905.35	71.10	1073.21
	0.85		39.16	745.96	142.20	927.32
	0.91		0.00	586.57	213.30	799.87
	0.97			427.17	284.40	711.58
	1.03			267.78	241.83	509.61
	1.09			108.39	199.25	307.64
	1.15			0.00	156.68	156.68
	1.21				114.10	114.10
					71.53	71.53
					28.95	28.95
					0.00	0.00

HYDROGRAPH CALCULATION FOR ONE-HOUR PMP EVENTS USING THE SCS CURVE NUMBER METHOD

WATERSHED A2 LNC PROJECT RM86-060-01
14-May-87 06:23

ONE-HOUR RAINFALL AMOUNT	8.4 INCHES		
SCS CURVE NUMBER	80	S =	2.50
MEAN BASIN ELEV.	7080 FEET		
DURATION (D)	0.25 HOURS		
WATER COURSE LENGTH (L)	0.62 MILES	1.216854060	
WATERSHED AREA (A)	0.12 SQ. MILES		
MAXIMUM RELIEF (H)	360.00 FEET		
ELEV ADJUSTMENT	0.896 ADJ. RAINFAL	8.42 INCHES	
AREAL ADJUSTMENT (DSD)	1 ADJ. RAINFAL	8.42 INCHES	

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
PERCENT OF 1-HOUR RAINFALL (DSD.TABLE 2, PG 52)	48	71	88	100
CUMULATIVE RAINFALL	4.04	5.98	7.41	8.42
INCREMENTAL RAINFALL	4.04	1.94	1.43	1.01
SEQUENCE	1.43	1.94	4.04	1.01
P - CUMULATIVE DESIGN RAINFALL	1.43	3.37	7.41	8.42
Q - CUMULATIVE RUNOFF	0.25	1.53	5.08	6.02
INCREMENTAL RUNOFF OR EXCESS RAINFALL	0.25	1.28	3.54	0.95

TIME OF CONCENTRATION (Tc)	0.15 HOURS	
LAND USE ADJUSTMENT (DSD. TABLE 3, PG 67)	1.00	
ADJUSTED Tc	0.15 HOURS	
TIME TO PEAK (Tp)	0.22 HOURS	

UNIT PEAK DISCHARGE 186 CFS

INTERMEDIATE HYDROGRAPHS

TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)	67.42	341.10	944.05	252.16	
0.00	0.00				0.00
0.05	16.86				16.86
0.11	33.71				33.71
0.16	50.57				50.57
0.22	67.42				67.42
0.27	57.33	0.00			57.33
0.33	47.23	85.28			132.51
0.38	37.14	170.55			207.69
0.44	27.05	255.83			282.88
0.49	16.96	341.10	0.00		358.06
0.54	6.86	290.04	236.01		532.92
0.60	0.00	238.98	472.02		711.00
0.65		187.91	708.04		895.95
0.71		136.85	944.05		1080.90
0.76		85.79	802.77	0.00	888.51
0.82		34.72	661.40	63.04	759.17
0.87		0.00	520.08	126.08	646.16
0.93			378.75	189.12	567.88
0.98			237.43	252.16	489.59
1.04			96.10	214.42	310.52
1.09			0.00	176.67	176.67
				138.92	138.92
				101.17	101.17
				63.42	63.42
				25.67	25.67
				0.00	0.00

HYDROGRAPH CALCULATION FOR ONE-HOUR PMP EVENTS USING THE SCS CURVE NUMBER METHOD

WATERSHED B UNC PROJECT RM86-060-01
20-Mar-87 10:58

ONE-HOUR RAINFALL AMOUNT	9.4	INCHES	
SCS CURVE NUMBER	80	S =	2.50
MEAN BASIN ELEV.	7100	FEET	
DURATION (D	0.25	HOURS	
WATER COURSE LENGTH (L)	1.23	MILES	
WATERSHED AREA (A)	0.57	SQ. MILES	
MAXIMUM RELIEF (H)	440.00	FEET	
ELEV ADJUSTMENT	0.895	ADJ. RAINFAL	8.41 INCHES
AREAL ADJUSTMENT (DSD)	1	ADJ. RAINFAL	8.41 INCHES

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
PCENT OF 1-HOUR RAINFALL (SD,TABLE 2, PG 52)	48	71	88	100
CUMULATIVE RAINFALL	4.04	5.97	7.40	8.41
INCREMENTAL RAINFALL	4.04	1.93	1.43	1.01
SEQUENCE	1.43	1.93	4.04	1.01
P - CUMULATIVE DESIGN RAINFALL	1.43	3.37	7.40	8.41
Q - CUMULATIVE RUNOFF	0.25	1.53	5.07	6.01
INCREMENTAL RUNOFF OR EXCESS RAINFALL	0.25	1.28	3.54	0.95

TIME OF CONCENTRATION (Tc)	0.32	HOURS
WATERSHED ADJUSTMENT (DSD, TABLE 3, PG 67)	1.00	
ADJUSTED Tc	0.32	HOURS
TIME TO PEAK (To)	0.31	HOURS
BASE PERIOD (Tb)	0.84	HOURS
UNIT PEAK DISCHARGE	876	CFS

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		221.05	1119.79	3100.34	828.21	
	0.00	0.00				0.00
	0.08	55.26				55.26
	0.16	110.53				110.53
	0.24	165.79	0.00			165.79
	0.31	221.05	279.95			501.00
	0.39	187.96	559.90			747.86
	0.47	154.87	839.84	0.00		994.71
	0.55	121.78	1119.79	775.08		2016.66
	0.63	88.69	952.16	1550.17		2591.01
	0.71	55.59	784.52	2325.25	0.00	3165.37
	0.79	22.50	616.89	3100.34	207.05	3946.78
	0.87	0.00	449.26	2636.22	414.11	3499.58
	0.94		281.62	2172.09	621.16	3074.86
	1.02		113.99	1707.97	828.21	2650.17
	1.10		0.00	1243.85	704.23	1948.08
	1.18			779.73	580.24	1359.97
	1.26			315.60	456.26	771.86
	1.34			0.00	332.28	332.28
	1.42				208.29	208.29
	1.50				84.31	84.31
	1.57				0.00	0.00

CanonieEnvironmental

E-78

By TMS Date 5-21-87 Subject UNC - North Diversion Ditch Sheet No. 1 of 1

Chkd. By ____ Date ____ Proj. No. RM86-000-01

1/4" X 1/4"

Objective: Determine the PMF flow rate for Sections along the North Diversion Ditch

Summary of PMF Flow Rates

Section	Watershed which contributes to flow	Qmax (1) cfs	time Qmax occurs (1) hrs
K	A_2	1081	.71
L	A_1+A_2	2265	.71
M	A_1+A_2	2265	.71
N	A_2+A_1+B	5844	.79
O	A_2+A_1+B	5844	.79

Breakdown of Qmax into individual [illegible]

watershed	A1	A2	$\Sigma A_1 A_2$	B	$\Sigma A_1 A_2 B$
time	Flowrate				
.71	1184	1081	2265 ← Qmax	3165	5430
.72	1219	1042	2261	3266	5527
.79	1073	842	1879	3947	5844 - Qmax

E.2(b)

100 Year Flood Calculations for

Watersheds A_1, A_2, and B

:PDGRAPH CALCULATION FOR ONE-HOUR RAINFALL EVENTS USING THE SCS CURVE NUMBER METHOD

-:ERSHED A1 - NORTH DIVERSION DITCH UNC PROJECTRM86-060-01
08-May-87 08:25

ETURN PERIOD	100 YRS		
E-HOUR RAINFALL AMOUNT	1.81 INCHES		
.S CURVE NUMBER	80	S =	2.50
EAN BASIN ELEV.	5000 FEET		
.RATION (D)	0.25 HOURS		
-TER COURSE LENGTH (L)	0.62 MILES		
-TERSHED AREA (A)	0.15 SQ. MILES		
EXIMUM RELIEF (H)	200 FEET		

-EAL ADJUSTMENT 0.999 ADJ. RAINFAL 1.81 INCHES
.SD. FIG 21, PG E4)

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
: OF 1-HOUR RAINFALL .SD, TABLE 2, PG 52)	48	71	88	100
:UMULATIVE RAINFALL	0.87	1.28	1.59	1.81
:NCREMENTAL RAINFALL	0.87	0.42	0.31	0.22
:EQUENCE	0.31	0.42	0.87	0.22
: - CUMULATIVE DESIGN RAINFALL	0.3074	0.7233	1.5912	1.8082
: - CUMULATIVE RUNOFF	0.0000	0.0183	0.3316	0.4494
:NCREMENTAL RUNOFF OR EXCESS RAINFALL	0.0000	0.0183	0.3133	0.1178

TIME OF CONCENTRATION (Tc)	0.19 HOURS
WATERSHED ADJUSTMENT (DSD, TABLE 5, PG 67)	1.04
:DJUSTED Tc	0.20 HOURS
. D PEAK (Tp)	0.25 HOURS
BASE PERIOD (Tb)	0.66 HOURS
:NIT PEAK DISCHARGE	295 CFS

WATERSHED A1 - NORTH DIVERSION DITCH LNC PROJECTRM86-060-01
08-May-87 08:25

RETURN PERIOD 100 YRS
ONE-HOUR RAINFALL AMOUNT 1.81 INCHES

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		0.0	5.4	92.4	34.7	
	0.00	0.0				0.0
	0.06	0.0				0.0
	0.12	0.0				0.0
	0.18	0.0				0.0
	0.25	0.0	0.0			0.0
	0.31	0.0	1.3			1.3
	0.37	0.0	2.7			2.7
	0.43	0.0	4.0			4.0
	0.49	0.0	5.4	0.0		5.4
	0.55	0.0	4.6	23.1		27.7
	0.62	0.0	3.8	46.2		50.0
	0.68	0.0	3.0	69.3		72.2
	0.74		2.2	92.4	0.0	94.5
	0.80		1.4	78.5	8.7	88.6
	0.86		0.5	64.7	17.4	82.6
	0.92		0.0	50.9	26.1	76.9
	0.98			37.1	34.7	71.8
	1.05			23.2	29.5	52.8
	1.11			9.4	24.3	33.7
	1.17			0.0	19.1	19.1
	1.23				13.9	13.9
					8.7	8.7
					3.5	3.5
					0.0	0.0
						0.0

--DROGRAPH CALCULATION FOR ONE-HOUR RAINFALL EVENTS USING THE SCS CURVE NUMBER METHOD

.WR1

-ATERSHED A2 - NORTH DIVERSION DITCH UMC PROJECTRM86-060-01
08-May-87 09:30

-ETURN PERIOD	100	YRS
ONE-HOUR RAINFALL AMOUNT	1.81	INCHES
SCS CURVE NUMBER	80	S = 2.50
MEAN BASIN ELEV.	5000	FEET
DURATION (D)	0.25	HOURS
WATER COURSE LENGTH (L)	0.62	MILES
WATERSHED AREA (A)	0.12	SQ. MILES
MAXIMUM RELIEF (H)	360	FEET

-REAL ADJUSTMENT 0.999 ADJ. RAINFAL 1.81 INCHES
(DSD. FIG 21, PG 54)

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
% OF 1-HOUR RAINFALL (DSD.TABLE 2, PG 52)	48	71	88	100
CUMULATIVE RAINFALL	0.87	1.28	1.59	1.81
INCREMENTAL RAINFALL	0.87	0.42	0.31	0.22
SEQUENCE	0.31	0.42	0.87	0.22
P - CUMULATIVE DESIGN RAINFALL	0.3074	0.7233	1.5912	1.8082
Q - CUMULATIVE RUNOFF	0.0000	0.0183	0.3316	0.4494
INCREMENTAL RUNOFF OR EXCESS RAINFALL	0.0000	0.0183	0.3133	0.1178

TIME OF CONCENTRATION (Tc)	0.15	HOURS
WATERSHED ADJUSTMENT (DSD, TABLE 5, PG 67)	1.04	
ADJUSTED Tc	0.16	HOURS
TO PEAK (Tp)	0.22	HOURS
BASE PERIOD (Tb)	0.59	HOURS
UNIT PEAK DISCHARGE	262	CFS

..ED 42 - NORTH DIVERSION DITCH UNC PROJECTRM86-060-01
03-May-87 08:30

RETURN PERIOD 100 YRS
ONE--HOUR RAINFALL AMOUNT 1.81 INCHES

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		0.0	4.8	32.1	30.9	
	0.00	0.0				0.0
	0.06	0.0				0.0
	0.11	0.0				0.0
	0.17	0.0				0.0
	0.22	0.0				0.0
	0.28	0.0	0.0			0.0
	0.33	0.0	1.2			1.2
	0.39	0.0	2.4			2.4
	0.44	0.0	3.6			3.6
	0.50	0.0	4.8	0.0		4.8
	0.55	0.0	4.1	20.5		24.6
	0.61	0.0	3.4	41.0		44.4
	0.67		2.6	61.6		64.2
	0.72		1.9	82.1	0.0	84.0
	0.78		1.2	69.8	7.7	78.7
	0.83		0.5	57.5	15.4	73.4
	0.89		0.0	45.2	23.2	68.4
	0.94			32.9	30.9	63.8
	1.00			20.6	26.2	46.9
	1.05			8.4	21.6	30.0
	1.11			0.0	17.0	17.0
					12.4	12.4
					7.8	7.8
					3.1	3.1
					0.0	0.0

WATERSHED B - NORTH DIVERSION DITCH UNC PROJECT RM86-060-01
09-May-87 08:19

RETURN PERIOD 100 YRS
ONE-HOUR RAINFALL AMOUNT 1.81 INCHES

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		0.0	14.8	262.6	99.2	
	0.00	0.0				0.0
	0.08	0.0				0.0
	0.16	0.0				0.0
	0.24	0.0	0.0			0.0
	0.32	0.0	3.7			3.7
	0.40	0.0	7.4			7.4
	0.48	0.0	11.1	0.0		11.1
	0.56	0.0	14.8	65.7		80.5
	0.64	0.0	12.6	131.3		143.9
	0.73	0.0	10.4	197.0	0.0	207.3
	0.81	0.0	8.2	262.6	24.8	295.6
	0.89	0.0	5.9	223.3	49.6	278.8
	0.97		3.7	184.0	74.4	262.1
	1.05		1.5	144.7	99.2	245.4
	1.13		0.0	105.4	84.4	189.7
	1.21			66.0	69.5	135.6
	1.29			26.7	54.7	81.4
	1.37			0.0	39.8	39.8
	1.45				25.0	25.0
	1.53				10.1	10.1
	1.61				0.0	0.0
						0.0
						0.0
						0.0
						0.0

0.102

Canonie Environmental

E-85

By _____ Date _____ Subject UNC - North Diversion Ditch Sheet No. 1 of 1

Chkd. By _____ Date _____ Proj. No. 86-060

1/4" X 1/4"

Calculation to total the 100 year flow rate for the North Diversion Ditch from watersheds A1, A2, and B.

Procedure: Combine the hydrographs for all watersheds to determine the maximum total flow rate - Q max

From trial & error time at which Q max occures = .81 hrs

Breakdown of flow rates

Watershed	Flow rate @ .81 hrs (CFS)
A_1	87.6
A_2	75.5
A_3	295.6

Qmax for 100 year flood 458.7 cfs

E.2(c)

Flow Depth Calculations North-Diversion Ditch

Sections K, L, M, N, and O

LOCATION: NORTH DIVERSION CHANNEL -- SECTION K

	DISCHARGE =	1081	CFS
	BOTTOM WIDTH =	18	FT
	Z (SIDE SLOPE) =	2.3	
	CHANNEL SLOPE =	0.0054	
	MANNING'S n =	0.0230	
*	d =	4.22	FT
*	A =	120.5	FT^2
CALCS *	R =	2.96	FT
*	V =	9.0	FPS
*	Q (CALC) =	1085	CFS
*	DIFFERENCE =	0.3%	%

- SELECT A TRIAL DEPTH

- CHECK THIS Q VALUE AND THE DIFFERENCE TO SEE IF IT MATCHES LISTED DISCHARGE

MANNING'S EQUATION FOR DETERMINING NORMAL FLOW DEPTHS IN TRAPEZOIDAL CHANNELS

MANEQT.WP

LOCATION: NORTH DIVERSION CHANNEL - SECTION L

DISCHARGE =	2265	CFS
BOTTOM WIDTH =	20	FT
Z (SIDE SLOPE) =	2.1	
CHANNEL SLOPE =	0.00714	
MANNING'S n =	0.0250	

*	d =	5.69	FT	- SELECT A TRIAL DEPTH
*	A =	181.8	FT^2	
CALCS *	R =	3.91	FT	
*	v =	12.5	FPS	
*	Q (CALC) =	2267	CFS	- CHECK THIS Q VALUE AND THE DIFFERENCE TO SEE IF IT MATCHES LISTED DISCHARGE
*	DIFFERENCE =	0.09	%	

ATION: NORTH DIVERSION CHANNEL - SECTION M

DISCHARGE =	2265	CFS
BOTTOM WIDTH =	20	FT
Z (SIDE SLOPE) =	7.6	
CHANNEL SLOPE =	0.00746	
MANNING'S n =	0.0250	

*	d =	4.34	FT	- SELECT A TRIAL DEPTH
*	A =	230.0	FT^2	
CALCS *	R =	2.66	FT	
*	v =	9.8	FPS	
*	Q (CALC) =	2265	CFS	- CHECK THIS Q VALUE AND THE DIFFERENCE TO SEE IF IT MATCHES LISTED DISCHARGE
*	DIFFERENCE =	-0.00	%	

CATION: NORTH DIVERSION CHANNEL - SECTION N

```
            DISCHARGE =      5850 CFS
         BOTTOM WIDTH =        22 FT
       Z (SIDE SLOPE) =       3.3
       CHANNEL SLOPE =   0.00746
         MANNING'S n =    0.0250

      *            d =      8.02 FT      - SELECT A TRIAL DEPTH
      *            A =     388.7 FT^2
CALCS *            R =      5.03 FT
      *            V =      15.1 FPS
      *      Q (CALC) =      5857 CFS     - CHECK THIS Q VALUE AND
      *    DIFFERENCE =      0.12 %         THE DIFFERENCE TO
                                             SEE IF IT MATCHES LISTED
                                             DISCHARGE
```

MANNING'S EQUATION FOR DETERMINING NORMAL FLOW DEPTHS
IN TRAPEZOIDAL CHANNELS

ATION: NORTH DIVERSION CHANNEL - SECTION O

	DISCHARGE =	5850	CFS
	BOTTOM WIDTH =	12	FT
	Z (SIDE SLOPE) =	1.11	
	CHANNEL SLOPE =	0.00746	
	MANNING'S n =	0.0250	
*	d =	12.54	FT
*	A =	325.0	FT^2
CALCS *	R =	6.57	FT
*	v =	18.0	FPS
*	Q (CALC) =	5854	CFS
*	DIFFERENCE =	0.07	%

- SELECT A TRIAL DEPTH

- CHECK THIS Q VALUE AND THE DIFFERENCE TO SEE IF IT MATCHES LISTED DISCHARGE

E.2(d)

North Diversion Ditch

Confluence Stability

Canonie Environmental

E-93

By MT Date 12 Nov 90 Subject UMC Sheet No. 1 of 9

Chkd. By MJM Date 12/3/90 Confluence Stability Proj. No. 85-060-24

1/4" X 1/4"

Purpose: To compare the total head of the PMF peak discharge in three tributaries to the North Diversion Ditch with the total head of the PMF peak discharge in the North Diversion Ditch at their confluences.

Figure 1 provides the tributary locations and designations

Methods: 1. The PMF peak discharges in the North Diversion Ditch at the locations shown on Figure 2 were estimated by the SCS triangular unit hydrograph method as discussed in Appendix C of the original reclamation plan.

2. The PMF peak discharges of the tributaries at the confluence was determined by the SCS TP-55 graphical method.

3. The depth and velocity of the PMF peak discharges was determined with Manning's equation

4. The total head (velocity head + elevation head) was determined using Bernoulli's equation.

Results: Table 1 on Page 2 provides the results of the calculations

Table 1
Results of Calculations

Location (1)	Peak Discharge (cfs)	Channel Slope (ft/ft)	Depth of Flow (ft)	Velocity (fps)	Velocity head (ft)	Total Head (2) (ft)
K	1081	0.0054	4.22	9.0	1.26	[illegible]
A_1	383	0.044	0.98	11.2	1.95	2.93
L	2265	0.00714	5.69	12.5	2.43	8.12
A_2	765	0.02	1.81	10.8	1.82	3.63
M	2265	0.00746	4.34	9.8	1.49	5.83
B	2046	0.019	2.48	13.2	2.74	5.19
N	5850	0.00746	8.02	15.1	3.54	11.56

(1) See Figure 2 for schematic of locations

(2) Total head = Depth of flow + Velocity head.
This assumes that the channel bottom for the North Division Ditch and the tributary are at the same datum at each confluence

CanonieEnvironmental

E-95

By MC Date 12 Nov 90 Subject Confluence Stability Sheet No. 3 of 10

Chkd. By mjm Date 12/3/90 Proj. No. 85-050-2

1/4" X 1/4"

Methods

1. The peak discharges and velocities at cross-sections 1, 2, 3, and 4 are provided in Appendix C to the original reclamation plan. They are summarized in Table 1 of this calc brief.

2. The peak discharges at cross sections A_1, A_2, and B were determined with the SCS-TR-55 method. The input data for the watersheds contributing runoff to these locations are summarized below. Figure 1 delineates the watersheds.

		A_1	A_2	B
Mean Basin EL	(ft)	7080	7080	7100
Longest Flow Path	(mi)	0.62	0.62	1.23
Maximum Relief	(ft)	360	200	440
Watershed Area	(mi^2)	0.08	0.16	0.58
Curve Number		80	80	80
PMP Amount	(inches)	9.4	9.4	9.4
Corrected PMP	(inches)	8.42	8.42	8.41
t_c	(hours)	0.2	0.2	0.4

The curve number is that used in previous calculations as shown in Appendix C of the reclamation plan. The PMP amount of 9.4 inches was determined from HMR-49. It is corrected by the formula

$$PMP \times [1 - [(\text{Mean Basin Elevation} - 5000\,ft)/1000 \times 0.05]]$$

The t_c values (times of concentration) were determined by the methods provided in TR-55.

The output from the SCS TR-55 calculations are provided on page 6.

CanonieEnvironmental

E-96

By MT Date 12 Nov 90 Subject UNC Sheet No. 4 of 9
Chkd. By mjj Date 12/3/90 Confluence Stability Proj. No. 85-050 24
1/4" X 1/4"

3. Mannings equation, as utilized by the Haestad Methods Inc Program Flow Master, was used to calculate flow depth and velocity for the peak discharges calculated above. The channel characteristics for the tributaries are summarized below:

		A_1	A_2	B
Bottom Width	(ft)	30	30	50
Side slope, z		5	5	5
Mannings n		0.025	0.025	0.025
Channel Slope	(ft/ft)	0.044	0.020	0.019
Peak Discharge	(cfs)	383	765	2046

The resulting depths and velocities are summarized below: (See page 7,8,9)

Depth	(ft)	0.98	1.81	2.48
Velocity	(fps)	11.2	10.8	13.2

4. The velocity head was calculated with the formula $H_v = V^2/2g$ where H_v = velocity head, V = flow velocity and g = gravitational acceleration (32.2 fps^2). Total head was calculated as the velocity head plus the depth as follows

		A_1	A_2	B
Velocity head	(ft)	1.95	1.82	2.71
Depth	(ft)	0.98	1.81	2.48
Total head	(ft)	2.93	3.63	5.19

Table 1 provides the velocity and total heads at the cross sections on the North Diversion Ditch

Discussion

Table 1 shows that the total head for flows in tributaries A1 and A2 are considerably less than those of the North Diversion cross sections ~~B~~ (1 & 2) located immediately upstream of the confluences. Thus, while the tributary flow will cause turbulence at the confluences, the tributary flow will not be able to impinge directly on the far bank of the ditch. The total head of tributary B flows is greater than that of cross section 3 of the North Diversion Ditch. Thus this tributary has the potential for more direct impingement on the far bank of the ditch. However, the tributary B confluence angle is about 45° thus lessening the effect of impingement. Also about 150' of bank material exists on the far bank ~~which~~ that would have to be scoured away before flow could pass over the tailings.

Tc = 0.2 RUNOFF HYDROGRAPHS BY THE SCS TR-55 METHOD

TYPE-II STORM DISTRIBUTION

01-Dec-90
05:21 PM

TIME OF CONCENTRATION = 0.2 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6
						(CSM/IN)	23	31	47	209	403	739	800	481	250	166	128	102	86	70	61	54	49	44	40	35	33
TRIBUTARY A1	51.00	7.97E-02	80.0	8.4	6.00	(CFS)	10.999	14.824	22.475	99.944	192.715	353.391	382.561	230.015	119.550	79.381	61.210	48.777	41.125	33.474	29.170	25.823	23.432	21.041	19.128	16.737	15.781
TRIBUTARY A2	102.00	1.59E-01	80.0	8.4	6.00	(CFS)	21.997	29.649	44.951	199.888	385.431	706.782	765.123	460.030	239.101	158.763	122.420	97.553	82.251	66.948	58.341	51.646	46.864	42.082	38.256	33.474	31.561

Tc = 0.4 RUNOFF HYDROGRAPHS BY THE SCS TR-55 METHOD

TYPE-II STORM DISTRIBUTION

01-Dec-90
05:23 PM

TIME OF CONCENTRATION = 0.4 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6
						(CSM/IN)	18	25	36	77	141	271	468	592	574	431	298	216	163	104	77	63	55	49	44	38	34
TRIBUTARY B	368	5.75E-01	80.0	8.41	6.01	(CFS)	62	86	124	266	487	937	1617	2046	1984	1490	1030	746	563	359	266	218	190	169	152	131	118

Page 6 of 6
96-060-24
2 of 2
[illegible]

Page 7 of 9
85-060-24
mi
✓ mjg 12/3/90

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: UNC

Comment: CONFLUENCE A1

Solve For Depth

Given Input Data:

Bottom Width.....	30.00 ft
Left Side Slope..	5.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0440 ft/ft
Discharge.....	383.00 cfs

Computed Results:

Depth.....	0.98 ft
Velocity.....	11.22 fps
Flow Area.....	34.13 sf
Flow Top Width...	39.78 ft
Wetted Perimeter.	39.98 ft
Critical Depth...	1.57 ft
Critical Slope...	0.0084 ft/ft
Froude Number....	2.13 (flow is Supercritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Westad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Page 8 of 9
86-060-24
MC
12/3/90

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: UNC

Comment: CONFLUENCE A2

Solve For Depth

Given Input Data:

Bottom Width.....	30.00 ft
Left Side Slope..	5.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	765.00 cfs

Computed Results:

Depth.....	1.81 ft
Velocity.....	10.82 fps
Flow Area.....	70.73 sf
Flow Top Width...	48.11 ft
Wetted Perimeter.	48.47 ft
Critical Depth...	2.37 ft
Critical Slope...	0.0075 ft/ft
Froude Number....	1.57 (flow is Supercritical)

Page 9 of 9
86-060-24
MT
[illegible] 12/3/90

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: UNC

Comment: CONFLUENCE B

Solve For Depth

Given Input Data:

Bottom Width.....	50.00 ft
Left Side Slope..	5.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0190 ft/ft
Discharge.....	2046.00 cfs

Computed Results:

Depth.....	2.48 ft
Velocity.....	13.24 fps
Flow Area.....	154.56 sf
Flow Top Width...	74.77 ft
Wetted Perimeter.	75.27 ft
Critical Depth...	3.32 ft
Critical Slope...	0.0066 ft/ft
Froude Number....	1.62 (flow is Supercritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

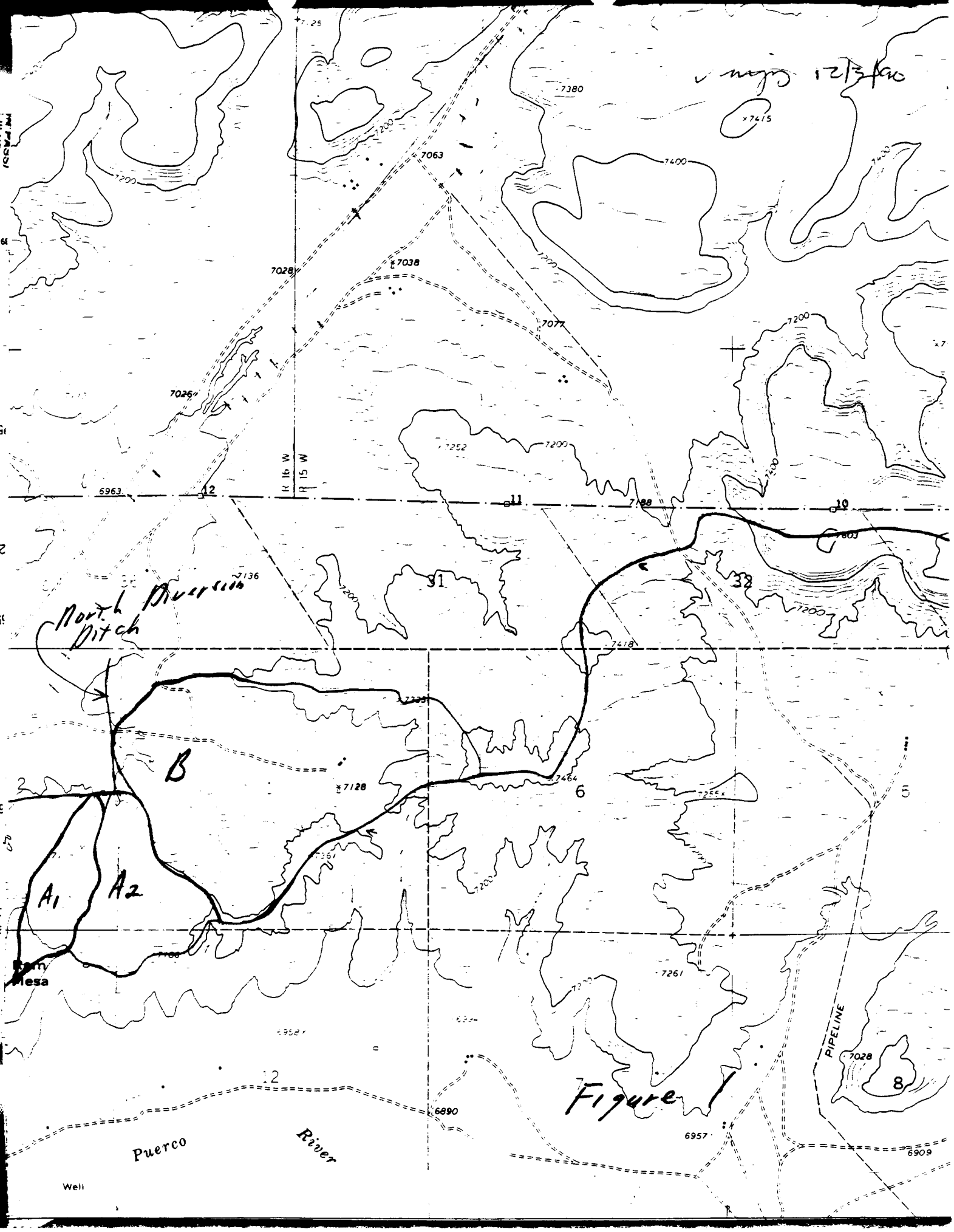

North Diversion Ditch
B
A1
A2
Ram Mesa
Puerco River
Well
PIPELINE
R 16 W
R 15 W
31
32
6
5
12
11
10
8
7380
7415
7400
7063
7038
7028
7077
7026
7252
7188
7136
7418
7128
7464
7261
7028
6963
6890
6957
6909

Figure 1

Canonie Environmental

E-103

By _____ Date _____ Subject _____ Sheet No. ____ of ____

Chkd. By ____ Date _____ _____ Proj. No. _____

1/4" X 1/4"

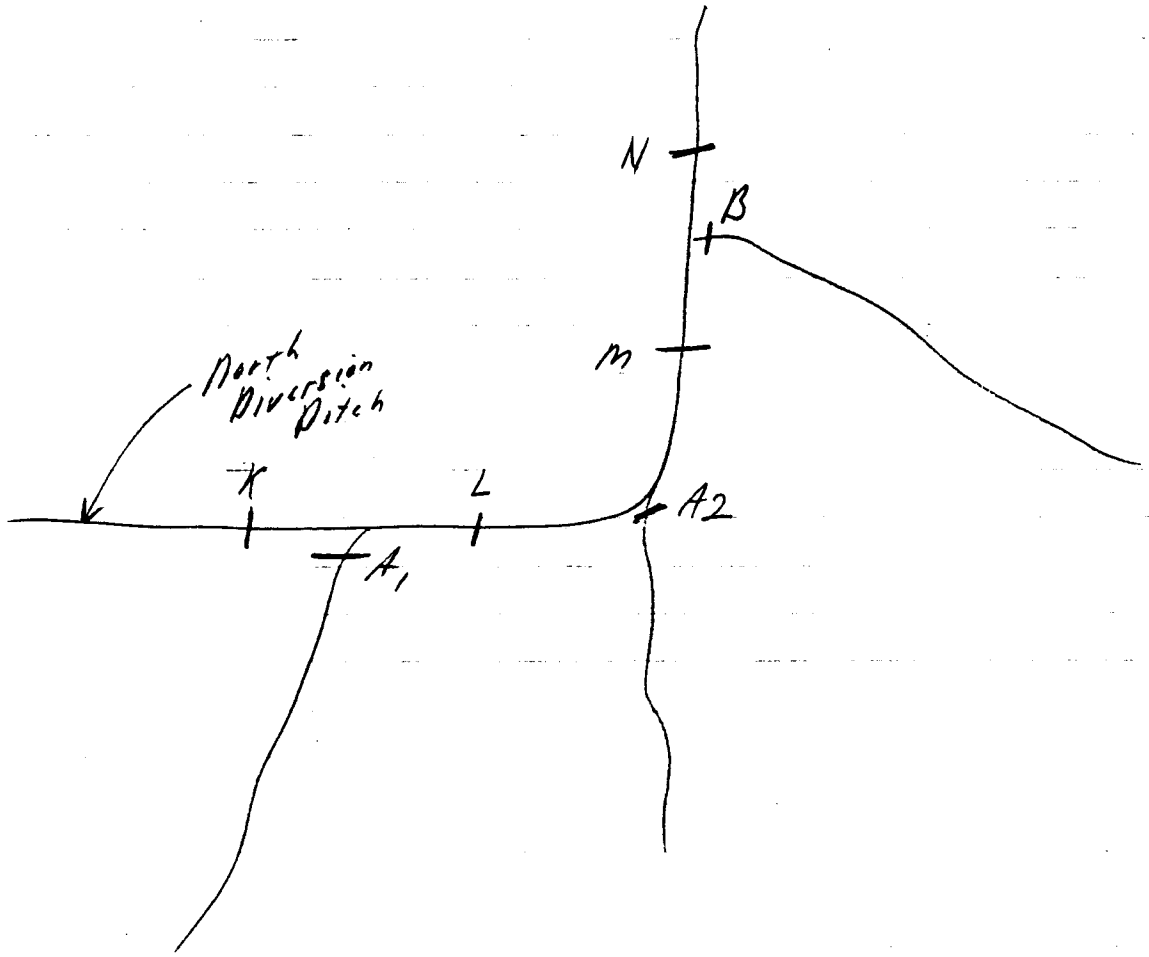


Figure 2

Schematic of Cross-Section Locations

E.2(e)

PMF Calculations for the South Diversion Ditch and

Flow Depth Calculations for Limiting Sections 1 and 2

HYDROGRAPH CALCULATION FOR ONE-HOUR PMP EVENTS USING THE SCS CURVE NUMBER METHOD

South Quarter Creek

WATERSHED C UNC PROJECT RM86-060-01
20-Mar-97 13:45

ONE-HOUR RAINFALL AMOUNT	9.4 INCHES		
SCS CURVE NUMBER	80	S =	2.50
MEAN BASIN ELEV.	7080 FEET		
DURATION (D)	0.25 HOURS		
WATER COURSE LENGTH (L)	0.73 MILES		
WATERSHED AREA (A)	0.17 SQ. MILES		
MAXIMUM RELIEF (H)	400.00 FEET		
ELEV ADJUSTMENT	0.896 ADJ. RAINFAL		8.42 INCHES
AREAL ADJUSTMENT (DSD)	1 ADJ. RAINFAL		8.42 INCHES

ITEM	TIME PERIOD, HRS 0-0.25	0.25-0.50	0.50-0.75	0.75-1.00
PERCENT OF 1-HOUR RAINFALL (DSD.TABLE 2. PG 52)	48	71	88	100
CUMULATIVE RAINFALL	4.04	5.98	7.41	8.42
INCREMENTAL RAINFALL	4.04	1.94	1.43	1.01
SEQUENCE	1.43	1.94	4.04	1.01
P - CUMULATIVE DESIGN RAINFALL	1.43	3.37	7.41	8.42
Q - CUMULATIVE RUNOFF	0.25	1.53	5.08	6.02
INCREMENTAL RUNOFF OF EXCESS RAINFALL	0.25	1.28	3.54	0.95

TIME OF CONCENTRATION (Tc)	0.18 HOURS
WATERSHED ADJUSTMENT (DSD. TABLE 5. PG 67)	1.00
ADJUSTED Tc	0.18 HOURS
TIME TO PEAK (Tp)	0.23 HOURS
BASE PERIOD (Tb)	0.62 HOURS
UNIT PEAK DISCHARGE	353 CFS

INTERMEDIATE HYDROGRAPHS

	TIME	FIRST	SECOND	THIRD	FOURTH	COMBINED HYDROGRAPH
PEAK DISCHARGE (cfs)		89.42	452.44	1252.18	334.47	
	0.00	0.00				0.00
	0.06	22.36				22.36
	0.12	44.71				44.71
	0.17	67.07				67.07
	0.23	89.42	0.00			89.42
	0.29	76.04	113.11			189.15
	0.35	62.65	226.22			288.87
	0.41	49.26	339.33			388.59
	0.47	35.88	452.44			488.31
	0.52	22.49	384.71	0.00		407.20
	0.58	9.10	316.98	313.04		639.12
	0.64	0.00	249.25	626.09		875.33
	0.70		181.52	939.13		1120.65
	0.76		113.79	1252.18	0.00	1365.96
	0.81		46.06	1064.72	83.62	1194.40
	0.87		0.00	877.27	167.23	1044.51
	0.93			689.82	250.85	940.67
	0.99			502.37	334.47	836.84
	1.05			314.92	284.40	599.32
	1.11			127.47	234.33	361.79
	1.16			0.00	184.26	184.26
					134.19	134.19
					84.12	84.12
					34.05	34.05
					0.00	0.00

CanonieEnvironmental

E-107

By MT Date 3-21-87 Subject UNC - South Diversion Ditch Sheet No. ____ of 2

Chkd. By ____ Date ____ Proj. No. FM86-060-01

1/4" X 1/4"

Objective: Determine the depth of Flow for the PMF at Limiting Sections 1 & 2 on the South Diversion Ditch

Method: Used HP41 Calculator Program: "Hydraulic Properties for Irregular River Cross-Sections

Section 1 - Cross Section Coordinates

X ft	Y ft
0	97.5
12	90.0
24.7	90.4
37.2	91.9
50.4	95.1
55.3	97.5

Trial & error calculations: Find Depth that correlates with Q = 1366 cfs

Depth ft	K (1)	Q (2) cfs
	S = 0.002	
1	480	21.5
2	2293	101
4	10982	491
5	17845	798
6	26944	1205
6.4	31100	1390 ← Close to Q.

Depth of flow = 6.4

Canonie Environmental

E-108

By MT Date 5-21-87 Subject UNC - South Diversion Ditch Sheet No. 2 of 2

Chkd. By ____ Date ____ Proj. No. RM86-000-0

1/4" X 1/4"

Section 2 - Cross Section Coordinates:

x ft	y ft
1	95.7
11.1	90.2
39.7	90.1
58.0	90.3
69.2	92.0
93.2	93.9
104.2	94.8
115.2	95.7

[illegible]

[illegible] S = 0.002 Q (2)

6	65387	
4	27012	1216
5	43257	1946
4.2	29922	1346
4.24	30523	1373 ←

Depth of Flow = 4.24 ft

Note (1) $K = \frac{1486}{N} r^{2/5} A$

(2) $Q = K S^{1/2}$

E.2(f)

Flow Depth Calculations North-Diversion Ditch Inward Curves

```
MANNING'S EQUATION FOR DETERMINING NORMAL FLOW DEPTHS        MANEQT.WR
        IN TRAPEZOIDAL CHANNELS


LOCATION:UNC - NORTH DIVERSION DITCH, SECTION DD

           DISCHARGE =     1081 CFS
        BOTTOM WIDTH =       18 FT
      Z (SIDE SLOPE)=      1.6
      CHANNEL SLOPE =   0.0033
        MANNING'S n =   0.0250


      *            d =     5.14 FT     - SELECT A TRIAL DEPTH
      *            A =    134.8 FT^2
CALCS *            R =     3.60 FT
      *            t =   34.448 FT
      *            v =      8.0 FPS
      *     Q (CALC) =     1082 CFS    - CHECK THIS Q VALUE TO
      *   DIFFERENCE =     0.10 %        SEE IF IT MATCHES LISTED
                                         DISCHARGE

       Froude Number  =   0.715
       Velocity Head =    1.001 FT
       Tractive force =   0.742 PSF
```

MANNING'S EQUATION FOR DETERMINING NORMAL FLOW DEPTHS IN TRAPEZOIDAL CHANNELS MANEQT.WR

LOCATION:UNC - NORTH DIVERSION DITCH. SECTION EE

DISCHARGE =	1081	CFS
BOTTOM WIDTH =	20	FT
Z (SIDE SLOPE)=	5.43	
CHANNEL SLOPE =	0.0033	
MANNING'S n =	0.0250	

*	d =	4.01	FT	- SELECT A TRIAL DEPTH
*	A =	167.5	FT^2	
CALCS *	R =	2.61	FT	
*	t =	63.5486	FT	
*	v =	6.5	FPS	
*	Q (CALC) =	1083	CFS	- CHECK THIS Q VALUE TO SEE IF IT MATCHES LISTED DISCHARGE
*	DIFFERENCE =	0.21	%	

Froude Number =	0.702	
Velocity Head =	0.649	FT
Tractive force =	0.537	PSF

E.2(g)

Riprap Calculations for the North Diversion Ditch Inward Curves

CanonieEnvironmental

E-113

By [illegible] Date 7/28/88 Subject UNC - North Diversion Ditch calcs for curved sections update Sheet No. 1 of 8

Chkd. By MAD Date 8/1/88 Proj. No. 86-060-04

1/4" X 1/4"

Purpose: To determine riprap size needed for the curved sections of the North diversion ditch at cross sections DD + EE.

Method: Determined necessary parameters from various figures & calc briefs, previously generated, & ran riprap2 spreadsheet calcs.

Results: For cross section DD:

$D_{50} = 0.458$

$D_{max} = 0.578$ ft.

For cross section EE

$D_{50} = 0.362$

$D_{max} = 0.454$ ft

* NOTE: The riprap calcs were run using the side slopes of the sides nearest the tailings.

Canonie Environmental

E-114

By LBD Date 7/28/88 Subject UNC - NORTH DIVERSION Sheet No. 2 of 8
Chkd. By MAD Date 8/11/88 Ditch calcs for curve sections update Proj. No. 86-060-04
1/4" X 1/4"

Channel slope = 0.003 — See figures 1, 2, & 3

side slope = 3 (towards tailings)
8 (east side) } see figure 2
Bottom width = 20'
C = 0.3*
Discharge 1081 cfs — See pg 4 (from previous calc Rice)

D_{50} = 0.362
D_{max} = 0.454 ft } — see spread sheets

CROSS SECTION DD

Channel slope = 0.0033 — Figures 1, 2, & 3

Side slope = 1.0 (towards tailings)
2.0 (east side) } figure 2
Bottom width = 18 ft
C = 0.3*
Discharge 1081 CFS — See pg 5 (from previous calc [illegible])

D50 = 0.458
Dmax = 0.578 ft } see spread sheets

* See pg. 3 for reference

UAD 8/1/88

over the toe of the side slope, the velocity and shear stress on the side slope are significantly higher on the outer bank of the curved channel. Side slope stability tests in straight channels cannot be used in channel bends. The representative velocity used herein for side slope riprap stability is the average velocity in the vertical over the toe of the side slope. Maximum velocities in the curved channel tests occurred over the toe of the side slope.

Using depth and velocity over the toe of the side slope, the threshold of incipient failure of 1V:2H side slope riprap in <u>straight</u> channels is described by

$$\frac{d_{30}}{D} = 0.24\left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{1/2} \frac{V}{\sqrt{gD}}\right]^{2.5}$$

based on model and prototype data for thickness = $1d_{100}$.

For 1V:2H side slope riprap in <u>curved</u> channels:

$$\frac{d_{30}}{D} = \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{1/2} \frac{V}{\sqrt{gD}}\right]^{2.5}$$

based on model and prototype data for thickness of $1d_{100}$. This relation was also found applicable to bottom riprap in straight channels.

Since these relations define the threshold of incipient failure, safety factors must be determined before they can be used. A common problem in the design of riprap is the addition of safety factors at each step in the design procedure. A safety factor of 1.2 times the d_{30} riprap size given by the threshold of incipient failure curve is used in the sizing nomograph (Figure 5.1) developed in this investigation. The designer can easily use other safety factors and apply them to the incipient failure relations.

MAD 8/1/88

```
MAYNORD'S (1987) METHOD FOR DETERMINING RIPRAP              RIPRAP2.WR1
        SIZE FOR OPEN CHANNEL FLOWS


LOCATION:UNC NORTH DIVERSION DITCH SECTION EE

        BOTTOM WIDTH =       20 FT
        Z (SIDE SLOPE)        3
        CHANNEL SLOPE =   0.003
        DISCHARGE =        1081 CFS
        C =                 0.3 - SEE PG 78 OF MAYNORD'S MAR 1988 REPORT
        RIPRAP S.W. =       165
        SAFETY FACTOR =    1.00
                Vmax =     1.33 Vavg - SEE PG 73 OG MAYNORD'S MAR 1988 REPORT

        D30 (ASSUMED) =   0.217 FT     - SELECT A D30 SIZE
            D50(CALC) =   0.362
                    n =   0.033
                    d =    5.30 FT     - SELECT A DEPTH OF FLOW
                    A =   190.3 FT^2
                    R =    3.56 FT
            Q (CALC) =   1082.0 CFS    - CHECK THIS Q VALUE TO
                    v =     5.7 FPS      SEE IF IT MATCHES LISTED
                                         DISCHARGE
                 Vmax =   7.563
                   Fr =   0.523

          D30 (CALC) =   0.218 FT     - CHECK THIS D30 VALUE TO
                Dmax =   0.454 FT       SEE IF IT MATCHES THE
           THICKNESS =    0.50 FT       ASSUMED D30 VALUE


           FREEBOARD =     0.5 FT      -FROM TOP OF WATER TO TOP OF RIPRAP
        RIPRAP DEPTH =     5.8 FT      -DEPTH OF WATER + DEPTH OF FREEBOARD
        CHANNEL LENGTH     600 FT
          RIPRAP VOL =  629.80 CY      -RIPRAP PERIMETER * THICKNESS * CHANNEL LENGTH
          TOP WIDTH OF
        WATER CHANNEL =   51.8 FT
```

Reference: Maynord, Stephen T, 1987, Stable Riprap Size For Open Channel Flows, Dissertation, Colorado State University, Fort Collins, Colorado.

MAD 2/1/88

MAYNORD'S (1987) METHOD FOR DETERMINING RIPRAP SIZE FOR OPEN CHANNEL FLOWS — RIPRAP2.WR1

LOCATION: UNC NORTH DIVERSION DITCH SECTION DD

BOTTOM WIDTH =	18	FT	
Z (SIDE SLOPE)	1		
CHANNEL SLOPE =	0.003		
DISCHARGE =	1081	CFS	
C =	0.3		- SEE PG 78 OF MAYNORD'S MAR 1988 REPORT
RIPRAP S.W. =	165		
SAFETY FACTOR =	1.00		
Vmax =	1.33	Vavg	- SEE PG 73 OF MAYNORD'S MAR 1988 REPORT
D30 (ASSUMED) =	0.275	FT	- SELECT A D30 SIZE
D50(CALC) =	0.458		
n =	0.035		
d =	6.80	FT	- SELECT A DEPTH OF FLOW
A =	168.6	FT^2	
R =	4.53	FT	
Q (CALC) =	1083.4	CFS	- CHECK THIS Q VALUE TO SEE IF IT MATCHES LISTED DISCHARGE
v =	6.4	FPS	
Vmax =	8.544		
Fr =	0.490		
D30 (CALC) =	0.278	FT	- CHECK THIS D30 VALUE TO SEE IF IT MATCHES THE ASSUMED D30 VALUE
Dmax =	0.578	FT	
THICKNESS =	0.50	FT	
FREEBOARD =	0.5	FT	-FROM TOP OF WATER TO TOP OF RIPRAP
RIPRAP DEPTH =	7.3	FT	-DEPTH OF WATER + DEPTH OF FREEBOARD
CHANNEL LENGTH	600	FT	
RIPRAP VOL =	429.42	CY	-RIPRAP PERIMETER * THICKNESS * CHANNEL LENGTH
TOP WIDTH OF WATER CHANNEL =	31.6	FT	

Reference: Maynord, Stephen T, 1987, Stable Riprap Size For Open Channel Flows, Dissertation, Colorado State University, Fort Collins, Colorado.

MAYNORD'S (1987) METHOD FOR DETERMINING RIPRAP RIPRAP2 WR1
SIZE FOR OPEN CHANNEL FLOWS

LOCATION-UNC NORTH DIVERSION DITCH SECTION 0[illegible]

BOTTOM WIDTH =	18	FT	
Z (SIDE SLOPE)	1		
CHANNEL SLOPE =	0.003		
DISCHARGE =	1081	CFS	
C	0.3	SEE P.78 OF MAYNORD'S MAR 1988 REPORT	
RIPRAP S.W. =	165		
SAFETY FACTOR =	1.00		
Vmax =	1.33	Vavg	
D30 (ASSUMED) =	0.275	FT	- SELECT A D30 SIZE
D50(CALC) =	0.458		
n =	0.035		
d =	6.79	FT	- SELECT A DEPTH OF FLOW
A =	168.4	FT^2	
R =	4.52	FT	
Q (CALC) =	1081.0	CFS	- CHECK THIS Q VALUE TO SEE IF IT MATCHES LISTED DISCHARGE
v =	6.4	FPS	
Vmax =	8.539		
Fr =	0.490		
D30 (CALC) =	0.277	FT	- CHECK THIS D30 VALUE TO SEE IF IT MATCHES THE ASSUMED D30 VALUE
Dmax =	0.578	FT	
THICKNESS =	0.58	FT	

Reference: Maynord, Stephen T, 1987, Stable Riprap Size for Open Channel Flows, Dissertation, Colorado State University, Fort Collins, Colorado.

FREEBOARD =	0.5	FT	- FROM TOP OF WATER TO TOP OF RIPRAP
RIPRAP DEPTH =	7.2915	FT	-DEPTH OF WATER + DEPTH OF FREEBOARD
CHANNEL LENGTH	150	FT	
RIPRAP VOL =	123.94	CY	-RIPRAP PERIMETER * THICKNESS * CHANNEL [illegible]
TOP WIDTH OF WATER CHANNEL =	31.583	FT	

E.3(a)

Runoff Control Ditch Design Calculation

By GS Date 11/12/90 Subject LNC - Runoff Control Ditch Design Sheet No. 1 of 10

Chkd. By [illegible] Date 11/30/90 Proj. No. [illegible]

1/4" X 1/4"

PURPOSE: To determine the right design for the run-off control ditch for the reclaimed uranium tailings impoundment embankment at the LNC site.

METHODS: 1) Determine:

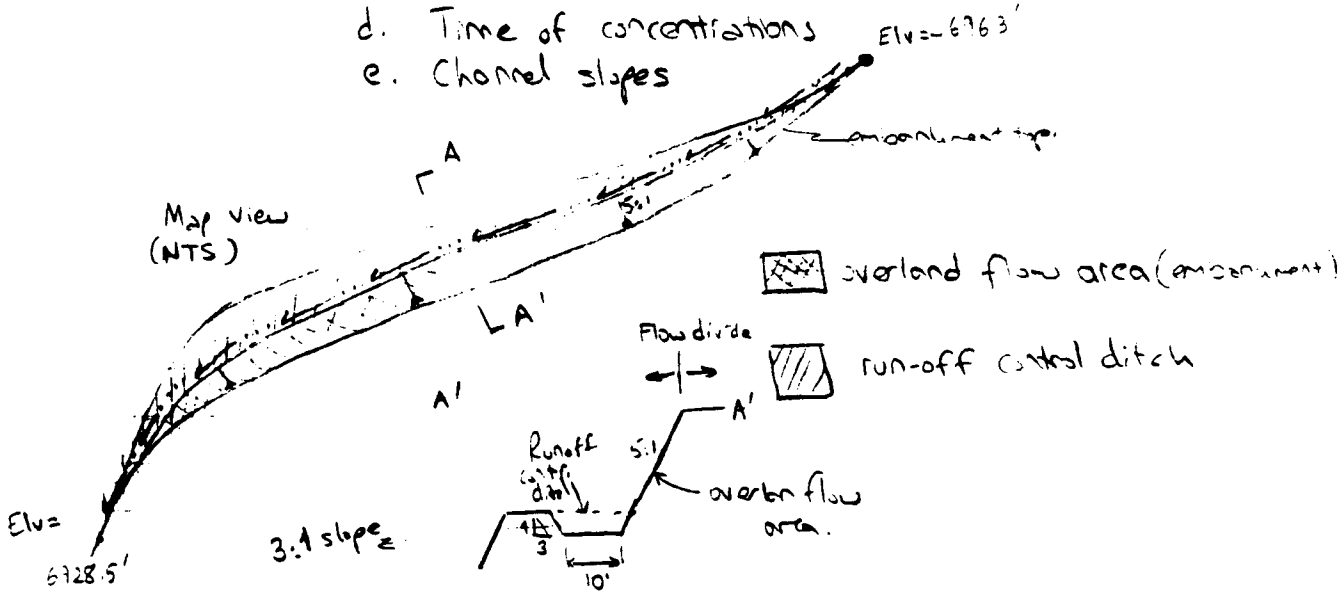
a. Drainage Area

b. Maximum flow length

c. Maximum elevation difference

d. Time of concentrations

e. Channel slopes



2) Inputting the probable maximum precipitation event and curve numbers previously determined for the site, determine the PMF storm hydrograph using the SCS TR-55 Method for a type II storm distribution

CanonieEnvironmental

E-121

By GS Date 1-12-90 Subject UNC - Run-off Control Sheet No. 2 of 10

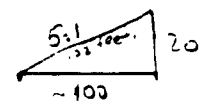
Chkd. By mjp Date 11/30/90 Ditch Design Proj. No. [illegible]

1/4" X 1/4"

CALCULATIONS Measure the following from plan topo map

Drainage area (embankment area + run-off control ditch area) =
402,587.46 ft² = 9.24 acres

Max overland flow length = 102 feet



Max. channel flow length = 4,400 feet

Max. elev. diff (6963 - 6928.5) = 34.5 feet

Determine 1st cut time of concentration by adding overland flow time and channel flow time. Assume $V_{overland}$ = 1 ft/sec & V_{ditch} = 3 ft/sec

t_c = 102 ft / (1 ft/sec) + 4,400 ft / (3 ft/sec) = 1569 sec.

t_c = 26.15 min. / 60 = 2.43 hrs

DETERMINE CURVE NO. (CN)

A CN of 79 was determined by Faith & provided in its 1981 Report to UNC entitled "Design Flood Analysis: North Cell Tailings Embankment". Faith used an area-weighted determination using the names, cover types, hydrologic soil groups, CN.

Science Application, Inc. determined a CN of 80 for the area draining to the N & S diversion ditches in its June 1981 report entitled "PMF Determination for the Southeast Diversion Channel & Section 1 Watershed Using SCS Hydrologic Techniques" (REF: Response to NRC Comments, May 23, 1988)

USE CN = 80

Canonie Environmental

E-122

By GS Date 11-12-90 Subject UNC-Runoff Control Sheet No. 3 of 10

Chkd. By [illegible] Date 11/30/90 Ditch Design Proj. No. 86-060-221

1/4" X 1/4"

DETERMINE PMP EVENT

PMP has been determined to be 9.4 inch. However a correction must be made for the high elevation of the site. (Mean basin elevation correction)

The correction factor is -5%. For every 1000 ft of elevation in excess of 5000 ft concentratively choose mean basin elevation of 7000 ft.

PMP = 8.43 inches.

DETERMINE HYDROGRAPH BY TR-55 METHOD.

(see p. 4)

Tc = 0.4

RUNOFF HYDROGRAPHS BY THE SCS TR-55 METHOD

TYPE-II STORM DISTRIBUTION

27-Nov-90
02:40 PM

TIME OF CONCENTRATION = 0.4 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT ANT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0
						(CSM/IN)	18	25	36	77	141	271	468	592	574	431	298	216	163	104	77	63	55	49	44
RUNOFF CONTROL DITCH	9.24	1.44E-02	80.0	8.43	6.03	(CFS)	1.57	2.18	3.13	6.70	12.27	23.59	40.74	51.53	49.97	37.52	25.94	18.80	14.19	9.05	6.70	5.48	4.79	4.27	3.83

peak flow

14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
38	34	31	28	25	22	21	20	18	16	14	12	0
3.31	2.96	2.70	2.44	2.18	1.92	1.83	1.74	1.57	1.39	1.22	1.04	0.00

Calmo 11/3/90

Canonie Environmental

E-124

By GS Date 11-12-90 Subject UNC - Runoff Control Sheet No. 5 of 10

Chkd. By [illegible] Date 11/30/90 Ditch Design Proj. No. 86-060-24

1/4" X 1/4"

Determine channel & riprap design

Use peak flows resulting from PMF as determined by SCS TR-55 Hydrograph

Peak flow = 51.5 cfs at time 12.3 hrs

Input peak flow rates assumed channel slopes & bottom widths and side slopes to calculate channel dimensions & riprap sizes by Safety Factor Method. Use spreadsheet "RIPSF. WR1".

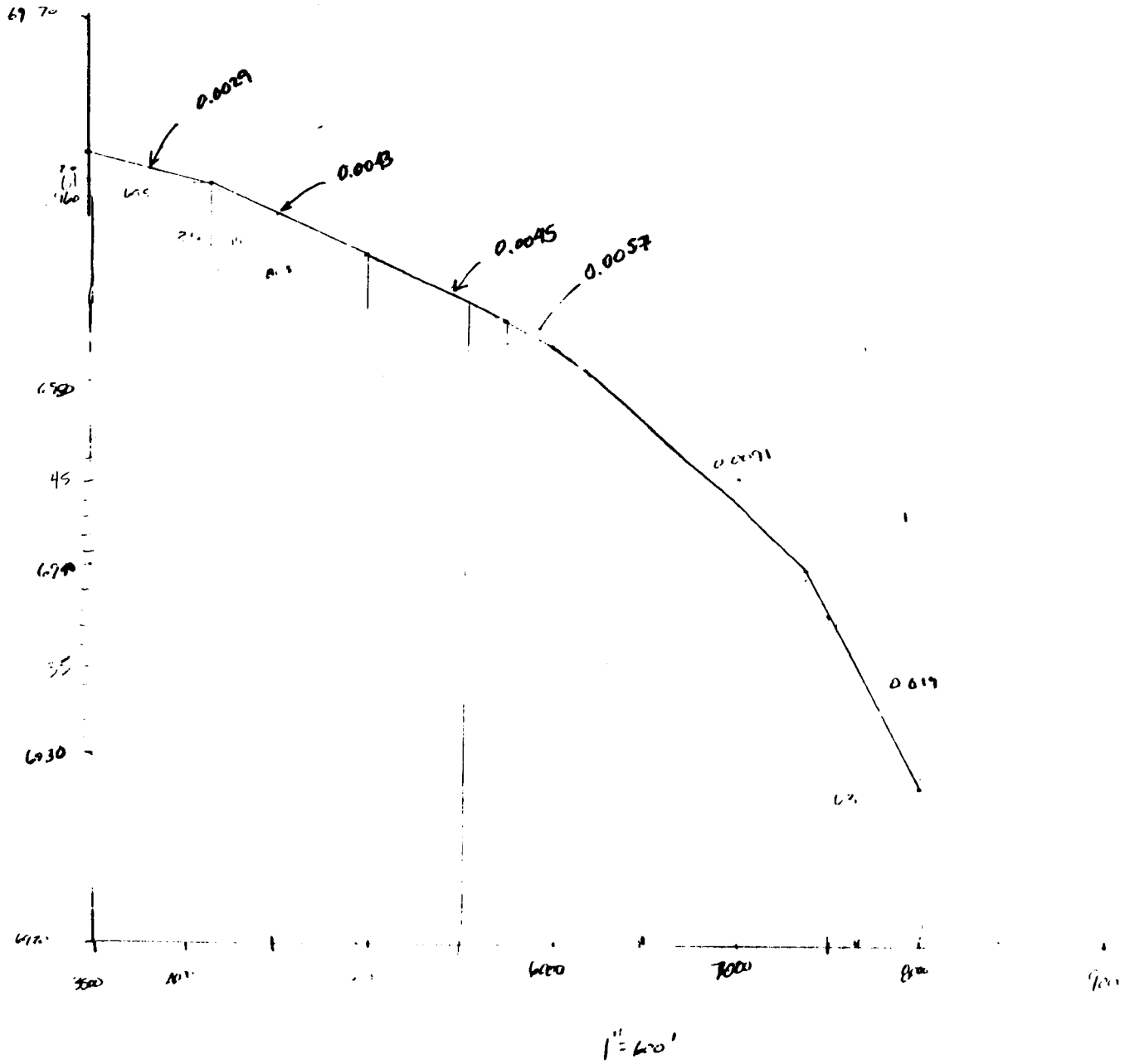
(results in pages 7, 8 & 9).

DITCH SLOPE

ΔElv.	Length	Slope	
6963 - 6928.5 = 34.5	4,400 feet	0.0078	Avg.
	for 3" rock	0.019	Max
	for 1.5" rock	0.0029	Min
		0.0091	Max

→ see profile in next page for slope variation.

8010,6920
7380,6940
6230,6950.5
6140,6951.6
6040,6952
5775,6953.5
5000,6957
4195,6960.5
3500,6962.5



1" = 6'

Chrs 11/30/90

0000 ✓ mjg 11/30/90

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

Using avg. slope (0.0078)

LOCATION: RUNOFF CONTROL DITCH

DISCHARGE =	51.5 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	4	Alpha =	14.04 Degrees
CHANNEL SLOPE =	0.0078	Theta =	0.45 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.13 FT	1.5 inches	D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028		n =	0.028	
* TRIAL d =	1.00 ft	******			
DIFFERENCE =	7.06 %				
* calc d =	0.96 ft	******			
DIFFERENCE =	0.22 %				
* calc d =	0.96 ft	******			
DIFFERENCE =	0.02 %				
* calc d =	0.96 ft	******			
DIFFERENCE =	0.00 %				
FINAL d =	0.96 ft				
A =	13.35 sq ft				
R =	0.74 ft		t =	0.35 PSF	
t =	17.71 ft		nb =	0.63	
V =	3.86 fps				
Q(calc) =	52 cfs		Beta =	44.23	
t =	0.47 PSF				
nb =	0.842		n' =	0.54	
SFb =	1.17	OK	SFs =	1.26	OK

d = 0.96'

✓ mjg 11/30/90

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

Using max. slope (0.019)

LOCATION: RUNOFF CONTROL DITCH

DISCHARGE =	51.5 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	4	Alpha =	14.04 Degrees
CHANNEL SLOPE =	0.019	Theta =	1.09 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.80 see Fig 3.16, ref.		

CHANNEL BOTTOM

D50 (ASSUM) =	0.22 FT	2.6 inches	
n =	0.031		
* TRIAL d =	0.80 ft	******	
DIFFERENCE =	1.24 %		
* calc d =	0.80 ft	******	
DIFFERENCE =	0.11 %		
* calc d =	0.79 ft	******	
DIFFERENCE =	0.01 %		
* calc d =	0.79 ft	******	
DIFFERENCE =	0.00 %		
FINAL d =	0.79 ft		
A =	10.47 sq ft		
R =	0.63 ft		
t =	16.36 ft		
V =	4.92 fps		
Q(calc) =	52 cfs		
t =	0.94 PSF		
nb =	0.961		
SFb =	(1.01) ok		

CHANNEL SIDE SLOPES

D50 (ASSUM) =	0.22 FT	2.6 inches
n =	0.031	
t =	0.75 PSF	
nb =	0.77	
Beta =	49.41	
n' =	0.68	
SFs =	(1.09) ok	

d = 0.79

mjj 11/30/90

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: RUNOFF CONTROL DITCH

Using min. slope. (0.0029)

DISCHARGE =	51.5 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	4	Alpha =	14.04 Degrees
CHANNEL SLOPE =	0.0029	Theta =	0.17 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.80 see Fig 3.16, ref.		

CHANNEL BOTTOM

D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028	
* TRIAL d =	1.25 ft	******
DIFFERENCE =	-1.09 %	
* calc d =	1.26 ft	******
DIFFERENCE =	-0.07 %	
* calc d =	1.26 ft	******

CHANNEL SIDE SLOPES

D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028	

DIFFERENCE =	-0.00 %	
* calc d =	1.26 ft	******
DIFFERENCE =	-0.00 %	

FINAL d =	1.26 ft		
A =	18.90 sq ft	t =	0.18 PSF
R =	0.93 ft	nb =	0.33
t =	20.06 ft		
V =	2.73 fps	Beta =	26.87
Q(calc) =	51 cfs		
t =	0.23 PSF	n' =	0.24
nb =	0.408		
SFb =	2.43 ✓ok	SFs =	1.85 ✓ok

d = 1.26 ft

12/3/90

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: RUNOFF CONTROL DITCH

DISCHARGE =	51.5 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	4	Alpha =	14.04 Degrees
CHANNEL SLOPE =	0.0091	Theta =	0.52 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.13 FT	1.5 inches	D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028		n =	0.028	
* TRIAL d =	0.92 ft	******			
DIFFERENCE =	-0.77 %				
* calc d =	0.92 ft	******			
DIFFERENCE =	-0.07 %				
* calc d =	0.92 ft	******			
DIFFERENCE =	-0.01 %				
* calc d =	0.92 ft	******			
DIFFERENCE =	-0.00 %				
FINAL d =	0.92 ft				
A =	12.65 sq ft				
R =	0.72 ft		t =	0.39 PSF	
t =	17.39 ft		nb =	0.71	
V =	4.07 fps				
Q(calc) =	51 cfs		Beta =	47.37	
t =	0.52 PSF				
nb =	0.942		n' =	0.62	
SFb =	1.05		SFs =	1.16	

VERIFICATION OF THE TIME OF CONCENTRATION ASSUMPTION FOR THE RUNOFF CONTROL DITCH:

Water velocity of 3 ft/sec was assumed in calculating the time of concentration in page 2. This velocity revealed 0.4 hrs for the time of concentration. This number was checked by using the average slope (0.0078) of the runoff control ditch (see the spread sheet in page 7).

As shown in the spread sheet, water velocity in the ditch was calculated to be 3.8 ft/sec.

Using the velocity of 3.8 ft/sec

$$t_c = \underbrace{102\ (1\ ft/s)}_{\text{For the overland flow}} + \underbrace{4{,}400\ (3.8\ ft/s)}_{\text{For the runoff control ditch}} = 0.35\ hrs = \sim \underline{\underline{0.4\ hrs}}$$

RESULTS

The runoff control ditch for the reclaimed uranium tailings impoundment embankment at the UNC site will be armored with 6" thick 1.5" diameter rock except the last 630' in the profile. This part requires 6" thick, 3" diameter rock.

E.3(b)

Scour Along Protective Bench Calculation

Canonie Environmental

E-132

By MT Date 26 Nov 90 Subject UNC Sheet No. 1 of 4

Chkd. By MJJ Date 12/3/90 Bench Scour Proj. No. 84-060-24

1/4" X 1/4"

Purpose: The purpose of this calc sheet is to estimate the potential scour of the protective bench during passage of the PMF

Methods: The empirical methods found in the US Bureau of Reclamations Technical Guideline "Computing Degradation and Local Scour" by Pemberton and Lara (1984) were used. Specifically equations 25 through 30 were used. These equations were derived primarily for wide alluvial channels. The width of the PMF (> 430') indicates that these equations are valid for determining the depth of scour.

The extent of lateral bank scour on the protective bench was considered as one half of the depth of scour, because the tractive forces are less on the bench sideslope than on the channel bottom and the bench is located approximately 350 feet from the channel. Most of the scour will occur in or near the channel

Results: The extent of scour as determined by three methods are summarized below

Method	Extent of bench scour
Neill	2.45 ft
Lacey	1.91 ft
Blench	4.85 ft

Thus for the worst case the bench will be scoured 4.85 ft.

Calculations

Neill Method (Equations 25 and 28)

$$d_f = d_i \left(\frac{q_f}{q_i}\right)^m \qquad (25)$$

where d_f = Scoured depth below design flood water level

d_i = Average depth of bankfull discharge in incised reach - assumed to be 8 feet

q_f = Design flood discharge per unit width

= 26300 cfs / 430 ft = 61.2 cfs/ft

q_i = Bankfull discharge in incised reach per unit width

= 2250 cfs / 50' = 45 cfs/ft

m = 0.67 for sand

$$d_f = 8 \left(\frac{61.2}{45}\right)^{0.67} = 9.83'$$

$d_s = 0.5\, d_f$ for straight reach (28)

where d_s = depth of scour

$$d_s = 0.5 \cdot 9.83 = 4.92'$$

Extent of scour = 0.5 · 4.92 = 2.45'

Canonie Environmental

E-134

By MT Date 26 Nov 90 Subject UNC Sheet No. 3 of 4

Chkd. By MJ Date 12/3/90 Bench Scour Proj. No. 86-060-24

1/4" X 1/4"

Lacey Method

$$d_m = 0.47 \left(\frac{Q}{f}\right)^{1/3} \qquad (26)$$

where d_m = Mean depth at design discharge

Q = Design discharge = 26300 cfs

$f = 1.76 (D_m)^{1/2}$ where D_m = average grain size of bed material

assume that bed material is a fine sand

so $D_m = 0.2$ mm

$= 1.76 (0.2)^{1/2} = 0.79$

$$d_m = 0.47 \left(\frac{26300}{0.79}\right)^{1/3} = 15.1'$$

$$d_s = 0.25\, d_m = 3.78' \qquad (29)$$

Extent of scour = 0.5 · 3.78 = 1.9'

Blench Equation

$$d_{fo} = \frac{q_f^{2/3}}{F_{bo}^{1/3}} \qquad (27)$$

where d_{fo} = Depth for zero bed transport

q_f = Design flood discharge for unit width

= 26300 cfs / 430 ft = 61.2 cfs/ft

F_{bo} = Blench's zero bed factor from Figure 9 (attached)

= 0.9 for D_m = 0.2 mm

$$d_{fo} = \frac{61.2^{2/3}}{0.9^{1/3}} = 16.1'$$

$$d_s = 0.6 \cdot 16.1' = 9.7' \qquad (30)$$

Extent of scour = 0.5 · 9.7' = 4.85'

The use of equation 24 except as a check on other methods would be limited to channels similar to those observed on relatively steep slopes ranging from 0.004 to 0.008 ft/ft (m/m). Because of shallow depths of flow and medium to coarse sand size bed material the bedload transport should also be very high.

Regime equations supported by field measurements method. - This approach as suggested by Neill (1973) on recommendations by Blench (1969) involves obtaining field measurements in an incised reach of river from which the bankfull discharge and hydraluics can be determined. From the bankfull hydraulics in the incised reach of river, the flood depths can be computed by:

$$d_f = d_i \left(\frac{q_f}{q_i}\right)^m \qquad (25)$$

where:

d_f = Scoured depth below design floodwater level
d_i = Average depth at bankfull discharge in incised reach
q_f = Design flood discharge per unit width
q_i = Bankfull discharge in incised reach per unit width
m = Exponent varying from 0.67 for sand to 0.85 for coarse gravel

This method has been expanded for Reclamation use to include the empirical regime equation by Lacey (1930) and the method of zero bed-sediment transport by Blench (1969) in the form of the Lacey equation:

$$d_m = 0.47 \left(\frac{Q}{f}\right)^{1/3} \qquad (26)$$

where:

d_m = Mean depth at design discharge, ft (m)
Q = Design discharge, ft^3/s (m^3/s)
f = Lacey's silt factor equals $1.76\ (D_m)^{1/2}$ where D_m equal mean grain size of bed material in millimeters

and the Blench equation for "zero bed factor":

$$d_{fo} = \frac{q_f^{\ 2/3}}{F_{bo}^{1/3}} \qquad (27)$$

where:

d_{fo} = Depth for zero bed sediment transport, ft (m)
q_f = Design flood discharge per unit width, ft^3/s per ft (m^3/s per m)
F_{bo} = Blench's "zero bed factor" in ft/s^2 (m/s^2) from figure 9

The maximum natural channel scour depth for design of any structure placed below the streambed (i.e., siphon) or along the bank of a channel must

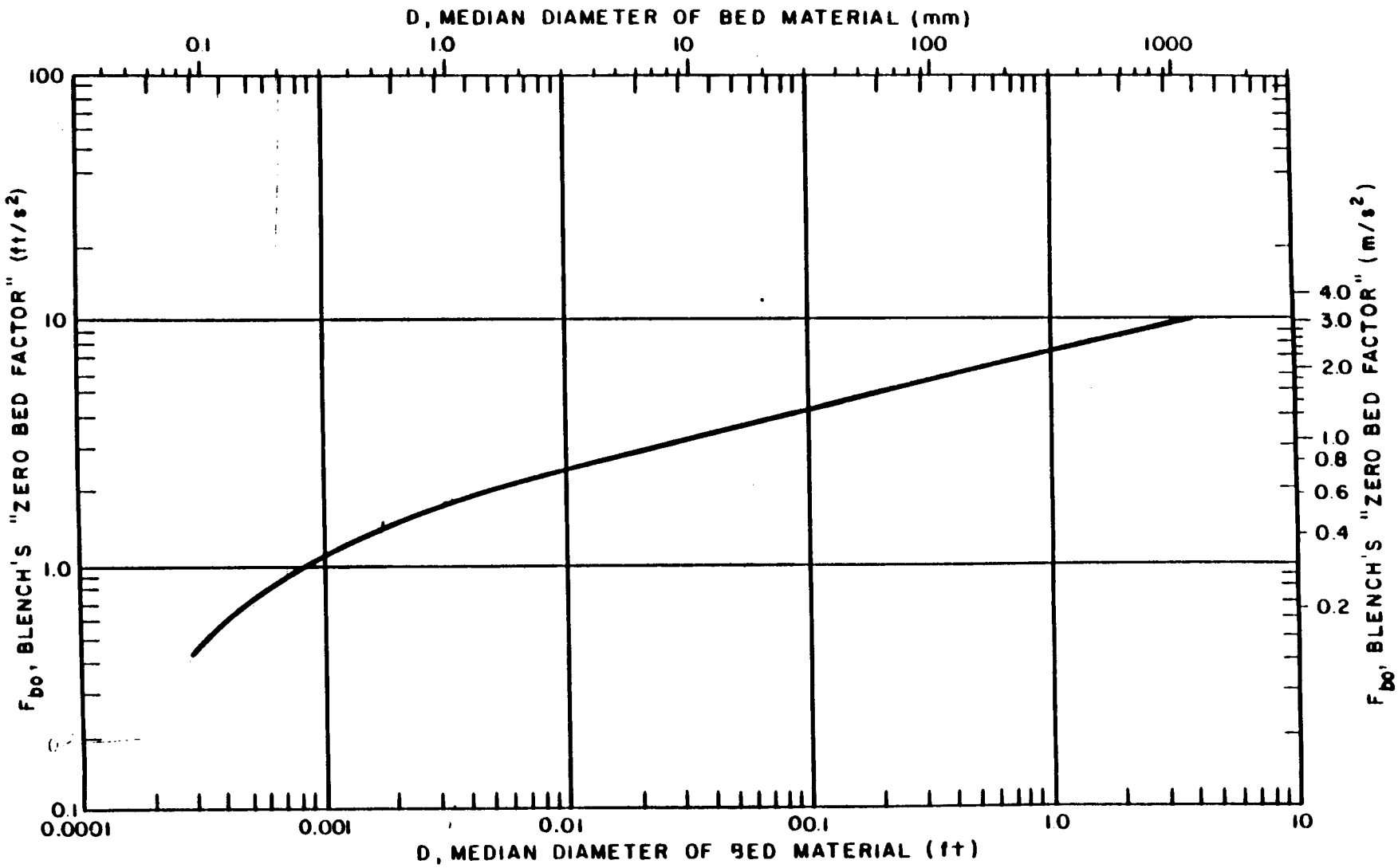


CHART FOR ESTIMATING F_{bo} (AFTER BLENCH)

Figure 9. - Chart for estimating F_{bo} (after Blench, 1969).

E-1337

consider the probable concentration of floodflows in some portion of the natural channel. Equations 25, 26, or 27 for predicting this maximum depth are to be adjusted by the empirical multiplying factors, Z, shown for formula Types A and B (table 6), in table 7. An illustration of maximum scour depth associated with a flood discharge is shown in a sketch of a natural channel, figure 10. As shown in table 7 and on figure 10, the d_s equals depth of scour below streambed.

$$d_s = Z\ d_f \tag{28}$$

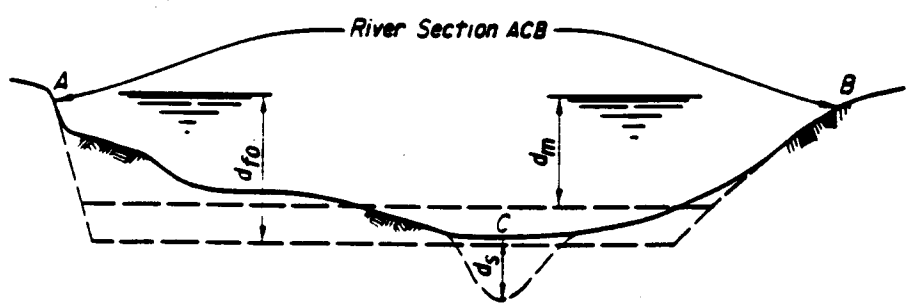
$$d_s = Z\ d_m \tag{29}$$

$$d_s = Z\ d_{fo} \tag{30}$$

Table 7. - Multiplying factors, Z, for use in scour depths by regime equations

Condition	Value of Z		
	Neill $d_s = Z\ d_f$	Lacey $d_s = Z\ d_m$	Blench $d_s = Z\ d_{fo}$
Equation Types A and B			
Straight reach	[redacted]	[redacted]	[redacted]
Moderate bend	0.6	0.5	
Severe bend	0.7	0.75	
Right angle bends		1.0	1.25
Vertical rock bank or wall		1.25	
Equation Types C and D			
Nose of piers	1.0		0.5 to 1.0
Nose of guide banks	0.4 to 0.7	1.50 to 1.75	1.0 to 1.75
Small dam or control across river		1.5	0.75 to 1.25

1/ Z value selected by USBR for use on bends in river.



NOTE: $d_{fo} > d_f > d_m$. Point C is low point of natural section.

Figure 10. - Sketch of natural channel scour by regime method.

EY mjg 10/29/90

F/2
86-060-24

E-139

✓ SWM 12/2/90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UNC: 86-060-24
LOCATION: EMBANKMENT SIDESLOPES

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF:	1	RETURN PERIOD:	PMP
SLOPE LENGTH:	100 FT	1-HR PPT AMOUNT:	8.47 INCHES
AVE SLOPE:	0.2 FT/FT	Tc (calc):	0.502 MIN EQTN 4.44, NUREG4620
MANNING'S n:	0.038	Tc (actual):	2.5 MIN
FLOW CONC:	3	%OF 1-HR PPT:	27.5 % TABLE 2.1, NUREG 4620
DRAINAGE AREA:	0.002 ACRES	PPT AMOUNT:	2.329 INCHES
Mannings n(calc)	0.038	PPT INTENSITY:	55.90 IPH

PEAK DISCHARGE: 0.128 CFS Q = CiA
CONC. DISCHARGE: 0.385 CFS

DEPTH: 0.101 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 1.264 PSF
FLOW VELOCITY: 3.80 FPS V = Q/FLOW AREA

CALC. d50: 1.533 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT O 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

E.3(c)

Rock Mulch Design for Embankment

Canonie Environmental

E-141

By mjj Date 10/29/90 Subject UNC - ROCK MULCH SIZING Sheet No. 1 of ___

Chkd. By SWM Date 12/2/90 FOR 5:1 EMBANKMENT SIDES Proj. No. 86-060-24

1/4" X 1/4"

PURPOSE: TO DETERMINE THE SIZE (D_{50}) OF ROCK MULCH REQUIRED TO PROTECT THE 5H:1V EMBANKMENT SIDESLOPES AT UNC

METHOD: USE THE CSU METHOD (NUREG 4651) FOR OVERLAND FLOW CALCULATIONS TO DETERMINE ROCK MULCH SIZE REQUIRED.

THE SPREADSHEET PROGRAM OVERCSU.WR1 WAS DEVELOPED TO AID IN CALCULATION OF ROCK MULCH SIZE.

RESULTS: FOR THE PMF, A ROCK MULCH WITH A $D_{50} = 1.5"$ IS REQUIRED

CALCULATIONS:

THE EMBANKMENT SLOPE IS 100 FT WIDE AND HAS A 5H:1V SLOPE (WORST CASE, MAX.)

AT 5H:1V
THE SLOPE IS 20% OR 0.20

~~FOR THE~~
THE PMP CORRECTED FOR ALTITUDE = 8.47 INCHES

THE SPREADSHEET OUTPUT, INCLUDING INPUT VALUES FOLLOWS.

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: ENBANKMENT SIDESLOPES

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF: 1
SLOPE LENGTH: 100 FT
AVE SLOPE: 0.2 FT/FT
MANNING'S n: 0.038
FLOW CONC: 3
DRAINAGE AREA: 0.002 ACRES
Mannings n(calc)0.038

RETURN PERIOD: PMP
1-HR PPT AMOUNT: 8.47 INCHES
Tc (calc): 0.502 MIN EQTN 4.44, NUREG4620
Tc (actual): 2.5 MIN
%OF 1-HR PPT: 27.5 % TABLE 2.1, NUREG 4620
PPT AMOUNT: 2.329 INCHES
PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.128 CFS Q = CiA
CONC. DISCHARGE:0.385 CFS

DEPTH: 0.101 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 1.264 PSF
FLOW VELOCITY: 3.80 FPS V = Q/FLOW AREA

CALC. d50: 1.533 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

E.4

Tailings Embankment Slope Stability Calculation

Canonie Environmental

E-144

By CEM Date 8/13/91 Subject UNC - SLOPE STABILITY Sheet No. 1 of 61

Chkd. By [illegible] Date 8-16-91 Proj. No 86-060-2

1/4 X 1/4

PURPOSE: TO DETERMINE THE SLOPE STABILITY OF THE MODIFIED PIPELINE ARROYO AT STATION 55+00 AT THE UNC SITE IN GALLUP, NEW MEXICO. THE MOST CRITICAL FAILURE CIRCLE AND THE MINIMUM FACTOR OF SAFETY WAS DETERMINED FOR THE MODIFIED ARROYO. TWO SCENARIO'S WERE CONSIDERED; THE FIRST SCENARIO IS, THE ARROYO PROFILE WITH A WATER TABLE AND NO EARTHQUAKE EFFECTS, AND THE SECOND SCENARIO IS, THE ARROYO WITH A WATER TABLE AND EARTHQUAKE (PSUEDO-STATIC) EFFECTS.

METHODS:

1.) DETERMINE MODIFIED ARROYO PROFILE AT CRITICAL STATION LOCATION ALONG THE MODIFIED ARROYO. REFER TO FIGURE 1 Pg. 41 FOR BOUNDARY POINTS OF THE CRITICAL PROFILE CONFIGURATION. REFER TO DRAWING 86-060-E544 FOR CRITICAL STATION LOCATION.

FIGURE 51

NOTE: ADDITIONAL SLOPE STABILITY CHECKS WERE CONSIDERED (REFER TO UNC SLOPE STABILITY SUPPORT FILE 8/16/91), ONLY THE CRITICAL STATION WAS CONSIDERED IN THIS CALCULATION BRIEF.)

2.) SELECT WORST CASE SCENARIO FOR WATER TABLE ELEVATION, REFER TO FIGURE 1, P. 41

3.) DETERMINE SOIL TYPES (PARAMETERS) FOR THE EMBANKMENT SOIL "1b" AND FOR THE NATIVE SOIL "1a".

METHOD (CONT.):

4.) RUN COMPUTER ITERATION USING "STABL" FOR FIRST SCENARIO, ARROYO PROFILE WITH WATER TABLE AND NO EARTH QUAKE EFFECTS. IN OTHER WORDS, STATIC SCENARIO.

5.) SELECT EARTHQUAKE PARAMETERS AND RUN COMPUTER ITERATION USING "STABL" FOR SECOND SCENARIO, ARROYO PROFILE WITH WATER TABLE AND EARTHQUAKE EFFECTS. IN OTHER WORDS, PSUEDO-STATIC SCENARIO.

6) DRAW CONCLUSIONS, DETERMINE IF COMPUTER GENERATED FACTOR-OF-SAFETY (FS) IS O.K, IF FS > 1 THEN NO FAILURE AND SLOPE IS STABLE. FS > 1 IS A TYPICAL CHECK USED WHEN DETERMINING SLOPE STABILITY USING "STABL".

"STABL" - SLOPE STABILITY PROGRAM IS USED TO DETERMINE THE FACTOR OF SAFETY OF SPECIFIC FAILURE SURFACES GENERATED WHILE RUNNING THE PROGRAM.

REFERENCES:

- "STABL" PURDUE UNIVERSITY, DEPARTMENT OF HIGHWAY, MAY 1986, (JAMES R. CARPENTER).
- SERGENT, HAUSKINS AND BECKWITH, GEOTECHNICAL AND DESIGN DEVELOPMENT INVESTIGATION REPORT, JULY 1978.

CONCLUSIONS: AT STATION 80+00:

SCENARIO	CRITICAL FACTOR-OF-SAFETY
1) STATIC	2.651
2) PSUEDO-STATIC	1.617

NOTE: FAILURE SURFACES CAN BE SEEN AT THE END OF EACH COMPUTER ITERATION. CRITICAL FAILURE SURFACE IS REPRESENTED BY THE NUMBER "1".

Canonie Environmental

E-147

By FM Date 8/13/91 Subject UNC - SLOPE STAB. Sheet No. 4 of 61

Chkd. By [illegible] Date [illegible] Proj. No 36-560-3

1/4 X 1/4

SLOPE CONFIGURATION AT STATION 80+00 FOR EACH BOUNDARY

STATION	BOUNDARY #	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BOUNDAR
80+00	1	0	110	10	105	2
	2	10	105	40	100	2
	3	40	100	85	74	2
	4	85	74	105	74	2
	5	105	74	160	100	2
	6	160	100	180	110	1
	7	180	110	370	115	1
	8	370	115	420	118	1
	9	420	118	550	125	2
	10	550	125	580	126.5	2
	11	580	126.5	635	137	1
	12	635	137	650	137	1
	13	650	137	655	135	1
	14	655	135	665	135	1
	15	665	135	790	160	1
	16	790	160	990	160	1
	17	160	100	280	110	2
	18	280	110	340	110	2
	19	340	110	420	118	2
	~~-~~	~~420~~	~~118~~	~~450~~	~~120~~	~~2~~
	~~21~~	~~450~~	~~120~~	~~550~~	~~125~~	~~2~~
	21	550	125	580	126.5	2
	22	580	126.5	990	126.5	2

Canonie Environmental

E-148

By CEM Date 3/13/91 Subject UNC-SLOPE STAB. Sheet No. 5 of 61

Chkd. By [illegible] Date 3-14-91 Proj. No 86-060-27

1/4" X 1/4"

WATER SURFACE ELEVATION FOR STATION 30+00 %

-LOOK AT A WORSE CASE SITUATION

BOUNDARY #	X-AXIS (FT)	Y-AXIS (FT)
1	0	110
2	10	105
3	40	100
4	55	92
5	145	92
6	160	100
7	180	110
8	370	115
9	450	120
10	550	125
11	580	126.5
12	635	137
13	990	137

Canonie Environmental

E-149

By CEM Date 8/13/91 Subject UNC - SLOPE STAB. Sheet No. 6 of 61

Chkd. By mjj Date 8-16-91 Proj. No 860602 7

1/4" X 1/4"

SOIL TYPES OF CONCERN:

SOIL NAME	SOIL TYPE	TOT. UNIT WEIGHT (PCF)	SATURATED UNIT WEIGHT (PCF)	COHESION COEFF. (PSF)	FRICTION ANGLE(°)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZ SURFACE NO.
NATIVE	1a	# 94.6	#### 120.3	+ 960	+ 11	0	0	1
EMBANK	1b	# 94.6	#### 120.3	### 1600	## 15	0	0	1

Canonie Environmental

E-150

By CEM Date 8/13/91 Subject UNC - SLOPE STAB. Sheet No. 7 of 61

Chkd. By mjy Date 8-16-91 Proj. No 86-060-27

1/4 X 1/4

SOIL TYPES OF CONCERN (CONT.):

+ REF.: SERGENT, HAUSKINS & BECKWITH, FIGURE E-11 ATTACHED IN APPENDIX B.

++ REF.: SERGENT, HAUSKINS & BECKWITH, p. 49 AND p. 53 ATTACHED IN APPENDIX B.

BOREHOLE #	DEPTH (FT)	IN-SITU DRY DENSITY	IN-SITU DRY DENSITY (AVE)	AVERAGE IN-SITU DRY DENSITY
9	5½ - 6½	90.8 (PCF)		
↓	↓ - ↓	91.85		
		92.34	91.66	
13	9½ - 10½	98.92		
↓	↓ - ↓	99.86		
		93.53	97.44	94.6

+++ REF.: S, H AND B., FIGURE B-24, ATTACHED IN APPENDIX B.

++++ REF.: S, H AND B, p. B-85, ATTACHED IN APPENDIX B. AND IN CALCULATION FOR γ SATURATED.

NOTES: CONSIDERING REFERENCES, TOTAL DENSITY IS CALCULATED USING DIRECT SHEAR TEST INFORMATION FROM BOREHOLES LOCATED IN THE AREAS. THE TWO BOREHOLES SELECTED, 9 AND 13, WERE DRILLED IN NATIVE MATERIAL AT SHALLOW DEPTHS. THE AVERAGE TOTAL "IN-SITU" DENSITY WERE CONSERVATIVE FOR BOTH BOREHOLE SAMPLES IN COMPARISON TO THE EXISTING AVAILABLE SAMPLE DATA IN S, H AND B. THESE BOREHOLE SAMPLES ARE REPRESENTATIVE OF OF THE NATIVE SOILS.

SOIL TYPES OF CONCERN (CONT.):

NOTES: THE COHESION COEFFICIENTS AND FRICTION ANGLES WERE DETERMINED IN S, H AND B FOR EMBANKMENT SOIL "1b" AND NATIVE SOIL "1a". TRI-AXIAL TESTS WERE RUN ON SAMPLES COLLECTED ALONG THE ARROYO AT UNC. WITH THE RESULTS FROM THE TRI-AXIAL TESTS, MOHR'S CIRCLE WAS PLOTTED FOR EACH SAMPLE. TWO STRENGTH ENVELOPES WITH COHESION COEFF.S AND FRICTION ANGLES, FOR BOTH, WERE DETERMINED FROM THE PLOTS FOR EMBANKMENT SOIL "1b" AND NATIVE SOIL "1a". GRADATION, BORING DEPTHS, AND OTHER PERTINANT DATA IS AVAILABLE IN S, H AND B REPORT.

THE COHESION COEFFICIENTS AND FRICTION ANGLES DETERMINED IN S, H AND B REPORT ARE CONSERVATIVE VALUES FOR THE REPRESENTATIVE SOIL MATERIALS (NATIVE AND EMBANKMENT BEING USED FOR SLOPE STABILITY. IN FIGURES B-24 AND B-11, APPENDIX B, THE STRENGTH ENVELOPE IS DRAWN BELOW MOST OF THE SAMPLES (MOHR'S CIRCLE PLOTS) FAILURE PLANES AND THEREFORE, PRODUCE COHESION COEFFICIENTS AND FRICTION ANGLES WHICH ARE CONSERVATIVE.

THE TOTAL "IN SITU" DENSITY AND SATURATED DENSITY, 94.6 AND 120.3 pcF, RESPECTFULLY, ARE USED FOR BOTH EMBANKMENT "B" AND NATIVE SOIL "A". SINCE THE EMBANKMENT SOIL IS NATIVE SOIL COMPACTED TO 95% MAXIMUM DRY DENSITY, THESE VALUES ARE CONSERVATIVE VALUES FOR EMBANKMENT SOIL.

$\gamma_{H_2O} = 62.4$ PCF

1 lb. = 453.6 g

- THE FOLLOWING SOIL VARIABLES WHERE REFERENCED FROM SERGENT, HAUSKINS & BECKWITH, GEOTECHNICAL AND DESIGN DEVELOPMENT INVESTIGATION REPORT, JULY 1978.

$W_S = 242.2\,g = 0.54$ lbs

$e = 0.8290$

$V_T = 167.171$ cc $= 0.0059$ FT^3

<u>CALCULATIONS TO FIND $\gamma_{SAT.}$</u>:

$$e = \frac{V_V}{V_S} = \frac{V_V}{V_T - V_V}$$

$$0.8290 = \frac{V_V}{167.171 - V_V}$$

$$138.6 - 0.8290 V_V = V_V$$

$$V_V 1.829 = 138.6$$

$$V_V = 75.8 \text{ cc}$$

CONVERSION:

$$V_V = \frac{75.8\ cm^3}{} \left| \frac{(1)^3\ IN^3}{(2.54)^3\ cm^3} \right| \frac{(1)^3\ FT^3}{(12)^3\ IN^3}$$

$$V_V = 0.0027\ FT^3$$

CALCULATIONS TO FIND γ_{SAT} (CONT.):

$$W_{SAT} = W_S + W_W$$

$$W_{SAT} = W_S + V_V \gamma_W$$

$$W_{SAT} = .54 + 0.0027 (62.5)$$

$$W_{SAT} = .54 + 0.169$$

$$W_{SAT} = 0.71 \text{ lbs}$$

$$\gamma_{SAT} = \frac{W_{SAT}}{V_T}$$

$$\gamma_{SAT} = \frac{0.71}{0.0059}$$

$$\underline{\gamma_{SAT} = 120.3 \text{ PCF}}$$

Canonie Environmental

E-154

By CEM Date 8/13/91 Subject UNC - SLOPE STAB. Sheet No. 11 of 61

Chkd. By mjy Date 8-16-91 Proj. No [illegible]

1/4" X 1/4"

COMPUTER ITERATION OF PSUEDO-STATIC SCENARIO

THE FILE NAME IS UNCSTAB12.IN. THIS ITERATION CONSIDERS WATER TABLE AND EARTHQUAKE EFFECTS WHEN USING "STABL".

STATION 80+00

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	8/16/91
Time of Run:	1330
Run By:	CEM
Input Data Filename:	A:UNCSTA12.IN
Output Filename:	A:UNCSTA12.OUT
Plotted Output Filename:	A:UNCSTA12.PLT

PROBLEM DESCRIPTION UNC ARROYO - LOCATION, STATION 80+00

BOUNDARY COORDINATES

16 Top Boundaries
21 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	110.00	10.00	105.00	2
2	10.00	105.00	40.00	100.00	2
3	40.00	100.00	85.00	74.00	2
4	85.00	74.00	105.00	74.00	2
5	105.00	74.00	160.00	100.00	2
6	160.00	100.00	180.00	110.00	1
7	180.00	110.00	370.00	115.00	1
8	370.00	115.00	420.00	118.00	1
9	420.00	118.00	550.00	125.00	2
10	550.00	125.00	580.00	126.50	2
11	580.00	126.50	635.00	137.00	1
12	635.00	137.00	650.00	137.00	1
13	650.00	137.00	655.00	135.00	1
14	655.00	135.00	665.00	135.00	1
15	665.00	135.00	790.00	160.00	1
16	790.00	160.00	990.00	160.00	1
17	160.00	100.00	280.00	110.00	2
18	280.00	110.00	340.00	110.00	2
19	340.00	110.00	420.00	118.00	2
20	550.00	125.00	580.00	126.50	2
21	580.00	126.50	990.00	126.50	2

by CEM
12 of 61
✓ mjy 8-16-91

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.6	120.3	1600.0	15.0	.00	.0	1
2	94.6	120.3	960.0	11.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 13 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	110.00
2	10.00	105.00
3	40.00	100.00
4	55.00	92.00
5	145.00	92.00
6	160.00	100.00
7	180.00	110.00
8	370.00	115.00
9	450.00	120.00
10	550.00	125.00
11	580.00	126.50
12	635.00	137.00
13	990.00	137.00

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = 200.0 psf

by CEM
13 of 61

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

✓ mjy 8-16-91

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 85.00 ft.
and X = 665.00 ft.

Unless Further Limitations Were Imposed The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

20.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.53	66.48
3	122.22	59.36
4	141.06	52.63
5	160.03	46.30
6	179.13	40.36
7	198.35	34.84
8	217.68	29.72
9	237.12	25.00
10	256.65	20.70
11	276.27	16.81
12	295.96	13.33
13	315.73	10.27
14	335.55	7.62
15	355.43	5.40
16	375.34	3.59
17	395.30	2.20
18	415.27	1.23
19	435.27	.69
20	455.27	.56
21	475.26	.85
22	495.25	1.57
23	515.22	2.71
24	535.16	4.26
25	555.06	6.24
26	574.92	8.64
27	594.72	11.45
28	614.45	14.68
29	634.12	18.32
30	653.70	22.38
31	673.20	26.85
32	692.59	31.73
33	711.88	37.01
34	731.06	42.70
35	750.11	48.79
36	769.02	55.29
37	787.80	62.18
38	806.43	69.46
39	824.89	77.13
40	843.20	85.19

by CEM
14 of 61
✓ mjy
8-16-91

42	874.18	102.46
43	887.03	111.86
44	914.60	121.23
45	931.95	131.17
46	949.09	141.48
47	966.01	152.14
48	977.93	160.00

*** 1.617 ***

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.74	67.02
3	122.62	60.42
4	141.63	54.19
5	160.75	48.34
6	179.99	42.86
7	199.33	37.78
8	218.77	33.07
9	238.30	28.76
10	257.91	24.83
11	277.59	21.29
12	297.34	18.14
13	317.15	15.39
14	337.01	13.03
15	356.92	11.06
16	376.85	9.49
17	396.82	8.31
18	416.81	7.54
19	436.80	7.15
20	456.80	7.17
21	476.80	7.58
22	496.78	8.39
23	516.74	9.59
24	536.68	11.19
25	556.58	13.18
26	576.44	15.57
27	596.24	18.36
28	615.99	21.53
29	635.67	25.10
30	655.27	29.06
31	674.80	33.40
32	694.23	38.13
33	713.56	43.25
34	732.79	48.74
35	751.91	54.62
36	770.91	60.88
37	789.77	67.51
38	808.51	74.52
39	827.10	81.89
40	845.54	89.64
41	863.82	97.74
42	881.94	106.21
43	899.89	115.04
44	917.65	124.22
45	935.24	133.75
46	952.63	143.63

by CEM
15 of 61
mjy 8-16-91

48	879.71	160.00

*** 1.655 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.63	66.72
3	122.43	59.91
4	141.40	53.56
5	160.52	47.68
6	179.77	42.28
7	199.15	37.35
8	218.65	32.89
9	238.25	28.92
10	257.95	25.44
11	277.72	22.44
12	297.56	19.93
13	317.46	17.91
14	337.40	16.38
15	357.38	15.34
16	377.37	14.79
17	397.37	14.74
18	417.36	15.18
19	437.34	16.11
20	457.29	17.53
21	477.20	19.45
22	497.05	21.85
23	516.84	24.74
24	536.56	28.12
25	556.18	31.99
26	575.70	36.34
27	595.11	41.16
28	614.39	46.47
29	633.54	52.24
30	652.54	58.49
31	671.38	65.20
32	690.05	72.38
33	708.53	80.01
34	726.83	88.10
35	744.91	96.63
36	762.79	105.61
37	780.43	115.03
38	797.84	124.87
39	815.00	135.15
40	831.90	145.84
41	848.53	156.95
42	852.87	160.00

*** 1.710 ***

by CEM
16 of 61
✓ mjy 8-16-91

Failure Surface Specified By 40 Coordinate Points

No.	(ft)	(ft)
1	278.33	112.59
2	294.40	100.68
3	310.90	89.37
4	327.80	78.68
5	345.09	68.63
6	362.74	59.23
7	380.73	50.49
8	399.03	42.42
9	417.62	35.04
10	436.47	28.35
11	455.55	22.37
12	474.85	17.10
13	494.32	12.55
14	513.95	8.72
15	533.71	5.63
16	553.57	3.27
17	573.51	1.65
18	593.49	.77
19	613.49	.64
20	633.48	1.24
21	653.43	2.59
22	673.32	4.68
23	693.12	7.51
24	712.80	11.07
25	732.34	15.35
26	751.70	20.36
27	770.87	26.08
28	789.80	32.52
29	808.49	39.65
30	826.90	47.47
31	845.00	55.96
32	862.78	65.12
33	880.21	74.94
34	897.25	85.40
35	913.90	96.48
36	930.13	108.17
37	945.91	120.46
38	961.22	133.32
39	976.05	146.75
40	989.64	160.00

*** 1.766 ***

by CEM
17 of 61
✓ mjy 8-16-91

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	104.02	67.83
3	123.17	62.05
4	142.43	56.67
5	161.80	51.69
6	181.27	47.11
7	200.83	42.93
8	220.47	39.16
9	240.19	35.80
10	259.97	32.85

12	299.69	24.17
13	319.62	26.44
14	339.58	25.13
15	359.55	24.24
16	379.55	23.75
17	399.55	23.68
18	419.55	24.02
19	439.53	24.78
20	459.50	25.95
21	479.43	27.53
22	499.34	29.52
23	519.19	31.93
24	538.99	34.74
25	558.73	37.97
26	578.40	41.60
27	597.99	45.64
28	617.49	50.08
29	636.89	54.92
30	656.19	60.17
31	675.38	65.81
32	694.45	71.85
33	713.38	78.28
34	732.18	85.10
35	750.84	92.30
36	769.34	99.90
37	787.69	107.87
38	805.86	116.22
39	823.86	124.95
40	841.67	134.04
41	859.29	143.50
42	876.71	153.33
43	887.99	160.00

*** 1.770 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	342.78	114.28
2	358.05	101.37
3	373.91	89.19
4	390.33	77.77
5	407.27	67.13
6	424.69	57.31
7	442.56	48.32
8	460.82	40.18
9	479.46	32.91
10	498.41	26.53
11	517.64	21.04
12	537.12	16.47
13	556.78	12.82
14	576.59	10.11
15	596.51	8.33
16	616.50	7.49
17	636.50	7.59
18	656.47	8.63
19	676.37	10.62
20	696.16	13.54
21	715.78	17.39

by CEN
18 of 61
✓ mjy 8-16-91

23	754.39	27.84
24	773.27	34.42
25	791.33	41.38
26	810.01	50.20
27	827.78	59.38
28	845.10	69.38
29	861.93	80.19
30	878.23	91.78
31	893.97	104.12
32	909.11	117.19
33	923.61	130.96
34	937.45	145.40
35	950.18	160.00

*** 1.772 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	342.78	114.28
2	358.24	101.60
3	374.25	89.61
4	390.77	78.34
5	407.78	67.81
6	425.23	58.04
7	443.09	49.05
8	461.34	40.86
9	479.93	33.48
10	498.82	26.93
11	517.99	21.22
12	537.39	16.36
13	556.99	12.37
14	576.74	9.24
15	596.62	6.98
16	616.57	5.61
17	636.56	5.12
18	656.56	5.51
19	676.52	6.79
20	696.40	8.94
21	716.17	11.97
22	735.79	15.87
23	755.21	20.63
24	774.41	26.25
25	793.34	32.71
26	811.96	39.99
27	830.25	48.09
28	848.16	56.99
29	865.66	66.68
30	882.71	77.12
31	899.29	88.31
32	915.36	100.22
33	930.88	112.83
34	945.84	126.11
35	960.19	140.04
36	973.92	154.58
37	978.59	160.00

by CEM
19 of 61
Vmjy 5-16-91

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	104.12	68.12
3	123.34	62.62
4	142.68	57.49
5	162.11	52.75
6	181.63	48.39
7	201.23	44.42
8	220.90	40.84
9	240.65	37.64
10	260.45	34.84
11	280.30	32.42
12	300.20	30.40
13	320.13	28.77
14	340.10	27.54
15	360.08	26.69
16	380.07	26.24
17	400.07	26.19
18	420.07	26.53
19	440.06	27.26
20	460.03	28.39
21	479.97	29.91
22	499.88	31.83
23	519.74	34.14
24	539.56	36.83
25	559.32	39.92
26	579.01	43.40
27	598.64	47.26
28	618.18	51.51
29	637.64	56.15
30	657.00	61.17
31	676.25	66.57
32	695.40	72.34
33	714.43	78.50
34	733.34	85.03
35	752.11	91.93
36	770.74	99.19
37	789.23	106.83
38	807.56	114.82
39	825.73	123.18
40	843.73	131.90
41	861.56	140.96
42	879.20	150.38
43	896.40	160.00

*** 1.792 ***

by CEM
20 of 61
✓ mjy 8-16-91

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

2	243.09	38.33
3	308.52	36.26
4	324.60	74.46
5	341.27	63.42
6	358.49	53.25
7	376.22	44.00
8	394.41	35.67
9	413.00	28.31
10	431.95	21.92
11	451.21	16.53
12	470.73	12.15
13	490.44	8.78
14	510.31	6.45
15	530.26	5.15
16	550.26	4.89
17	570.25	5.67
18	590.16	7.50
19	609.96	10.35
20	629.58	14.23
21	648.97	19.12
22	668.08	25.02
23	686.86	31.90
24	705.26	39.75
25	723.22	48.55
26	740.70	58.26
27	757.65	68.88
28	774.03	80.36
29	789.78	92.68
30	804.88	105.80
31	819.27	119.68
32	832.92	134.30
33	845.80	149.61
34	853.65	160.00

*** 1.795 ***

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	104.26	68.62
3	123.61	63.55
4	143.04	58.81
5	162.54	54.38
6	182.12	50.28
7	201.76	46.50
8	221.46	43.05
9	241.21	39.92
10	261.01	37.11
11	280.86	34.64
12	300.74	32.49
13	320.66	30.67
14	340.61	29.17
15	360.57	28.01
16	380.55	27.18
17	400.55	26.67
18	420.55	26.50
19	440.55	26.65
20	460.54	27.14

by CEM
21 of 61

✓ mjy 8-16-91

22	500.49	29.09
23	520.44	30.56
24	540.36	32.37
25	560.24	34.49
26	580.09	36.95
27	599.90	39.73
28	619.65	42.84
29	639.36	46.28
30	659.00	50.04
31	678.58	54.12
32	698.09	58.52
33	717.52	63.25
34	736.87	68.29
35	756.14	73.66
36	775.32	79.34
37	794.40	85.33
38	813.38	91.64
39	832.25	98.26
40	851.01	105.19
41	869.65	112.43
42	888.18	119.98
43	906.57	127.83
44	924.83	135.98
45	942.96	144.44
46	960.94	153.19
47	974.38	160.00

*** 1.803 ***

```
          Y            A     X     I     S            F     T

           .00    123.75    247.50    371.25    495.00    618.75

X       .00 +-------**+---------+---------+---------+---------+
            -
            -       *
            -      W
            -     *
            -    1*
     123.75 +    1
            -   15 W.
            -   1. .*
            -  15....*
            -  18.....
            - 12......
A    247.50 + 15.....
            -125.....4
            -138....4*
            -150...4.
            -15...4..*
            125.994.66
X    371.25 125.44.6.*
            1254..6...
            1254.6....*
            124.66....
            1246......*
            1236.......
I    495.00 1238.......
            1235.......
```

by CEM
22 of 61
✓mjy 8-16-91

```
              41.3.....  *
              41.38.....*
              41.35.......
S     618.75 41203.......
              412.38.....*
              461.03.....*
              4612033.....
              -4.1.03... .
              -4 19053....
      742.50 +44.19053  ..
              - 46129.53...
              - 74.199.3...*
              -  46.10.53...
              -   46120 533
              -   .461 0.593
F     866.25 +    46.10.85.
              -     46110.55
              -      4421...
              -       .4.16.
              -        .4126
              -         .411
T     990.00 +          *W.*
```

by CEM

23 of 61

✓ mjy 8-16-91

COMPUTER ITERATION

OF

STATIC SCENARIO

THE FILE NAME IS UNCSTAB13.IN. THIS ITERATION CONSIDERED ONLY WATER TABLE EFFECTS WHEN USING "STABL".

STATION 80+00

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 8/16/91
Time of Run: 1420
Run By: CEM
Input Data Filename: A:UNCSTA13.IN
Output Filename: A:UNCSTA13.OUT
Plotted Output Filename: A:UNCSTA13.PLT

PROBLEM DESCRIPTION UNC ARROYO - LOCATION, STATION 80+00

BOUNDARY COORDINATES

16 Top Boundaries
21 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	110.00	10.00	105.00	2
2	10.00	105.00	40.00	100.00	2
3	40.00	100.00	85.00	74.00	2
4	85.00	74.00	105.00	74.00	2
5	105.00	74.00	160.00	100.00	2
6	160.00	100.00	180.00	110.00	1
7	180.00	110.00	370.00	115.00	1
8	370.00	115.00	420.00	118.00	1
9	420.00	118.00	550.00	125.00	2
10	550.00	125.00	580.00	126.50	2
11	580.00	126.50	635.00	137.00	1
12	635.00	137.00	650.00	137.00	1
13	650.00	137.00	655.00	135.00	1
14	655.00	135.00	665.00	135.00	1
15	665.00	135.00	790.00	160.00	1
16	790.00	160.00	990.00	160.00	1
17	160.00	100.00	280.00	110.00	2
18	280.00	110.00	340.00	110.00	2
19	340.00	110.00	420.00	118.00	2
20	550.00	125.00	580.00	126.50	2
21	580.00	126.50	990.00	126.50	2

by CEM
25 of 61
✓ mjy 8-16-91

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.6	120.3	1600.0	15.0	.00	.0	1
2	94.6	120.3	960.0	11.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 13 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	110.00
2	10.00	105.00
3	40.00	100.00
4	55.00	92.00
5	145.00	92.00
6	160.00	100.00
7	180.00	110.00
8	370.00	115.00
9	450.00	120.00
10	550.00	125.00
11	580.00	126.50
12	635.00	137.00
13	990.00	137.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

by CEM
26 of 61

100 Trial Surfaces Have Been Generated.

✓ mjy 8-16-91

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 85.00 ft.
and X = 665.00 ft.

Each Surface Terminates Between X = 790.00 ft.
and X = 990.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

20.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Ten Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.53	66.48
3	122.22	59.36
4	141.06	52.63
5	160.03	46.30
6	179.13	40.36
7	198.35	34.34
8	217.68	29.72
9	237.12	25.00
10	256.65	20.70
11	276.27	16.81
12	295.96	13.33
13	315.73	10.27
14	335.55	7.62
15	355.43	5.40
16	375.34	3.59
17	395.30	2.20
18	415.27	1.23
19	435.27	.69
20	455.27	.56
21	475.26	.85
22	495.25	1.57
23	515.22	2.71
24	535.16	4.26
25	555.06	6.24
26	574.92	8.64
27	594.72	11.45
28	614.45	14.68
29	634.12	18.32
30	653.70	22.38
31	673.20	26.85
32	692.59	31.73
33	711.88	37.01
34	731.06	42.70
35	750.11	48.79
36	769.02	55.29
37	787.80	62.18
38	806.43	69.46
39	824.89	77.13
40	843.20	85.19
41	861.33	93.64
42	879.28	102.46
43	897.03	111.66
44	914.60	121.23
45	931.95	131.17
46	949.09	141.48
47	966.01	152.14
48	977.93	160.00

*** 2.651 ***

by CEM
27 of 61
✓ mjy
8-16-91

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.74	67.02
3	122.62	60.42
4	141.63	54.19
5	160.75	48.34
6	179.99	42.86
7	199.33	37.78
8	218.77	33.07
9	238.30	28.76
10	257.91	24.83
11	277.59	21.29
12	297.34	18.14
13	317.15	15.39
14	337.01	13.03
15	356.92	11.06
16	376.85	9.49
17	396.82	8.31
18	416.81	7.54
19	436.80	7.15
20	456.80	7.17
21	476.80	7.58
22	496.78	8.39
23	516.74	9.59
24	536.68	11.19
25	556.58	13.18
26	576.44	15.57
27	596.24	18.36
28	615.99	21.53
29	635.67	25.10
30	655.27	29.06
31	674.80	33.40
32	694.23	38.13
33	713.56	43.25
34	732.79	48.74
35	751.91	54.62
36	770.91	60.88
37	789.77	67.51
38	808.51	74.52
39	827.10	81.89
40	845.54	89.64
41	863.82	97.74
42	881.94	106.21
43	899.89	115.04
44	917.65	124.22
45	935.24	133.75
46	952.63	143.63
47	969.82	153.85
48	979.71	160.00

*** 2.712 ***

by CEM
28 of 61

✓ mjy
8-16-91

1

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	103.63	66.72
3	122.43	59.91
4	141.40	53.56
5	160.52	47.68
6	179.77	42.28
7	199.15	37.35
8	218.65	32.89
9	238.25	28.92
10	257.95	25.44
11	277.72	22.44
12	297.56	19.93
13	317.46	17.91
14	337.40	16.39
15	357.38	15.34
16	377.37	14.79
17	397.37	14.74
18	417.36	15.18
19	437.34	16.11
20	457.29	17.53
21	477.20	19.45
22	497.05	21.85
23	516.84	24.74
24	536.56	28.12
25	556.18	31.99
26	575.70	36.34
27	595.11	41.16
28	614.39	46.47
29	633.54	52.24
30	652.54	58.49
31	671.38	65.20
32	690.05	72.38
33	708.53	80.01
34	726.83	88.10
35	744.91	96.63
36	762.79	105.61
37	780.43	115.03
38	797.84	124.87
39	815.00	135.15
40	831.90	145.84
41	848.53	156.95
42	852.87	160.00

*** 2.742 ***

by CEM
29 of 61
✓ mjj 8-16-91

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	407.22	117.33
2	421.44	103.26
3	436.62	90.23
4	452.68	78.32
5	469.56	67.59
6	487.15	58.08
7	505.38	49.85
8	524.15	42.94

10	[illegible]	[illegible]
11	582.73	30.44
12	602.68	29.08
13	622.68	29.15
14	642.63	30.64
15	662.41	33.55
16	681.94	37.86
17	701.12	43.55
18	719.84	50.59
19	738.01	58.95
20	755.54	68.58
21	772.34	79.43
22	788.32	91.45
23	803.41	104.58
24	817.53	118.74
25	830.60	133.83
26	842.56	149.91
27	849.02	160.00

*** 2.825 ***

1

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	407.22	117.33
2	421.93	103.77
3	437.52	91.24
4	453.92	79.80
5	471.07	69.51
6	488.87	60.40
7	507.26	52.52
8	526.13	45.91
9	545.42	40.60
10	565.01	36.61
11	584.84	33.96
12	604.80	32.67
13	624.80	32.73
14	644.75	34.15
15	664.55	36.93
16	684.12	41.04
17	703.37	46.48
18	722.20	53.21
19	740.54	61.20
20	758.28	70.42
21	775.36	80.83
22	791.70	92.37
23	807.21	105.00
24	821.82	118.65
25	835.48	133.26
26	848.11	148.77
27	856.05	160.00

*** 2.839 ***

by CFM
30 of 61
✓ mjy 8-16-91

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.00	74.00
2	104.02	67.83
3	123.17	62.05
4	142.43	56.67
5	161.80	51.69
6	181.27	47.11
7	200.83	42.93
8	220.47	39.16
9	240.19	35.80
10	259.97	32.85
11	279.81	30.30
12	299.69	28.17
13	319.62	26.44
14	339.58	25.13
15	359.55	24.24
16	379.55	23.75
17	399.55	23.68
18	419.55	24.02
19	439.53	24.78
20	459.50	25.95
21	479.43	27.53
22	499.34	29.52
23	519.19	31.93
24	538.99	34.74
25	558.73	37.97
26	578.40	41.60
27	597.99	45.64
28	617.49	50.08
29	636.89	54.92
30	656.19	60.17
31	675.38	65.81
32	694.45	71.85
33	713.38	78.28
34	732.18	85.10
35	750.84	92.30
36	769.34	99.90
37	787.69	107.87
38	805.86	116.22
39	823.86	124.95
40	841.67	134.04
41	859.29	143.50
42	876.71	153.33
43	887.99	160.00

*** 2.840 ***

by CEM
31 of 61
✓ mjy 8-16-

1

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	342.78	114.28
2	358.21	101.56
3	374.32	89.70
4	391.05	78.75
5	408.36	68.73

7	444.50	51.62
8	463.22	44.33
9	482.30	38.53
10	501.68	33.64
11	521.30	29.77
12	541.10	26.98
13	561.03	25.29
14	581.02	24.69
15	601.02	25.19
16	620.95	26.79
17	640.77	29.49
18	660.41	33.26
19	679.81	38.12
20	698.92	44.03
21	717.67	50.98
22	736.01	58.95
23	753.89	67.92
24	771.25	77.86
25	788.03	88.73
26	804.19	100.51
27	819.68	113.16
28	834.46	126.65
29	848.46	140.92
30	861.67	155.94
31	864.85	160.00

*** 2.849 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	342.78	114.28
2	358.05	101.37
3	373.91	89.19
4	390.33	77.77
5	407.27	67.13
6	424.69	57.31
7	442.56	48.32
8	460.82	40.18
9	479.46	32.91
10	498.41	26.53
11	517.64	21.04
12	537.12	16.47
13	556.78	12.82
14	576.59	10.11
15	596.51	8.33
16	616.50	7.49
17	636.50	7.59
18	656.47	8.63
19	676.37	10.62
20	696.16	13.54
21	715.78	17.39
22	735.21	22.16
23	754.38	27.84
24	773.27	34.42
25	791.83	41.88
26	810.01	50.20
27	827.78	59.38
28	845.10	69.38

by CEM
32 of 61
✓ mjj
9-16-91

30	878.23	91.78
31	893.97	104.12
32	909.11	117.19
33	923.61	130.96
34	937.45	145.40
35	950.18	160.00

*** 2.852 ***

1

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	278.33	112.59
2	293.09	99.08
3	308.52	86.36
4	324.60	74.46
5	341.27	63.42
6	358.49	53.25
7	376.22	44.00
8	394.41	35.67
9	413.00	28.31
10	431.95	21.92
11	451 21	16.53
12	470.73	12.15
13	490.44	8.78
14	510.31	6.45
15	530.26	5.15
16	550.26	4.89
17	570.25	5.67
18	590.16	7.50
19	609.96	10.35
20	629.58	14.23
21	648.97	19.12
22	668.08	25.02
23	686.86	31.90
24	705.26	39.75
25	723.22	48.55
26	740.70	58.26
27	757.65	68.88
28	774.03	80.36
29	789.78	92.68
30	804.88	105.80
31	819.27	119.68
32	832.92	134.30
33	845.80	149.61
34	853.65	160.00

*** 2.856 ***

by

33 of 61

✓mjy
E-16-91

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

2	357.50	100.75
3	373.04	88.15
4	389.31	76.53
5	406.28	65.94
6	423.86	56.41
7	442.00	47.99
8	460.63	40.70
9	479.67	34.57
10	499.05	29.63
11	518.69	25.89
12	538.54	23.38
13	558.49	22.09
14	578.49	22.03
15	598.46	23.21
16	618.31	25.61
17	637.98	29.24
18	657.39	34.07
19	676.46	40.09
20	695.13	47.27
21	713.32	55.59
22	730.95	65.02
23	747.98	75.51
24	764.32	87.04
25	779.93	99.55
26	794.73	113.00
27	808.67	127.34
28	821.71	142.51
29	833.78	158.45
30	834.81	160.00

*** 2.874 ***

1

```
          Y            A     X     I     S            F     T

          .00    123.75    247.50    371.25    495.00    618.75

X       .00 +-------**+---------+---------+---------+---------+
            -
            -       *
            -      W
            -     *
            -    1*
     123.75 +    1
            -   16 W.
            -   1. .*
            -  16....*
            -  1.. ...
            - 12......
A    247.50 + 16......
            -126.....9
            -13.....9*
            -16....9.
            -16...9..*
            126.99..77
X    371.25 126.9..7.*
            1269..7...
            126..87.44*
            126.87.4..
            12687.4.. *
```

by CER
34 of 61
/mjy 5-16-91

```
I     495.00 1237.4....
             12344......
             12345  .. .
             9173 .....*
             9143... ..*
             .1436.......
S     618.75 .1253......
             .1253......*
             .814.3.....*
             .812.33.....
             -8.14.3... .
             -8 14063....
      742.50 + 8.14063....
             - 88124063...
             -  8.19403...*
             -  .8.1.463...
             -   .812.74330
             -   ..81...543
F     866.25 +    .8.1...65
             -     .811..66
             -      ..21...
             -       ...18.
             -        ..128
             -         ..11
T     990.00 +         *W.*
1
****************************************
******          - Illegal Command  ******
****************************************


Legal Commands - PROFIL
                 LOADS
                 TIES
                 WATER
                 SURFAC
                 EXECUT
                 EQUAKE
                 SOIL
                 RANDOM
                 CIRCLE
                 CIRCL2
                 BLOCK
                 BLOCK2
                 LIMITS
                 ANISO
                 SURBIS
                 SPENCR
```

by CEM
35 of 61

✓ mjy 8-16-91

Canonie Environmental

E-179

By CEM Date 8/13/91 Subject UNC - SLOPE STAB Sheet No. 36 of 61

Chkd. By MJY Date 8-16-91 Proj. No. 86-666-27

1/4" X 1/4"

FIGURES

PROFILE AND BOUNDARY POINTS FOR STATION 80+00

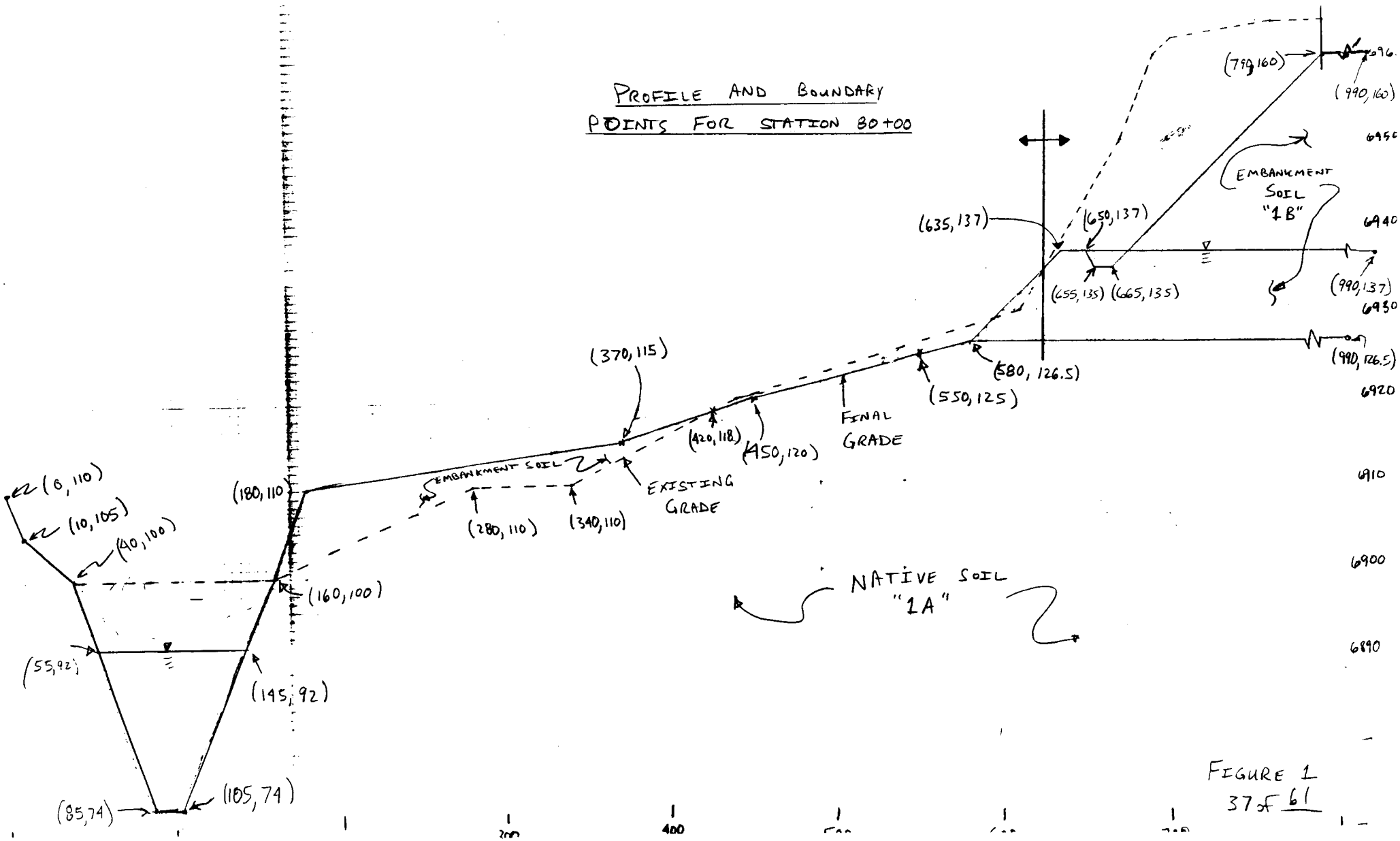
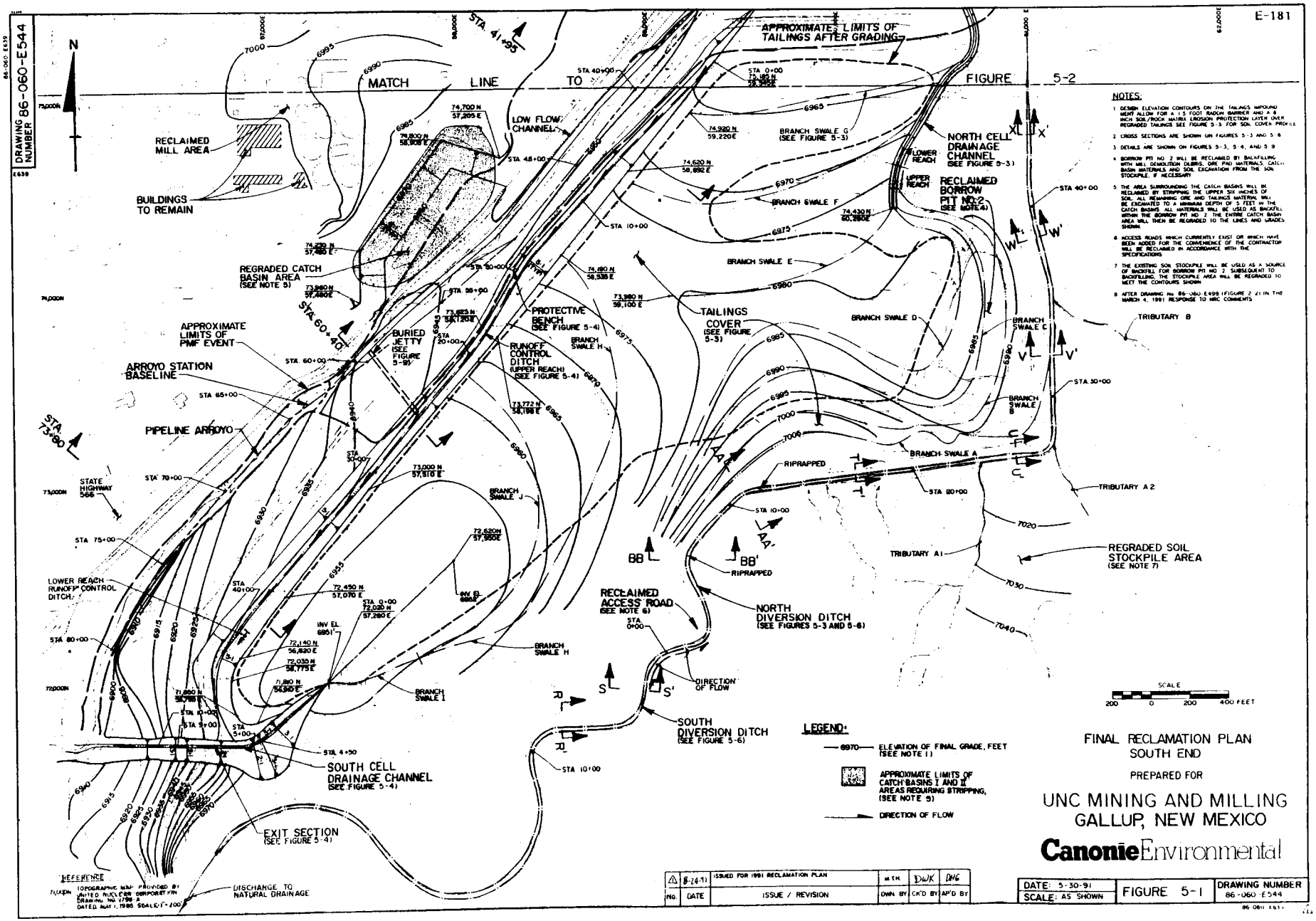
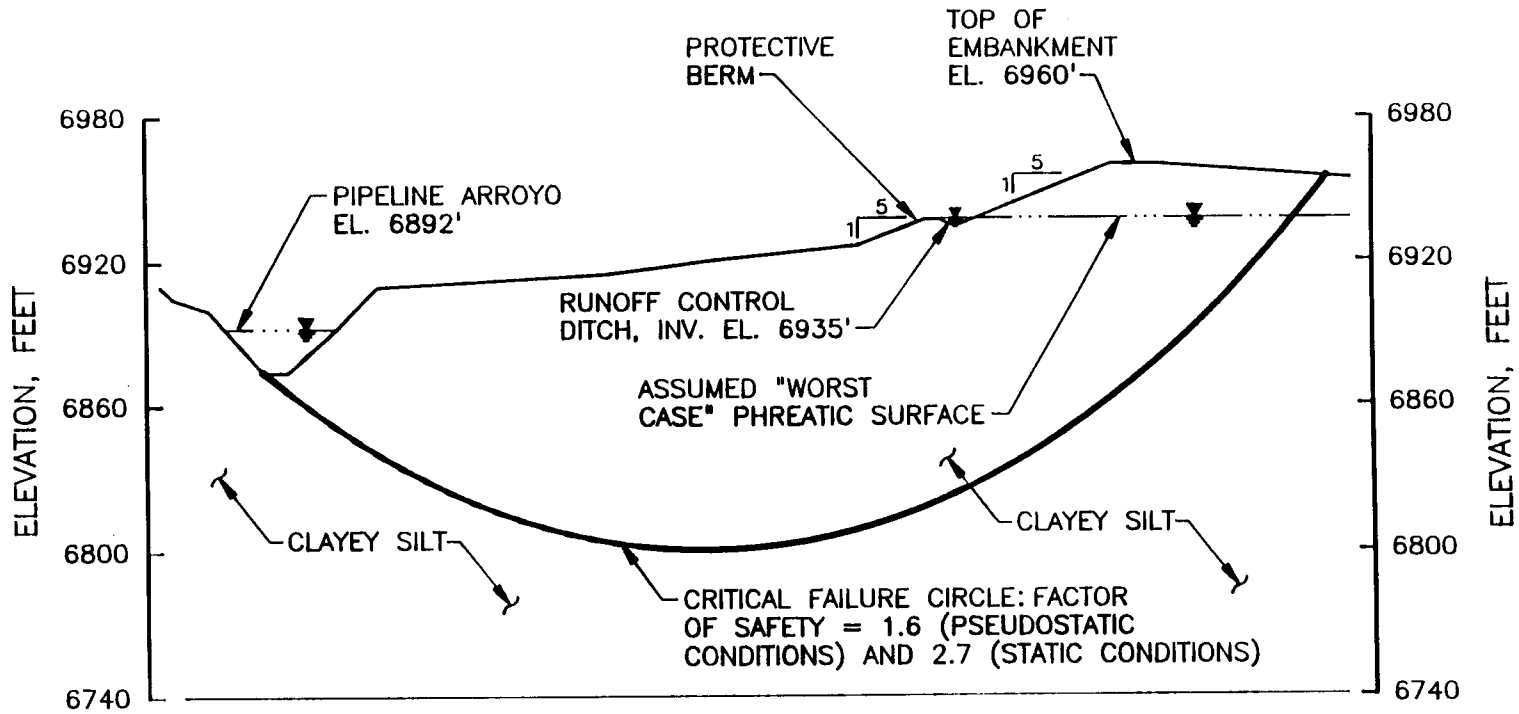


FIGURE 1


E-181
DRAWING NUMBER 86-060-E544
MATCH LINE TO FIGURE 5-2
APPROXIMATE LIMITS OF TAILINGS AFTER GRADING
RECLAIMED MILL AREA
BUILDINGS TO REMAIN
LOW FLOW CHANNEL
NORTH CELL DRAINAGE CHANNEL (SEE FIGURE 5-3)
RECLAIMED BORROW PIT NO. 2 (SEE NOTE 4)
REGRADED CATCH BASIN AREA (SEE NOTE 5)
APPROXIMATE LIMITS OF PMF EVENT
ARROYO STATION BASELINE
PIPELINE ARROYO
BURIED JETTY (SEE FIGURE 5-9)
PROTECTIVE BENCH (SEE FIGURE 5-4)
RUNOFF CONTROL DITCH (UPPER REACH) (SEE FIGURE 5-4)
TAILINGS COVER (SEE FIGURE 5-3)
STATE HIGHWAY 566
LOWER REACH RUNOFF CONTROL DITCH
RECLAIMED ACCESS ROAD (SEE NOTE 6)
NORTH DIVERSION DITCH (SEE FIGURES 5-3 AND 5-6)
SOUTH DIVERSION DITCH (SEE FIGURE 5-6)
SOUTH CELL DRAINAGE CHANNEL (SEE FIGURE 5-4)
EXIT SECTION (SEE FIGURE 5-4)
DISCHARGE TO NATURAL DRAINAGE
REGRADED SOIL STOCKPILE AREA (SEE NOTE 7)
TRIBUTARY A1
TRIBUTARY A2
TRIBUTARY B
RIPRAPPED
DIRECTION OF FLOW
LEGEND:
ELEVATION OF FINAL GRADE, FEET (SEE NOTE 1)
APPROXIMATE LIMITS OF CATCH BASINS I AND II AREAS REQUIRING STRIPPING, (SEE NOTE 5)
DIRECTION OF FLOW
SCALE
200 0 200 400 FEET
NOTES:
1 DESIGN ELEVATION CONTOURS ON THE TAILINGS IMPOUNDMENT ALLOW FOR A 1.5 FOOT RADON BARRIER AND A 8 INCH SOIL/ROCK MATRIX EROSION PROTECTION LAYER OVER REGRADED TAILINGS SEE FIGURE 5-3 FOR SOIL COVER PROFILE
2 CROSS SECTIONS ARE SHOWN ON FIGURES 5-3 AND 5-6
3 DETAILS ARE SHOWN ON FIGURES 5-3, 5-4, AND 5-9
4 BORROW PIT NO. 2 WILL BE RECLAIMED BY BACKFILLING WITH MILL DEMOLITION DEBRIS, ORE PAD MATERIALS, CATCH BASIN MATERIALS AND SOIL EXCAVATION FROM THE SOIL STOCKPILE, IF NECESSARY
5 THE AREA SURROUNDING THE CATCH BASINS WILL BE RECLAIMED BY STRIPPING THE UPPER SIX INCHES OF SOIL. ALL REMAINING ORE AND TAILINGS MATERIAL WILL BE EXCAVATED TO A MINIMUM DEPTH OF 5 FEET IN THE CATCH BASINS. ALL MATERIALS WILL BE USED AS BACKFILL WITHIN THE BORROW PIT NO. 2. THE ENTIRE CATCH BASIN AREA WILL THEN BE REGRADED TO THE LINES AND GRADES SHOWN
6 ACCESS ROADS WHICH CURRENTLY EXIST OR WHICH HAVE BEEN ADDED FOR THE CONVENIENCE OF THE CONTRACTOR WILL BE RECLAIMED IN ACCORDANCE WITH THE SPECIFICATIONS
7 THE EXISTING SOIL STOCKPILE WILL BE USED AS A SOURCE OF BACKFILL FOR BORROW PIT NO. 2. SUBSEQUENT TO BACKFILLING, THE STOCKPILE AREA WILL BE REGRADED TO MEET THE CONTOURS SHOWN
8 AFTER DRAWING No. 86-060-E499 (FIGURE 2-2) IN THE MARCH 4, 1991 RESPONSE TO NRC COMMENTS
REFERENCE
TOPOGRAPHIC MAP PROVIDED BY UNITED NUCLEAR CORPORATION DRAWING NO. 1796-A DATED MAY 1, 1985 SCALE: 1"=200'
FINAL RECLAMATION PLAN
SOUTH END
PREPARED FOR
UNC MINING AND MILLING
GALLUP, NEW MEXICO
Canonie Environmental
ISSUED FOR 1991 RECLAMATION PLAN
DATE: 5-30-91
SCALE: AS SHOWN
FIGURE 5-1
DRAWING NUMBER 86-060-E544

DRAWING NUMBER 86-060-A606



SOIL PARAMETERS	NATIVE SOIL	EMBANKMENT SOIL
COHESION (psf)	960	1,600
INTERNAL ANGLE OF FRICTION	11°	15°
DRY DENSITY (pcf)	95	95
SATURATED DENSITY (pcf)	120	120

NOTES:

1. MAXIMUM SECTION SHOWN IS TAKEN FROM STATION 80+00.
2. HORIZONTAL ACCELERATION = 0.05 g.

SLOPE STABILITY ANALYSIS

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

E-182

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
1		ISSUED FOR 1991 RECLAMATION PLAN	P.M.W.		

DATE: 8-19-91	FIGURE 5-11	DRAWING NUMBER 86-060-A606
SCALE: N.T.S.		

3/4 1

APPENDIX A

FILE NAME: UNCSTAB6.IN

COMPUTER ITERATION OF PSUEDO-STATIC SCENARIO. THIS ITERATION VARIES THE CAVITATION PRESSURE TO PROVE ONCE A MAXIMUM LOAD IS APPLIED, CAVITATION PRESSURE HAS NO EFFECT ON THE FACTOR-OF-SAFETY. THEREFORE, EARTHQUAKE EFFECTS UTILIZED THE CAVITATION PRESSURE WHICH RESULTS IN THE MINIMUM FACTOR-OF-SAFETY.

** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	8/13/91
Time of Run:	1400
Run By:	CEM
Input Data Filename:	A:UNCSTAB6.IN
Output Filename:	A:UNCSTAB6.OUT
Plotted Output Filename:	A:UNCSTAB6.PLT

By LEM
41 → 61
✓ mjp
8-16-91

PROBLEM DESCRIPTION UNC ARROYO - LOCATION, STATION 50+00

BOUNDARY COORDINATES

8 Top Boundaries
9 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	50.00	171.00	51.50	2
2	171.00	51.50	201.75	57.50	2
3	201.75	57.50	212.00	59.50	1
4	212.00	59.50	227.00	59.50	1
5	227.00	59.50	233.00	57.50	1
6	233.00	57.50	243.00	57.50	1
7	243.00	57.50	340.00	76.00	1
8	340.00	76.00	390.00	76.00	1
9	201.75	57.50	390.00	57.50	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.6	120.3	1600.0	15.0	.00	.0	1
2	94.6	120.3	960.0	11.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

by CEM
42 of 67
✓ mjy
8-16-91

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	50.00
2	171.00	51.50
3	212.00	59.50
4	390.00	59.50

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = 5000.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 212.00 ft.

Each Surface Terminates Between X = 243.00 ft.
and X = 390.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

43 of 61

8-16-91

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	141.33	51.24
2	149.35	45.26
3	157.68	39.73
4	166.31	34.67
5	175.20	30.10
6	184.34	26.04
7	193.69	22.49
8	203.22	19.47
9	212.91	16.98
10	222.71	15.03
11	232.62	13.64
12	242.58	12.80
13	252.58	12.52
14	262.57	12.79
15	272.54	13.62
16	282.44	15.00
17	292.25	16.93
18	301.94	19.41
19	311.48	22.42
20	320.83	25.96
21	329.97	30.02
22	338.87	34.57
23	347.51	39.62
24	355.85	45.14
25	363.86	51.11
26	371.54	57.53
27	378.84	64.36
28	385.75	71.58
29	389.53	76.00

*** 2.836 ***

by C-M
44 of 61
✓ mjy 8-16-91

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.67	50.62
2	79.18	45.37
3	87.89	40.45
4	96.77	35.87
5	105.83	31.62
6	115.04	27.72
7	124.39	24.18
8	133.86	20.99
9	143.46	18.16
10	153.15	15.70
11	162.93	13.61
12	172.78	11.89
13	182.69	10.55
14	192.64	9.58
15	202.62	9.00
16	212.62	8.79
17	222.62	8.96
18	232.60	9.51
19	242.56	10.44
20	252.48	11.75
21	262.33	13.43
22	272.12	15.49
23	281.82	17.91
24	291.42	20.70
25	300.91	23.86
26	310.28	27.37
27	319.50	31.24
28	328.57	35.45
29	337.47	40.00
30	346.19	44.89
31	354.73	50.11
32	363.05	55.64
33	371.17	61.49
34	379.05	67.64
35	386.69	74.09
36	388.79	76.00

*** 2.943 ***

by CEM
45 of 61
✓ mjy
8-16-91

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.67	50.62
2	79.21	45.42
3	87.94	40.54
4	96.85	36.00
5	105.92	31.79
6	115.14	27.93
7	124.51	24.42
8	134.00	21.26
9	143.60	18.47
10	153.30	16.03
11	163.08	13.96
12	172.93	12.26
13	182.85	10.94
14	192.80	9.99
15	202.78	9.41
16	212.78	9.21
17	222.78	9.38
18	232.76	9.93
19	242.72	10.86
20	252.64	12.16
21	262.50	13.83
22	272.29	15.88
23	281.99	18.28
24	291.60	21.06
25	301.10	24.19
26	310.47	27.68
27	319.70	31.51
28	328.79	35.70
29	337.71	40.22
30	346.45	45.07
31	355.00	50.25
32	363.36	55.75
33	371.50	61.55
34	379.41	67.66
35	387.10	74.07
36	389.25	76.00

*** 2.956 ***

by CEN
46 of 61
✓ mjy
8-16-91

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.67	50.62
2	78.15	43.99
3	85.99	37.77
4	94.14	31.99
5	102.60	26.65
6	111.33	21.77
7	120.31	17.37
8	129.51	13.46
9	138.91	10.05
10	148.48	7.15
11	158.20	4.78
12	168.02	2.92
13	177.94	1.60
14	187.90	.82
15	197.90	.57
16	207.90	.87
17	217.86	1.69
18	227.77	3.06
19	237.59	4.96
20	247.29	7.38
21	256.85	10.32
22	266.23	13.77
23	275.42	17.72
24	284.38	22.16
25	293.09	27.08
26	301.52	32.46
27	309.65	38.28
28	317.45	44.53
29	324.91	51.20
30	331.99	58.25
31	338.69	65.68
32	344.98	73.46
33	346.81	76.00

*** 2.964 ***

by C + [illegible]
47 of 61
✓mjy
8-16-91

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	164.89	51.45
2	172.61	45.09
3	180.75	39.28
4	189.28	34.06
5	198.16	29.46
6	207.33	25.48
7	216.76	22.16
8	226.41	19.51
9	236.21	17.55
10	246.13	16.27
11	256.11	15.69
12	266.11	15.82
13	276.08	16.64
14	285.96	18.17
15	295.71	20.38
16	305.29	23.27
17	314.63	26.82
18	323.71	31.03
19	332.47	35.85
20	340.86	41.28
21	348.86	47.29
22	356.42	53.84
23	363.49	60.91
24	370.06	68.45
25	375.75	76.00

*** 2.965 ***

Imjy
8-16-91

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	141.33	51.24
2	148.96	44.77
3	157.02	38.86
4	165.49	33.54
5	174.32	28.84
6	183.46	24.78
7	192.87	21.39
8	202.49	18.68
9	212.29	16.67
10	222.20	15.36
11	232.18	14.77
12	242.18	14.89
13	252.15	15.73
14	262.03	17.28
15	271.77	19.53
16	281.33	22.47
17	290.65	26.09
18	299.69	30.37
19	308.40	35.28
20	316.74	40.80
21	324.66	46.91
22	332.12	53.56
23	339.09	60.74
24	345.52	68.39
25	351.04	76.00

*** 3.040 ***

49 of 61

✓ mjj

8-16-91

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	117.78	51.03
2	126.24	45.70
3	134.95	40.79
4	143.89	36.31
5	153.04	32.28
6	162.38	28.70
7	171.88	25.58
8	181.52	22.93
9	191.28	20.76
10	201.14	19.07
11	211.07	17.87
12	221.04	17.16
13	231.04	16.93
14	241.04	17.20
15	251.01	17.96
16	260.93	19.21
17	270.78	20.94
18	280.53	23.16
19	290.16	25.85
20	299.65	29.01
21	308.97	32.63
22	318.10	36.70
23	327.02	41.22
24	335.71	46.17
25	344.15	51.54
26	352.31	57.32
27	360.17	63.50
28	367.73	70.05
29	373.95	76.00

*** 3.058 ***

61

mjy
8-16-91

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	164.89	51.45
2	173.11	45.76
3	181.69	40.61
4	190.58	36.03
5	199.74	32.03
6	209.15	28.63
7	218.75	25.85
8	228.51	23.69
9	238.40	22.16
10	248.36	21.28
11	258.36	21.04
12	268.35	21.45
13	278.29	22.50
14	288.15	24.20
15	297.87	26.52
16	307.43	29.47
17	316.77	33.03
18	325.87	37.19
19	334.68	41.92
20	343.16	47.21
21	351.29	53.04
22	359.02	59.39
23	366.32	66.21
24	373.17	73.50
25	375.24	76.00

*** 3.130 ***

bu [illegible]
E1 of 6

✓ mjy
8-16-91

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	117.78	51.03
2	126.21	45.66
3	134.91	40.73
4	143.86	36.26
5	153.03	32.27
6	162.39	28.76
7	171.92	25.74
8	181.60	23.22
9	191.40	21.22
10	201.29	19.72
11	211.24	18.75
12	221.23	18.29
13	231.23	18.36
14	241.21	18.95
15	251.15	20.06
16	261.02	21.69
17	270.78	23.83
18	280.43	26.47
19	289.92	29.62
20	299.23	33.26
21	308.35	37.38
22	317.23	41.96
23	325.87	47.01
24	334.22	52.50
25	342.28	58.42
26	350.03	64.75
27	357.43	71.48
28	361.91	76.00

*** 3.168 ***

52 of 61

✓ mjy
8-16-91

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	50.00
2	8.74	45.15
3	17.63	40.55
4	26.64	36.22
5	35.77	32.15
6	45.02	28.35
7	54.38	24.82
8	63.84	21.57
9	73.38	18.59
10	83.01	15.90
11	92.72	13.48
12	102.49	11.36
13	112.32	9.52
14	122.20	7.96
15	132.12	6.70
16	142.07	5.73
17	152.04	5.04
18	162.04	4.65
19	172.04	4.56
20	182.03	4.75
21	192.02	5.24
22	201.99	6.02
23	211.94	7.08
24	221.84	8.44
25	231.71	10.09
26	241.52	12.03
27	251.27	14.25
28	260.95	16.76
29	270.55	19.54
30	280.07	22.61
31	289.49	25.96
32	298.82	29.57
33	308.03	33.46
34	317.12	37.62
35	326.09	42.04
36	334.93	46.72
37	343.63	51.66
38	352.17	56.85
39	360.57	62.29
40	368.80	67.97
41	376.86	73.88
42	379.57	76.00

*** 3.190 ***

53.561

✓mj
8-16-91

```
                Y            A     X     I     S            F     T

          -      .00     48.75     97.50    146.25    195.00    243.75

 X        .00 +---------*---------+---------+---------+---------+
             -        0.
             -       0.
             -     .0. .
             -    ..0 ..
             -   . . ..
       48.75 +  .  0....
             -  . 0.....
             - . 0.....
             -  .0.....2
             -..0 ....2.
             -..0....2..
 A     97.50 +......2...
             . 0..423...
             ..0.4.2...7
             ..0.42.....
             .0.42....7.
             .04.....7..1
 X    146.25 .4..2..7.1.
             .4.2...71..
             .0.2..71.. 5
             -423.76..5.*
             402..71.5..
             4.3..1.5....
 I    195.00 402.615.....
             -02.1..8... *
             4021758.....*
             4 2175.......
             -4 758......*
             -42158......*
 S    243.75 + 217.......*
             - 217........
             - 416.........
             -  269........
             -  148........
             -  124.........
      292.50 +  1264........
             -   1264.......
             -    1264......
             -    12864......
             -     527064....
             -     15.7064...
 F    341.25 +      12.8764 4*
             -       1258796.4
             -        12587.9.
             -         125.7.9
             -           12585
             -            1210
 T    390.00 +           *  2*
```

bucem
54 of 61
✓mjy
8-16-91

APPENDIX B.

REFERENCES.

Tailings Disposal Systems Analysis
United Nuclear Church Rock Mill
Church Rock, New Mexico
SHB Job No. E78-1041

E-199

NATIVE SOIL

PERMEABILITY TEST
(Pressurized Permeameter)

Lab No. 8-1041-118: Boring #7 @ 6' to 7' -- test insitu on tube sample

Diameter 4.887 cm Length 8.913 cm Area 18.755 cm^2 Vol. 167.171 cc

W_s 242.2 grms. w_o 3.8% w_f 30.0% G_s 2.65 V_s 91.396 cc

Void Ratio 0.8290 Dry Density 90.4 PCF Trials 9 days

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
0	43.9	315	242	9.25×10^{-5}	96.0	Flow
0	45.7	335	385	5.95×10^{-5}	61.0	Flow
0	45.6	295	537	3.76×10^{-5}	39.0	Flow
Constant Head	70.8	875	1570	2.45×10^{-5}	25.0	Flow
Constant Head	70.8	135	410	1.45×10^{-5}	15.0	Flow
Constant Head	70.8	140	447	1.38×10^{-5}	14.0	Flow
5	181.9	320	351	1.56×10^{-5}	16.0	Flow
5	181.5	215	265	1.39×10^{-5}	14.0	Flow
5	181.7	170	203	1.44×10^{-5}	15.0	Flow

Note: Saturation (initial) = 12%, saturation achieved 96% based on assumed 2.65 specific gravity.

56 of 61

REPORT ON LABORATORY TESTS

PROJECT Tailings Disposal Systems Analysis JOB NO. E78-1041
LOCATION UNC Church Rock Mill LAB NO. 8-1041-348
SAMPLE #9 @ 5½' - 6½'

DIRECT SHEAR TESTS

In Situ - Point No. 1 (=±1.00 KSF)

Initial Moisture Content	29.7	%
Dry Density (PCF)	90.80	
Submerged		
Final Moisture Content	29.7	%
Maximum Vertical Strain @ T Max.	(-).023	inches
Shearing Stress T Max	0.19	KSF

In Situ - Point No. 2 (=± 3.00 KSF)

Initial Moisture Content	30.2	%
Dry Density (PCF)	91.85	
Submerged (Specimen extruded from ring upon saturation)		
Final Moisture Content	30.2	%
Maximum Vertical Strain @ T max.	(-).036	inches
Shearing Stress T max.	0.41	KSF

In Situ - Point No. 3 (=± 5.08KSF)

Initial Moisture Content	29.6	%
Dry Density (PCF)	92.34	
Submerged		
Final Moisture Content	29.6	%
Maximum Vertical Strain @ T max.	(-).019	inches
Shearing Stress T max.	1.74	KSF

57 of 61

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS
MATERIALS TESTING ENGINEERS
ENGINEERING ANALYSIS • PHYSICAL TESTING • QUALITY CONTROL • FIELD EXPLORATION

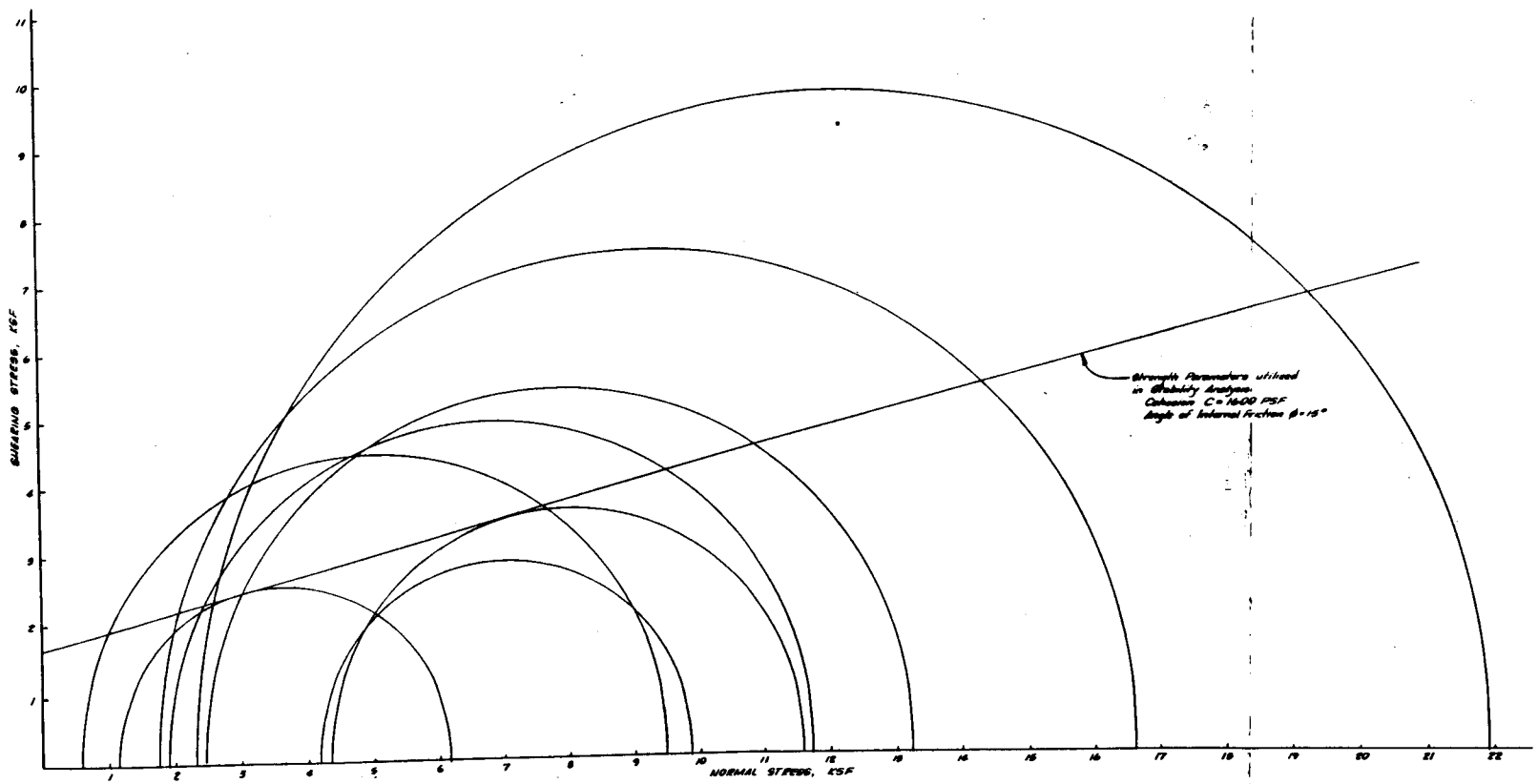
REPORT ON LABORATORY TESTS

PROJECT Tailings Disposal Systems Analysis JOB NO. E78-1041
LOCATION UNC Church Rock Mill LAB NO. 8-1041-236
SAMPLE #13 @ 9½' - 10½'

DIRECT SHEAR TESTS

In Situ - Point No. 1 (=± 1.00KSF)		
Initial Moisture Content	8.8	%
Dry Density (PCF)	98.92	
Submerged		
Final Moisture Content	24.1	%
Maximum Vertical Strain @ T Max.	(-).012	inches
Shearing Stress T Max	0.57	KSF
In Situ - Point No. 2 (=± 3.00 KSF)		
Initial Moisture Content	8.0	%
Dry Density (PCF)	99.86	
Submerged		
Final Moisture Content	24.0	%
Maximum Vertical Strain @ T max.	(-).017	inches
Shearing Stress T max.	1.71	KSF
In Situ - Point No. 3 (=± 5.08KSF)		
Initial Moisture Content	8.6	%
Dry Density (PCF)	93.53	
Submerged		
Final Moisture Content	26.4	%
Maximum Vertical Strain @ T max.	(-).022	inches
Shearing Stress T max.	2.99	KSF

58 of 61

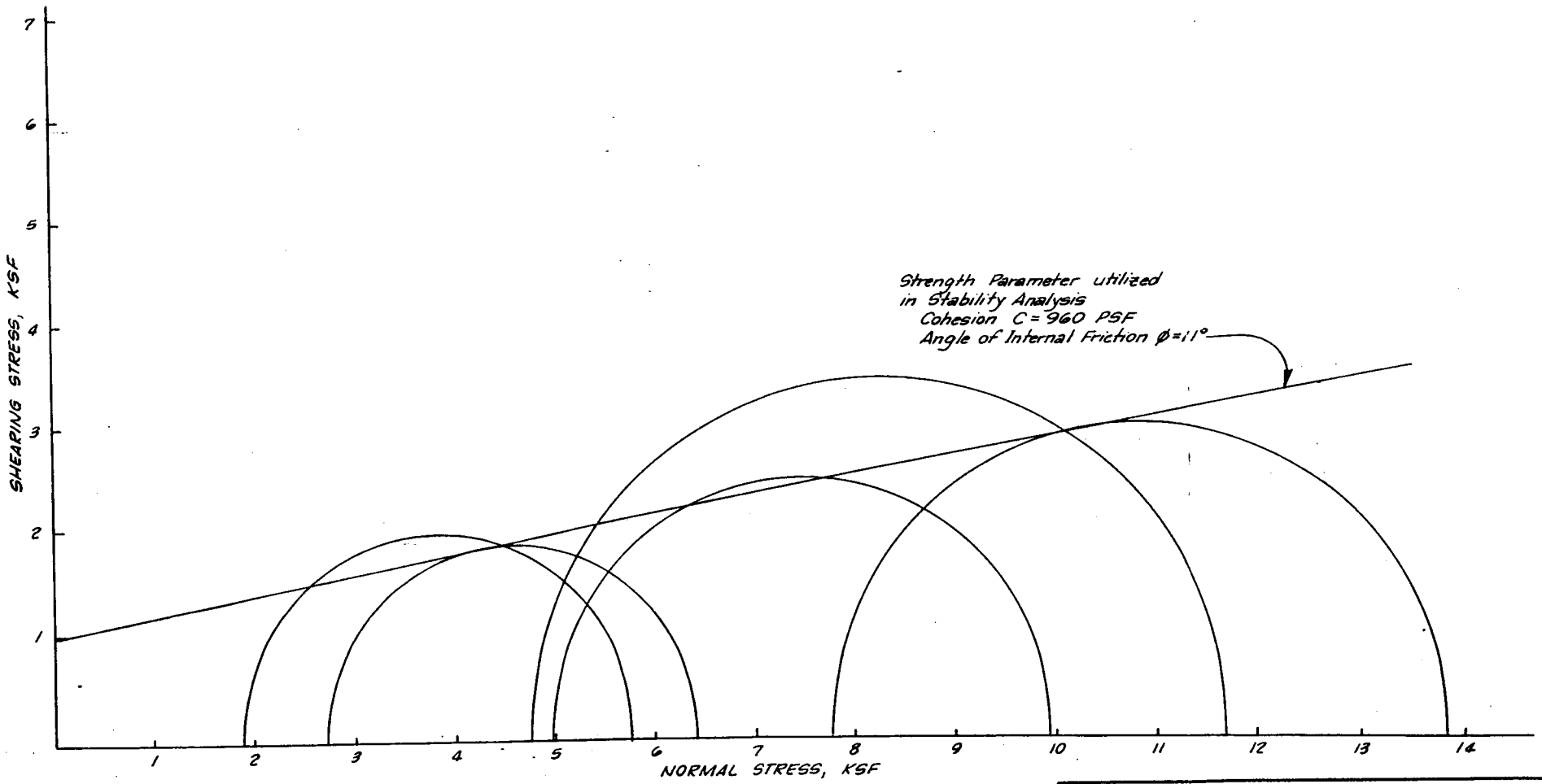


SUMMARY OF TRIAXIAL SHEAR TESTS
PERFORMED BY ROLLA GEOTECHNICAL
CONSULTANTS, ROLLA, MISSOURI

EXISTING EMBANKMENT SOILS
TOTAL STRESS ANALYSIS

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS

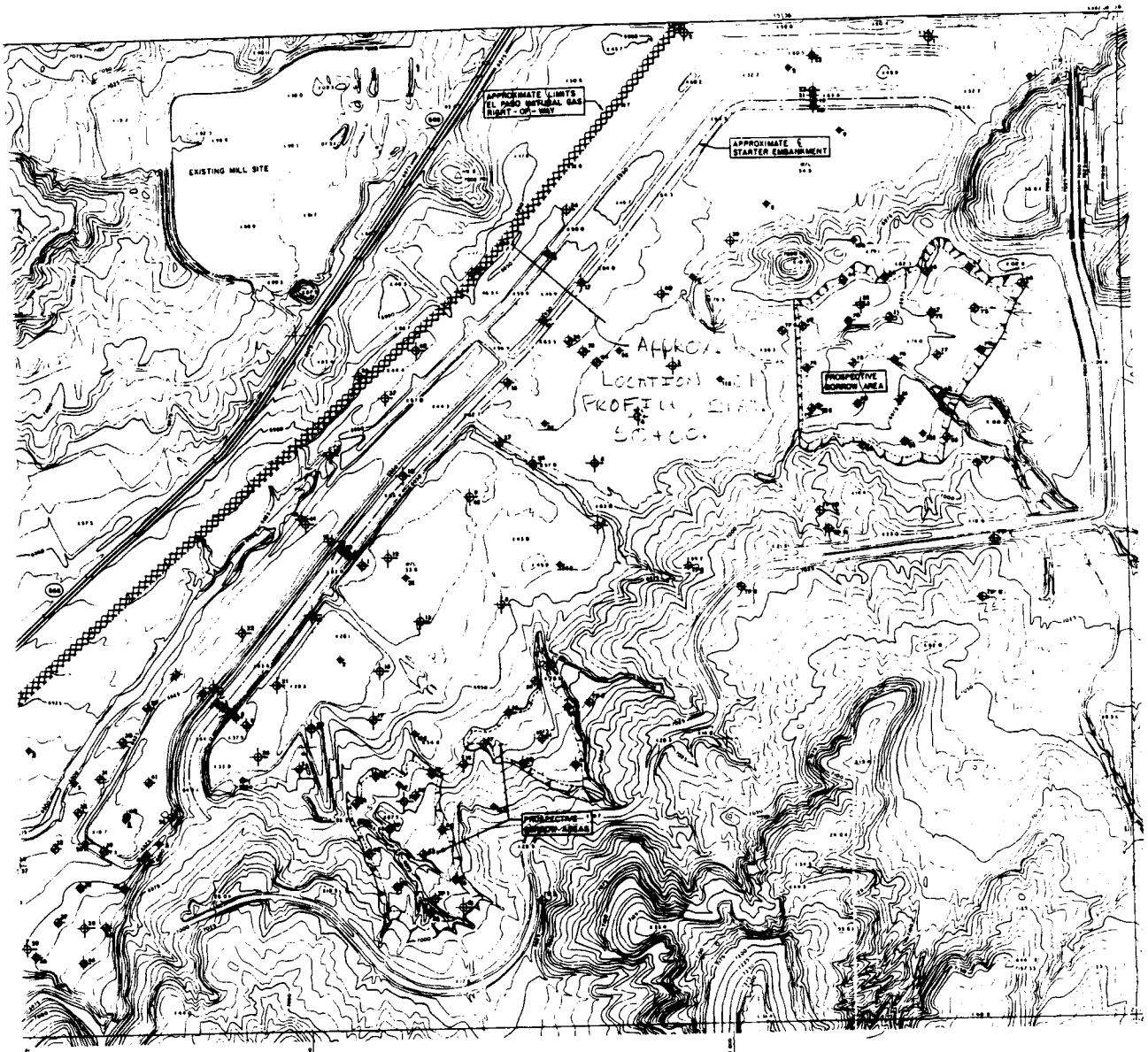
B-24



SUMMARY OF TRIAXIAL SHEAR TESTS
PERFORMED BY ROLLA GEOTECHNICAL
CONSULTANTS, ROLLA, MISSOURI

FOUNDATION (NATIVE) SOILS
TOTAL STRESS ANALYSIS

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS



LEGEND

- TEST BORING PREVIOUS INVESTIGATION JOB NO. E74-1072
- TEST PIT PREVIOUS INVESTIGATION JOB NO. E75-1118
- TEST BORING PREVIOUS INVESTIGATION WITH ADJACENT E-19 TEST JOB NO. E76-1013
- SEEPAGE DETECTION WELL, PREVIOUS INVESTIGATION WITH ADJACENT GROUND WATER MONITORING WELL JOB NO. E76-1013
- TEST BORING HOLLOW STEM AUGER, THIS INVESTIGATION JOB NO. E78-1041
- TEST BORING CONVENTIONAL FLIGHT AUGER, THIS INVESTIGATION JOB NO. E78-1041

RECOVERED SECTION CORNER
PROJECTED SECTION CORNER
FIELD CONTROL POINT
DRILL HOLE
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION
SPOT ELEVATION

KEY MAP

Scale 1" = 200'

COMPOUND INTERVAL 5 FEET
LOCAL DATUM DATED ON UNITED NUCLEAR CONTROL POINT 1942-5
COMPILED BY PHOTOGRAMMETRIC METHODS
BASE OF PHOTOGRAPHY MARCH 25, 1970

THIS MAP COMPLIES WITH THE MAPPING STANDARD MAP ACCURACY REQUIREMENTS

SITE PLAN
SHOWING BORING LOCATIONS

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS

UNITED NUCLEAR CORPORATION

DRAWN BY
REVISED

SEC. 2, T.16 N., R.16 W., N.M.P.M.

C1 of 61

E.5(a)

Hydraulic Analyses for Swales

Canonie Environmental

E-206

By _____ Date _____ Subject _____ Sheet No. ____ of 23

Chkd. By GC Date 12-03-90 _____ Proj. No. _____

1/4" X 1/4"

PURPOSE: TO DETERMINE THE SWALE DESIGN(S) FOR THE RECLAIMED URANIUM TAILINGS IMPOUNDMENT AT THE UNC SITE.

METHODS:

1) DIVIDE IMPOUNDMENT TOP INTO DRAINAGE AREAS BASED ON SWALE LOCATIONS AND DETERMINE FOR EACH AREA:
   - A) AREA
   - B) MAX. FLOW LENGTH
   - C) MAX ELEVATION DIFFERENCE
   - D) TIME OF CONCENTRATION

2) INPUTTING THE PROBABLE MAXIMUM PRECIPITATION EVENT AND CURVE NUMBER PREVIOUSLY DETERMINED FOR THE SITE, DETERMINE THE PMF STORM HYDROGRAPH USING THE SCS TR-55 METHOD FOR A TYPE II STORM DISTRIBUTION

RESULTS: SEE TABLE NEXT PAGE FOR DETAILS

Canonie Environmental

By mjj Date 11/14/90 Subject UNC - IMPOUNDMENT TOP Sheet No. 2 of 23
Chkd. By GS Date 12-03-90 SWALE DESIGN Proj. No. 88-060-24
1/4" X 1/4"

E-207

IMPOUNDMENT TOP DRAINAGE SWALE CHARACTERISTICS
SIDE SLOPES 3H:1V

CHANNEL REACH	LENGTH (ft)	SLOPE (ft/ft)	BOTTOM WIDTH (ft)	Q (cfs)	DEPTH OF FLOW (ft)	RIPRAP D_{50} (in)	
A	2600	0.0038	10	40	0.98	0.7	USE 1.5
B	3600	0.0083	20	97	0.97	1.5	
C	3400	0.0050	10	75	1.38	1.5	
D	3200	0.0028	10	68	1.43	0.7	= USE 1.5"
E	1350	0.0037	10	85	1.53	0.9	USE 1.5"
F	1600	0.0031	10	126	2.00	1.0	USE 1.5"
G	1400	0.0021	10	99	1.88	0.7	USE 1.5"
H	2,550	0.0085	20	284	1.90	3.0	
I	550	0.0040	20	385	2.65	1.8	
J	1900	0.0042	10	101	1.66	1.2	USE 1.5"

Canonie Environmental

E-208

By [illegible] Date 11/10/90 Subject UNC - Impoundment Top Sheet No. 3 of 23

Chkd. By GS Date 12-03-90 SWALE DESIGN Proj. No. B6-060-[illegible]

1/4" X 1/4"

CHANNEL SLOPE DETERMINATIONS

CHANNEL	ΔEL	LENGTH	SLOPE
SWALE A	7005 - 6995 (10)	2600	0.0038
B	7003 - 6973 (30)	3600	0.0083
C	6995 - 6978 (17)	3100	0.0054
D	6989 - 6980 (9)	3200	0.0028
E	6982 - 6977 (5)	1350	0.0037
F	6973 - 6968 (5)	1600	0.0031
G	6966 - 6963 (3)	1400	0.0021
H	6977 - 6955 (22)	2600	0.0085
J	6963 - 6955 (8)	1900	0.0042
I	6955 - 6953 2ft	500'	0.004

CALCULATIONS: MEASURE THE FOLLOWING FROM PLAN TOPO MAP

FOR AREA AND DRAINAGE SWALE A

DRAINAGE AREA: 231880 ft² = 5.3 AC

MAX OVERLAND FLOW LENGTH: 200 ft

MAX CHANNEL FLOW LENGTH: 2600 ft

MAX ELEV DIFF (7005 - 6995) 10 ft

DETERMINE 1ST CUT TIME OF CONCENTRATION BY ADDING OVERLAND FLOW TIME AND CHANNEL FLOW TIME. ASSUME $V_{overland} = 1$ ft/sec & $V_{channel} = 5$ ft/sec. (Check this assumption later)

$$t_c = 200 \text{ ft}/(1 \text{ ft/sec}) + 2600 \text{ ft}/(5 \text{ ft/sec}) = 720 \text{ sec}$$
$$= 0.2 \text{ hrs}$$

FOR AREA AND DRAINAGE SWALE B

DRAINAGE AREA: 562961 = 12.9 AC

MAX OVERLAND FLOW LENGTH: 540 ft

MAX CHANNEL FLOW LENGTH: 3600 ft

MAX ELEV DIFF 7003 - 6936 36 ft

First cut $t_c = 540/1 + 3600/5 = 1,260$ sec

$= 0.35$ hrs $\rightarrow 0.3$ hrs

THE 540' overland flow length is at the downstream end of the swale (near end of swale). Max upstream overland flow length is 120 ft. If 120 ft is used a more conservative $t_c = 0.23 \Rightarrow 0.2$ is obtained

Use $0.2 = t_c$

FOR AREA AND DRAINAGE SWALE C

DRAINAGE AREA: 430281 = 9.9 AC.
MAX. OVERLAND FLOW LENGTH: 200 ft
MAX CHANNEL FLOW LENGTH: 3400 ft
MAX ELEV. DIFF: 6995 - 6978 17 ft

First cut $t_c = 200/1 + 3400/5 = 880$ sec
$= 0.24$ hrs $\rightarrow 0.2$ hrs

FOR AREA AND DRAINAGE SWALE D

DRAINAGE AREA: 462521 ft² = 10.6 AC
MAX OVERLAND FLOW LENGTH: 260 ft
MAX CHANNEL FLOW LENGTH: 3200 ft
MAX ELEV DIFF: 6989 - 6980 9 ft

FIRST CUT $t_c = 260/1 + 3200/5 = 900$ sec
$= 0.25$ hrs $\rightarrow 0.3$ hrs.

FOR AREA AND DRAINAGE SWALE E

DRAINAGE AREA: 580321 ft² = 13.3 AC.
MAX OVERLAND FLOW LENGTH: 750 ft
MAX CHANNEL FLOW LENGTH: 1350 ft
MAX ELEV DIFF: (6982 - 6977) 5 ft

FIRST CUT $t_c = 750/1 + 1350/5 = 1020$ sec
$= 0.28$ hrs $\rightarrow 0.3$ hrs

FOR AREA AND DRAINAGE SWALE F

DRAINAGE AREA:	729121 ft²	= 16.7 AC
MAX OVERLAND FLOW LENGTH:		500 ft
MAX CHANNEL FLOW LENGTH:		1600 ft
MAX ELEV. DIFF:	6973 - 6968	5 ft

FIRST CUT $t_c = 500/1 + 1600/5 = 820$ sec
$= 0.23$ hrs $\rightarrow$ 0.2 hrs

FOR AREA AND DRAINAGE SWALE G

DRAINAGE AREA:	570401 ft² =	13.1 AC.
MAX OVERLAND FLOW LENGTH:		500 ft
MAX CHANNEL FLOW LENGTH:		1400 ft
MAX ELEV. DIFF:	6966 - 6963	3 ft

FIRST CUT $t_c = 500/1 + 1400/5 = 780$ sec
$= 0.22$ hrs $\rightarrow$ 0.2 hrs

FOR AREA AND DRAINAGE SWALE H & I

DRAINAGE AREA:	2,481,864 ft²	57.0 Ac.
MAX OVERLAND FLOW LENGTH:		1300 ft
MAX CHANNEL FLOW LENGTH:		3100 ft
MAX ELEV. DIFF:	(6953 - 6977)	24 ft

First cut $t_c = 1300\ ft/1 + 3100\ ft/5 = 1920$ sec
$= 0.53$ hrs $\rightarrow$ 0.5 hrs

Canonie Environmental

E-212

By mm Date 11/10/90 Subject UNC - IMPOUNDMENT TOP SWALE DESIGN Sheet No. 7 of 23

Chkd. By GS Date 12-03-90 Proj. No. 86-060-24

1/4" X 1/4"

FOR AREA AND DRAINAGE SWALE J

DRAINAGE AREA: 689,441 ft² = 15.8 Ac.

MAX. OVERLAND FLOW LENGTH 800 ft

MAX CHANNEL FLOW LENGTH 1900 ft

MAX ELEV DIFF. 963-955 8 ft

FIRST CUT $t_c = 800/1 + 1900/5 = 1180$ sec

$= 0.33$ hrs $\rightarrow 0.3$ hrs

DETERMINE CURVE NO.

A CN OF 79 WAS DETERMINED BY FAITH AND PROVIDED IN ITS 1981 REPORT TO UNC ENTITLED "DESIGN FLOOD ANALYSIS: NORTH CELL TAILINGS EMBANKMENT." FAITH USED AN AREA-WEIGHTED DETERMINATION USING THE NAMES, COVER TYPES, HYDROLOGIC SOIL GROUPS, CN, AND AREA OF EACH OF FIVE SOIL ASSOCIATIONS FOUND IN PIPELINE ARROYO.

SCIENCE APPLICATION, INC. DETERMINED A CN OF 80 FOR THE AREA DRAINING TO THE N. & S. DIVERSION DITCHES IN ITS JUNE 1981 REPORT ENTITLED "PMF DETERMINATION FOR THE SOUTHEAST DIVERSION CHANNEL AND SECTION 1 WATERSHED USING SCS HYDROLOGICAL TECHNIQUES." (REF: RESPONSE TO NRC COMMENTS, MAY 22, 1981)

USE CN = 80

DETERMINE PMP EVENT

PMP HAS BEEN DETERMINED TO BE 9.4 IN HOWEVER A CORRECTION MUST BE MADE FOR THE HIGH ELEVATION OF THE SITE. (MEAN BASIN ELEVATION CORRECTION).

THE CORRECTION FACTOR IS -5% FOR EVERY 1000 FT OF ELEVATION IN EXCESS OF 5000 FT. CONSERVATIVELY CHOOSE MEAN BASIN ELEVATION OF 7000 FT.

PMP = 8.43 inches

DETERMINE HYDROGRAPH BY TR-55 METHOD

Canonie Environmental

E-214

By mjg Date 11/10/90 Subject UNC - IMPOUNDMENT TOP SWALE DESIGN Sheet No. 9 of 23

Chkd. By GS Date 12-03-90 Proj. No. 86-060-24

1/4" X 1/4"

DETERMINE CHANNEL AND RIPRAP DESIGN

USE PEAK FLOWS RESULTING FROM PMF AS DETERMINED BY SCS TR-55 HYDROGRAPH.

INPUT PEAK FLOW RATES, (ASSUMED) CHANNEL SLOPES & BOTTOM WIDTHS, AND SIDE SLOPES TO CALCULATE CHANNEL DIMENSIONS AND RIPRAP SIZES BY SAFETY FACTOR METHOD. USE SPREADSHEET "RIPSF.WR1."

TRY TO KEEP ROCK SIZES AS UNIFORM AS POSSIBLE

D

101

12-0340

Tc = 0.2 RUNOFF HYDROGRAPHS BY THE SCS TR-56 METHOD

TYPE-II STORM DISTRIBUTION

10-Nov-90
02:24 PM

TIME OF CONCENTRATION = 0.2 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6
						(CSM/IN)	23	31	47	209	403	739	800	481	250	166	128	102	86	70	61	54	49	44	40	35	33
AREA A UNC	5.3	8.28E-03	80.0	8.43	6.03	(CFS)	1	2	2	10	20	37	40	24	12	8	6	5	4	3	3	3	2	2	2	2	2
AREA B UNC	12.9	2.02E-02	80.0	8.43	6.03	(CFS)	3	4	6	25	49	90	97	58	30	20	16	12	10	9	7	7	6	5	5	4	4
AREA C UNC	9.9	1.55E-02	80.0	8.43	6.03	(CFS)	2	3	4	19	38	69	75	45	23	15	12	10	8	7	6	5	5	4	4	3	3
AREA F UNC	16.7	2.61E-02	80.0	8.43	6.03	(CFS)	4	5	7	33	63	116	126	76	39	26	20	16	14	11	10	8	8	7	6	6	5
AREA G UNC	13.1	2.05E-02	80.0	8.43	6.03	(CFS)	3	4	6	26	50	91	99	59	31	20	16	13	11	9	8	7	6	5	5	4	4

5.133

Tc = 0.5 RUNOFF HYDROGRAPHS BY THE SCS TR-56 METHOD

TYPE-II STORM DISTRIBUTION

10-Nov-90
02:24 PM

TIME OF CONCENTRATION = 0.5 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6
						(CSM/IN)	17	23	32	57	94	170	388	467	529	507	402	297	226	140	96	74	61	53	47	41	36
AREA ~~G~~ F UNC	57.0	8.91E-02	80.0	8.43	6.03	(CFS)	9	12	17	31	50	91	165	251	284	272	216	159	121	75	52	40	33	28	25	22	19

Tc = 0.3 RUNOFF HYDROGRAPHS BY THE SCS TR-56 METHOD

TYPE II STORM DISTRIBUTION

10-Nov 90
02:24 PM

TIME OF CONCENTRATION = 0.3 HOURS
TRAVEL TIME = 0 HOURS

(a) 12-03-80

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6
						(CSM/IN)	20	28	41	118	236	447	676	676	459	283	196	146	114	80	66	57	51	46	42	37	33
AREA D UNC	10.6	1.66E-02	80.0	8.43	6.03	(CFS)	2	3	4	12	23	45	68	68	46	28	20	15	11	8	7	6	5	5	4	4	3
AREA E UNC	13.3	2.08E-02	80.0	8.43	6.03	(CFS)	3	4	5	15	29	56	85	85	58	35	25	18	14	10	8	7	6	6	5	5	4
AREA G-2 UNC	15.8	2.47E-02	80.0	8.43	6.03	(CFS)	3	4	6	18	35	67	101	101	68	42	29	22	17	12	10	8	8	7	6	6	5
AREA G-3 UNC	13.6	2.12E-02	80.0	8.43	6.03	(CFS)	3	4	5	15	30	57	87	87	59	36	25	19	15	10	8	7	7	6	5	5	4

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE A

DISCHARGE =	40 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0038	Theta =	0.22 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.06 FT	0.7 inches	D50 (ASSUM) =	0.06 FT	0.7 inches
n =	0.025		n =	0.025	
* TRIAL d =	1.00 ft	******			
DIFFERENCE =	3.49 %				
* calc d =	0.98 ft	******			
DIFFERENCE =	0.28 %				
* calc d =	0.98 ft	******			
DIFFERENCE =	0.03 %				
* calc d =	0.98 ft	******			
DIFFERENCE =	0.00 %				
FINAL d =	0.98 ft				
A =	12.70 sq ft				
R =	0.78 ft		t =	0.17 PSF	
t =	15.89 ft		nb =	0.65	
V =	3.15 fps				
Q(calc) =	40 cfs		Beta =	37.78	
t =	0.23 PSF				
nb =	0.070		n' =	0.53	
SFb =	1.14		SFs =	1.10	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UMC -- DRAINAGE SWALE B

DISCHARGE =	97 CFS		
BOTTOM WIDTH =	20 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0083	Theta =	0.48 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.13 FT	1.5 inches	D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028		n =	0.028	
* TRIAL d =	0.97 ft	******			
DIFFERENCE =	-0.33 %				
* calc d =	0.97 ft	******			
DIFFERENCE =	-0.05 %				
* calc d =	0.97 ft	******			
DIFFERENCE =	-0.01 %				
* calc d =	0.97 ft	******			
DIFFERENCE =	-0.00 %				
FINAL d =	0.97 ft				
A =	22.27 sq ft				
R =	0.85 ft		t =	0.38 PSF	
t =	25.83 ft		nb =	0.68	
V =	4.36 fps				
Q(calc) =	97 cfs		Beta =	38.73	
t =	0.50 PSF				
nb =	0.903		n' =	0.55	
SFb =	1.09		SFs =	1.08	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE C

DISCHARGE =	75 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	[redacted]	Theta =	0.29 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.13 FT	1.5 inches	D50 (ASSUM) =	0.13 FT	1.5 inches
n =	0.028		n =	0.028	
* TRIAL d =	1.40 ft	******			
DIFFERENCE =	3.30 %				
* calc d =	1.38 ft	******			
DIFFERENCE =	0.18 %				
* calc d =	1.38 ft	******			
DIFFERENCE =	0.01 %				
* calc d =	1.38 ft	******			
DIFFERENCE =	0.00 %				
FINAL d =	1.38 ft				
A =	19.43 sq ft				
R =	1.04 ft		t =	0.32 PSF	
t =	18.25 ft		nb =	0.58	
V =	3.86 fps				
Q(calc) =	75 cfs		Beta =	34.45	
t =	0.43 PSF				
nb =	0.770		n' =	0.45	
SFb =	1.29		SFs =	1.19	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas". pages 185-194

LOCATION: UNC -- DRAINAGE SWALE D

DISCHARGE =	68 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0028	Theta =	0.16 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16. ref.		

CHANNEL BOTTOM				CHANNEL SIDE SLOPES		
	D50 (ASSUM) =	0.06 FT	0.7 inches	D50 (ASSUM) =	0.06 FT	0.7 inches
	n =	0.025		n =	0.025	
*	TRIAL d =	1.50 ft	******			
	DIFFERENCE =	9.50 %				
*	calc d =	1.43 ft	******			
	DIFFERENCE =	0.05 %				
*	calc d =	1.43 ft	******			
	DIFFERENCE =	0.00 %				
*	calc d =	1.43 ft	******			
	DIFFERENCE =	0.00 %				
	FINAL d =	1.43 ft				
	A =	20.40 sq ft				
	R =	1.07 ft		t =	0.19 PSF	
	t =	18.57 ft		nb =	0.70	
	V =	3.33 fps				
	Q(calc) =	68 cfs		Beta =	39.76	
	t =	0.25 PSF				
	nb =	0.933		n' =	0.57	
	SFb =	1.07		SFs =	1.06	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE E

DISCHARGE =	85 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0037	Theta =	0.21 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM

D50 (ASSUM) =	0.08 FT	0.9 inches	
n =	0.026		
* TRIAL d =	1.50 ft	******	
DIFFERENCE =	-4.02 %		
* calc d =	1.53 ft	******	
DIFFERENCE =	-0.40 %		
* calc d =	1.53 ft	******	
DIFFERENCE =	-0.03 %		
* calc d =	1.53 ft	******	
DIFFERENCE =	-0.00 %		
FINAL d =	1.53 ft		
A =	22.39 sq ft		
R =	1.14 ft		
t =	19.20 ft		
V =	3.80 fps		
Q(calc) =	85 cfs		
t =	0.35 PSF		
nb =	0.993		
SFb =	1.00		

CHANNEL SIDE SLOPES

D50 (ASSUM) =	0.08 FT	0.9 inches
n =	0.026	
t =	0.27 PSF	
nb =	0.74	
Beta =	41.49	
n' =	0.62	
SFs =	1.02	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UMC -- DRAINAGE SWALE F

DISCHARGE =	126 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0031	Theta =	0.18 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.09 FT	1.0 inches	D50 (ASSUM) =	0.09 FT	1.0 inches
n =	0.026		n =	0.026	
* TRIAL d =	2.00 ft	******			
DIFFERENCE =	0.06 %				
* calc d =	2.00 ft	******			
DIFFERENCE =	0.00 %				
* calc d =	2.00 ft	******			
DIFFERENCE =	0.00 %				
* calc d =	2.00 ft	******			
DIFFERENCE =	0.00 %				
FINAL d =	2.00 ft				
A =	31.99 sq ft				
R =	1.41 ft		t =	0.29 PSF	
t =	22.00 ft		nb =	0.72	
V =	3.94 fps				
Q(calc) =	126 cfs		Beta =	40.67	
t =	0.39 PSF				
nb =	0.964		n' =	0.60	
SFb =	1.03		SFs =	1.04	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC — DRAINAGE SWALE G

DISCHARGE =	99 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0021	Theta =	0.12 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.06 FT	0.7 inches	D50 (ASSUM) =	0.06 FT	0.7 inches
n =	0.025		n =	0.025	
* TRIAL d =	1.97 ft	******			
DIFFERENCE =	8.94 %				
* calc d =	1.88 ft	******			
DIFFERENCE =	-0.18 %				
* calc d =	1.88 ft	******			
DIFFERENCE =	-0.01 %				
* calc d =	1.88 ft	******			
DIFFERENCE =	-0.00 %				
FINAL d =	1.88 ft				
A =	29.48 sq ft				
R =	1.35 ft		t =	0.19 PSF	
t =	21.30 ft		nb =	0.69	
V =	3.36 fps				
Q(calc) =	99 cfs		Beta =	39.47	
t =	0.25 PSF				
nb =	0.923		n' =	0.57	
SFb =	1.08		SFs =	1.07	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE H

DISCHARGE =	284 CFS		
BOTTOM WIDTH =	20 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0085	Theta =	0.49 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.25 FT	3 inches	D50 (ASSUM) =	0.25 FT	3 inches
n =	0.031		n =	0.031	
* TRIAL d =	2.00 ft	******			
DIFFERENCE =	9.12 %				
* calc d =	1.91 ft	******			
DIFFERENCE =	0.37 %				
* calc d =	1.91 ft	******			
DIFFERENCE =	0.04 %				
* calc d =	1.90 ft	******			
DIFFERENCE =	0.00 %				
FINAL d =	1.90 ft				
A =	48.98 sq ft				
R =	1.53 ft		t =	0.76 PSF	
t =	31.43 ft		nb =	0.68	
V =	5.80 fps				
Q(calc) =	284 cfs		Beta =	38.82	
t =	1.01 PSF				
nb =	0.907		n' =	0.56	
SFb =	1.09		SFs =	1.08	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE I

DISCHARGE =	385 CFS		
BOTTOM WIDTH =	20 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.004	Theta =	0.23 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.15 FT	1.8 inches	D50 (ASSUM) =	0.15 FT	1.8 inches
n =	0.029		n =	0.029	
* TRIAL d =	2.60 ft	******			
DIFFERENCE =	-3.26 %				
* calc d =	2.64 ft	******			
DIFFERENCE =	-0.35 %				
* calc d =	2.65 ft	******			
DIFFERENCE =	-0.03 %				
* calc d =	2.65 ft	******			
DIFFERENCE =	-0.00 %				
FINAL d =	2.65 ft				
A =	73.97 sq ft				
R =	2.01 ft		t =	0.50 PSF	
t =	35.00 ft		nb =	0.74	
V =	5.20 fps				
Q(calc) =	385 cfs		Beta =	41.35	
t =	0.66 PSF				
nb =	0.900		n' =	0.62	
SFb =	1.01		SFs =	1.02	

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SL

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: UNC -- DRAINAGE SWALE J

DISCHARGE =	101 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0042	Theta =	0.24 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.10 FT	1.2 inches	D50 (ASSUM) =	0.10 FT	1.2 inches
n =	0.027		n =	0.027	
* TRIAL d =	1.65 ft	******			
DIFFERENCE =	-0.91 %				
* calc d =	1.66 ft	******			
DIFFERENCE =	-0.06 %				
* calc d =	1.66 ft	******			
DIFFERENCE =	-0.00 %				
* calc d =	1.66 ft	******			
DIFFERENCE =	-0.00 %				
FINAL d =	1.66 ft				
A =	24.03 sq ft				
R =	1.21 ft		t =	0.33 PSF	
t =	19.95 ft		nb =	0.73	
V =	4.07 fps				
Q(calc) =	101 cfs		Beta =	40.96	
t =	0.43 PSF				
nb =	0.975		n' =	0.61	
SFb =	1.02		SFs =	1.03	

CHECK TIME OF CONCENTRATIONS

AREA A: Design channel velocity = 3.19 fps
Assume overland flow still = 1 ft/sec

$t_c = 200/1 + 2600/3.19 = 1025$ sec = 0.28 hrs
∴ use of t_c = 0.2 hrs is conservative.
(ie will give higher peak flow)

AREA B: Design channel velocity = 4.36 fps

$t_c = 540/1 + 3600/4.36 = 946$ sec = 0.38 hrs
∴ use of t_c = 0.2 hrs is conservative

AREA C: Design channel velocity = 3.86 fps

$t_c = 200/1 + 3400/3.86 = 1081$ sec = 0.30 hrs
∴ use of t_c = 0.2 hrs is conservative

AREA D: Design channel velocity = 3.33 fps

$t_c = 260/1 + 3200/3.33 = 1220$ sec = .34 hrs
∴ use of t_c = 0.3 is conservative

AREA E: Design channel velocity = 3.80 fps

$t_c = 960/1 + 1350/3.80 = 1125$ sec = 0.30 hrs
∴ use of t_c = 0.3 hrs is appropriate

AREA F: Design channel velocity = 3.94 fps

$t_c = 500/1 + 1600/3.94 = 900$ sec = 0.25 hrs
∴ use of t_c = 0.2 hrs is conservative

Canonie Environmental

By [illegible] Date 11/12/90 Subject UNC - Impoundment Top Sheet No. 23 of 23
Chkd. By [illegible] Date 12-03-90 Swale Design Proj. No. 86-060-24
1/4" X 1/4"

AREA G: Design channel velocity = 3.36 fps

$t_c = 500/1 + 1400/3.36 = 917$ sec $= 0.25$ hrs
∴ use of $t_c = 0.2$ hrs is conservative

AREA H-I: Design channel velocity = 5.80 fps in Swale G-H

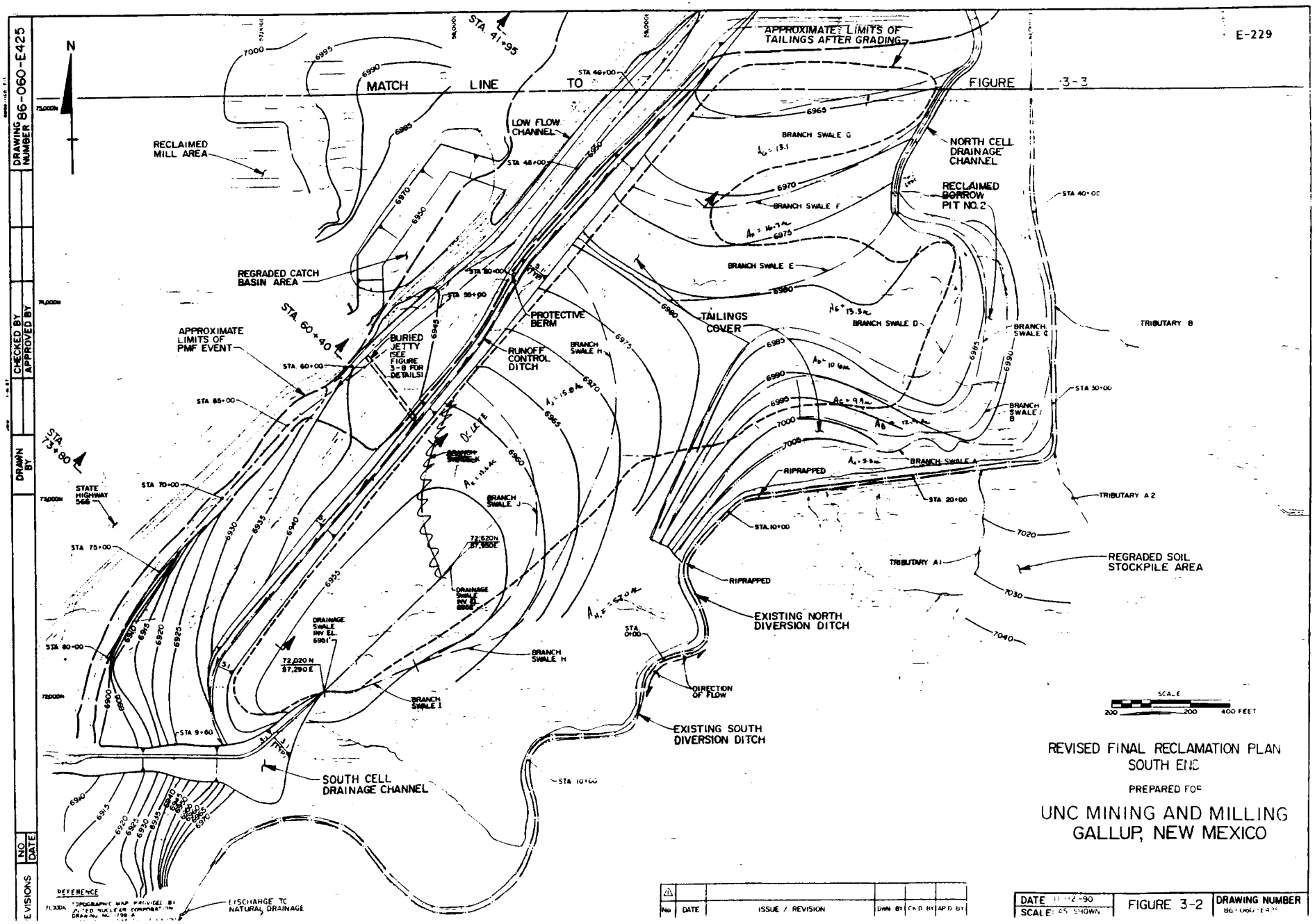
$t_{c_{G-1A}} = 1300/1 + 3100/5.80 = 1834$ sec $= 0.50$ hrs
∴ use of $t_c = 0.5$ hrs is appropriate

Design channel velocity = 4.17 ft/sec in SWALE G-1B

$t_{c_{G-1B}} = 1300/1 + 3100/4.17 = 2043$ sec $= 0.57$ hrs
∴ use of $t_c = 0.5$ hrs is conservative

AREA J: Design channel velocity = 4.02 fps

$t_c = 800/1 + 1900/4.02 = 1261$ sec $= 0.35$ hrs
∴ use of $t_c = 0.3$ hrs is conservative



REVISED FINAL RECLAMATION PLAN
SOUTH END

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

NO	DATE	ISSUE / REVISION	DWN BY	CK'D BY	APP'D BY

DATE 11-12-90	FIGURE 3-2	DRAWING NUMBER 86-060-E425
SCALE: AS SHOWN		

DRAWING NUMBER 86-060-E425
CHECKED BY
APPROVED BY
DRAWN BY
REVISIONS
NO. DATE

E.5(b)

Soil/Rock Matrix Stability Calculations

PURPOSE : DETERMINE THE ROCK MULCH SIZE (d_{50}) AND THICKNESS FOR THE IMPOUNDMENT TOPS AT UNC USING THE PROPOSED REVISED GRADING PLAN (2' RADON BARRIER).

METHOD : FIGURE 1 SHOWS THE SLOPE SEGMENTS FOR WHICH THE OVERLAND FLOW CALCULATIONS WERE PERFORMED. THE CSU METHOD OF RIPRAP SIZING (NUREG/CR-4651 PHASE II) WAS USED TO SIZE THE RIPRAP.

THE SPREADSHEET PROGRAM "OVERCSU" (LOTUS SYMPHONY) WAS DEVELOPED TO ASSIST IN THE CALCULATIONS. THIS PROGRAM DETERMINES THE OVERLAND FLOW RATE PER UNIT WIDTH (q) FOR THE IMPOUNDMENT TOP USING THE RATIONAL FORMULA AS PER NUREG 4620 AND THE NRC'S STP. FROM THIS POINT THE PROGRAM UTILIZES THE q VALUE AND THE SLOPE TO DETERMINE THE RIPRAP d_{50} BY MEANS OF THE FOLLOWING FORMULA (AS PER NUREG/CR-4651 PHASE II):

$$d_{50} = 5.23 \times (\text{slope})^{0.43} \times (q)^{0.56}$$

THIS IS THE CSU METHOD.

Canonie Environmental

E-232

By SWM Date 11-29-90 Subject UNC - ROCK MULCH SIZING ON IMPOUNDMENT TOP Sheet No. 2 of 16

Chkd. By GS Date 12-03-90 Proj. No. 86-060-29

1/4" X 1/4"

RESULTS : PAGE 3 PROVIDES A SUMMARY TABLE OF THE SLOPE SEGMENTS AND THE RIPRAP SIZES AND THICKNESSES CALCULATED BY THE CSU METHOD.

Canonie Environmental

E-233

By SWM Date 11-29-90 Subject UNC - SIZING OF ROCK MULCH Sheet No. 3 of 16

Chkd. By GS Date 12-03-90 Proj. No. 86-060-29

1/4" X 1/4"

TABLE 1 SUMMARY OF RESULTS

SLOPE SEGMENT	SLOPE LENGTH (ft)	RELIEF (ft)	SLOPE (ft/ft)	q (cfs/ft)	CSU d_{50} (inches)	THICKNESS (inches)
A	240	13.0	0.054	0.92	1.49	3.0
B	120	5.0	0.042	0.46	0.37	↓
C	205	9.0	0.044	0.79	1.20	↓
D	260	7.5	0.029	1.00	1.14	↓
E	205	3.5	0.017	0.79	0.79	↓
F	470	9.0	0.019	1.55	1.22	↓
G	440	6.5	0.015	1.49	1.05	↓
H	500	15.0	0.030	1.71	1.56	↓
J	800	14.5	0.018	2.20	1.44	↓
K	1100	11.0	0.010	2.37	1.71	↓
L	95	5.5	0.058	0.37	0.88	↓
M	155	9.5	0.061	0.60	1.18	↓
N	100	7.0	0.070	0.39	0.98	↓

BY: SWM

p. 4 of 16

BY: SWM
11-30-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION A

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD:   PMP
  SLOPE LENGTH:   240 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.054 FT/FT        Tc (calc): 1.632 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.030            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.005 ACRES       PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.030          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.308 CFS      Q = CiA
CONC. DISCHARGE:0.924 CFS

        DEPTH: 0.220 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.741 PSF
 FLOW VELOCITY:  4.20 FPS      V = Q/FLOW AREA

    CALC. d50: 1.426 INCHES    d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                               Development of Riprap Design Criteria,
                               Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY SWM

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION B

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD: PMP YEARS
  SLOPE LENGTH:   120 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.042 FT/FT        Tc (calc): 1.054 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.027            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.002 ACRES       PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.027          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.154 CFS      Q = CiA
CONC. DISCHARGE:0.462 CFS

        DEPTH: 0.147 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.385 PSF
 FLOW VELOCITY:  3.14 FPS      V = Q/FLOW AREA

    CALC. d50: 0.868 INCHES   d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                              Development of Riprap Design Criteria,
                              Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION C

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD: PMP YEARS
  SLOPE LENGTH:   205 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.044 FT/FT        Tc (calc): 1.564 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.029            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.004 ACRES       PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.029          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.263 CFS      Q = CiA
CONC. DISCHARGE:0.789 CFS

        DEPTH: 0.208 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.573 PSF
 FLOW VELOCITY:  3.78 FPS      V = Q/FLOW AREA

    CALC. d50: 1.195 INCHES    d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                               Development of Riprap Design Criteria,
                               Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

P. 7 of 16

BY: SWM
11-29-90

Chkd By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION D

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD: PMP YEARS
  SLOPE LENGTH:   260 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.029 FT/FT        Tc (calc): 2.205 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.027            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.005 ACRES        PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.027          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.333 CFS      Q = CIA
CONC. DISCHARGE:1.001 CFS

        DEPTH: 0.261 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.472 PSF
 FLOW VELOCITY:  3.83 FPS      V = Q/FLOW AREA

    CALC. d50: 1.141 INCHES    d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                               Development of Riprap Design Criteria,
                               Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY: SWM

p. 8 of 6

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION E

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD: PMP YEARS
  SLOPE LENGTH:   205 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.017 FT/FT        Tc (calc): 2.256 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.025            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.004 ACRES       PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.025          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.263 CFS      Q = CiA
CONC. DISCHARGE:0.789 CFS

        DEPTH: 0.253 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.269 PSF
 FLOW VELOCITY:  3.11 FPS      V = Q/FLOW AREA

    CALC. d50: 0.794 INCHES    d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                               Development of Riprap Design Criteria,
                               Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY: SWM

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION F

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD: PMP YEARS
  SLOPE LENGTH:   470 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE: 0.019 FT/FT        Tc (calc): 4.095 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.027            Tc (actual):   4.1 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  38.7 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.010 ACRES        PPT AMOUNT: 3.277 INCHES
Mannings n(calc)0.027           PPT INTENSITY: 47.96 IPH

PEAK DISCHARGE: 0.517 CFS      Q = CiA
CONC. DISCHARGE:1.552 CFS

        DEPTH: 0.386 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.457 PSF
 FLOW VELOCITY:  4.02 FPS      V = Q/FLOW AREA

    CALC. d50: 1.217 INCHES   d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                              Development of Riprap Design Criteria,
                              Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	38.7
5	45	41.94
10	62	47.84
15	74	56.56
20	82	70.87
30	89	78.64
45	95	81.366666667
60	100	

BY: SWM

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION 6

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF: 1
SLOPE LENGTH: 440 FT
AVE SLOPE: 0.015 FT/FT
MANNING'S n: 0.026
FLOW CONC: 3
DRAINAGE AREA: 0.010 ACRES
Mannings n(calc)0.026

RETURN PERIOD: PMP YEARS
1-HR PPT AMOUNT: 8.47 INCHES
Tc (calc): 4.263 MIN EQTN 4.44, NUREG4620
Tc (actual): 4.3 MIN
%OF 1-HR PPT: 40.1 % TABLE 2.1, NUREG 4620
PPT AMOUNT: 3.396 INCHES
PPT INTENSITY: 47.39 IPH

PEAK DISCHARGE: 0.478 CFS Q = CiA
CONC. DISCHARGE:1.436 CFS

DEPTH: 0.386 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.361 PSF
FLOW VELOCITY: 3.71 FPS V = Q/FLOW AREA

CALC. d50: 1.052 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT O 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	40.1
5	45	42.62
10	62	48.32
15	74	56.88
20	82	71.01
30	89	78.72
45	95	81.433333333
60	100	

BY: SWM

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

p. 11 of 16

BY: SWM
11-29-90

Ckd By: GS
12-03-90

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION H

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF:	1	RETURN PERIOD:	PMP
SLOPE LENGTH:	500 FT	1-HR PPT AMOUNT:	8.47 INCHES
AVE SLOPE:	0.03 FT/FT	Tc (calc):	3.602 MIN EQTN 4.44, NUREG4620
MANNING'S n:	0.028	Tc (actual):	3.6 MIN
FLOW CONC:	3	%OF 1-HR PPT:	35.2 % TABLE 2.1, NUREG 4620
DRAINAGE AREA:	0.011 ACRES	PPT AMOUNT:	2.981 INCHES
Mannings n(calc)	0.028	PPT INTENSITY:	49.69 IPH

PEAK DISCHARGE: 0.570 CFS Q = CiA
CONC. DISCHARGE: 1.711 CFS

DEPTH: 0.364 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.682 PSF
FLOW VELOCITY: 4.69 FPS V = Q/FLOW AREA

CALC. d50: 1.564 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	35.2
5	45	40.24
10	62	46.64
15	74	55.76
20	82	70.52
30	89	78.44
45	95	81.2
60	100	

BY: SWM

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

p. 12 of 16

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION J

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF:	1	RETURN PERIOD:	PMP YEARS
SLOPE LENGTH:	800 FT	1-HR PPT AMOUNT:	8.47 INCHES
AVE SLOPE:	0.018 FT/FT	Tc (calc):	6.297 MIN EQTN 4.44, NUREG4620
MANNING'S n:	0.020	Tc (actual):	6.3 MIN
FLOW CONC:	3	%OF 1-HR PPT:	49.42 % TABLE 2.1, NUREG 4620
DRAINAGE AREA:	0.018 ACRES	PPT AMOUNT:	4.185 INCHES
Mannings n(calc)	0.020	PPT INTENSITY:	39.86 IPH

PEAK DISCHARGE: 0.732 CFS Q = CiA
CONC. DISCHARGE: 2.196 CFS

DEPTH: 0.493 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.554 PSF
FLOW VELOCITY: 4.45 FPS V = Q/FLOW AREA

CALC. d50: 1.444 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	54.1
5	45	49.42
10	62	53.12
15	74	60.08
20	82	72.41
30	89	79.52
45	95	82.1
60	100	

BY: SWM

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

p. 13 of 16

BY: SWM
11-29-90

PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION K

Chkd. By: GS
12-03-90

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF:	1	RETURN PERIOD: PMP YEARS	
SLOPE LENGTH:	1100 FT	1-HR PPT AMOUNT: 8.47 INCHES	
AVE SLOPE:	0.01 FT/FT	Tc (calc): 10.09 MIN	EQTN 4.44, NUREG4620
MANNING'S n:	0.027	Tc (actual): 10.1 MIN	
FLOW CONC:	3	%OF 1-HR PPT: 62.24 %	TABLE 2.1, NUREG 4620
DRAINAGE AREA:	0.025 ACRES	PPT AMOUNT: 5.271 INCHES	
Mannings n(calc)	0.027	PPT INTENSITY: 31.31 IPH	

PEAK DISCHARGE: 0.790 CFS Q = CiA
CONC. DISCHARGE: 2.372 CFS

DEPTH: 0.603 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.376 PSF
FLOW VELOCITY: 3.93 FPS V = Q/FLOW AREA

CALC. d50: 1.171 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	80.7
5	45	62.34
10	62	62.24
15	74	66.16
20	82	75.07
30	89	81.04
45	95	83.366666667
60	100	

BY: SWM

P. 14 of 16

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UNC: 86-060-24
LOCATION: INPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION L

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

RUNOFF COEF: 1
SLOPE LENGTH: 95 FT
AVE SLOPE: 0.058 FT/FT
MANNING'S n: 0.028
FLOW CONC: 3
DRAINAGE AREA: 0.002 ACRES
Mannings n(calc)0.028

RETURN PERIOD: PMP YEARS
1-HR PPT AMOUNT: 8.47 INCHES
Tc (calc): 0.778 MIN EQTN 4.44, NUREG4620
Tc (actual): 2.5 MIN
%OF 1-HR PPT: 27.5 % TABLE 2.1, NUREG 4620
PPT AMOUNT: 2.329 INCHES
PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.121 CFS Q = CiA
CONC. DISCHARGE:0.365 CFS

DEPTH: 0.118 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.429 PSF
FLOW VELOCITY: 3.08 FPS V = Q/FLOW AREA

CALC. d50: 0.875 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
Development of Riprap Design Criteria,
Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT 0 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY: SWM

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

PROJECT: UMC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION M

BY: SWM
11-29-90

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

Chkd. By: GS
12-03-90

RUNOFF COEF: 1
SLOPE LENGTH: 155 FT
AVE SLOPE: 0.061 FT/FT
MANNING'S n: 0.030
FLOW CONC: 3
DRAINAGE AREA: 0.003 ACRES
Mannings n(calc)0.030

RETURN PERIOD: PMP YEARS
1-HR PPT AMOUNT: 8.47 INCHES
Tc (calc): 1.112 MIN EQTN 4.44, NUREG4620
Tc (actual): 2.5 MIN
%OF 1-HR PPT: 27.5 % TABLE 2.1, NUREG 4620
PPT AMOUNT: 2.329 INCHES
PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.198 CFS Q = CiA
CONC. DISCHARGE:0.596 CFS

DEPTH: 0.163 FT EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.621 PSF
FLOW VELOCITY: 3.65 FPS V = Q/FLOW AREA

CALC. d50: 1.176 INCHES d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
*Development of Riprap Design Criteria, Phase II, CSU Method

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT O 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	

BY: SWM

BY: SWM
11-29-90

Chkd. By: GS
12-03-90

OVERLAND FLOW AND RIPRAP CALCULATIONS USING THE CSU METHOD OVERCSU.WR1

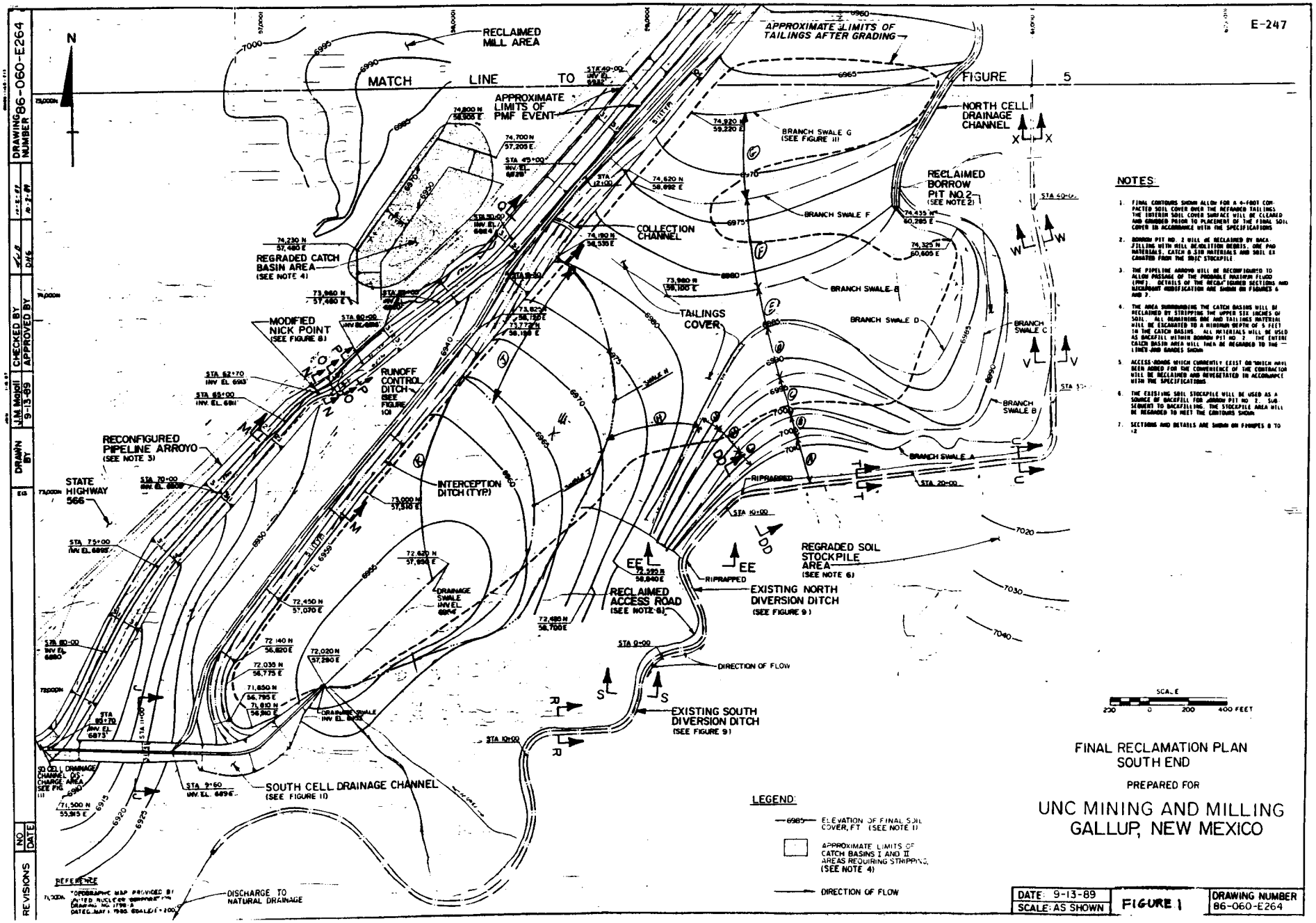
PROJECT: UNC: 86-060-24
LOCATION: IMPOUNDMENT TOP, ORIGINAL DESIGN, LOCATION N

OVERLAND FLOW CALCULATIONS (NUREG-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments)

```
   RUNOFF COEF:     1          RETURN PERIOD:   PMP
  SLOPE LENGTH:   100 FT      1-HR PPT AMOUNT: 8.47 INCHES
     AVE SLOPE:  0.07 FT/FT        Tc (calc): 0.752 MIN   EQTN 4.44, NUREG4620
   MANNING'S n: 0.030            Tc (actual):   2.5 MIN
     FLOW CONC:     3           %OF 1-HR PPT:  27.5 %     TABLE 2.1, NUREG 4620
 DRAINAGE AREA: 0.002 ACRES       PPT AMOUNT: 2.329 INCHES
Mannings n(calc)0.030          PPT INTENSITY: 55.90 IPH

PEAK DISCHARGE: 0.128 CFS      Q = CiA
CONC. DISCHARGE:0.385 CFS

        DEPTH: 0.120 FT        EQTN 4.46, NUREG 4620
TRACTIVE FORCE: 0.526 PSF
 FLOW VELOCITY:  3.20 FPS      V = Q/FLOW AREA

    CALC. d50: 0.976 INCHES    d50 = 5.23 x Slope^0.43 x Conc. Discharge^0.56
                               Development of Riprap Design Criteria,
                               Phase II, CSU Method
```

TABLE 2.1 OF NUREG 4620

RAINFALL DURATION (MIN)	PERCENT O 1-HR PPT	INTERPOLATED PERCENT
2.5	27.5	27.5
5	45	36.5
10	62	44
15	74	54
20	82	69.75
30	89	78
45	95	80.833333333
60	100	



NOTES:

1. FINAL CONTOURS SHOWN ALLOW FOR A 4-FOOT COMPACTED SOIL COVER OVER THE REGRADED TAILINGS. THE INTERIM SOIL COVER SURFACE WILL BE CLEARED AND GRUBBED PRIOR TO PLACEMENT OF THE FINAL SOIL COVER IN ACCORDANCE WITH THE SPECIFICATIONS.
2. BORROW PIT NO. 2 WILL BE RECLAIMED BY BACKFILLING WITH MILL DEMOLITION DEBRIS, ORE PAD MATERIALS, CATCH BASIN MATERIALS AND SOIL EXCAVATED FROM THE SOIL STOCKPILE.
3. THE PIPELINE ARROYO WILL BE RECONFIGURED TO ALLOW PASSAGE OF THE PROBABLE MAXIMUM FLOOD (PMF). DETAILS OF THE RECONFIGURED SECTIONS AND RECHANNEL MODIFICATION ARE SHOWN ON FIGURES 6 AND 7.
4. THE AREA SURROUNDING THE CATCH BASINS WILL BE RECLAIMED BY STRIPPING THE UPPER SIX INCHES OF SOIL. ALL REMAINING ORE AND TAILINGS MATERIAL WILL BE EXCAVATED TO A MINIMUM DEPTH OF 5 FEET IN THE CATCH BASINS. ALL MATERIALS WILL BE USED AS BACKFILL WITHIN BORROW PIT NO. 2. THE ENTIRE CATCH BASIN AREA WILL THEN BE REGRADED TO THE LINES AND GRADES SHOWN.
5. ACCESS ROADS WHICH CURRENTLY EXIST OR WHICH HAVE BEEN ADDED FOR THE CONVENIENCE OF THE CONTRACTOR WILL BE RECLAIMED AND REVEGETATED IN ACCORDANCE WITH THE SPECIFICATIONS.
6. THE EXISTING SOIL STOCKPILE WILL BE USED AS A SOURCE OF BACKFILL FOR BORROW PIT NO. 2. SUBSEQUENT TO BACKFILLING, THE STOCKPILE AREA WILL BE REGRADED TO MEET THE CONTOURS SHOWN.
7. SECTIONS AND DETAILS ARE SHOWN ON FIGURES 8 TO 12.

FINAL RECLAMATION PLAN
SOUTH END

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

DATE: 9-13-89	FIGURE 1	DRAWING NUMBER 86-060-E264
SCALE: AS SHOWN		

E.6

South Cell Drainage Channel Hydraulic Calculations

By [illegible] Date 1/31/91 Subject UNC Sheet No. 1 of ___

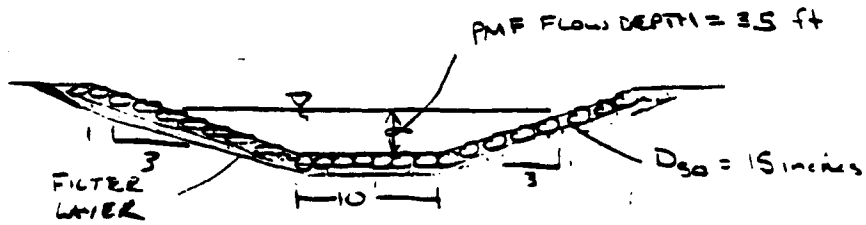
Chkd. By [illegible] Date [illegible] South Cell Drainage Channel Proj. No. [illegible]

1/4" X 1/4"

PURPOSE: TO DETERMINE THE DESIGN FOR THE SOUTH CELL DRAINAGE CHANNEL AT UNC

METHODS:
1) DETERMINE DRAINAGE AREA CHARACTERISTICS,
2) DETERMINE PMF HYDROGRAPH USING THE TABULAR SCS TR-55 METHOD,
3) DETERMINE CHANNEL SIZE AND RIPRAP DESIGN USING THE SAFETY FACTORS METHOD

RESULT: DESIGN FOR CHANNEL STA 0+00 TO 4+50



Canonie Environmental

E-250

By [illegible] Date 1/31/91 Subject LINC Sheet No. 2 of

Chkd. By [illegible] Date 2-1-91 SOUTH CELL DRAINAGE CHANNEL Proj. No. 86-060-2d

1/4" X 1/4

CALCULATIONS.

DETERMINE DRAINAGE BASIN CHARACTERISTICS

AREA: MEASURED BY DIGITAL PLANIMETER TAKEN FOR THE AREA SHOWN ON FIGURE 1, ATTACHED

AREA = 109 ACRES = 0.170 SQ MILES

TIME OF CONCENTRATION. SINCE THE SOUTH CELL DRAINAGE CHANNEL IS FED NOT ONLY BY OVERLAND FLOW BUT BY DRAINAGE SWALES MUST CONSIDER BOTH OVERLAND FLOW AND IN-CHANNEL FLOW.

THE MAXIMUM OVERLAND FLOWLENGTH IS 1300'; THE SOUTH CELL DRAINAGE CHANNEL IS ~ 450' LONG (in riprapped portion), BRANCH SWALES H & I COMBINED ARE ~ 3100' LONG

WATER FALLING AT THE HYDRAULICALLY MOST DISTANT PORTION OF THE BASIN (THE NE END) WOULD TRAVEL 800 ft overland, 2200 feet in swales H & I and 450 feet in the south cell drainage channel.
Velocity of overland flow at a slope of 0.019 ≈ 1 fps (See Figure 2).
Velocity of water in Swales H & I = 5.8 fps (See Appendix A of Plan 90 Submittal)
Velocity of water in South Cell Drainage Channel = 9.4 fps

$$t_c = \frac{800 ft}{1 fps} + \frac{2200 ft}{5.8 fps} + \frac{450 ft}{9.4 fps} = 1227 sec = 0.34 hrs$$

CURVE NO: SCIENCE APPLICATION, INC. DETERMINED A CN OF 80 FOR THE AREA DRAINING THE N. & S. DIVERSION DITCHES IN ITS JUNE 1981 REPORT ENTITLED "PMF DETERMINATION FOR THE SOUTHEAST DIVERSION CHANNEL AND SECTION 1 WATERSHED USING SCS HYDROLOGICAL TECHNIQUES." (REF: RESPONSE TO NRC COMMENTS, MAY 23, 1982). THIS AREA INCLUDES ROCKY AREAS AND SOIL AREAS WITH LIMITED VEGETATION. THE SOIL/ROCK MATRIX COVER WILL BE SIMILAR. THEREFORE, USE CN OF 80

DETERMINE PMP EVENT:

THE PMP HAS BEEN DETERMINED TO BE 9.4 INCHES. THIS MUST BE CORRECTED FOR ELEVATION. THE CORRECTION IS -5% FOR EVERY 1000 FT OF ELEVATION IN EXCESS OF 5000 FT.

PMP = 8.43 inches

DETERMINE THE PMF HYDROGRAPH:

USE SCS TR-55 METHOD

SEE SPREADSHEET, NEXT PAGE

Q_{max} = 694 cfs @ 12.3 hrs

✓SWM 2-1-91

tc = 0.3 RUNOFF HYDROGRAPHS BY THE SCS TR 55 METHOD

TYPE II STORM DISTRIBUTION

31-Jan-91
01:22 PM

TIME OF CONCENTRATION = 0.3 HOURS
TRAVEL TIME = 0.0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT ADJ (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0
						(CSM/IN)	28	28	41	110	235	407	676	676	459	283	196	146	114	80	66	57	51	46	42
SOUTH CELL DRAINAGE	105.00	1.701	01	80.0	0.43	6.03	(CFS)	20.54	28.75	42.10	121.17	241.31	459.00	694.15	694.15	471.33	290.60	201.26	149.92	117.06	82.15	67.77	58.53	52.37	47.24	43.13

Canonie Environmental

E-253

By [illegible] Date 1/31/91 Subject UNC Sheet No. 5 of

Chkd. By SWM Date 2-1-91 S. CELL DRAINAGE CHANNEL Proj. No. 86-060-24

1/4" X 1/4"

DETERMINE CHANNEL CHARACTERISTICS

DETERMINE CHANNEL SLOPES

STA	ELEV	SLOPE
0+00	6960	
		0.0244
4+50	6940	
		0.0533
12+00	6400	
		0.0750
16+00	6870	

ONLY THE CHANNEL FROM 0+00 TO 4+50 NEEDS RIPRAPPED. FROM 4+50 TO 9+60 IS IN BEDROCK AND THE REMAINDER DOES NOT NEED RIPRAP BECAUSE THE ROCK UPSTREAM OF 9+60 WILL NOT ALLOW HEADCUTS.

USE THE SAFETY FACTOR METHOD TO DETERMINE CHANNEL SIZE AND TO SIZE RIPRAP.

SEE SPREADSHEET, NEXT PAGE.
FOR 10' BOTTOM, 3:1 SIDESLOPES AT 0.0244 slope

D_{50} = 15 inches ∴ D_{max} = 19 inches
THICKNESS = 28 inches

FROM STA 4+50 to 9+60 USE 2:1 SIDESLOPES, 10' BOTTOM BECAUSE IT IS IN ROCK.
FROM 9+60 TO PIPELINE ARROYO USE 3:1 SIDESLOPES, 10' BOTTOM

✓ SWM 2-1-91

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: SOUTH CELL DRAINAGE CHANNEL

DISCHARGE =	694 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0244	Theta =	1.40 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM

D50 (ASSUM) =	1.25 FT	15.0 inches	
n =	0.041		
* TRIAL d =	3.00 ft	57.0 **	
DIFFERENCE =	-26.99 %		
* calc d =	3.40 ft	68.8 **	
DIFFERENCE =	-5.52 %		
* calc d =	3.50 ft	71.7 **	
DIFFERENCE =	-0.00 %		
* calc d =	3.50 ft	71.8 **	
DIFFERENCE =	0.00 %		
FINAL d =	3.50 ft		
A =	71.75 sq ft		
R =	2.23 ft		
t =	31.00 ft		
V =	9.67 fps		
Q(calc) =	694 cfs		
t =	5.33 PSF		
nb =	0.956		
SFb =	1.01		

CHANNEL SIDE SLOPES

D50 (ASSUM) =	1.25 FT	15.0 inches
n =	0.041	
t =	4.00 PSF	
nb =	0.72	
Beta =	39.93	
n' =	0.60	
SFs =	1.03	

E-255

✓ Sum 2-1-91

J - 165

product of the rainfall excess intensity, i_e, in iph and the flow length, L, in feet is greater than 500. The equation is

$$t_c = 0.928\,(n\,L)^{0.6}/(i_e^{\,0.4}\,S^{0.3}) \qquad (2.57)$$

where t_c is in minutes, n is Mannings n, L is in feet, i_e is in iph and S is the slope in ft/ft. Table 2.25 presents some values for n for overland flow surfaces.

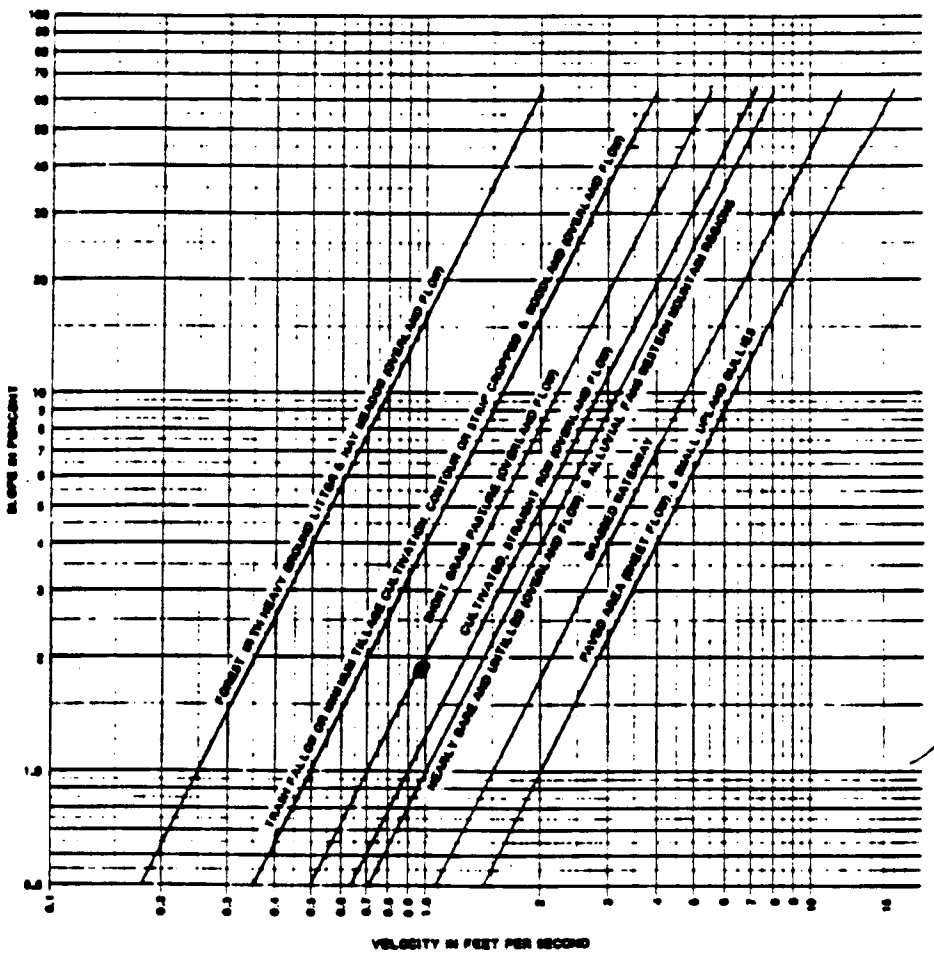


Figure 2.34. Velocities for upland method of estimating t_c.

Figure 2

Canonie Environmental

E-256

By _____ Date _____ Subject _____ Sheet No. ____ of ____

Chkd. By SWM Date 2-1-91 _____ Proj. No. _____

1/4" X 1/4"

For Reference Only

$$SF_b = \frac{\cos\theta \tan\phi}{\sin\theta + \eta_b \tan\phi}$$

θ = channel slope

ϕ = angle of repose = 37°

$$\eta_b = \frac{21\,\tau}{\gamma(SG-1)D} \qquad \tau = \gamma d S$$

$S = 0.0244$

$d = 3.31$ ft

$\gamma = 62.4$

$\tau = 62.4\ \text{lbm/ft}^3 (3.31\ \text{ft})(0.0244) = 5.04\ \text{lb/ft}^2$

$$\eta_b = \frac{21\,(5.04\ \text{lb/ft}^2)}{(62.4\ \text{lb/ft}^3)(2.5-1)(1.25\ \text{ft})} = 0.905$$

$\theta = \tan^{-1} 0.0244 = 1.40°$

$\phi = 37°$

$$SF_b = \frac{\cos(1.4)\tan(37)}{\sin(1.4) + 0.905(\tan 37)} = 1.066 = 1.07 \quad \checkmark \text{OK}$$

E-257

FIGURE 2-3

MATCH LINE TO FIGURE 2-2

APPROXIMATE LIMITS OF TAILINGS AFTER GRADING

RECLAIMED MILL AREA

LOW FLOW CHANNEL

BRANCH SWALE G

NORTH CELL DRAINAGE CHANNEL

RECLAIMED BORROW PIT NO. 2

BRANCH SWALE F

BRANCH SWALE E

REGRADED CATCH BASIN AREA

PROTECTIVE BENCH

TAILINGS COVER

BRANCH SWALE D

BRANCH SWALE C

TRIBUTARY B

APPROXIMATE LIMITS OF PMF EVENT

BURIED JETTY (SEE FIGURE 2-6 FOR DETAILS)

RUNOFF CONTROL DITCH (SEE FIGURE 2-6 FOR DETAILS)

BRANCH SWALE H

BRANCH SWALE B

PIPELINE ARROYO

STATE HIGHWAY 566

BRANCH SWALE A

BRANCH SWALE J

TRIBUTARY A2

TRIBUTARY A1

REGRADED SOIL STOCKPILE AREA

RIPRAPPED

EXISTING NORTH DIVERSION DITCH

DRAINAGE SWALE NO. 61

DRAINAGE SWALE NO. 62

BRANCH SWALE H

DIRECTION OF FLOW

BRANCH SWALE I

LOWER REACH RUNOFF CONTROL DITCH

EXISTING SOUTH DIVERSION DITCH

SOUTH CELL DRAINAGE CHANNEL

DISCHARGE NATURAL DRAINAGE

STA 60+00

STA 66+00

STA 75+00

STA 80+00

STA 91+00

STA 101+00

STA 30+00

STA 40+00

STA 50+00

STA 9+00

NOTES

1. DESIGN ELEVATION CONTOURS ON THE TAILINGS IMPOUNDMENT ALLOW FOR A 1.5 FOOT RADON BARRIER AND A 6 INCH SOIL/ROCK MATRIX EROSION PROTECTION LAYER OVER REGRADED TAILINGS. SEE FIGURE 2-1 FOR SOIL COVER PROFILE.

2. CROSS SECTIONS ARE SHOWN ON FIGURES 2-5 AND 2-6.

SCALE

200 0 200 400 FEET

REVISED FINAL RECLAMATION PLAN
SOUTH END

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

CanonieEnvironmental

No	DATE	ISSUE / REVISION
1	11-30-90	ISSUED FOR RESPONSE TO COMMENTS AND PROPOSED RECLAMATION PLAN MODIFICATIONS

DATE	FIGURE	DRAWING NUMBER
12-90	1	86-060-E425
SCALE AS SHOWN		

REVISIONS | NO | DATE | DRAWN BY | CHECKED BY | APPROVED BY | DRAWING NUMBER 86-060-E425

SOUTH CELL DRAINAGE AREA

E.7

North Cell Drainage Channel Hydraulic Calculations

Canonie Environmental

E-259

By [illegible] Date 1/31/91 Subject UNC Sheet No. 1 of

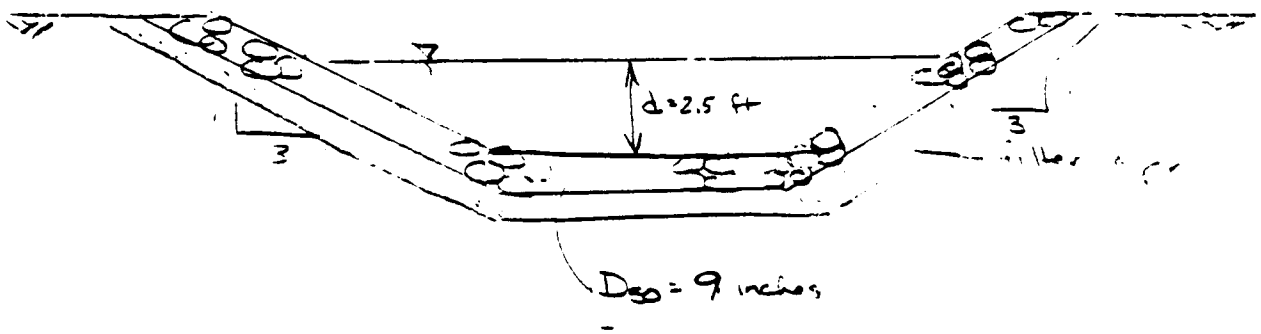
Chkd. By [illegible] Date 2-1-91 NORTH CELL DRAINAGE CHANNEL Proj. No. [illegible]

1/4" X 1/4

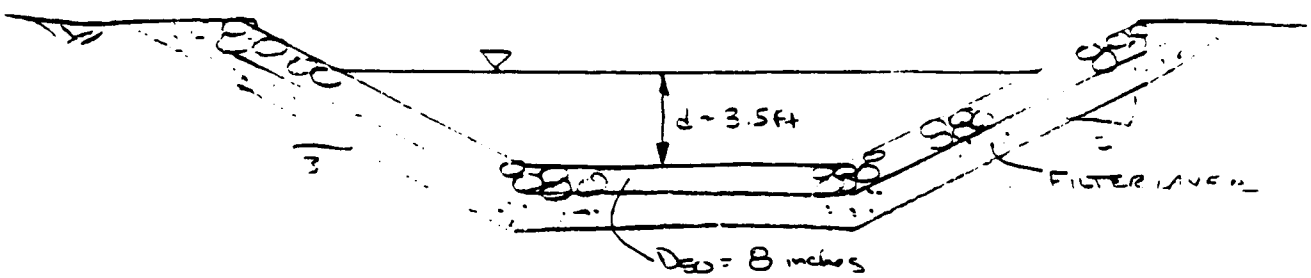
PURPOSE: TO DETERMINE THE DESIGN FOR BOTH THE UPPER AND LOWER SECTIONS OF THE NORTH CELL DRAINAGE CHANNEL AT UNC

METHODS:
1) DETERMINE DRAINAGE BASIN CHARACTERISTICS,
2) DETERMINE THE PMF HYDROGRAPH USING THE TABULAR SCS TR-55 METHOD.
3) DETERMINE CHANNEL SIZE AND RIPRAP DESIGN USING THE SAFETY FACTORS METHOD

RESULTS:



UPPER SECTION (NTS)



LOWER SECTION NTS

CALCULATIONS:

DETERMINE DRAINAGE BASIN CHARACTERISTICS

AREA: AREA FROM FIGS 1 & 2 ATTACHED MEASURED BY DIGITAL PLANIMETER

UPPER DRAINAGE AREA = 47.6 ACRES

LOWER DRAINAGE AREA = 34.8 Ac + 5.9 = 40.7 acres

Total = 88.3 acres

TIME OF CONCENTRATION

SINCE THE DRAINAGE BASIN IS DIVIDED BY BRANCH SWALES, OVERLAND FLOW IS LIMITED. THEFORE, ASSUME (CONSERVATIVELY) THAT t_c = time for flow from farthest BRANCH SWALE w/ flow AT 5 FPS.

BRANCH SWALE B IS 3600 FT LONG AND THE NORTH CELL DRAINAGE CHANNEL IS 1750 FT LONG (400 FT = UPPER SECTION, 1350 FT LOWER SECTION)

$t_{c_{upper}} = (3600 + 400)/5\ ft/sec = 800\ sec = 0.2\ hrs$

$t_{c_{lower}} = (3600 + 1750\ ft)/5\ ft/sec = 1070\ sec = 0.3\ hrs$

CURVE NUMBER

SCIENCE APPLICATION, INC. DETERMINED A CN OF 80 FOR THE AREA DRAINING THE N 4S. DIVERSION DITCHES IN ITS JUNE 1981 REPORT ENTITLED "PMF DETERMINATION FOR THE SOUTHEAST DIVERSION CHANNEL AND SECTION 1 WATERSHED USING SCS HYDROLOGICAL TECHNIQUES." (REF: RESPONSE TO NRC COMMENTS, MAY 23, 1989) THIS AREA INCLUDES ROCKY AREAS AND SOILS AREA WITH LIMITED VEGETATION. THE SOIL/ROCK MATRIX POWER WILL BE V. SIMILAR. THEREFORE, USE CN = 80.

DETERMINE PMP EVENT

THE PMP FOR THIS AREA HAS BEEN DETERMINED TO BE 9.4 INCHES. THIS VALUE MUST BE CORRECTED FOR ELEVATION (MEAN BASIN ELEVATION). THE CORRECTION IS -5% FOR EVERY 1000 FT OF ELEVATION IN EXCESS OF 5000 FT

PMP = 8.43 INCHES

DETERMINE PMF HYDROGRAPH

USE SCS TR-55 METHOD ON COMPUTER SPREADSHEET SCSHYII.WR1 FOR $t_c = 0.3$

SEE RESULTS NEXT PAGE

PEAK FLOW = CFS

DETERMINE CHANNEL CHARACTERISTICS

DETERMINE CHANNEL SLOPES

UPPER SECTION $S_{max} = \frac{6973-6968}{250} = 0.0200$ ft/ft

LOWER SECTION $S = \frac{6168-5956}{1350} = 0.0126$ ft/ft

ASSUME 3:1 SIDESLOPES

USE SAFETY FACTORS METHOD TO DETERMINE CHANNEL AND RIPRAP DESIGN

✓ SWM 2-1-91

Tc = 0.3

RUNOFF HYDROGRAPHS BY THE SCS TR 55 METHOD

TYPE II STORM DISTRIBUTION

31-Jan-91
07:50 PM

TIME OF CONCENTRATION 0.3 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0
						(CSM/IN)	20	28	41	110	235	447	676	676	459	283	196	146	114	80	66	57	51	46	42
LOWER SECTION																									
NORTH CELL DRAINAGE	80.30	1.30E-01	80.0	0.43	6.03	(CFS)	16.64	23.29	34.11	90.16	195.40	371.04	562.33	562.33	381.02	235.41	163.04	121.45	94.83	66.55	54.90	47.42	42.42	38.26	34.94

E-262

V SWM 2-1-91

Tc = 0.2

RUNOFF HYDROGRAPHS BY THE SCS TR-55 METHOD

TYPE-II STORM DISTRIBUTION

31-Jan 91
10:41 PM

TIME OF CONCENTRATION = 0.2 HOURS
TRAVEL TIME = 0 HOURS

HYDROGRAPH TIME IN HOURS

WATERSHED DESIGNATION	DRAINAGE AREA (AC)	DRAINAGE AREA (SQ MI)	CURVE NUMBER	PPT AMT (IN)	RUNOFF (IN)	(TIME)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0
						(CSM/IN)	23	38	47	209	409	739	800	491	250	166	128	102	86	70	61	54	49	44	40
UPPER SECTION NORTH CELL DRAINAGE	47.6000	7.44E-02	80.0	8.4	6.03	(CFS)	10.1	[illegible]	1.1	[illegible]	180.7	331.4	358.7	215.7	112.1	74.4	57.4	45.7	38.6	31.4	27.4	24.2	22.0	19.7	17.9

√ SWM 2-1-91

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

RIPSF.WR1 REF: "Applied Hydrology and Sedimentology for Disturbed Areas", pages 185-194

LOCATION: LOWER SECTION - NORTH CELL DRAINAGE CHANNEL

DISCHARGE =	562 CFS		
BOTTOM WIDTH =	10 FT		
Z (SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.0126	Theta =	0.72 Degrees
RIPRAP S.G. =	2.5	Phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.16, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.67 FT	8.0 inches	D50 (ASSUM) =	0.67 FT	8.0 inches
n =	0.037		n =	0.037	
* TRIAL d =	3.00 ft	57.0 **			
DIFFERENCE =	-28.11 %				
* calc d =	3.42 ft	69.3 **			
DIFFERENCE =	-6.02 %				
* calc d =	3.52 ft	72.5 **			
DIFFERENCE =	-0.10 %				
* calc d =	3.53 ft	72.6 **			
DIFFERENCE =	0.00 %				
FINAL d =	3.53 ft.				
A =	72.57 sq ft				
R =	2.35 ft		t =	2.08 PSF	
T =	31.16 ft		nb =	0.70	
V =	7.74 fps				
Q(calc) =	562 cfs		Beta =	39.39	
t =	2.77 PSF				
nb =	0.928		n' =	0.57	
SFb =	1.06		SFs =	1.06	

V Sum 2-(-9)

RIPRAP DETERMINATION BY SAFETY FACTOR METHOD FOR CHANNEL BOTTOM AND SIDE SLOPES

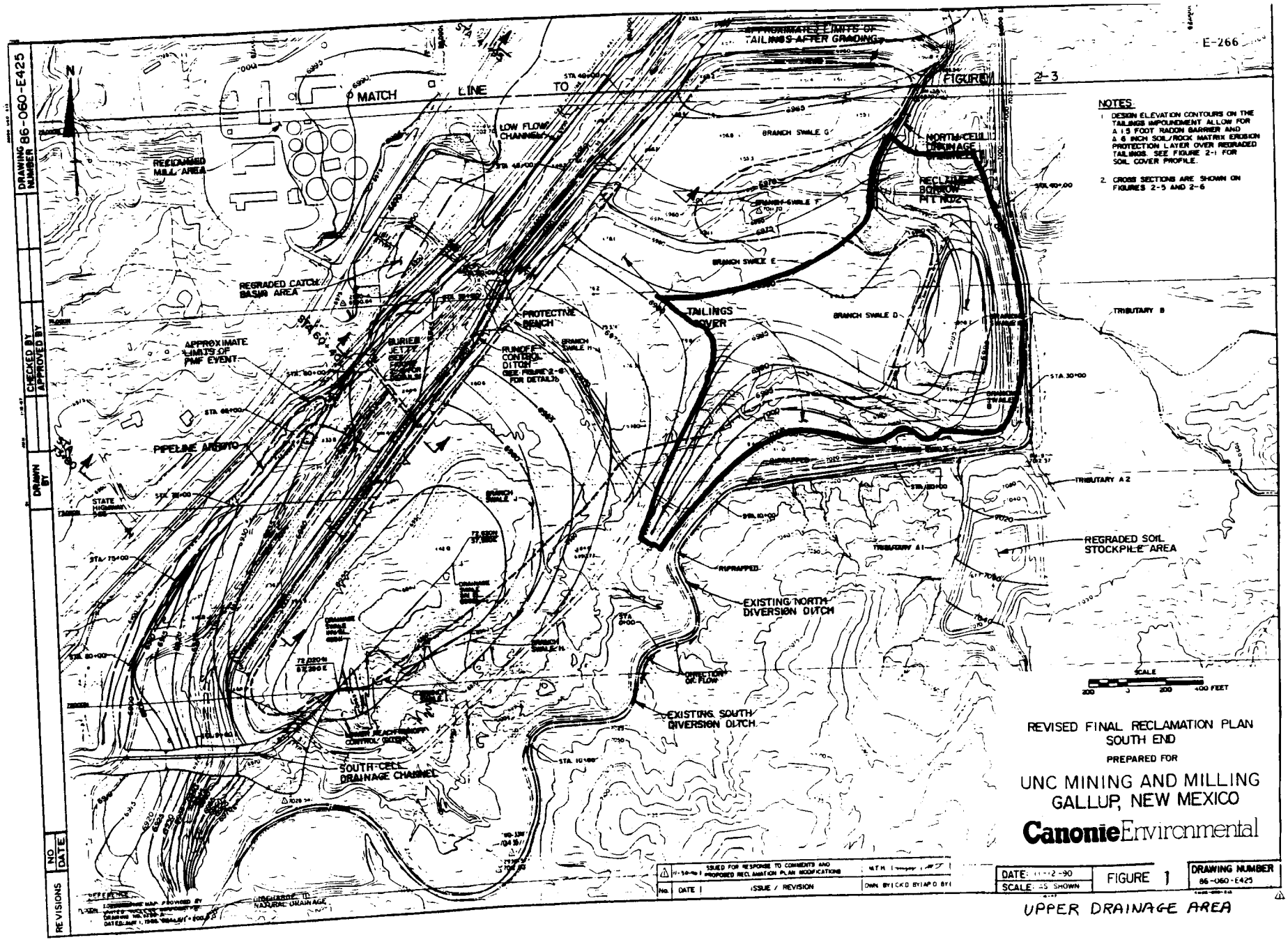
RIPRF.WR1 REF: "Riprap Hydrology and Sedimentology for Disturbed Areas", pages 135-137

LOCATION: UPPER SECTION - NORTH CELL DRAINAGE CHANNEL

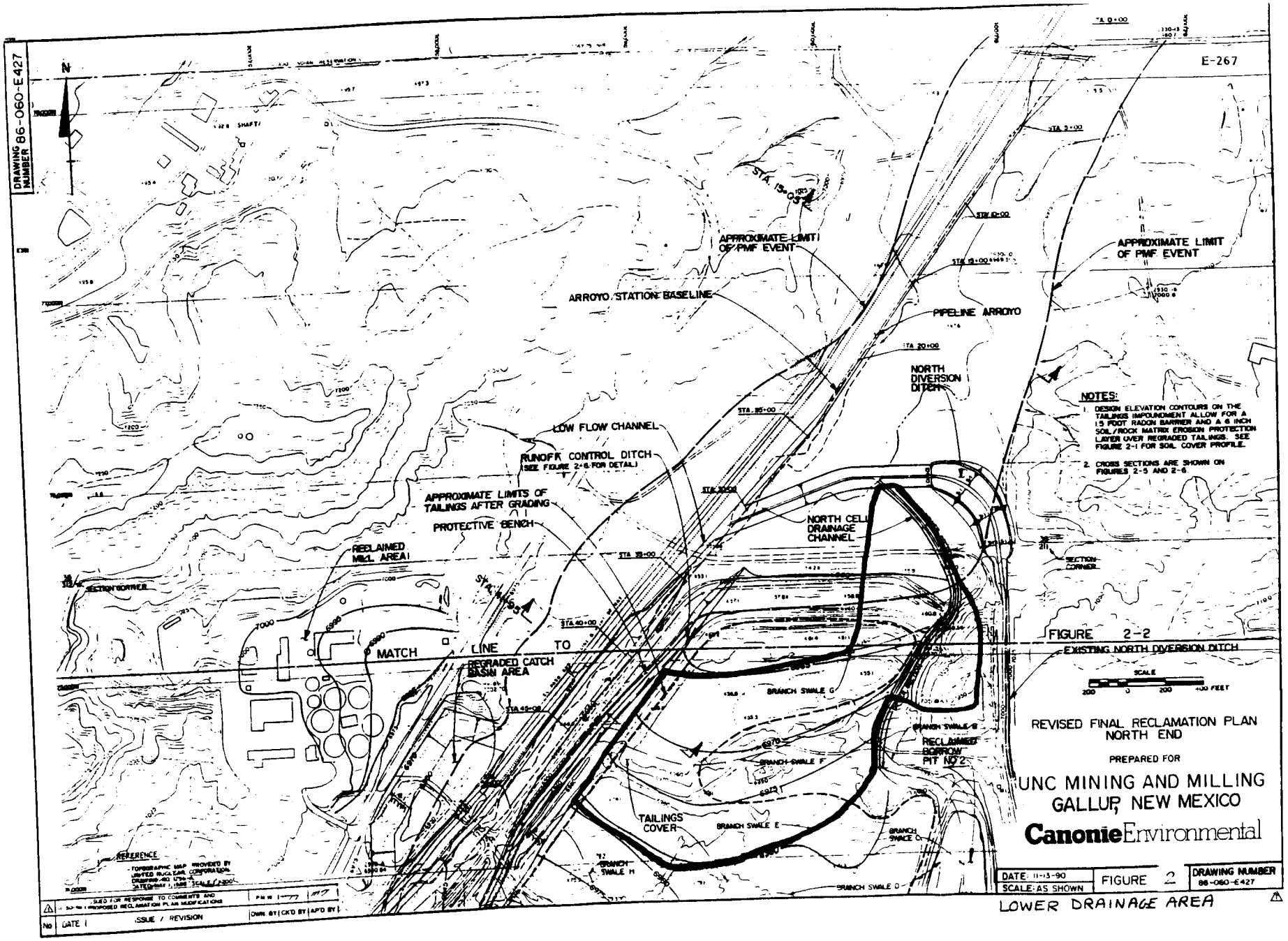
DISCHARGE =	359 CFS		
BOTTOM WIDTH =	10 FT		
(SIDE SLOPE)=	3	Alpha =	18.43 Degrees
CHANNEL SLOPE =	0.02	Theta =	1.15 Degrees
RIPRAP S.G. =	2.5	phi =	37.00 Degrees
COEF FOR t =	0.75 see Fig 3.15, ref.		

CHANNEL BOTTOM			CHANNEL SIDE SLOPES		
D50 (ASSUM) =	0.75 ft	9.0 inches	D50 (ASSUM) =	0.75 ft	9.0 inches
n =	0.031		n =	0.032	
* TRIAL d =	1.50 ft	43.9 **			
DIFFERENCE =	-1.30 %				
* calc d =	2.54 ft	44.8 **			
DIFFERENCE =	-0.12 %				
* calc d =	2.54 ft	44.8 **			
DIFFERENCE =	-0.00 %				
* calc d =	2.54 ft	44.8 **			
DIFFERENCE =	-0.00 %				

FINAL d =	2.54 ft		
A =	44.83 sq ft		
R =	1.72 ft	t =	1.15 PSF
t =	23.26 ft	nb =	0.71
V =	8.01 fps		
Q(calc) =	359 cfs	Beta =	89.83
t =	3.17 PSF		
nb =	0.943	t' =	0.69
SFb =	1.02	SFs =	1.04



UPPER DRAINAGE AREA


DRAWING NUMBER 86-060-E427
E-267
APPROXIMATE LIMIT OF PMF EVENT
ARROYO STATION BASELINE
PIPELINE ARROYO
NORTH DIVERSION DITCH
LOW FLOW CHANNEL
RUNOFF CONTROL DITCH (SEE FIGURE 2-6 FOR DETAIL)
APPROXIMATE LIMITS OF TAILINGS AFTER GRADING
PROTECTIVE BENCH
RECLAIMED MILL AREA
NORTH CELL DRAINAGE CHANNEL
MATCH LINE TO
REGRADED CATCH BASIN AREA
BRANCH SWALE G
BRANCH SWALE F
BRANCH SWALE E
BRANCH SWALE C
BRANCH SWALE D
BRANCH SWALE H
RECLAIMED BORROW PIT NO 2
TAILINGS COVER
SECTION CORNER
NOTES:
1. DESIGN ELEVATION CONTOURS ON THE TAILINGS IMPOUNDMENT ALLOW FOR A 1.5 FOOT RADON BARRIER AND A 6 INCH SOIL/ROCK MATRIX EROSION PROTECTION LAYER OVER REGRADED TAILINGS. SEE FIGURE 2-1 FOR SOIL COVER PROFILE.
2. CROSS SECTIONS ARE SHOWN ON FIGURES 2-5 AND 2-6.
FIGURE 2-2
EXISTING NORTH DIVERSION DITCH
SCALE
200 0 200 400 FEET
REVISED FINAL RECLAMATION PLAN
NORTH END
PREPARED FOR
UNC MINING AND MILLING
GALLUP, NEW MEXICO
Canonie Environmental
DATE: 11-13-90
SCALE: AS SHOWN
FIGURE 2
DRAWING NUMBER 86-060-E427
LOWER DRAINAGE AREA
REFERENCE
No
DATE
ISSUE / REVISION
DWN. BY
CK'D BY
AP'D BY

E.8

Riprap and Bedding Calculations

By S.YM Date -22-91 Subject LNC - Riprap Distribution Sheet No. ___ of ___

Chkd. By [illegible] Date [illegible] Proj. No. 15-360-04

1/4 X 1/4

PURPOSE: THE PURPOSE OF THIS CALC. BRIEF IS TO DETERMINE THE GRADATION REQUIREMENTS FOR THE RIPRAP AND FILTER MATERIAL THAT IS TO BE USED IN THE TAILINGS RECLAMATION PROJECT.

METHOD: DEVELOP GRADATION CURVES THAT CONFORM TO THE FOLLOWING TWO SETS OF CRITERIA:

1) NUREG/CL-4620 ROCK GRADATION REQUIREMENTS RELATIVE TO WEIGHT DISTRIBUTION. (SEE PAGES 5-7)

2) PARTICLE SIZE GRADATION REQUIREMENTS AS PER UNIFIED SOIL CLASSIFICATION SYSTEM (WELL-GRADED GRAVELS; COARSE, LITTLE OR NO F

- $C_u = \frac{D_{60}}{D_{10}}$ $\left[\begin{array}{l} C_u > 4 \text{ - GRAVELS} \\ C_u > 6 \text{ - SANDS} \end{array}\right]$

- $C_z = \frac{D_{30}^2}{D_{10} D_{60}}$ $\left[1 \leq C_z \leq 3 \right]$

REFERENCES: "METHODOLOGIES FOR EVALUATING LONG-TERM STABILIZATION DESIGNS OF URANIUM MILL TAILINGS IMPOUNDMENTS" — NUREG/CL-4620 (PREPARED FOR NUCLEAR REGULATORY COMMISSION WASHINGTON, DC)

FUNDAMENTALS OF GEOTECHNICAL ANALYSIS, DUNN, ANDERSON, AND KIEFER; JOHN WILEY AND SONS INC, NEW YORK, 1980

By JJM Date 1-22-91 Subject LINC Sheet No. 2 of

Chkd. By Date Proj. No. 86-060-29

1/4" X 1/4

GRADATION CURVE DEVELOPMENT PROCEDURE:

THE GRADATION CURVES WERE DEVELOPED THROUGH A SERIES OF STEPS. GIVEN A D_{50}, D_{max} WAS CALCULATED BY MEANS OF THE FOLLOWING CRITERIA WHICH CANONIE HAS FOUND TO BE ADEQUATE FOR THIS TYPE OF APPLICATION:

$D_{max} = 1.25(D_{50})$ @ $D_{50} \geq 10''$

$D_{max} = 1.5(D_{50})$ @ $6'' < D_{50} \leq 10''$

$D_{max} = 2(D_{50})$ @ $D_{50} \leq 6''$

ONCE D_{50} AND D_{max} WERE KNOWN, THEY WERE PLOTTED ON A GRAIN SIZE DISTRIBUTION GRAPH. SINCE THE SHAPE OF A WELL-DISTRIBUTED CURVE WAS KNOWN, A CURVE WAS EXTRAPOLATED FROM THE AFOREMENTIONED POINTS. THIS INITIAL GRAIN SIZE DISTRIBUTION CURVE WAS CHECKED AGAINST THE UNIFIED SOIL CLASSIFICATION SYSTEM PARTICLE SIZE GRADATION REQUIREMENTS TO ENSURE THAT THE DISTRIBUTION WAS WELL-GRADED.

USING AN ITERATIVE PROCESS, UPPER AND LOWER LIMIT CURVES WERE DRAWN ON THE RIGHT AND LEFT SIDES (RESPECTIVELY) OF THE EXISTING CURVE.

CONTINUED →

Canonie Environmental

E-271

By SWM Date 1-23-91 Subject UNC Sheet No. 3 of

Chkd. By [illegible] Date 2/5/91 Proj. No. 86-060-29

1/4" X 1/4"

GRADATION CURVE DEVELOPMENT PROCEDURE CONT.:

THESE UPPER AND LOWER LIMIT CURVES WERE REFINED (THROUGH ITERATION) TO DEPICT THE LARGEST POSSIBLE BAND WIDTH WHILE BEING FAIRLY SYMMETRICAL ABOUT THE INITIAL GRAIN SIZE DISTRIBUTION CURVE (i.e. CURVE THAT CONTAINS d_{50} POINT). FOR THE SAKE OF BREVITY, THE ITERATIONS USED TO DEFINE THE CURVE PLACEMENT ARE NOT DOCUMENTED HERE. ONLY THE CHECKS OF THE FINAL CURVE PLACEMENTS AGAINST THE CRITERIA ARE SHOWN IN THIS CALC. BRIEF.

RESULTS:

SEE PAGE 4 FOR GRADATION REQUIREMENTS THAT WERE BASED ON THE ENCLOSED GRAPHS.

E-272

PAGE 5

NUREG/CR-4620

Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments

Oak Ridge National Lab., TN

Prepared for

Nuclear Regulatory Commission
Washington, DC

Jun 86

U.S. Department of Commerce
National Technical Information Service
NTIS

Canonie Environmental Services Corp.
94 Inverness Terrace East · Suite 100
Englewood, Colorado 80112

Phone: 303-790-1747
Fax: 303-799-0186

Peter M. Weber
Assistant Project Scientist

The riprap layer thickness should be underlain with a gravel filter for channel, toe and side slope applications. The filter will serve to stabilize the rock layer, allow drainage and prevent the movement of fine embankment materials. Filter criteria are presented in Section 4.4 of this report.

Rock Gradation

The gradation of rocks in riprap revetment affects the riprap's resistance to erosion. The stone should be reasonably well graded throughout the layer thickness. The following criteria provide guidelines for establishing gradation limit..

1. The lower limit of W_{50} rock should not be less than the weight of rock required to withstand the design shear forces.

2. The upper limit of W_{50} rock should not exceed that weight which can be obtained economically from the quarry or that size which will satisfy layer thickness requirements.

3. The lower limit of W_{100} rock should not be less than two times the lower limit of W_{50} rock.

4. The upper limit of W_{100} rock should not exceed: (a) five times the lower limit of W_{50} rock, (b) that size which can be obtained economically from the quarry, or (c) that size which will satisfy layer thickness requirements.

5. The lower limit of W_{15} rock should not be less than one-sixteenth the upper limit of W_{100} rock.

6. The upper limit of W_{15} rock should be less than the upper limit of W_{50} rock as required to satisfy criteria for graded stone filters.

7. The bulk volume of rock lighter than the W_{15} rock should not exceed the volume of voids in the revetment without this lighter rock.

8. W_0 to W_{25} rock may be used instead of W_{15} rock in criteria 5, 6, and 7 if desirable to better utilize available rock sizes. Design memoranda and specifications should indicate the permissible stone gradation limits.

4.2.2.4 U.S. Bureau of Reclamation Method

The U.S. Bureau of Reclamation (USBR) Method (DOI, 1978) for riprap design was developed for the prevention of damage in and near stilling basins. The USBR procedure is empirically based upon extensive laboratory testing and field observations. Riprap failure was determined to occur because alternative design procedures underestimate the required stone size in highly turbulent zones, and there is a tendency for inplace riprap to be

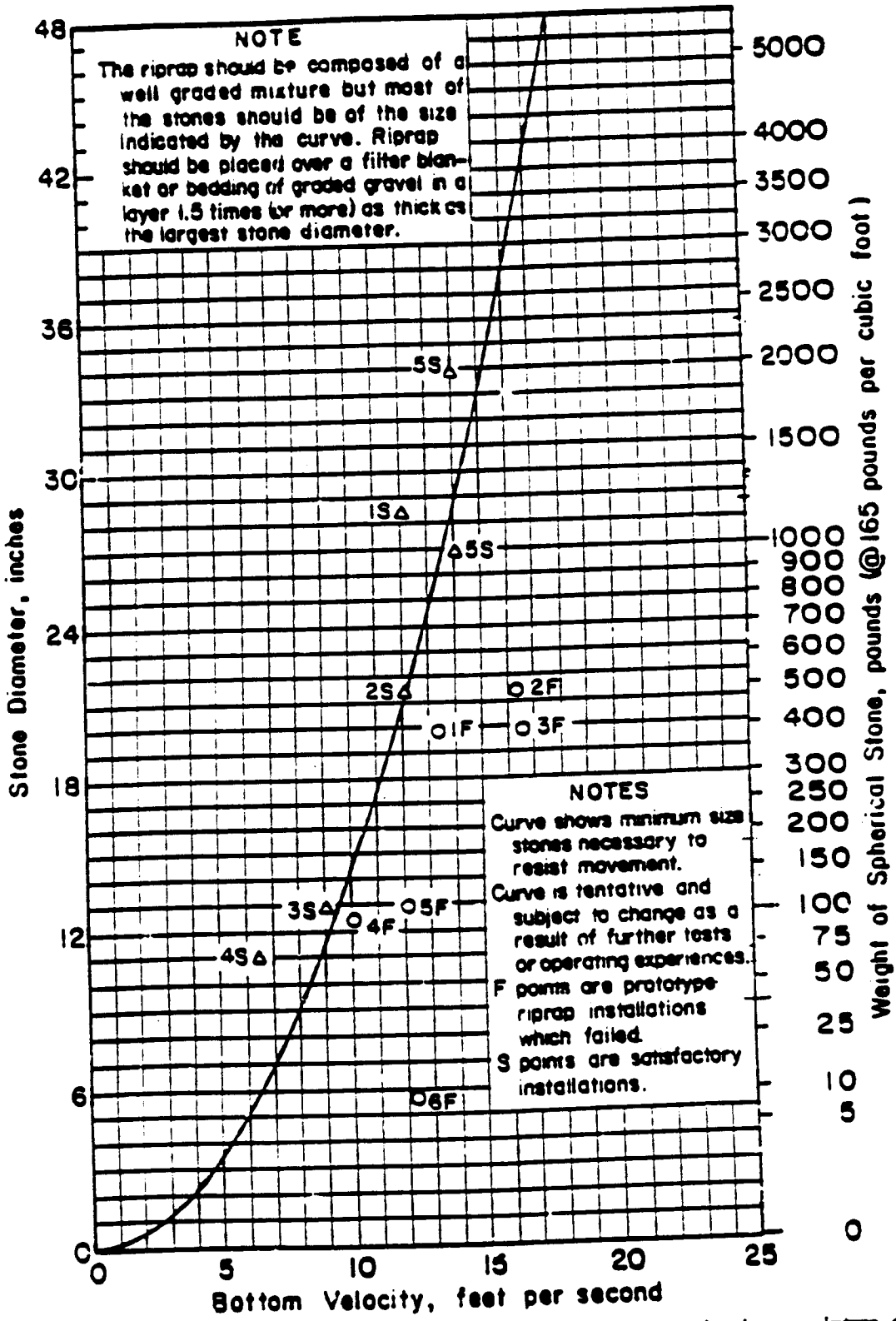


Fig. 4.11. Parametric curve used to determine maximum stone size in riprap mixture as a function of channel flow velocity.

Canonie Environmental

By ___ Date ___ Subject ___ Sheet No. ___ of ___

Chkd. By ___ Date ___ Proj. No. 86-060-24

1/4" X 1/4"

E-275

LOCATION	D50 1)	D100 1)	PERCENT PASSING BY WEIGHT 30"	25"	20"	15"	12"	10"	6"	5"	4"	3"	1"	NO4
UPPER SECTION ① SOUTH CELL DRAINAGE CHANNEL	15"	18.75" (say 19")			100		28-40		8-21		2-14	0-10		
② NORTH CELL DRAINAGE CHANNEL	9"	13.5" (SAY 15")				100		45-58		10-33		0-23		
③ NORTH DIVERSION DITCH BURIED JETTY	6"	10"						100	28-51		13-36		0-9	
④ SWALES H&I LOWER REACH OF RUNOFF CONTROL DITCH	3"	6"							100		45-67		0-22	
⑤ SOIL/ROCK MATRIX SWALES UPPER REACH RUNOFF CONTROL DITCH	1.5"	3"										100	8-37	0-8

1) D_{50} & D_{100} ARE BASED ON SAFETY FACTORS METHOD; D_{100} VALUE IS REFLECTED AS 100% PASSING BY WEIGHT

Canonie Environmental

E-276

By EB Date 02/27/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION (1): (UPPER SECTION SOUTH CELL DRAINAGE CHANNEL)

CHECK INITIAL GRAIN SIZE DISTRIBUTION CURVE TO SEE - ITS WELL GRADED:

D_{10} = 76 mm

D_{30} = 230 mm

D_{60} = 400 mm

C_u = 5.3

C_z = 1.7

LOCATION (1) - CONT.:

NU-PEG CL-4620 CRITERIA CHECK:

$W_{100LL} \rightarrow 22.5'' \rightarrow 570$ lbs

$W_{100UL} \rightarrow 19'' \rightarrow 343$ lbs

$W_{50LL} \rightarrow 17.7'' \rightarrow 277$ lbs

$W_{15LL} \rightarrow 7.9'' \rightarrow 25$ lbs

(#3) $W_{100LL} \geq 2(W_{50LL})$

$570 \geq 2(277)$

$570 > 554$ O.K.

(#4) $W_{100UL} \leq 5(W_{50LL})$

$343 \leq 5(277)$

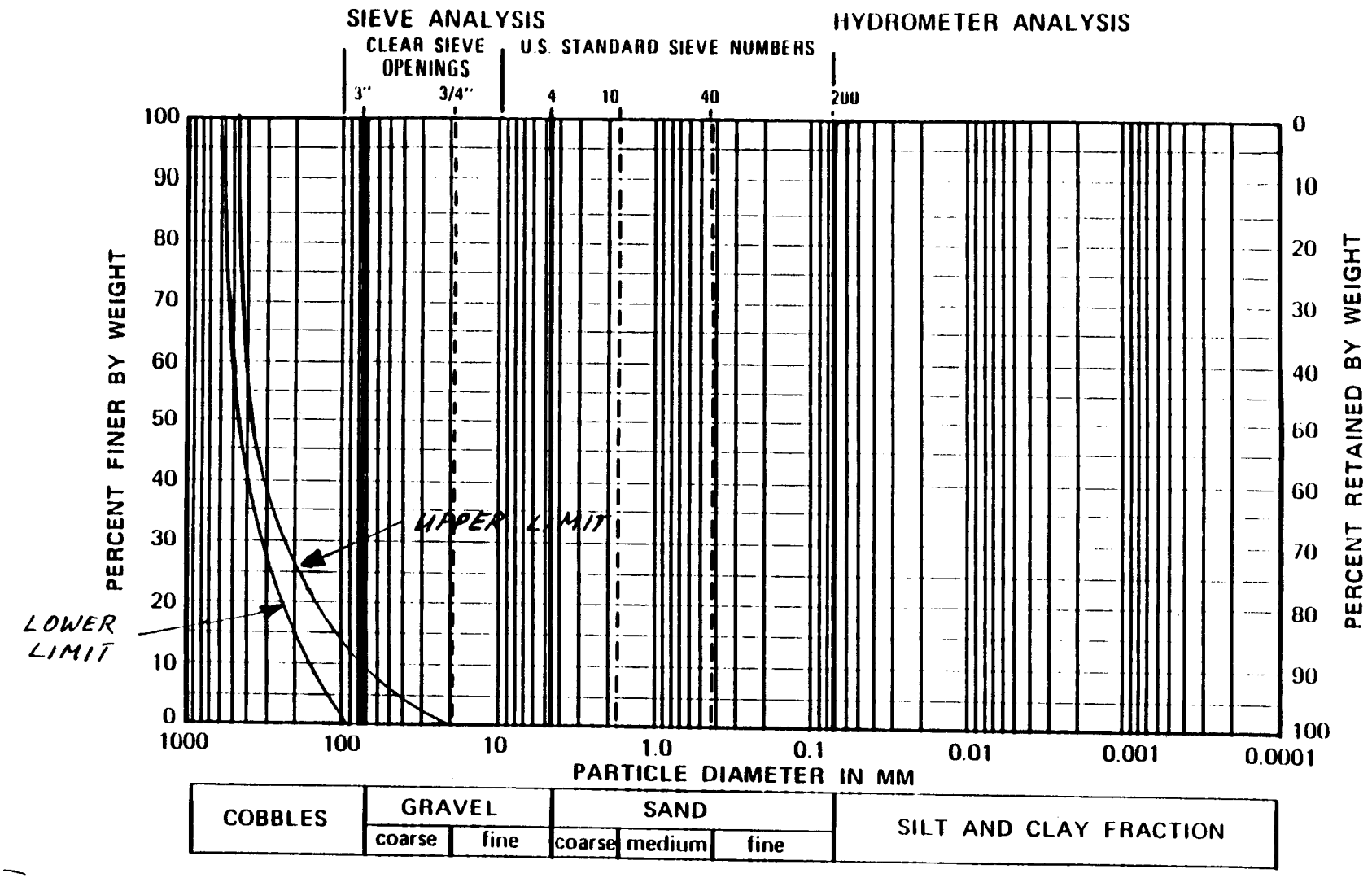
$343 < 1385$ O.K.

(#5) $W_{15LL} \geq \frac{W_{100UL}}{16}$

$25 \geq \frac{343}{16}$

$25 > 21$ O.K.

E-278



TYPICAL FORMAT

GRAIN SIZE DISTRIBUTION DATA

FIGURE 1

Cano e

Canonie Environmental

E-279

By EB Date 02/27/91 Subject _____ Sheet No. ____ of ____

Chkd. By ____ Date ____ _____ Proj. No. 85-060-24

1/4" X 1/4"

LOCATION (2): (NORTH CELL DRAINAGE CHANNEL)

CHECK INITIAL GRAIN SIZE DISTRIBUTION CURVE TO SEE - ITS WELL GRADED:

$D_{10} = 34$ mm

$D_{30} = 105$ mm

$D_{60} = 270$ mm

$C_u = 7.9$

$C_z = 1.2$

O.K.

By EB Date 02/27/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 25-060-241

1/4" X 1/4"

LOCATION (2) - CONT.

NU - REG CL - 4620 CRITERIA CHECK:

$W_{100\,LL} \rightarrow 15.0'' \rightarrow 169$ lbs

$W_{100\,UL} \rightarrow 15'' \rightarrow 169$ lbs

$W_{50\,LL} \rightarrow 10.6'' \rightarrow 60$ lbs

$W_{15\,LL} \rightarrow 6.1'' \rightarrow 11$ lbs

(#3) $W_{100\,LL} \geq 2\,(W_{50\,LL})$

$123 \geq 2\,(60)$

$169 > 120$ O.K

(#4) $W_{100\,UL} \leq 5\,(W_{50\,LL})$

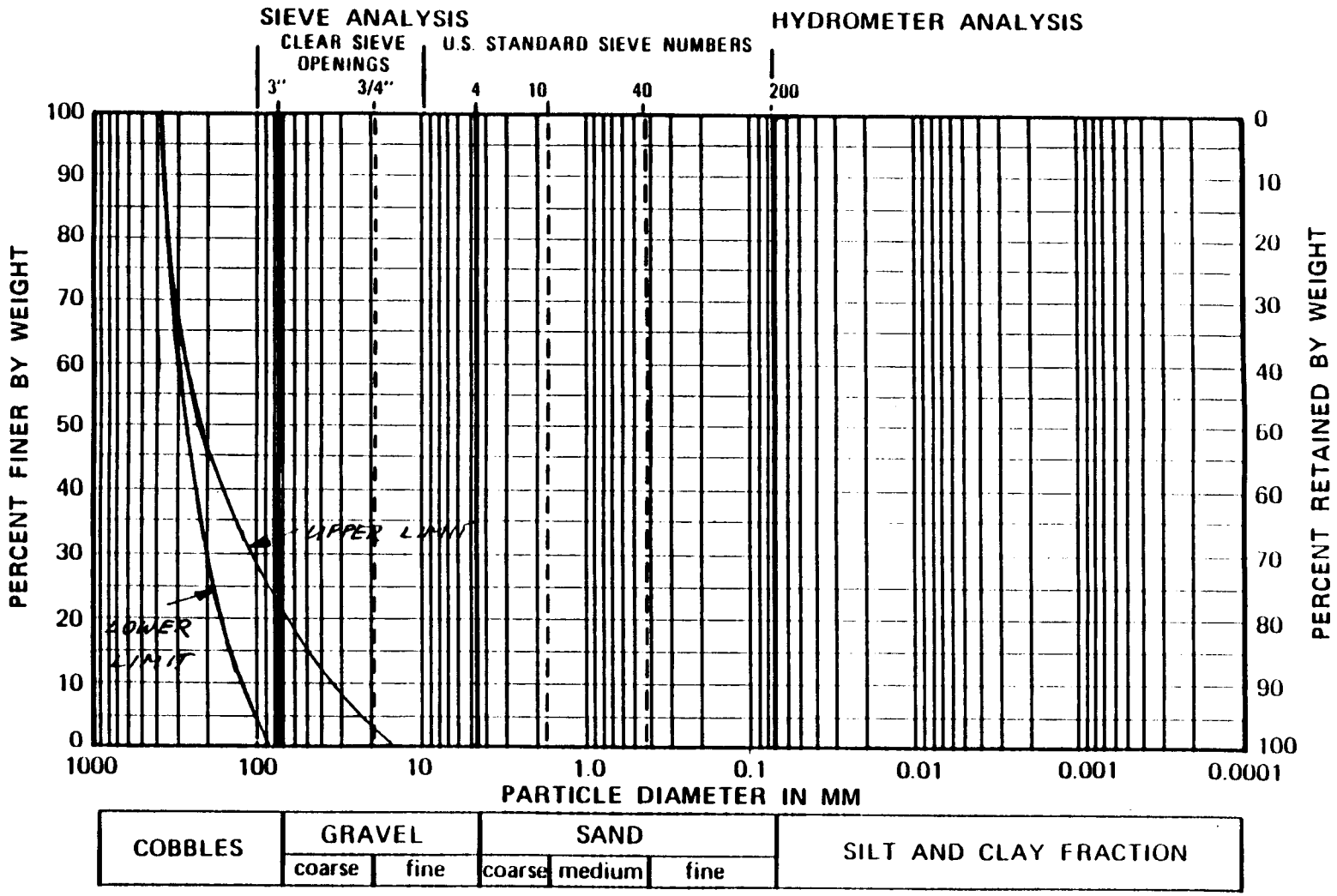
$169 \leq 5\,(60)$

$169 < 300$ O.K.

(#5) $W_{15\,LL} \geq \frac{W_{100\,UL}}{16}$

$11 \geq \frac{169}{16}$

$11 > 10.6$ O.K



TYPICAL FORMAT

GRAIN SIZE DISTRIBUTION DATA

FIGURE 1

Canonie

E-281

Canonie Environmental

E-282

By EB Date 02/27/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION ③: NORTH DIVERSION DITCH, BURIED JETTY

CHECK INITIAL GRAIN SIZE DISTRIBUTION CURVE TO SEE IF ITS WELL GRADED:

D_{10} = 27mm

D_{30} = 84mm

D_{60} = 170

C_u = 6.3

C_z = 1.5

O.K.

By EB Date 02/27/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 86-060-241

1/4" X 1/4"

LOCATION (3) - CONT.:

NU-REG CL-4620 CRITERIA CHECK:

$W_{100LL} \rightarrow 10'' \rightarrow 50$ lbs

$W_{100UL} \rightarrow 10'' \rightarrow 50$ lbs

$W_{50LL} \rightarrow 7.9'' \rightarrow 24.6$ lbs

$W_{15LL} \rightarrow 4.3 \rightarrow 4$ lbs

(#3) $W_{100LL} \geq 2\,(W_{50LL})$

$50 \geq 2(24.6)$

$50 > 49.2$ O.K

(#4) $W_{100UL} \leq 5\,(W_{50LL})$

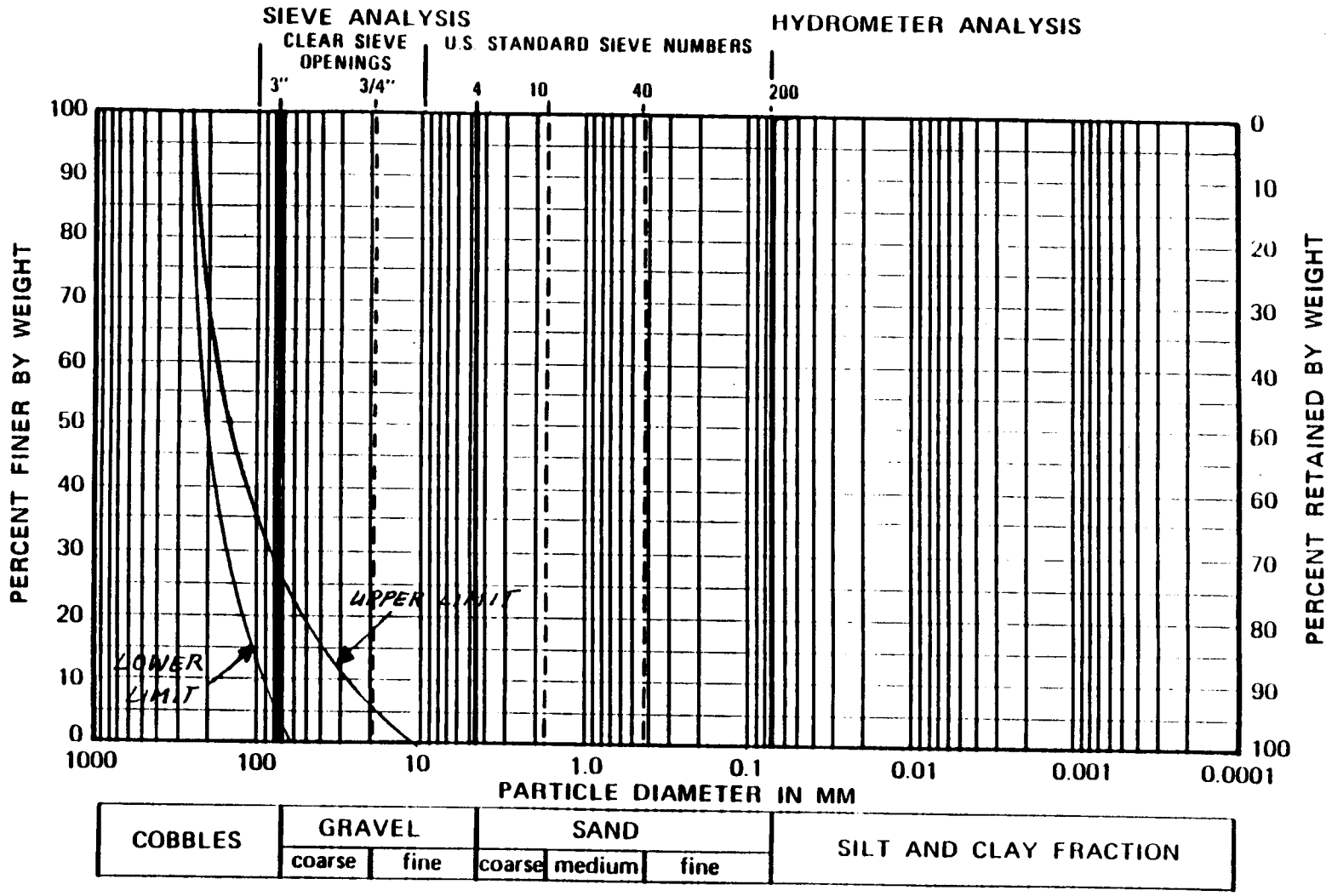
$50 \leq 5(24.6)$

$50 < 123$ O.K.

(#5) $W_{15LL} \geq \frac{W_{100UL}}{16}$

$4 \geq \frac{50}{16}$

$4 > 3.1$ O.K



TYPICAL FORMAT

GRAIN SIZE DISTRIBUTION DATA

FIGURE 1

Canonie

E-284

(3)

By EB Date 02/28/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION (4) - CONT.:

NU-REG CL-4620 CRITERIA CHECK:

$W_{100LL} \rightarrow 6'' \rightarrow 10.8$ lbs

$W_{100UL} \rightarrow 6'' \rightarrow 10.8$ lbs

$W_{50LL} \rightarrow 4.3'' \rightarrow 4.0$ lbs

$W_{15LL} \rightarrow 2.6'' \rightarrow 0.9$ lbs

(#3) $W_{100LL} \geq 2(W_{50LL})$

$10.8 \geq 2(4.0)$

$10.8 > 8.0$ O.K.

(#4) $W_{100UL} \leq 5(W_{50LL})$

$10.8 \leq 5(4.0)$

$10.8 < 20$ O.K.

(#5) $W_{15LL} \geq \frac{W_{100UL}}{16}$

$0.9 \geq \frac{10.8}{16}$

$0.9 > 0.7$ O.K

Canonie Environmental

E-286

By EB Date 02/28/91 Subject _____ Sheet No. ____ of ____

Chkd. By [illegible] Date [illegible] _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION (4): SWALES H & I LOWER REACH OF RUNOFF CONTROL DITCH.

CHECK INITIAL GRAIN SIZE DISTRIBUTION CURVE TO SEE IF ITS WELL GRADED:

$D_{10} = 13$ mm

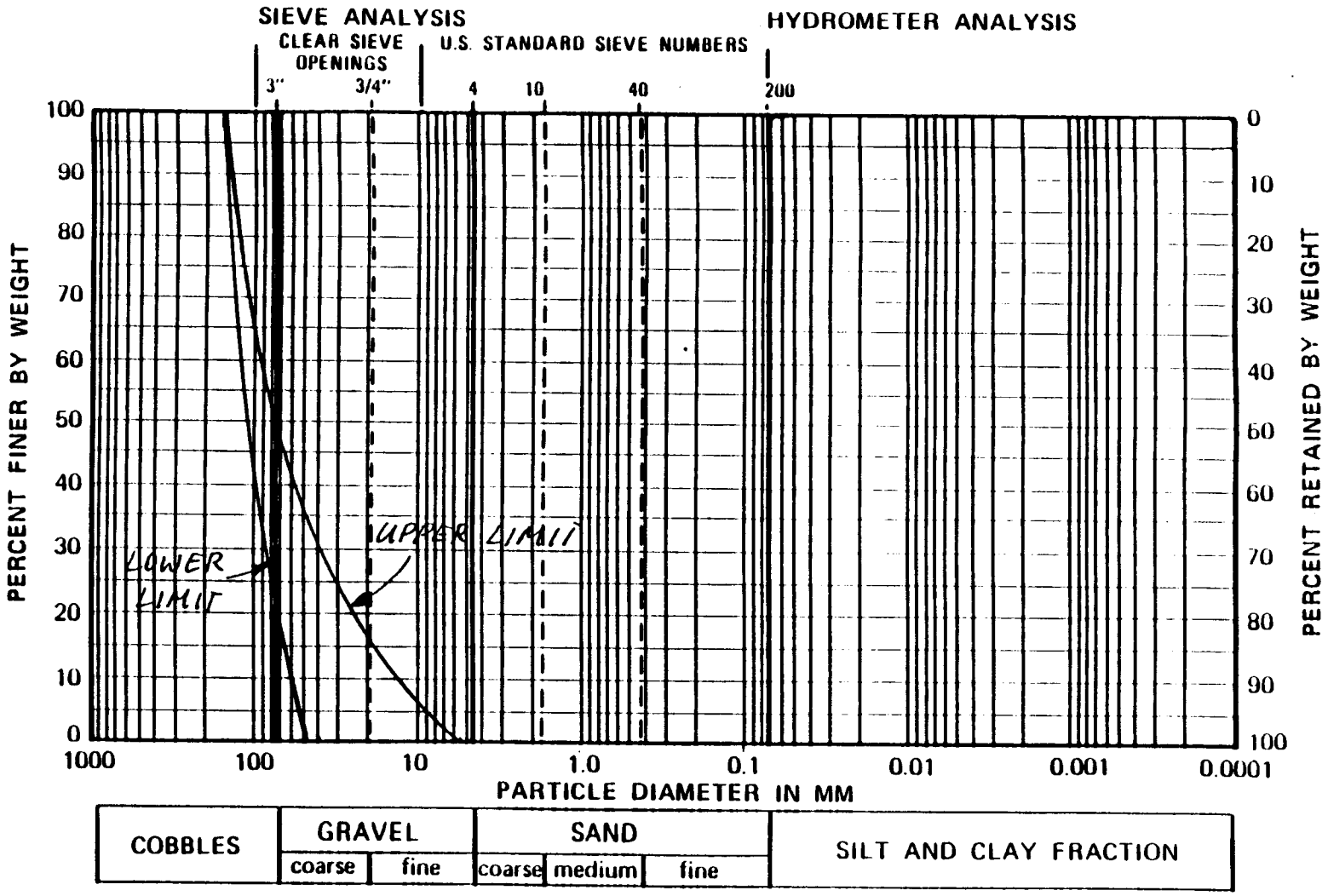
$D_{30} = 38$ mm

$D_{60} = 90$ mm

$C_u = 6.9$

$C_z = 1.2$

O.K.



TYPICAL FORMAT

GRAIN SIZE DISTRIBUTION DATA

FIGURE 1

Canonie

E-287

Canonie Environmental

E-288

By EB Date 02/28/91 Subject _____ Sheet No. ____ of ____

Chkd. By SWM Date 3-1-91 _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION (5): SOIL/ROCK MATRIX SWALES, UPPER REACH RUNOFF CONTROL DITCH.

CHECK INITIAL GRAIN SIZE DISTRIBUTION CURVE TO SEE IF ITS WELL GRADED:

D_{10} = 5.5 mm

D_{30} = 20 mm

D_{60} = 48 mm

C_u = 8.7

C_z = 1.5

O.K.

By EB Date 02/28/91 Subject _____ Sheet No. ____ of ____

Chkd. By SWM Date 3-1-91 _____ Proj. No. 86-060-24

1/4" X 1/4"

LOCATION (5) - CONT.:

NU-REG CL-4620 CRITERIA CHECK:

$W_{100LL} \rightarrow 3'' \rightarrow 1.3$ lbs

$W_{100UL} \rightarrow 3'' \rightarrow 1.3$ lbs

$W_{50LL} \rightarrow 2.3 \rightarrow 0.6$ lbs

$W_{15LL} \rightarrow 1.2'' \rightarrow 0.09$ lbs

(#3) $W_{100LL} \geq 2(W_{50LL})$

$1.3 \geq 2(0.6)$

$1.3 > 1.2$ O.K.

(#4) $W_{100UL} \leq 5(W_{50LL})$

$1.3 \leq 5(0.6)$

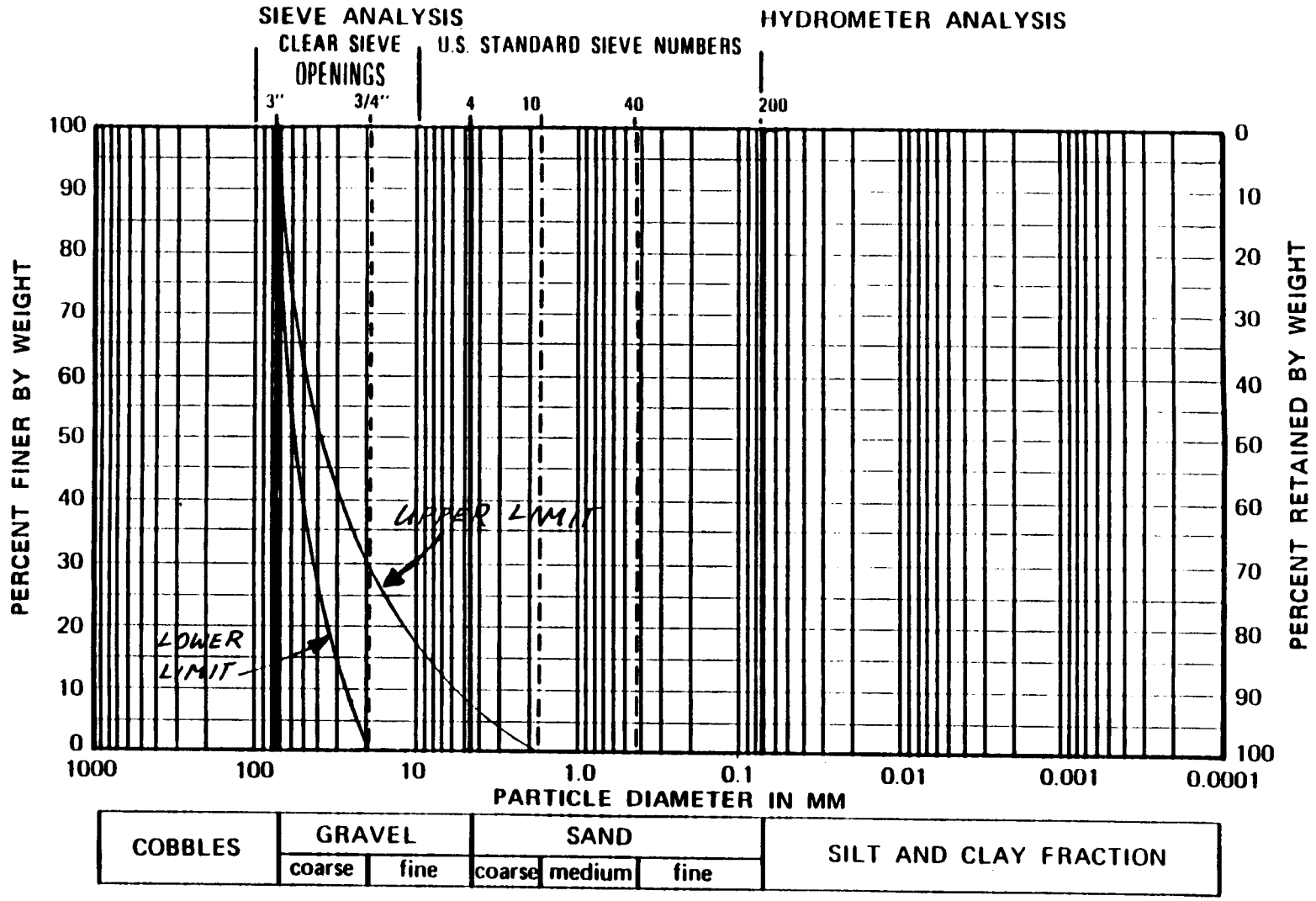
$1.3 < 3.0$ O.K

(#5) $W_{15LL} \geq \frac{W_{100UL}}{16}$

$0.09 \geq \frac{1.3}{16}$

$0.09 > 0.08$ O.K

E—290



TYPICAL FORMAT

GRAIN SIZE DISTRIBUTION DATA

FIGURE 1

Cano e

LOCATION (5)

16-1-3