APPENDIX B

Stability Analyses

Revised 11 Oct 1985

SLOPE STABILITY ANALYSIS
CRANDALL CANYON MINE SED. POND

Method

Use the computer code STABL2, as modified by GEOCOMP Corp. in the code GEOSLOPE.

System Coordinates

See page 2 of this calc.

Parameter Values

Soil Type	Description	γ_m (lb/ft³)	γ_{sat} (lb/ft³)	ϕ (°)	c (lb/ft²)
1 [a]	Embankment	120	132	38	0
2 [a]	Clay liner	120	132	20	1000
3 [a]	Natural soil	110	125	35	0
4 [b]	Riprap toe weighting	130	140	45	0

[a] See R&M Consultants (1981), Delta Geotechnical Consultants (1981)
[b] Assumed values based on field obs. and published typical values

Analysis Procedure

1. Lower limit to generation boundaries → bedrock surface
2. Use circular surface searching w/ random technique for generating surfaces.

Static Condition Results – Liner working

Minimum safety factor = 1.498 → **1.5**

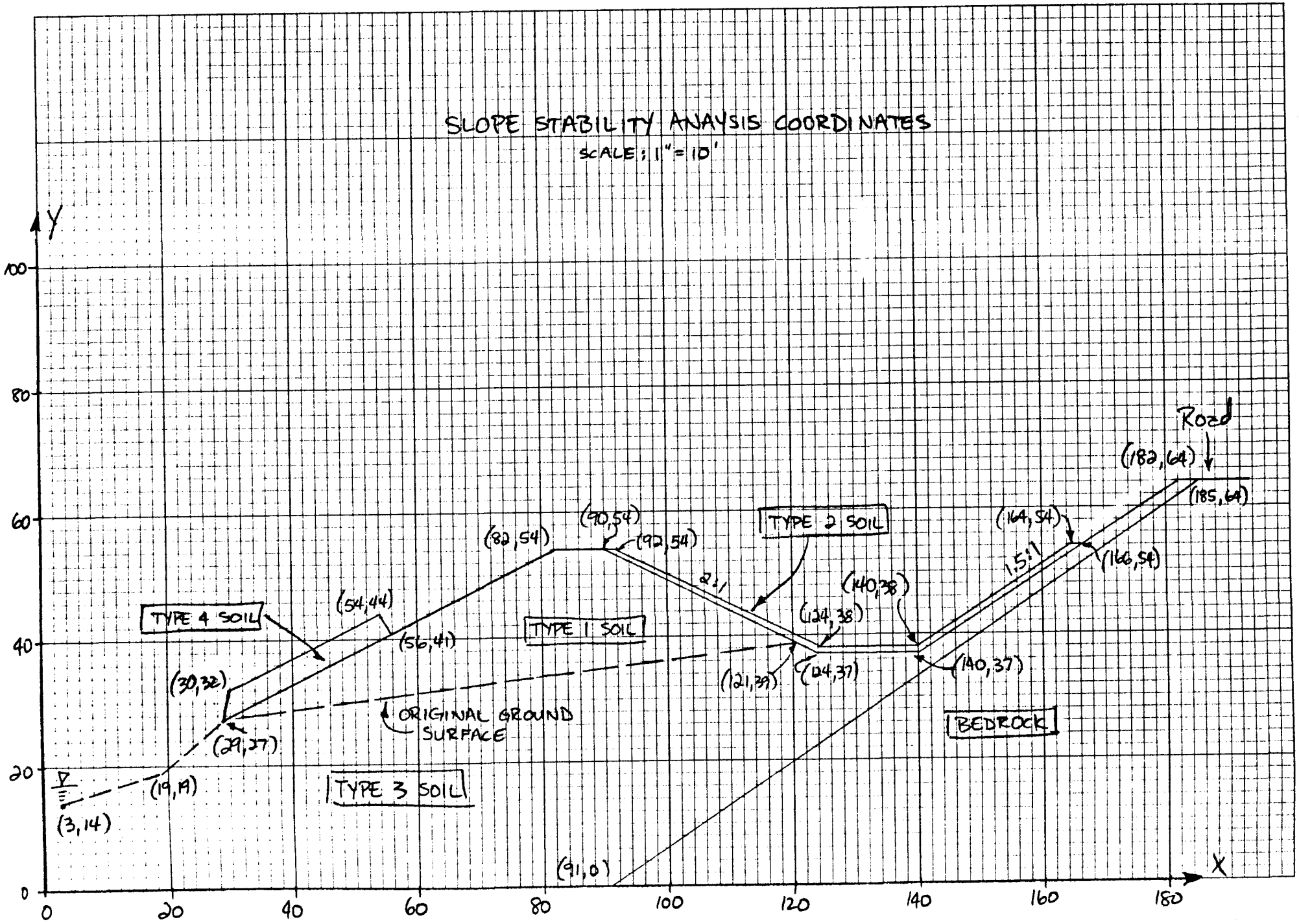
Seismic Parameters

Horizontal loading coefficient = 0.080
Vertical loading coefficient = 0.000
Cavitation pressure = 0.0 lb/ft²

Seismic Condition Results – Liner working

Minimum safety factor = 1.252 → **1.3**

K+E 10 X 10 TO THE INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A. 46 0700



Condition When Liner Fails

If the clay liner fails, a piezometric surface will form within the embankment. Assume both full and empty pond conditions with phreatic line extending from the maximum design water level (top of principal spillway - elev. 7783.0 ft - Y-coordinate 52) to the toe of the embankment. The phreatic surface will be extended from the toe of the embankment along the ground surface to meet the code requirement that the piezometric surface be defined continuously across the horizontal extent of the failure-surface region.

Failed Liner Results

Pond full, static → SF_{min} = 1.04 → **1.0**

Pond full, seismic → SF_{min} = 0.89 → **0.9**

Pond empty, static → SF_{min} = 1.04 → **1.0**

Pond empty, seismic → SF_{min} = 0.89 → **0.9**

Printouts

Attached

GEOSLOPE
Version 2.0

Supplied by GEOCOMP Corp.
342 Sudbury Rd., Concord, MA. 01742
(617)369-8304

portions of this software and documentation are copyrighted 1983,1984 by GEOCOMP Corp.
All rights are reserved.

GEOSLOPE is based on the program, STABL2, developed at Purdue University under sponsorship of the Federal Highway Administration.

GEOCOMP Corp. has modified the program to run on various microcomputers and plotting devices. GEOCOMP Corp. makes no warranties as to the fitness of this software. The user bears all responsibility for accuracy and correctness of results produced by this software. See the users manual for further warranty information.

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND WITH LINER - STATIC CON DITION

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES
OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	18.79
3	25.36	19.88
4	30.19	21.19
5	34.95	22.71
6	39.64	24.45
7	44.24	26.40
8	48.75	28.55
9	53.17	30.90
10	57.47	33.46
11	61.65	36.20
12	65.70	39.13
13	69.62	42.23
14	73.39	45.52
15	77.01	48.96
16	80.47	52.57
17	81.50	53.75

*** 1.498 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** 1.562 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	21.11	20.69
2	25.63	22.84
3	30.14	24.99
4	34.65	27.15
5	39.16	29.31
6	43.66	31.48
7	48.16	33.66
8	52.66	35.84
9	57.16	38.03
10	61.65	40.22
11	66.14	42.42
12	70.63	44.62
13	75.12	46.83
14	79.60	49.05
15	84.08	51.27
16	88.56	53.49
17	89.57	54.00

*** 1.578 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95
18	87.28	52.66
19	88.37	54.00

*** 1.609 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	23.89	22.91
2	28.83	23.70
3	33.72	24.74
4	38.55	26.01
5	43.32	27.52
6	48.01	29.26
7	52.61	31.23
8	57.10	33.41
9	61.48	35.82
10	65.74	38.44
11	69.87	41.27
12	73.85	44.29
13	77.68	47.50
14	81.35	50.90
15	84.38	54.00

*** 1.691 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	26.67	25.13
2	31.38	26.80
3	36.07	28.55
4	40.72	30.37
5	45.35	32.27
6	49.94	34.24
7	54.50	36.29
8	59.03	38.41
9	63.52	40.61
10	67.98	42.88
11	72.39	45.22
12	76.77	47.64
13	81.11	50.12
14	85.41	52.68
15	87.55	54.00

*** 1.717 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** 1.742 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	21.11	20.69
2	26.05	21.46
3	30.96	22.40
4	35.83	23.53
5	40.66	24.83
6	45.44	26.31
7	50.15	27.97
8	54.81	29.80
9	59.39	31.80
10	63.90	33.96
11	68.32	36.29
12	72.66	38.78
13	76.90	41.42
14	81.04	44.23
15	85.08	47.18
16	89.00	50.27
17	92.81	53.51
18	92.87	53.56

*** 1.770 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.71	16.23
3	22.69	15.75
4	27.68	15.63
5	32.68	15.87
6	37.64	16.46
7	42.55	17.41
8	47.38	18.70
9	52.11	20.34
10	56.70	22.31
11	61.15	24.60
12	65.41	27.21
13	69.49	30.11
14	73.34	33.30
15	76.95	36.75
16	80.32	40.45
17	83.40	44.38
18	86.20	48.53
19	88.70	52.86
20	89.25	54.00

*** 1.805 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** 1.841 ***

```
                Y            A     X     I     S            F     T

                .00     38.00     76.00    114.00    152.00    190.00
X          .00 +---*-----+---------+---------+---------+---------+
                -
                -  .21
                -  .2*
                - ..9136
                - ..921**.
          38.00 +...94153.
                -....9213..
                -....97213.
                -.....94213**
                - ....992213
                - ......94213
A         76.00 + .......94211
                - ........0942*
                L  .........07*
                -   ..........*
                -    .........
                -     ........
X        114.00 +       .....
                -         *.
                -         *
                -
                -         *
                -
I        152.00 +
                -
                -             *
                -
                -
                -                 *
S        190.00 +
                -
                -
                -
                -
                -
          228.00 +
                -
                -
                -
                -
                -
F        266.00 +
                -
                -
                -
                -
                -                 L
T        304.00 +
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND WITH LINER — SEISMIC CONDITION

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT OF .080 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE = .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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	18.79
3	25.36	19.88
4	30.19	21.19
5	34.95	22.71
6	39.64	24.45
7	44.24	26.40
8	48.75	28.55
9	53.17	30.90
10	57.47	33.46
11	61.65	36.20
12	65.70	39.13
13	69.62	42.23
14	73.39	45.52
15	77.01	48.96
16	80.47	52.57
17	81.50	53.75

*** 1.252 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	21.11	20.69
2	25.63	22.84
3	30.14	24.99
4	34.65	27.15
5	39.16	29.31
6	43.66	31.48
7	48.16	33.66
8	52.66	35.84
9	57.16	38.03
10	61.65	40.22
11	66.14	42.42
12	70.63	44.62
13	75.12	46.83
14	79.60	49.05
15	84.08	51.27
16	88.56	53.49
17	89.57	54.00

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** 1.305 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95
18	87.28	52.66
19	88.37	54.00

*** 1.343 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	23.89	22.91
2	28.83	23.70
3	33.72	24.74
4	38.55	26.01
5	43.32	27.52
6	48.01	29.26
7	52.61	31.23
8	57.10	33.41
9	61.48	35.82
10	65.74	38.44
11	69.87	41.27
12	73.85	44.29
13	77.68	47.50
14	81.35	50.90
15	84.38	54.00

*** 1.399 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	26.67	25.13
2	31.38	26.80
3	36.07	28.55
4	40.72	30.37
5	45.35	32.27
6	49.94	34.24
7	54.50	36.29
8	59.03	38.41
9	63.52	40.61
10	67.98	42.88
11	72.39	45.22
12	76.77	47.64
13	81.11	50.12
14	85.41	52.68
15	87.55	54.00

*** 1.410 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** 1.449 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	21.11	20.69
2	26.05	21.46
3	30.96	22.40
4	35.83	23.53
5	40.66	24.83
6	45.44	26.31
7	50.15	27.97
8	54.81	29.80
9	59.39	31.80
10	63.90	33.96
11	68.32	36.29
12	72.66	38.78
13	76.90	41.42
14	81.04	44.23
15	85.08	47.18
16	89.00	50.27
17	92.81	53.51
18	92.87	53.56

*** 1.456 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.71	16.23
3	22.69	15.75
4	27.68	15.63
5	32.68	15.87
6	37.64	16.46
7	42.55	17.41
8	47.38	18.70
9	52.11	20.34
10	56.70	22.31
11	61.15	24.60
12	65.41	27.21
13	69.49	30.11
14	73.34	33.30
15	76.95	36.75
16	80.32	40.45
17	83.40	44.38
18	86.20	48.53
19	88.70	52.86
20	89.25	54.00

*** 1.514 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** 1.533 ***

```
          Y            A     X     I     S            F     T

          .00     38.00     76.00    114.00    152.00    190.00

X       .00 +---*-----+---------+---------+---------+---------+
            -
            -  .31
            -  .3*
            - ..9126
            - ..931**.
      38.00 +...94152.
            -....9312..
            -....97312.
            -.....94312**
            - ....993312
            - ......94312
A     76.00 + .......94311
            - ........0942*
            L  .........07*
            -   ..........*
            -    .........
            -     ........
X    114.00 +       .....
            -         *.
            -         *
            -
            -         *
            -
I    152.00 +
            -
            -             *
            -
            -
            -                *
S    190.00 +
            -
            -
            -
            -
            -
      228.00 +
            -
            -
            -
            -
            -
F    266.00 +
            -
            -
            -
            -
            -                L
T    304.00 +
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND - FAILED LINER - FULL - STATIC

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	3.00	14.00
2	19.00	19.00
3	29.00	27.00
4	96.00	52.00
5	162.00	52.00

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** 1.035 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95

19	88.37	54.00

*** 1.068 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	18.79
3	25.36	19.88
4	30.19	21.19
5	34.95	22.71
6	39.64	24.45
7	44.24	26.40
8	48.75	28.55
9	53.17	30.90
10	57.47	33.46
11	61.65	36.20
12	65.70	39.13
13	69.62	42.23
14	73.39	45.52
15	77.01	48.96
16	80.47	52.57
17	81.50	53.75

*** 1.078 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.71	16.23
3	22.69	15.75
4	27.68	15.63
5	32.68	15.87
6	37.64	16.46
7	42.55	17.41
8	47.38	18.70
9	52.11	20.34
10	56.70	22.31
11	61.15	24.60
12	65.41	27.21
13	69.49	30.11
14	73.34	33.30
15	76.95	36.75
16	80.32	40.45
17	83.40	44.38
18	86.20	48.53
19	88.70	52.86
20	89.25	54.00

*** 1.099 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** 1.142 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** 1.149 ***

19	88.37	54.00

*** .917 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	18.79
3	25.36	19.88
4	30.19	21.19
5	34.95	22.71
6	39.64	24.45
7	44.24	26.40
8	48.75	28.55
9	53.17	30.90
10	57.47	33.46
11	61.65	36.20
12	65.70	39.13
13	69.62	42.23
14	73.39	45.52
15	77.01	48.96
16	80.47	52.57
17	81.50	53.75

*** .930 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.71	16.23
3	22.69	15.75
4	27.68	15.63
5	32.68	15.87
6	37.64	16.46
7	42.55	17.41
8	47.38	18.70
9	52.11	20.34
10	56.70	22.31
11	61.15	24.60
12	65.41	27.21
13	69.49	30.11
14	73.34	33.30
15	76.95	36.75
16	80.32	40.45
17	83.40	44.38
18	86.20	48.53
19	88.70	52.86
20	89.25	54.00

*** .948 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** .979 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** .985 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	15.00	16.27
3	19.99	16.53
4	24.97	16.96
5	29.94	17.56
6	34.88	18.34
7	39.78	19.30
8	44.66	20.42
9	49.49	21.72
10	54.27	23.18
11	58.99	24.81
12	63.66	26.60
13	68.26	28.56
14	72.79	30.68
15	77.25	32.95
16	81.62	35.38
17	85.90	37.96
18	90.09	40.69
19	94.18	43.56
20	98.17	46.58
21	101.47	49.26

*** .995 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.92	15.30
3	19.88	14.69
4	24.87	14.35
5	29.87	14.28
6	34.87	14.49
7	39.84	14.98
8	44.79	15.74
9	49.68	16.77
10	54.51	18.07
11	59.25	19.64
12	63.91	21.46
13	68.46	23.54
14	72.89	25.86
15	77.18	28.43
16	81.32	31.22
17	85.30	34.25
18	89.11	37.48
19	92.74	40.93
20	96.17	44.56
21	99.40	48.38
22	100.45	49.78

*** .997 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.27	18.01
3	28.26	17.65
4	33.26	17.70
5	38.24	18.17
6	43.16	19.05
7	47.99	20.33
8	52.70	22.01
9	57.26	24.07
10	61.62	26.51
11	65.77	29.30
12	69.67	32.43
13	73.30	35.86
14	76.63	39.59
15	79.65	43.58
16	82.31	47.81
17	84.62	52.25
18	85.36	54.00

*** 1.002 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	17.06
3	25.45	16.54
4	30.45	16.34
5	35.45	16.48
6	40.43	16.95
7	45.36	17.75
8	50.23	18.87
9	55.02	20.32
10	59.70	22.09
11	64.25	24.16
12	68.65	26.53
13	72.88	29.19
14	76.93	32.13
15	80.77	35.33
16	84.39	38.78
17	87.78	42.46
18	90.91	46.36
19	93.77	50.45
20	95.01	52.50

*** 1.016 ***

```
            Y            A     X     I     S            F     T

            .00     38.00     76.00    114.00    152.00    190.00

X        .00 +---*-----+---------+---------+---------+---------+
            -
            -  .13
            -  .1*
            - ..41..
            - ..413**.
      38.00 +...421...
            -...8413...
            -...84513..
            -....84213.**
            - ....44113.
            - ....804213.
A     76.00 + .....8042113
            - ......876421*
            L  .......7764*
            -   .......780*
            -    .......77
            -     ........
X    114.00 +       .....
            -         *.
            -         *
            -
            -         *
            -
I    152.00 +
            -
            -             *
            -
            -
            -                *
S    190.00 +
            -
            -
            -
            -
            -
      228.00 +
            -
            -
            -
            -
            -
F    266.00 +
            -
            -
            -
            -
            -                L
T    304.00 +
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND - FAILED LINER - EMPTY - STATIC

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES
OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 6 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	3.00	14.00
2	19.00	19.00
3	29.00	27.00
4	96.00	52.00
5	124.00	38.00
6	140.00	38.00

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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** 1.035 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.27	18.01
3	28.26	17.65
4	33.26	17.70
5	38.24	18.17
6	43.16	19.05
7	47.99	20.33
8	52.70	22.01
9	57.26	24.07
10	61.62	26.51
11	65.77	29.30
12	69.67	32.43
13	73.30	35.86
14	76.63	39.59
15	79.65	43.58
16	82.31	47.81
17	84.62	52.25
18	85.36	54.00

*** 1.162 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.92	15.30
3	19.88	14.69
4	24.87	14.35
5	29.87	14.28
6	34.87	14.49
7	39.84	14.98
8	44.79	15.74
9	49.68	16.77
10	54.51	18.07
11	59.25	19.64
12	63.91	21.46
13	68.46	23.54
14	72.89	25.86
15	77.18	28.43
16	81.32	31.22
17	85.30	34.25
18	89.11	37.48
19	92.74	40.93
20	96.17	44.56
21	99.40	48.38
22	100.45	49.78

*** 1.179 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.39	16.65
3	25.32	15.79
4	30.30	15.33
5	35.30	15.30
6	40.28	15.68
7	45.22	16.48
8	50.07	17.69
9	54.80	19.29
10	59.39	21.29
11	63.79	23.66
12	67.98	26.39
13	71.92	29.46
14	75.60	32.85
15	78.98	36.53
16	82.04	40.49
17	84.77	44.68
18	87.13	49.09
19	89.11	53.68
20	89.22	54.00

*** 1.187 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	15.00	16.27
3	19.99	16.53
4	24.97	16.96
5	29.94	17.56
6	34.88	18.34
7	39.78	19.30
8	44.66	20.42
9	49.49	21.72
10	54.27	23.18
11	58.99	24.81
12	63.66	26.60
13	68.26	28.56
14	72.79	30.68
15	77.25	32.95
16	81.62	35.38
17	85.90	37.96
18	90.09	40.69
19	94.18	43.56
20	98.17	46.58
21	101.47	49.26

```
                Y            A     X     I     S            F     T

                .00     38.00     76.00    114.00    152.00    190.00

X          .00 +---*-----+---------+---------+---------+---------+
                -
                -  .13
                -  .1*
                - ..41..
                - ..413**.
         38.00 +...421...
                -...8413...
                -...84513..
                -....84213.**
                - ....44113.
                - ....894213.
A        76.00 + .....8.42113
                - ......886421*
                L  .......8064*
                -   .......88.*
                -    .......08
                -     ........
X       114.00 +       .....
                -         *.
                -         *
                -
                -         *
                -
I       152.00 +
                -
                -             *
                -
                -
                -                *
S       190.00 +
                -
                -
                -
                -
                -
        228.00 +
                -
                -
                -
                -
                -
F       266.00 +
                -
                -
                -
                -
                -                L
T       304.00 +
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND - FAILED LINER - FULL - SEISMIC

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	3.00	14.00
2	19.00	19.00
3	29.00	27.00
4	96.00	52.00
5	162.00	52.00

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT OF .080 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE = .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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** .891 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** 1.142 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** 1.149 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.27	18.01
3	28.26	17.65
4	33.26	17.70
5	38.24	18.17
6	43.16	19.05
7	47.99	20.33
8	52.70	22.01
9	57.26	24.07
10	61.62	26.51
11	65.77	29.30
12	69.67	32.43
13	73.30	35.86
14	76.63	39.59
15	79.65	43.58
16	82.31	47.81
17	84.62	52.25
18	85.36	54.00

*** 1.162 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.92	15.30
3	19.88	14.69
4	24.87	14.35
5	29.87	14.28
6	34.87	14.49
7	39.84	14.98
8	44.79	15.74
9	49.68	16.77
10	54.51	18.07
11	59.25	19.64
12	63.91	21.46
13	68.46	23.54
14	72.89	25.86
15	77.18	28.43
16	81.32	31.22
17	85.30	34.25
18	89.11	37.48
19	92.74	40.93
20	96.17	44.56
21	99.40	48.38
22	100.45	49.78

*** 1.186 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.39	16.65
3	25.32	15.79
4	30.30	15.33
5	35.30	15.30
6	40.28	15.68
7	45.22	16.48
8	50.07	17.69
9	54.80	19.29
10	59.39	21.29
11	63.79	23.66
12	67.98	26.39
13	71.92	29.46
14	75.00	32.85
15	78.98	36.53
16	82.04	40.49
17	84.77	44.68
18	87.13	49.09
19	89.11	53.68
20	89.22	54.00

*** 1.187 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	17.06
3	25.45	16.54
4	30.45	16.34
5	35.45	16.48
6	40.43	16.95
7	45.36	17.75
8	50.23	18.87
9	55.02	20.32
10	59.70	22.09
11	64.25	24.16
12	68.65	26.53
13	72.88	29.19
14	76.93	32.13
15	80.77	35.33
16	84.39	38.78
17	87.78	42.46
18	90.91	46.36
19	93.77	50.45
20	95.01	52.50

*** 1.190 ***

```
                Y            A     X     I     S            F     T

                .00     38.00     76.00    114.00    152.00    190.00

X          .00 +---*-----+---------+---------+---------+---------+
                -
                -  .13
                -  .1*
                - ..41..
                - ..413**.
           38.00 +...421...
                -...8413...
                -...84513..
                -....84213.**
                - ....44113.
                - ....894213.
A          76.00 + .....8042113
                - ......886421*
                L  .......8064*
                -   .......880*
                -    ........8
                -     ........
X         114.00 +       .....
                -         *.
                -         *
                -
                -         *
                -
I         152.00 +
                -
                -             *
                -
                -
                -                *
S         190.00 +
                -
                -
                -
                -
                -
           228.00 +
                -
                -
                -
                -
                -
F         266.00 +
                -
                -
                -
                -
                -                L
T         304.00 +
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION GENWAL SED. POND - FAILED LINER - EMPTY - SEISMIC

BOUNDARY COORDINATES

14 TOP BOUNDARIES
20 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	3.00	14.00	19.00	19.00	3
2	19.00	19.00	29.00	27.00	3
3	29.00	27.00	30.00	32.00	4
4	30.00	32.00	54.00	44.00	4
5	54.00	44.00	56.00	41.00	4
6	56.00	41.00	82.00	54.00	1
7	82.00	54.00	90.00	54.00	1
8	90.00	54.00	92.00	54.00	2
9	92.00	54.00	124.00	38.00	2
10	124.00	38.00	140.00	38.00	2
11	140.00	38.00	164.00	54.00	2
12	164.00	54.00	166.00	54.00	2
13	166.00	54.00	182.00	64.00	3
14	182.00	64.00	185.00	64.00	3
15	29.00	27.00	56.00	41.00	1
16	90.00	54.00	121.00	39.00	1
17	121.00	39.00	124.00	37.00	3
18	124.00	37.00	140.00	37.00	3
19	140.00	37.00	166.00	54.00	3
20	29.00	27.00	121.00	37.00	3

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	120.0	132.0	.0	38.0	.00	.0	1
2	120.0	132.0	1000.0	20.0	.00	.0	1
3	110.0	125.0	.0	35.0	.00	.0	1
4	130.0	140.0	.0	45.0	.00	.0	1

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 2 BOUNDARIES OF WHICH THE FIRST 2 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	91.00	.00	185.00	64.00
2	185.00	64.00	300.00	64.00

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 6 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	3.00	14.00
2	19.00	19.00
3	29.00	27.00
4	96.00	52.00
5	124.00	38.00
6	140.00	38.00

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF .080 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE = .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 = 10.00 FT.
AND X = 35.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 80.00 FT.
AND X = 120.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 5.00 FT.

5.00 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 BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.99	16.49
3	19.96	17.03
4	24.90	17.81
5	29.80	18.82
6	34.64	20.07
7	39.42	21.54
8	44.12	23.25
9	48.73	25.18
10	53.25	27.32
11	57.65	29.69
12	61.94	32.25
13	66.10	35.03
14	70.13	38.00
15	74.00	41.15
16	77.72	44.49
17	81.28	48.01
18	84.66	51.69
19	86.59	54.00

*** .891 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.77	17.33
3	22.74	17.84
4	27.69	18.60
5	32.59	19.59
6	37.43	20.83
7	42.21	22.30
8	46.91	24.01
9	51.52	25.94
10	56.03	28.10
11	60.43	30.47
12	64.71	33.06
13	68.86	35.85
14	72.86	38.84
15	76.72	42.03
16	80.41	45.40
17	83.94	48.95

19	88.37	54.00

*** .917 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.33	18.79
3	28.33	19.08
4	33.29	19.66
5	38.22	20.52
6	43.08	21.66
7	47.88	23.09
8	52.58	24.79
9	57.18	26.75
10	61.65	28.98
11	65.99	31.47
12	70.18	34.20
13	74.20	37.17
14	78.04	40.37
15	81.70	43.78
16	85.15	47.40
17	88.38	51.21
18	90.48	54.00

*** .979 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.53	17.38
3	25.52	17.16
4	30.52	17.26
5	35.50	17.69
6	40.45	18.43
7	45.34	19.48
8	50.14	20.85
9	54.86	22.52
10	59.45	24.50
11	63.91	26.76
12	68.21	29.31
13	72.34	32.12
14	76.29	35.20
15	80.02	38.52
16	83.54	42.07
17	86.82	45.85
18	89.85	49.82
19	92.47	53.76

*** .985 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	18.79
3	25.36	19.88
4	30.19	21.19
5	34.95	22.71
6	39.64	24.45
7	44.24	26.40
8	48.75	28.55
9	53.17	30.90
10	57.47	33.46
11	61.65	36.20
12	65.70	39.13
13	69.62	42.23
14	73.39	45.52
15	77.01	48.96
16	80.47	52.57
17	81.50	53.75

*** .930 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	12.78	17.06
2	17.71	16.23
3	22.69	15.75
4	27.68	15.63
5	32.68	15.87
6	37.64	16.46
7	42.55	17.41
8	47.38	18.70
9	52.11	20.34
10	56.70	22.31
11	61.15	24.60
12	65.41	27.21
13	69.49	30.11
14	73.34	33.30
15	76.95	36.75
16	80.32	40.45
17	83.40	44.38
18	86.20	48.53
19	88.70	52.86
20	89.25	54.00

*** .948 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	14.92	15.30
3	19.88	14.69
4	24.87	14.35
5	29.87	14.28
6	34.87	14.49
7	39.84	14.98
8	44.79	15.74
9	49.68	16.77
10	54.51	18.07
11	59.25	19.64
12	63.91	21.46
13	68.46	23.54
14	72.89	25.86
15	77.18	28.43
16	81.32	31.22
17	85.30	34.25
18	89.11	37.48
19	92.74	40.93
20	96.17	44.56
21	99.40	48.38
22	100.45	49.78

*** 1.002 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	18.33	18.79
2	23.27	18.01
3	28.26	17.65
4	33.26	17.70
5	38.24	18.17
6	43.16	19.05
7	47.99	20.33
8	52.70	22.01
9	57.26	24.07
10	61.62	26.51
11	65.77	29.30
12	69.67	32.43
13	73.30	35.86
14	76.63	39.59
15	79.65	43.58
16	82.31	47.81
17	84.62	52.25
18	85.36	54.00

*** 1.002 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	10.00	16.19
2	15.00	16.27
3	19.99	16.53
4	24.97	16.96
5	29.94	17.56
6	34.88	18.34
7	39.78	19.30
8	44.66	20.42
9	49.49	21.72
10	54.27	23.18
11	58.99	24.81
12	63.66	26.60
13	68.26	28.56
14	72.79	30.68
15	77.25	32.95
16	81.62	35.38
17	85.90	37.96
18	90.09	40.69
19	94.18	43.56
20	98.17	46.58
21	101.47	49.26

*** 1.004 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	15.56	17.92
2	20.48	17.06
3	25.45	16.54
4	30.45	16.34
5	35.45	16.48
6	40.43	16.95
7	45.36	17.75
8	50.23	18.87
9	55.02	20.32
10	59.70	22.09
11	64.25	24.16
12	68.65	26.53
13	72.88	29.19
14	76.93	32.13
15	80.77	35.33
16	84.39	38.78
17	87.78	42.46
18	90.91	46.36
19	93.77	50.45
20	95.01	52.50

```
                Y            A     X     I     S            F     T

                .00     38.00     76.00    114.00    152.00    190.00
X          .00 +---*-----+---------+---------+---------+---------+
                -
                -  .13
                -  .1*
                - ..41..
                - ..413**.
          38.00 +...421...
                -...7413...
                -...74513..
                -....74213.**
                - ....44113.
                - ....704213.
A         76.00 + .....7042113
                - ......776421*
                L  .......7964*
                -   .......770*
                -    .......97
                -     ........
X        114.00 +       .....
                -         *.
                -         *
                -
                -         *
                -
I        152.00 +
                -
                -             *
                -
                -
                -                 *
S        190.00 +
                -
                -
                -
                -
                -
          228.00 +
                -
                -
                -
                -
                -
F        266.00 +
                -
                -
                -
                -
                -                 L
T        304.00 +
```

DESIGN OF DIVERSIONS AND CULVERTS
CRANDALL CANYON MINE

Methodology

Determine peak flow rates using the hydrograph model of Hawkins & Marshall (1979). Determine flow velocities in open channels using OSM design package (see Weider et al., 1983).

Design of Primary Undisturbed Area Diversion

Curve number → CN = 69
(see sed. pond calcs. — undisturbed areas)

Time of concentration → $T_c = 1.67\,L$

$$L = \frac{l^{0.8}\,(s+1)^{0.7}}{1900\,Y^{0.5}}$$

where L = watershed lag (hr)
l = hydraulic length (ft)
$s = \frac{1000}{CN} - 10$
Y = avg. watershed slope (%)

WS-1

$l = 3850$ ft

$s = \frac{1000}{69} - 10 = 4.49$

$$Y = \left[\frac{(55{,}600\text{ ft})(40\text{ ft})}{(95.2\text{ ac})(43{,}560\text{ ft}^2/\text{ac})}\right](100)$$

$= 53.6\%$

$$L = \frac{(3850)^{0.8}\,(5.49)^{0.7}}{(1900)(53.6)^{0.5}} = 0.17\text{ hr}$$

$T_c = (1.67)(0.17) = 0.29$ hr

WS-2

$l = 340$ ft

$s = 4.49$

$$Y = \left[\frac{(660\text{ ft})(40\text{ ft})}{(1.0\text{ ac})(43{,}560\text{ ft}^2/\text{ac})}\right](100) = 60.6\%$$

$$L = \frac{(340)^{0.8}\,(5.49)^{0.7}}{(1900)(60.6)^{0.5}} = 0.02\text{ hr}$$

$T_c = (1.67)(0.02) = 0.04$ hr

WS-4

$l = 260$ ft

$S = 4.49$

$$Y = \left[\frac{(970\text{ ft})(40\text{ ft})}{(0.9\text{ ac})(43{,}560\text{ ft}^2/\text{ac})}\right](100) = 99.0\%$$

$$L = \frac{(260)^{0.8}(5.49)^{0.7}}{(1900)(99.0)^{0.5}} = 0.01\text{ hr}$$

$T_c = 0.02$ hr

Area → WS-1 = 95.2 ac = 0.149 mi²
WS-2 = 1.0 ac = 0.002 mi²
WS-4 = 0.9 ac = 0.001 mi²

Design storm = 2.50 in (10-yr, 24-hr – Miller et al., 1973)

Rainfall distribution → SCS, which (probably most represented of long-duration storms in the region)

Hydrograph model results → see pages 3-5 of this calc. for short form printouts

WS-1 → $q_p = 8.50$ cfs @ $t = 10.0$ hr
WS-2 → $q_p = 0.13$ cfs @ $t = 10.0$ hr
WS-4 → $q_p = 0.07$ cfs @ $t = 10.0$ hr

$q_{total} = 8.50 + 0.13 + 0.07 = \underline{\underline{8.70\text{ cfs}}}$

```
*******************************
* EARTHFAX ENGINEERING, INC.  *
*                             *
* HYDROGRAPH GENERATION MODEL *
*   USING SCS CURVE NUMBER    *
*         METHODOLOGY         *
*******************************
```

IDENTIFICATION: WS-1

INPUT SUMMARY:

```
*************************************************************
     STORM:                      WATERSHED:
        DIST. = SCS TYPE B          AREA =  0.149 SQ. MI.
        DEPTH =  2.50 IN.           CN = 69.0
        DURATION = 24.0 HR.         TIME OF CONC. =  0.29 HR.
*************************************************************
```

```
*************************************************************
```

OUTPUT SUMMARY:

```
*************************************************************
     TOTAL RUNOFF DEPTH =  0.4208 INCHES
     INITIAL ABSTRACTION =  0.8986 INCHES
     PEAK FLOW =     8.50 CFS  ( 0.0884 IN/HR)
     TIME TO PEAK =  10.03 HOURS
     RUNOFF VOLUME CHECK =  0.4217 INCHES
*************************************************************
```

```
*******************************
* EARTHFAX ENGINEERING, INC.  *
*                             *
* HYDROGRAPH GENERATION MODEL *
*   USING SCS CURVE NUMBER    *
*         METHODOLOGY         *
*******************************
```

IDENTIFICATION: WS-2

INPUT SUMMARY:

```
************************************************************
     STORM:                    WATERSHED:
        DIST. = SCS TYPE B          AREA =  0.002 SQ. MI.
        DEPTH =  2.50 IN.           CN = 69.0
        DURATION = 24.0 HR.         TIME OF CONC. =  0.04 HR.
************************************************************
```

```
************************************************************
```

OUTPUT SUMMARY:

```
************************************************************
     TOTAL RUNOFF DEPTH =  0.4208 INCHES
     INITIAL ABSTRACTION =  0.8986 INCHES
     PEAK FLOW =     0.13 CFS  ( 0.1011 IN/HR)
     TIME TO PEAK =  10.00 HOURS
     RUNOFF VOLUME CHECK =  0.4217 INCHES
************************************************************
```

```
*******************************
* EARTHFAX ENGINEERING, INC.  *
*                             *
* HYDROGRAPH GENERATION MODEL *
*   USING SCS CURVE NUMBER    *
*         METHODOLOGY         *
*******************************
```

IDENTIFICATION: WS-~~3~~4

INPUT SUMMARY:

```
*************************************************************
     STORM:                    WATERSHED:
        DIST. = SCS TYPE B            AREA =  0.001 SQ. MI.
        DEPTH =  2.50 IN.             CN = 69.0
        DURATION - 24.0 HR.           TIME OF CONC. =  0.02 HR.
*************************************************************

*************************************************************
```

OUTPUT SUMMARY:

```
*************************************************************
     TOTAL RUNOFF DEPTH =  0.4208 INCHES
     INITIAL ABSTRACTION =  0.8986 INCHES
     PEAK FLOW =      0.07 CFS  ( 0.1016 IN/HR)
     TIME TO PEAK =  10.00 HOURS
     RUNOFF VOLUME CHECK =  0.4217 INCHES
*************************************************************
```

Flow velocities (from OSM program TRAP1):

Steepest section (elev. 7880 to 7870) → $\left(\frac{10\text{ ft}}{180\text{ ft}}\right)(100) = 5.6\%$ slope

Gentlest section (elev. 7910 to 7900) → $\left(\frac{10\text{ ft}}{400\text{ ft}}\right)(100) = 2.5\%$ slope

→ See site map (1" = 50' scale)

Base design depth on gentle section and riprap sizing on steep section (if required).

<u>Steep section</u>, no riprap (n = 0.025):

Bed Slope =	.056	
Manning's N =	.025	
Bottom Width =	2	feet
Channel Side Slope =	.5	
Flow Depth =	.4487555	feet
Cross Sectional Area =	1.300274	square feet
Wetted Perimeter =	4.006896	feet
Hydraulic Radius =	.3245091	feet
Discharge =	8.7	cubic feet/sec
Velocity =	6.690898	feet/sec

velocity too high w/o riprap. Add riprap. Assume $d_{50} = 6$ in $= 0.50$ ft

$$n = 0.0395\, d_{50}^{1/6}$$

$$= (0.0395)(0.50)^{1/6} = 0.035$$

Bed Slope =	.056	
Manning's N =	.035	
Bottom Width =	2	feet
Channel Side Slope =	.5	
Flow Depth =	.5379828	feet
Cross Sectional Area =	1.654817	square feet
Wetted Perimeter =	4.405933	feet
Hydraulic Radius =	.3755883	feet
Discharge =	8.7	cubic feet/sec
Velocity =	5.25738	feet/sec

Check riprap sizing requirement and iterate channel size if necessary:

$$d_{50} = (118 Q S^{13/6} R/P)^{2/5} \qquad \text{(Anderson et al., 1970)}$$

$$= \left[(118)(8.70)(0.056)^{13/6}(0.38)/(4.41)\right]^{2/5}$$

$$= \underline{\underline{0.49 \text{ ft}}}$$

→ Assumed d_{50} (0.50 ft) <u>OK</u>. $n = 0.035$

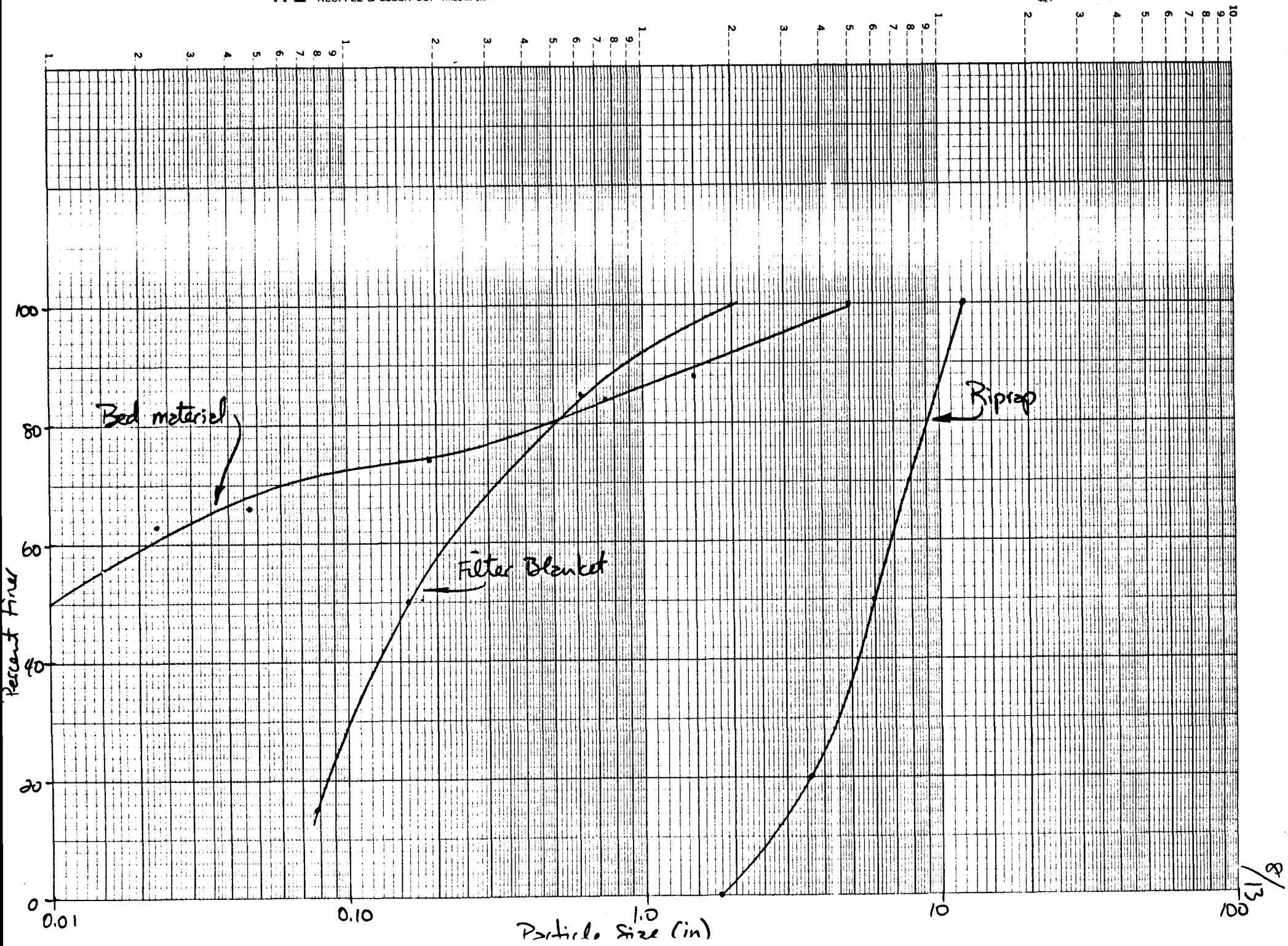
<u>Gentle section</u> (w/ d_{50} riprap = 0.50 ft, $n = 0.035$):

Bed Slope =	.025	
Manning's N =	.035	
Bottom Width =	2	feet
Channel Side Slope =	.5	
Flow Depth =	.6664273	feet
Cross Sectional Area =	2.221105	square feet
Wetted Perimeter =	4.980354	feet
Hydraulic Radius =	.4459735	feet
Discharge =	8.7	cubic feet/sec
Velocity =	3.916969	feet/sec

Design flow depth = 0.7 ft. Use a freeboard of 0.3 ft (Barfield et al., 1981). Completed channel depth = 1.0 ft.

The design riprap size (d_{50} = 6.0 in) is the same proposed for the sed. pond emergency spillway. Because soils in the pond embankment and in the diversion ditch are similar, filter blanket requirements will be the same. Gradations for the riprap and filter blanket are shown on page 8 of this calc. (see sed. pond calcs. for more detail).

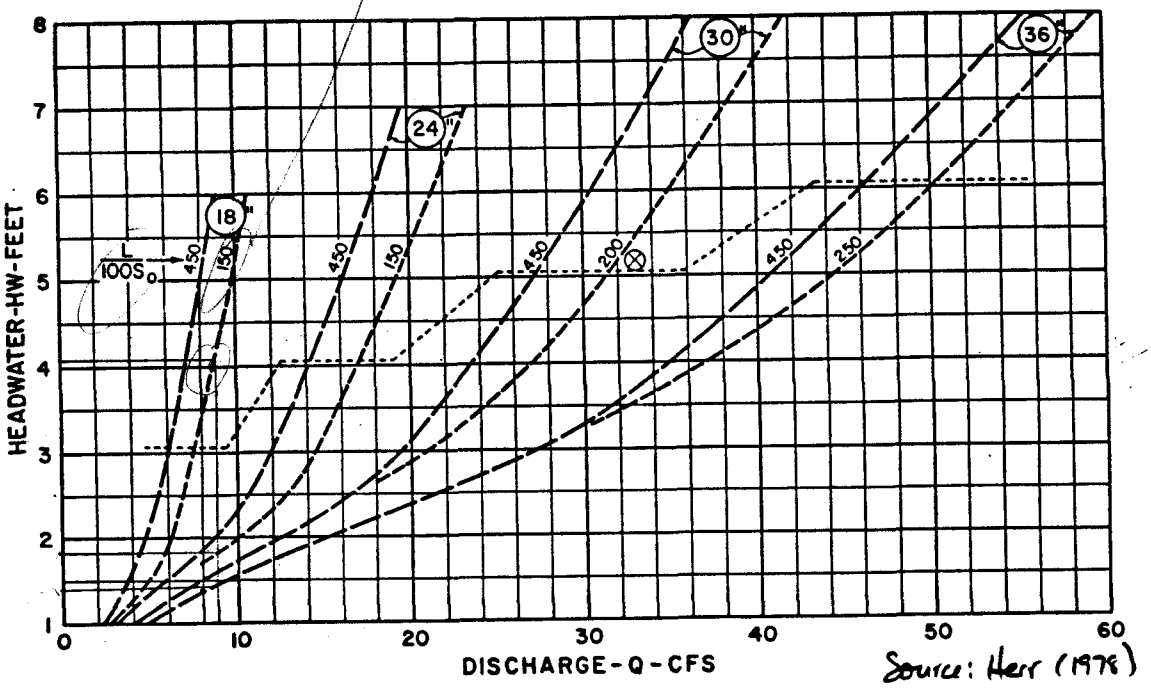
K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6010



Water from the diversion ditch should be discharged to Crandall Creek via a CMP culvert down the main creek bank to avoid excessive erosion. Place a riprap splash basin at the CMP outlet. Use chart below to determine culvert size.

$L = 90$ ft
$S_o = 11.1\%$

$$\frac{L}{100 S_o} = 8.1$$



Source: Herr (1978)

Chart indicates → 18" CMP — HW = 4.1 ft
24" CMP — HW = 1.8 ft
36" CMP — HW = 0.4 ft

Use 24" CMP. Provide headwall to increase efficiency. Provide splash basin at bottom of culvert. Use $d_{50} = 6$ in riprap used for channel. Riprap should be placed 24" deep in basin measuring 36" wide by 6' long.

BS

1) can't assume same
2) stream channel location must pass Crandall Creek
3)

WS-3 Diversion

$l = 1300$ ft

$S = 4.49$

$Y = \frac{160 \text{ ft}}{230 \text{ ft}} = 69.6\%$

$$L = \frac{(1300)^{0.8}(5.49)^{0.7}}{(1900)(69.6)^{0.5}}$$

$= 0.06$ hr

$T_c = 0.11$ hr

Area = 15.6 ac = 0.024 mi²

$P = 2.50$ in

$t = 24$ hr

Hydrograph results (see page 11 of this calc.):

$q_p = 1.51$ cfs @ $t = 10.0$ hr

TRAP1 results:

Earthen channel

Bed Slope =	.01	
Manning's N =	.025	
Bottom Width =	0	feet
Channel Side Slope =	.5	
Flow Depth =	.5644824	feet
Cross Sectional Area =	.6372807	square feet
Wetted Perimeter =	2.524442	feet
Hydraulic Radius =	.2524442	feet
Discharge =	1.51	cubic feet/sec
Velocity =	2.369443	feet/sec

Acceptable (no lining required)

V-shaped channel w/ 2h:1v sideslopes acceptable for WS-3 diversion. Channel depth = 1.0 ft

```
*******************************
* EARTHFAX ENGINEERING, INC.  *
*                             *
* HYDROGRAPH GENERATION MODEL *
*   USING SCS CURVE NUMBER    *
*         METHODOLOGY         *
*******************************
```

IDENTIFICATION: WS-3

INPUT SUMMARY:

```
*************************************************************
     STORM:                    WATERSHED:
        DIST. = SCS TYPE B          AREA =  0.024 SQ. MI.
        DEPTH =  2.50 IN.           CN = 69.0
        DURATION = 24.0 HR.         TIME OF CONC. =  0.11 HR.
*************************************************************
```

```
*************************************************************
```

OUTPUT SUMMARY:

```
*************************************************************
     TOTAL RUNOFF DEPTH =  0.4208 INCHES
     INITIAL ABSTRACTION =  0.8986 INCHES
     PEAK FLOW =     1.51 CFS  ( 0.0974 IN/HR)
     TIME TO PEAK =  10.00 HOURS
     RUNOFF VOLUME CHECK =  0.4217 INCHES
*************************************************************
```

Design of Mine Yard Culverts

Culvert at downstream end of yard (inlet to sed. pond):

$CN = 90$
$T_c = 0.12$ hr
$A = 0.009$ mi^2
$P = 2.50$ in in 24 hr

} see sed. pond calcs.

Storm distribution → SCS

Results of short-form printout:

```
*******************************
* EARTHFAX ENGINEERING, INC.  *
*                             *
* HYDROGRAPH GENERATION MODEL *
*   USING SCS CURVE NUMBER    *
*         METHODOLOGY         *
*******************************
```

IDENTIFICATION: CRANDALL CANYON MINE YARD - DOWNSTREAM END

INPUT SUMMARY:

```
*****************************************************************
     STORM:                          WATERSHED:
        DIST. = SCS TYPE B              AREA =  0.009 SQ. MI.
        DEPTH =  2.50 IN.               CN = 90.0
        DURATION = 24.0 HR.             TIME OF CONC. =  0.12 HR.
*****************************************************************
```

```
*****************************************************************
```

OUTPUT SUMMARY:

```
*****************************************************************
     TOTAL RUNOFF DEPTH =  1.5310 INCHES
     INITIAL ABSTRACTION =  0.2222 INCHES
     PEAK FLOW =      2.09 CFS  ( 0.3601 IN/HR)
     TIME TO PEAK =   9.99 HOURS
     RUNOFF VOLUME CHECK =  1.5340 INCHES
*****************************************************************
```

From nomograph on pg. 9 of this calc., capacity of 18" CMP with projecting end and HW/D = 1.0 is 5.6 cfs. Hence, 18" CMP more than adequate for all culverts within yard area. Existing yard area culverts are 24".

WS-4 diversion:
TRAP1 results:

Bed Slope =	.17	
Manning's N =	.025	
Bottom Width =	0	feet
Channel Side Slope =	.5	
Flow Depth =	.1045205	feet
Cross Sectional Area =	2.184907E-02	square feet
Wetted Perimeter =	.4674298	feet
Hydraulic Radius =	4.674299E-02	feet
Discharge =	.07	cubic feet/sec
Velocity =	3.203799	feet/sec

Velocity is acceptable for unlined channel. Construct V-channel with 2h:1v sideslopes, 1.0 ft deep.