RUNOFF VOLUME - POND 013

10-YR, 24-HR = 1.8 in

CN = 75 FOR UNDISTURBED AREA

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad P > 0.2S \text{ (BARFIELD et al., 1983)}$$

$$S = \frac{1000}{CN} - 10 = \frac{1000}{75} - 10 = 8.33$$

P = 1.8 in

$$Q = \frac{(1.8 - 0.2(8.33))^2}{(1.8 + 0.8(8.33))} = 0.288 \text{ in} = 0.024 \text{ FT}$$

UNDISTURBED AREA = 59.6 AC

RUNOFF VOLUME = (0.024 FT)(59.6 AC)(43560 FT²/AC)

UNDISTURBED AREA RUNOFF VOLUME = 62,300 FT³

CN = 80 FOR RECLAIMED AREAS

$$S = \frac{1000}{CN} - 10 = \frac{1000}{80} - 10 = 2.5$$

$$Q = \frac{(1.8 - 0.2(2.5))^2}{1.8 + 0.8(2.5)} = 0.44 \text{ in} = 0.037 \text{ FT.}$$

RECLAIMED (DISTURBED AREA) = 24.12 AC.

RUNOFF VOLUME = (0.037 FT)(24.12 AC)(43560 FT²/AC)

RECLAIMED AREA RUNOFF VOLUME = 38900 FT³

TOTAL RUNOFF:

UNDISTURBED AREA = 62,300 FT³
RECLAIMED AREA = 38,900 FT³

TOTAL RUNOFF = 101,200 FT³

RE-DESIGN OF POND 011 FOR RECLAMATION CONDITIONS

Stage-Area-Capacity Data (Proposed Structure)

	Elev. (ft)	Stage (ft)	Area (ft^2)	Δ Vol. (ft^3)	Cum. Vol. (ft^3)
	81	0	684		0
				894	
	82	1	1100		894
				2700	
	84	3	1600		3594
				3920	
	86	5	2320		7514
				5332	
	88	7	3012		12,846
				6872	
	90	9	3860		19,718
				8432	
	92	11	4572		28,150
				10,252	
	94	13	5080		38,402
				12,512	
	96	15	6832		50,914
Spillway crest →				7292	
	97	16	7752		58,206
				8284	
Primary	98	17	8816		66,490
				9408	
	99	18	10,000		75,898

Note: Elev. relative to 100.0 on top of embankment (see As-Built Drawing)

See drawing on page 2 of this calc.

Stage-Capacity Curve → See pg 3 of this calc.

Required Storage Volume (see previous calcs. in this appendix)

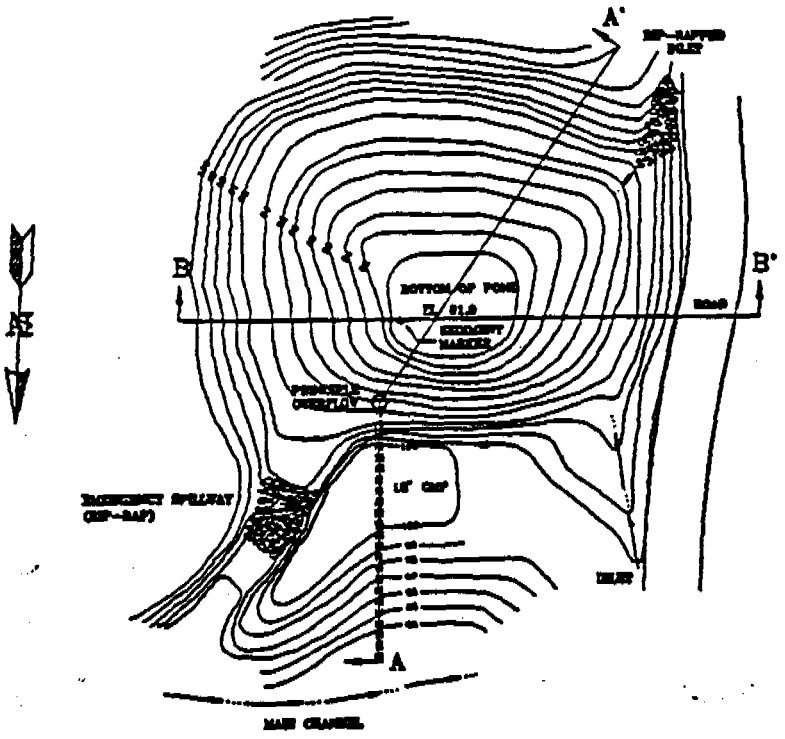
Runoff = 53,603 ft^3
3yr Sed. = 4959 ft^3

Adequate since 3-yr sed. storage is not a requirement.

15/60

POND 011

NOTE: POND 011 WILL BE DEWATERED TO THE MAXIMUM SEDIMENT LEVEL USING A PORTABLE PUMP SYSTEM.



NOTE: ELEVATIONS ARE RELATIVE TO 100.0

MAXIMUM SEDIMENT CAPACITY:	4,603 CUBIC FEET
CAPACITY AT PRINCIPLE OVERFLOW:	58,206 CUBIC FEET
MAXIMUM POND CAPACITY AT SPILLWAY:	66,500 CUBIC FEET

PLAN VIEW

EARTHFAX ENGINEERING, INC.
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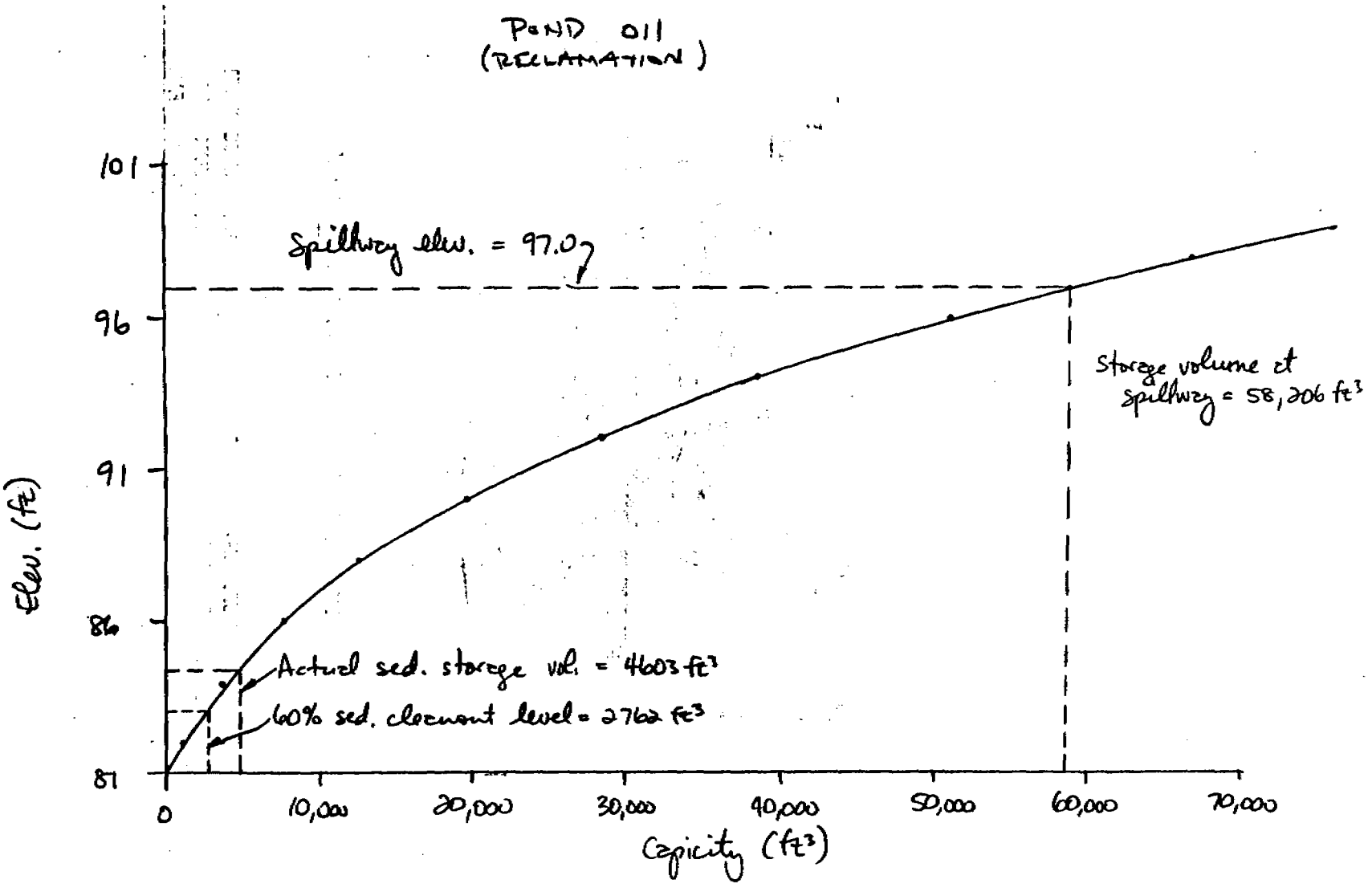
PROJECT UC-18-18 PAGE 16 OF 60
COMPUTED RSW DATE 1 May 92
CHECKED DATE

STAGE-CAPACITY CURVE
PREPARATION PLANT

POND 011
(RECLAMATION)



Spillway Adequacy

Methodology → SEDIMOT II

Design storm → 25-yr, 6-hr event (P = 1.6 in)

Storm distribution → SCS Type II

Time increment of outflow hydrograph = 0.1 hr

No. of junctions = 1

No. of branches = 1

Computation mode → hydr. and sed. (to allow flow routing through the pond). Suppress the sed. calcs.

Specific gravity of the eroded sed. = 2.5

Coef. for distributing sed. load = 1.5

Submerged bulk gravity = 1.25

Grain-size distribution:

Size (mm)	% Finer
0.25	100
0.10	50
0.05	35
0.01	19
0.005	15
0.001	6
0.0001	0

Assumed distribution to allow prog. operation only, Sed calcs not of interest.

No. of structures → 1 sed. pond

Between structures routing parameters → All Ø

No. of subwatersheds → 2 (reclaimed & undisturbed)

CGWS-R3 ↑ ↖ CGWS-U8 and U9

(see previous calcs in this appendix)

Data for Subwatershed 1 (reclaimed) — CGWS-R3

Area = 11.58 ac

CN = 80

T_c = 0.301 hr

Sed. yield calcs → All ∅

Data for Subwatershed 2 (undisturbed) — CGWS-U8 and CGWS-U9

Area = 33.42 ac

CN = 75

T_c → use T_c for CGWS-U9 + travel time from outlet of U9 to pond

$(T_c)_{U9}$ = 0.102 hr

U9 to pond → 1500 ft @ 1.7% slope ⇒ V = 2.6 ft/s (see pg 6 of this calc.)

$$\frac{1500 \text{ ft}}{2.6 \text{ ft/s}} = 577 \text{ sec} = 0.160 \text{ hr}$$

T_c = 0.102 hr + 0.160 hr

= 0.262 hr

Sed. yield calcs. → all parameters = ∅

Pond parameters:

Dead space → Assume = 20%

Outflow withdrawal → surface

Inflow → mixed (completely)

Stage-area data → see pg 1 of this calc. Program assumes pond full to spillway crest prior to storm.

No. of cont. stirred reactors → 2

19/60

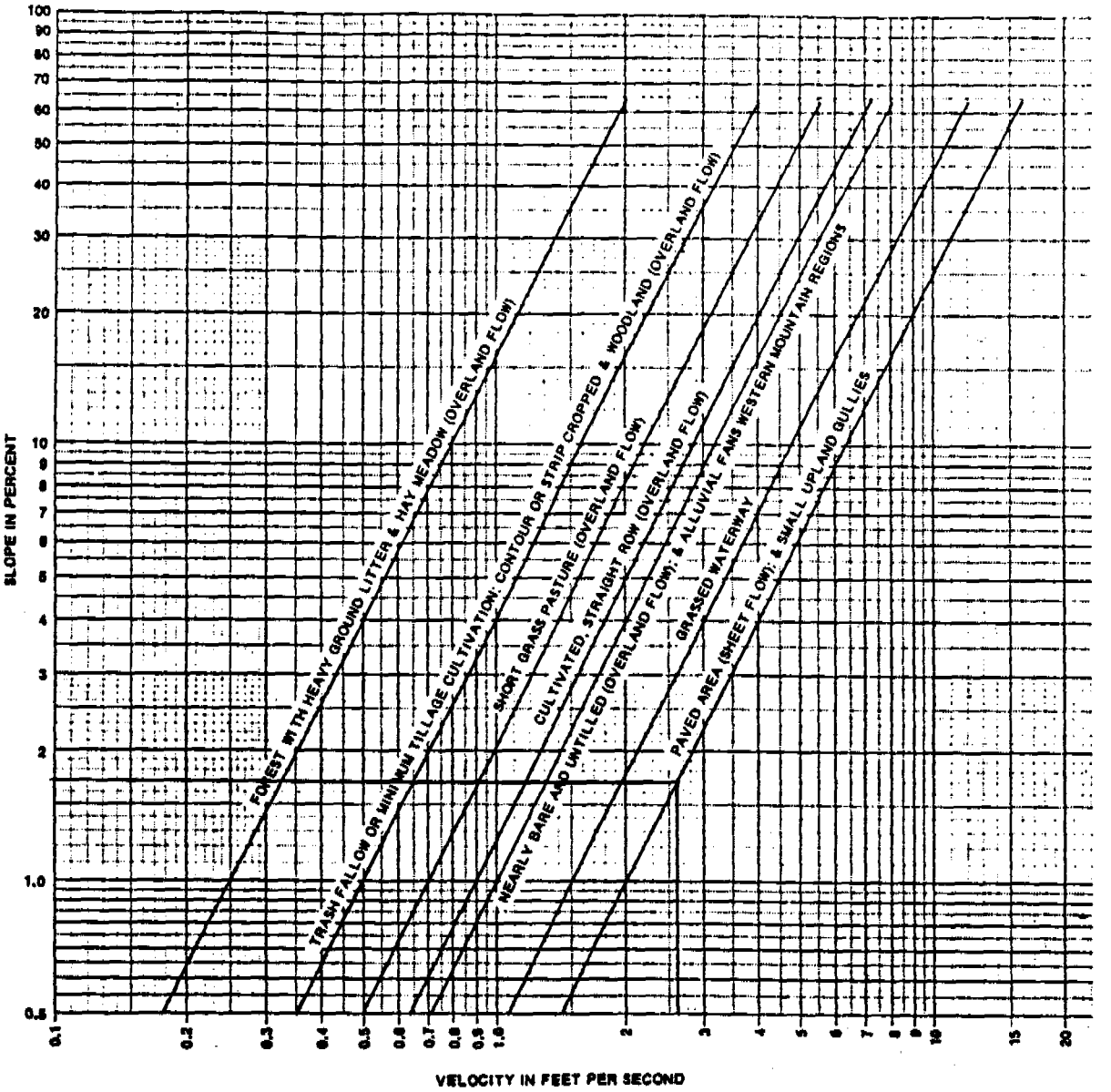


Figure 15.2.—Velocities for upland method of estimating T_c

Source → NEH-4

****

-- SEDPC --

SEDIMOT II MODEL FOR THE IBM PC/XT

CONVERTED BY TECH ENGINEERING INC.

VERSION 1.10 NOVEMBER 17,1983

****

****

****

UNIVERSITY OF KENTUCKY COMPUTER MODEL
OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
FOR MORE INFORMATION CONTACT THE AGRICULTURAL
ENGINEERING DEPARTMENT

THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

VERSION DATE 9-23-83

DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

****

****

****

THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.
THEY CAN BE FOUND IN SUMMARY TABLES.

1. PERIOD OF SIGNIFICANT CONCENTRATION
2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION
   DURING PERIOD OF SIGNIFICANT CONCENTRATION
3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION
   DURING PEAK 24 HOUR PERIOD
4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION
   DURING PERIOD OF SIGNIFICANT CONCENTRATION
5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION
   DURING PEAK 24 HOUR PERIOD

ALL CONCENTRATIONS ARE IN ML/L.

****

****

WATERSHED IDENTIFICATION CODE

POND 011, 25-YEAR, 6-HOUR STORM

****

********** INPUT RAINFALL PATTERN **********

VALUE	DEPTH	TIME
1	.00	.00
2	.06	.50
3	.13	1.00
4	.22	1.50
5	.37	2.00
6	.96	2.50
7	1.12	3.00
8	1.25	3.50
9	1.34	4.00
10	1.42	4.50
11	1.48	5.00
12	1.54	5.50
13	1.60	6.00

INPUT PARTICLE SIZE-PERCENT FINER DISTRIBUTIONS

SIZE,MM	.250	.100	.050	.010	.005	.001	.000
PCT FINER NO. 1	100.000	50.000	35.000	19.000	15.000	6.000	.000

**********INPUT VALUES**********

STORM DURATION	=	6.00	HOURS
PRECIPATION DEPTH	=	1.60	INCHES
SPECIFIC GRAVITY	=	2.50	
LOAD RATE EXPONENT FACTOR	=	1.50	
SUBMERGED BULK SPECIFIC GRAVITY	=	1.25	

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	11.58	80.00	.301	.000	.000	.00	2.0
2	33.42	75.00	.262	.000	.000	.00	3.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.00	.0	.00	.000	1.0	.0
2	1	.00	.0	.00	.000	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	1.81	.34	.00	.042	.664	1.000
2	1.78	.20	.00	.021	.525	1.000

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.8930	ACRE-FT
PEAK DISCHARGE	=	3.0451	CFS
AREA	=	45.0000	ACRES
TIME OF PEAK DISCHARGE	=	2.70	HRS
BETA	=	1.0000	
RAINFALL EROSITIVITY FACTOR	=	7.34	EI UNIT
PEAK CONCENTRATION	=	.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	.00	ML/L
PEAK SETTLEABLE CONCENTRATION	=	.00	MG/L
TOTAL SEDIMENT YIELD	=	.0000	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0001	MM
TIME OF PEAK CONCENTRATION	=	.00	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-9.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF			

SIGNIFICANT CONCENTRATION	-	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	-	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	-	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	-	.00	ML/L

* *

POND RESULTS

* *

***** CONTROL VARIABLES OPTIONS *****

FLOW	FRACTN	ISDO	NRHP	NSP	NCSTR
3	0	2	500	12	2

***** DROP SPILLWAY INPUTS *****

ENTRANCE LOSS COEFFICIENT	-	1.0000	
BEND LOSS COEFFICIENT	-	.5000	
WEIR COEFFICIENT	-	3.1000	
ORIFICE COEFFICIENT	-	.6000	
MANNING COEFFICIENT	-	.0240	
BARREL DIAMATER	-	15.00	INCHES
RISER DIAMETER	-	15.00	INCHES
LENGTH OF PIPE	-	58.30	FEET
VERTICAL HEAD DROP	-	3.90	FEET

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.016	.00	.00	.00
1.00	.025	.89	.00	.02
3.00	.037	2.57	.00	.08
5.00	.053	4.09	.00	.17
7.00	.069	5.52	.00	.29
9.00	.089	6.85	.00	.45
11.00	.105	8.17	.00	.65
13.00	.130	9.43	.00	.88
15.00	.157	10.60	.00	1.17
16.00	.178	11.14	.00	1.34
17.00	.202	11.62	5.91	1.53
18.00	.230	12.06	8.36	1.74

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	1.336	ACRE-FT
DEAD STORAGE	=	20.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	.893	ACRE-FT
OUTFLOW ROUTED VOLUME	=	.893	ACRE-FT
STORM VOLUME DISCHARGED (PLUG FLOW)	=	.893	ACRE-FT
POND VOLUME AT PEAK STAGE	=	1.427	ACRE-FT
PEAK STAGE	=	16.476	FT
PEAK INFLOW RATE	=	3.045	CFS
PEAK DISCHARGE RATE	=	2.815	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.00	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	.00	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
BASIN TRAP EFFICIENCY	=**********		PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	.39	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	.39	HRS
DETENTION TIME INCLUDING STORED FLOW	=	.39	HRS
SEDIMENT LOAD DISCHARGED	=	.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-10.90	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR			

PERIOD	-	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	-	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	-	.00	ML/L

*** RUN COMPLETED ****

SEDIMOT II results → Peak inflow = 3.04 cfs
Peak outflow = 2.82 cfs
Peak stage = 16.48 ft
= 0.48 ft above spillway crest.

Stage of emergency spillway = 17. Thus, emerg. spillway will not flow during the design event.

Freeboard = 18.00 - 16.48
= 1.52 ft (adequate)

RE-DESIGN OF POND 012 FOR RECLAMATION CONDITIONS

Stage - Area - Capacity Data (Proposed Structure)

Elev (ft)	(Stage)	Area (ft^2)	Δ Vol (ft^3)	cum. vol (ft^3)
6090	0.0	3696		0
			11,069	
6092	2.0	7373		11,069
			18,855	
6094	4.0	11,482		29,924
			26,711	
6096	6.0	15,229		56,635
			16,382	
6097	7.0	17,534		73,017
			18,687	
6098	8.0	19,840		91,704
			20,993	
6099	9.0	22,145		112,697

(See drawing on pg 2 of this calc.)

Stage - Capacity Curve

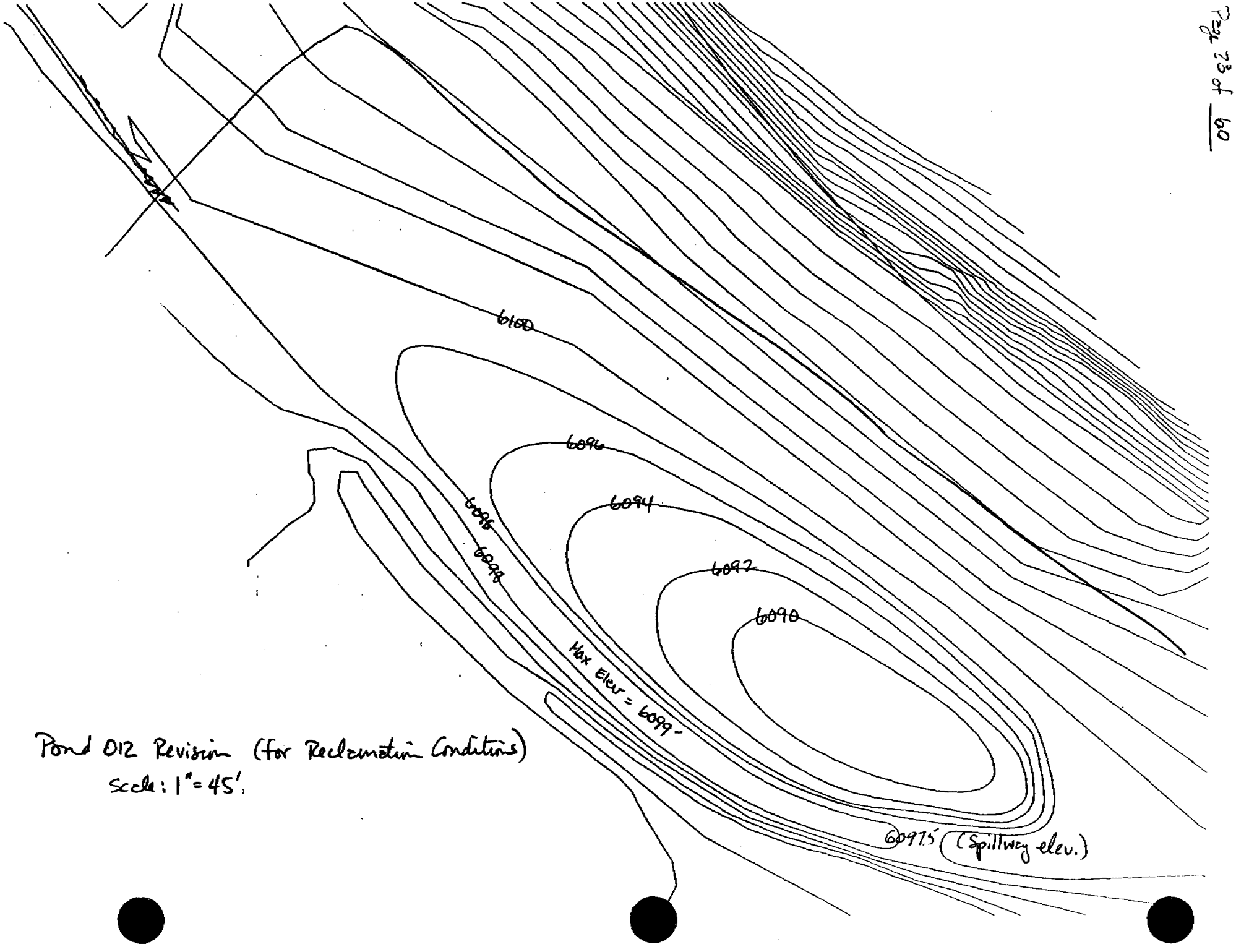
See pg 3 of this calc.

Required Storage Volume

Runoff volume = 60,035 ft^3

Sediment volume = 9,573 ft^3

Total ≈ 69,600 ft^3 (see previous calcs. in this appendix)



Pond 012 Revision (for Reclamation Conditions)
Scale: 1" = 45'.

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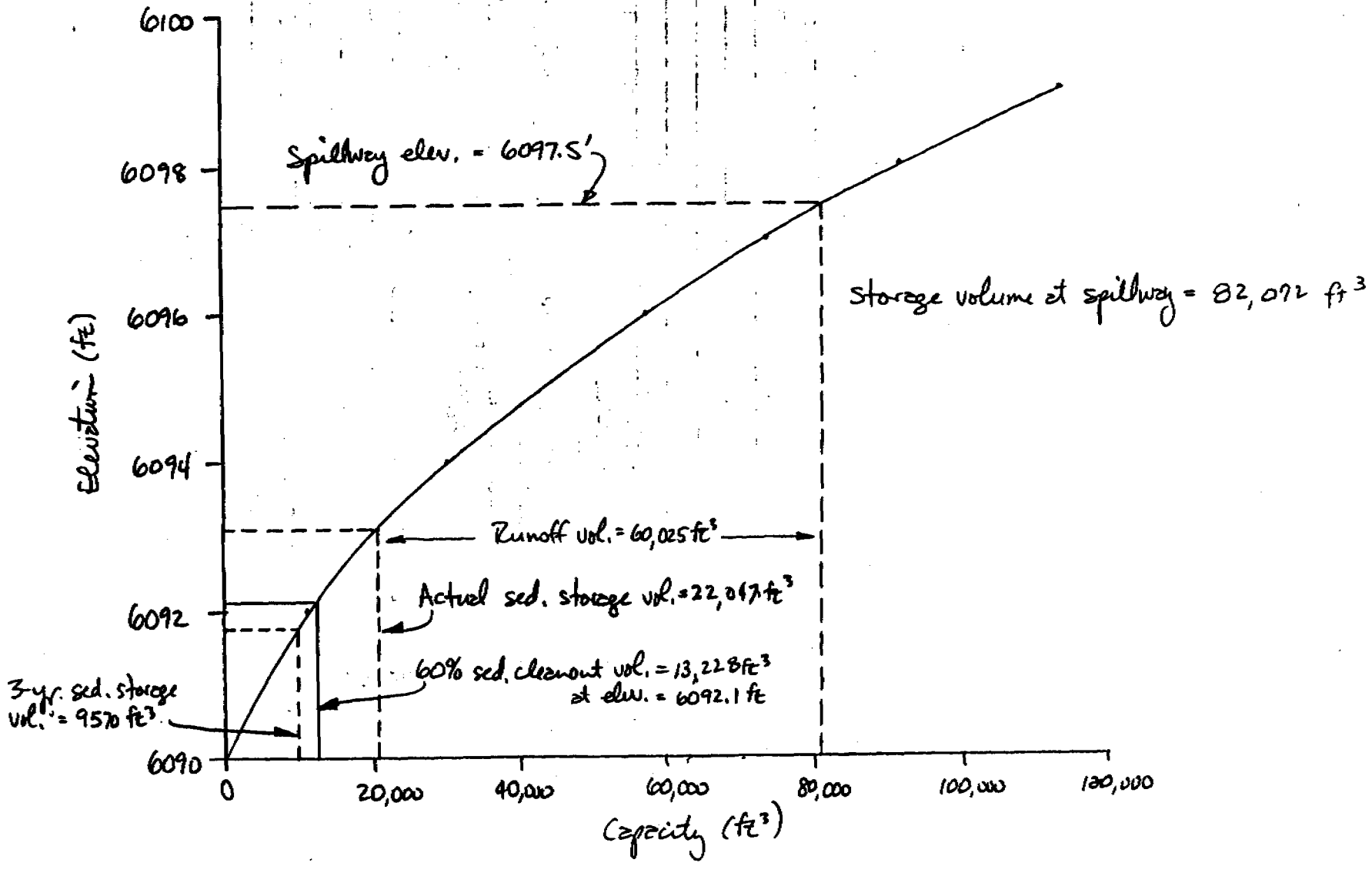
PROJECT UC-150-18 PAGE 29 OF 60
COMPUTED RDH DATE 30 Apr 1992
CHECKED [illegible] DATE 7/6/92 8/20/92

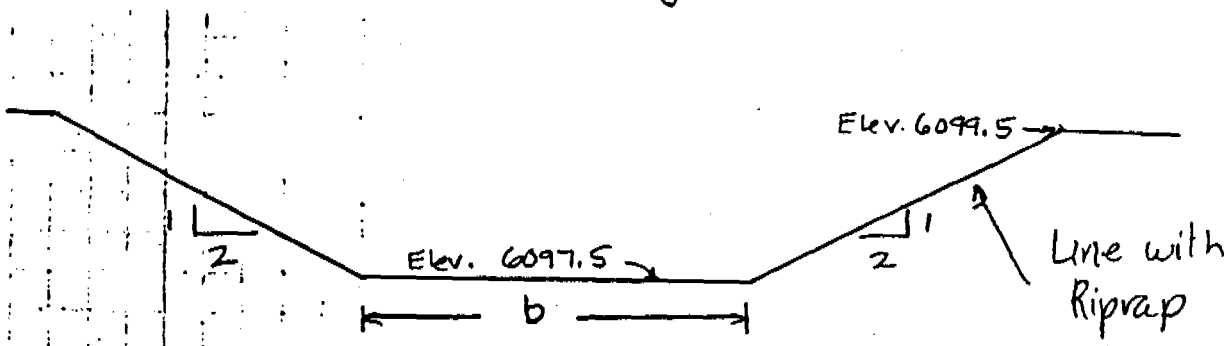
Pond 012 (Revised)

Stage - Capacity Curve



Spillway Capacity

Pond will be constructed to retain existing Pond 012B spillway. From the Pond 012B calcs dated February 1991:



Assume $D_{50} \sim 12"$ to calculate manning's $n \Rightarrow$

$n = .0395\ D_{50}^{1/6}$ (Barfield et al, 1983)

$n = .0395\ (1)^{1/6} = .0395$

Calculate a Stage-discharge curve for the Spillway channel:

Based on a 100-foot wide rectangular Section $\Rightarrow$

$q_r = (1.544)\, g^{1/2}\, (H_{ec})^{1.5}\, (100)$ (Barfield et al, 1983)

$= 308.69\ H_{ec}^{1.5}$

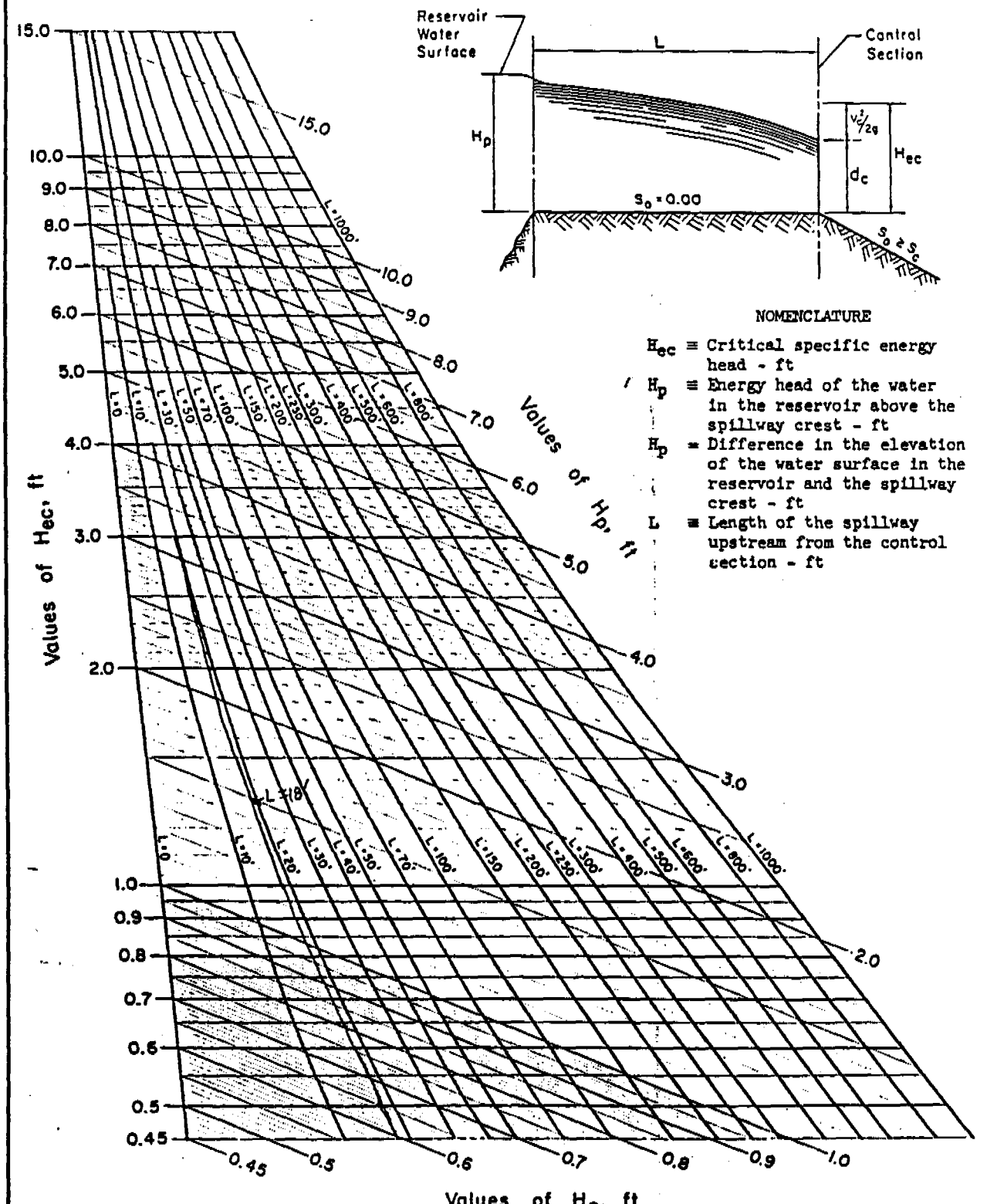
Using Attached Figure: (pg 5 of this calc.) $L = 18'$

H_p (ft)	H_{ec} (ft)	q_r (ft^3/s)
.6	.45	93.2
.8	.64	158.0
1.0	.83	233.4
1.2	1.04	327.4
1.4	1.28	447.1
1.5	1.32	468.1
2.0	1.80	745.5

SPILLWAYS: Hec vs Hp for Various Lengths, L

b = 100 ft
z = 2
n = 0.04

Case I



NOMENCLATURE

H_{ec} ≡ Critical specific energy head - ft

H_p ≡ Energy head of the water in the reservoir above the spillway crest - ft

H_p = Difference in the elevation of the water surface in the reservoir and the spillway crest - ft

L ≡ Length of the spillway upstream from the control section - ft

REFERENCE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING DIVISION - DESIGN UNIT

STANDARD DWG. NO.
ES- 171
SHEET 1 OF 10
DATE 2-67

Convert to a trapezoidal section using the equation

$$q_{trap} = [(1.5b + zH_{ec})/150](q_r)$$

where $b = 8'$

$z = 2:1 = 2$

(Stage)	Elev. (ft)	H_{ec} (ft)	q_r (ft^3/s)	q_{trap} (ft^3/s)
7.5	6097.5	0	0	0
8.1	6098.1	0.45	93.2	5.2
8.3	6098.3	0.64	158.0	9.2
8.5	6098.5	0.83	233.4	14.2
8.7	6098.7	1.04	327.4	20.9
8.9	6098.9	1.28	447.1	30.0
9.0	6099.0	1.32	468.1	31.6

Adequacy of Spillway Design

Methodology → Use Sedimot II

Design storm → 25-yr, 6-hr storm = 1.6 in (Miller et al., 1973)

Storm distribution → SCS Type B (see distribution on pg 7 of this calc.)

Time increment of outflow hydrograph = 0.1 hr

No. of junctions = 1

No. of branches = 1

Computation mode → hydro. & sed (to allow flow routing – only hydro. output is of concern). Suppress the sed. calcs.

Specific gravity of the eroded sediment = 2.5

Coef. for distributing sed. load = 1.5

Submerged bulk gravity = 1.25

Grain-size distribution:

Size (mm)	% Finer
0.25	100
0.10	50
0.05	35
0.01	19
0.005	15
0.001	6
0.0001	0

} Assumed distribution to allow program operation. Sed. calcs not of interest.

RAINFALL DISTRIBUTION - SCS TYPE II - 6 hr

TIME (%)	DEPTH (%)	TIME (hrs)	DEPTH (in)	30 min INTENSITY
0	0	0	0	
				.06
8.33	3.5	0.5	0.06	
				.07
16.67	8.0	1.0	0.13	
				.09
25.0	13.5	1.5	0.22	
				.15
33.33	23.0	2.0	0.37	
				.59
41.67	60.0	2.5	0.96	
				.16
50.0	70.0	3.0	1.12	
				.13
58.33	78.0	3.5	1.25	
				.09
66.67	83.5	4.0	1.34	
				.03
75.0	88.5	4.5	1.42	
				.06
83.33	92.5	5.0	1.48	
				.06
91.67	96.5	5.5	1.54	
				.06
100.0	100.0	6.0	1.60	

No. of structures = 1 (sed. pond)

Between structures routing parameters → All ∅ (no upstream structures or junctions)

No. of subwatersheds = 2 (reclaimed and undisturbed)
CGWS-R1 & CGWS-R2 (See previous calcs in this appendix) CGWS-U10

Data for subwatershed 1 (reclaimed) — CGWS-R1 & CGWS-R2

Area = 28.9 ac

CN = 80

T_c → Use T_c for CGWS-R2 + travel time from outlet of R2 to pond

$(T_c)_{R2}$ = 0.100 hr

R2 to pond distance = 700 ft
R2 to pond slope = 1.6%
} V = 2.5 ft/s (see pg 9 of this calc.)
(Paved area equivalent)

$\frac{700 \text{ ft}}{2.5 \text{ ft/s}}$ = 280 sec = 0.078 hr

T_c = 0.100 + 0.078 = 0.178 hr

Subwatershed 2 (CGWS-U10) (Undisturbed)
A = 3.95 ac
CN = 78
T_c = 0.048 hr

Sed. yield calcs. → All parameters = ∅ (to suppress output)

Pond parameters:

Dead space → Assume 20%
Outflow withdrawal → surface
Inflow → completely mixed
Stage-area data → see pg 10 of this calc. Program assumes pond full to spillway crest prior to storm.
No. of continuous stirred reactors → 2
Stage-discharge curve → see pg 6 of this calc.

35/60

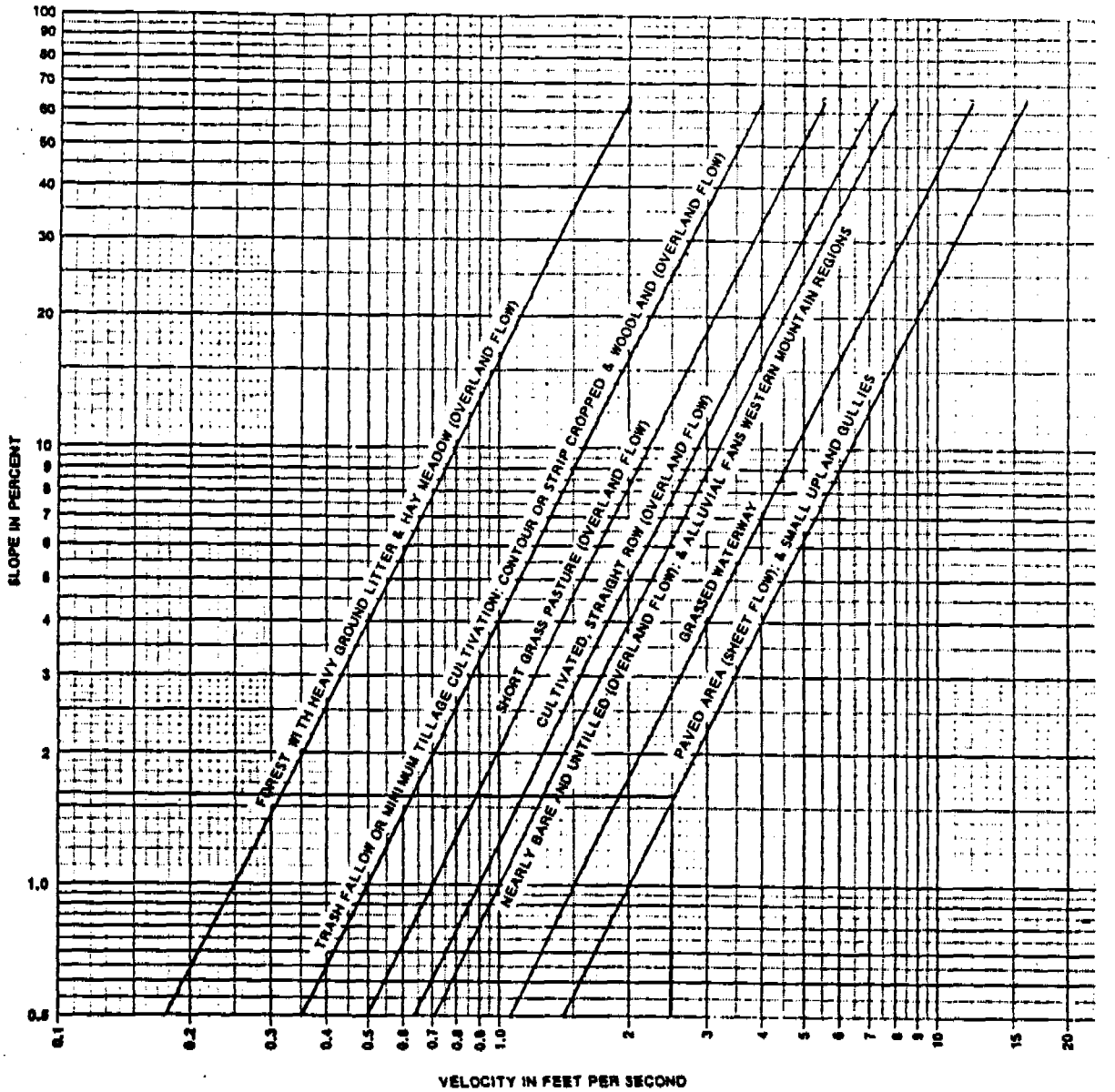
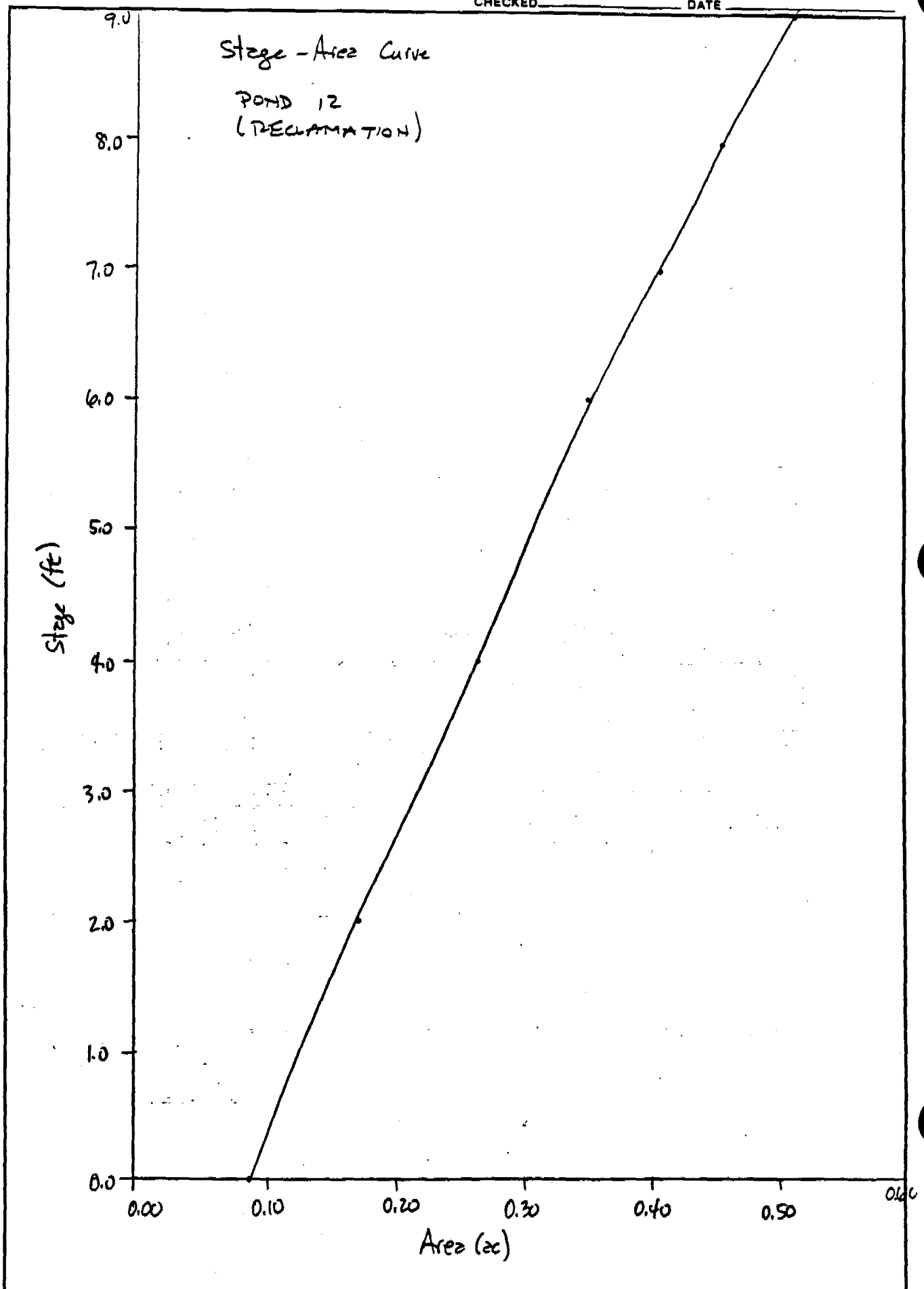


Figure 15.2.—Velocities for upland method of estimating T_c

Source → NEH-4


Stage - Area Curve
POND 12
(RECLAMATION)
Stage (ft)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
Area (ac)

```
**********************************************************************
                          -- SEDPC --
                  SEDIMOT II MODEL FOR THE IBM PC/XT
                  CONVERTED BY TECH ENGINEERING INC.
                     VERSION 1.10 NOVEMBER 17,1983
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       UNIVERSITY OF KENTUCKY COMPUTER MODEL
       OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
       FOR MORE INFORMATION CONTACT THE AGRICULTURAL
       ENGINEERING DEPARTMENT

       THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
       THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
       MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

       VERSION DATE 9-23-83

       DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
       ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
       CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

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*                                                                    *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.          *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                           *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                        *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION                 *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                                 *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION                *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION                 *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION                *
*         DURING PEAK 24 HOUR PERIOD                                 *
*                                                                    *
*     ALL CONCENTRATIONS ARE IN ML/L.                                *
*                                                                    *
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                 WATERSHED IDENTIFICATION CODE
                 -----------------------------
 POND 012, 25-YEAR, 6-HOUR STORM

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********** INPUT RAINFALL PATTERN **********

VALUE	DEPTH	TIME
1	.00	.00
2	.06	.50
3	.13	1.00
4	.22	1.50
5	.37	2.00
6	.96	2.50
7	1.12	3.00
8	1.25	3.50
9	1.34	4.00
10	1.42	4.50
11	1.48	5.00
12	1.54	5.50
13	1.60	6.00

INPUT PARTICLE SIZE-PERCENT FINER DISTRIBUTIONS

SIZE,MM	.250	.100	.050	.010	.005	.001	.000
PCT FINER NO. 1	100.000	50.000	35.000	19.000	15.000	6.000	.000

**********INPUT VALUES**********

STORM DURATION	=	6.00	HOURS
PRECIPATION DEPTH	=	1.60	INCHES
SPECIFIC GRAVITY	=	2.50	
LOAD RATE EXPONENT FACTOR	=	1.50	
SUBMERGED BULK SPECIFIC GRAVITY	=	1.25	

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	28.94	80.00	.178	.000	.000	.00	2.0
2	3.95	78.00	.048	.000	.000	.00	3.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.00	.0	.00	.000	1.0	.0
2	1	.00	.0	.00	.000	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	5.64	.34	.00	.056	.752	1.000
2	.95	.28	.00	.100	1.000	1.000

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.9022	ACRE-FT
PEAK DISCHARGE	=	5.9437	CFS
AREA	=	32.8900	ACRES
TIME OF PEAK DISCHARGE	=	2.60	HRS
BETA	=	1.0000	
RAINFALL EROSITIVITY FACTOR	=	7.34	EI UNIT
PEAK CONCENTRATION	=	.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	.00	ML/L
PEAK SETTLEABLE CONCENTRATION	=	.00	MG/L
TOTAL SEDIMENT YIELD	=	.0000	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0001	MM
TIME OF PEAK CONCENTRATION	=	.00	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-7.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

* *

POND RESULTS

* *

***** CONTROL VARIABLES OPTIONS *****

FLOW	FRACTN	ISDO	NRHP	NSP	NCSTR
3	0	1	500	12	2

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.085	.00	.00	.00
2.00	.169	1.67	.00	.25
4.00	.264	3.22	.00	.69
6.00	.350	4.69	.00	1.30
7.00	.403	5.40	.00	1.68
7.50	.430	5.75	.00	1.89
8.10	.460	6.16	5.20	2.15
8.30	.470	6.30	9.20	2.25
8.50	.484	6.43	14.20	2.34
8.70	.493	6.57	20.90	2.44
8.90	.505	6.70	30.00	2.54
9.00	.508	6.77	31.60	2.59

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	1.886	ACRE-FT
DEAD STORAGE	=	20.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	.902	ACRE-FT
OUTFLOW ROUTED VOLUME	=	.902	ACRE-FT
STORM VOLUME DISCHARGED (PLUG FLOW)	=	.902	ACRE-FT
POND VOLUME AT PEAK STAGE	=	2.053	ACRE-FT
PEAK STAGE	=	7.876	FT
PEAK INFLOW RATE	=	5.944	CFS
PEAK DISCHARGE RATE	=	3.255	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.00	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	.00	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
BASIN TRAP EFFICIENCY	=	******	PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	.62	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	.62	HRS
DETENTION TIME INCLUDING STORED FLOW	=	.62	HRS
SEDIMENT LOAD DISCHARGED	=	.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-11.30	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

Sedimot II results → Peak inflow = 5.94 cfs
Peak outflow = 3.26 cfs
Peak stage = 7.88 ft
= 0.38 ft above spillway crest

Freeboard during design event = 9.00 - 7.88
= 1.12 ft (adequate)

44/60

CASTLEGATE
PREP PLANT
RECLAMATION PHASE I
POND 011

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

POND 011 - EMERGENCY SPILLWAY ONLY

by

Name: ANTHONY MAGLIOCCHINO

Company Name: EarthFax Engineering INC.
File Name: D:\UC150\P011ESON

Date: 08-27-1992

Company Name: EarthFax Engineering INC.
Filename: D:\UC150\P011ESON User: ANTHONY MAGLIOCCHINO
Date: 08-27-1992 Time: 10:32:32
POND 011 - EMERGENCY SPILLWAY ONLY
Storm: 1.60 inches, 25 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	11.58	80	M	0.301	0.000	0.000	0.0	0.32	1.81
111	2	33.42	75	S	0.262	0.000	0.000	0.0	0.57	1.77
		Type: Pond Label: POND 011								
111	Structure	45.00							0.89	
111	Total IN	45.00							0.89	3.10
111	Total OUT								0.89	2.96

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POND INPUT/OUTPUT TABLE

J1, B1, S1
POND 011

Drainage Area from J1, B1, S1, SWS(s)1-2: 45.0 acres
Total Contributing Drainage Area: 45.0 acres

DISCHARGE OPTIONS:

	Emergency Spillway
Riser Diameter (in)	----
Riser Height (ft)	----
Barrel Diameter (in)	----
Barrel Length (ft)	----
Barrel Slope (%)	----
Manning's n of Pipe	----
Spillway Elevation	----
Lowest Elevation of Holes	----
# of Holes/Elevation	----
Entrance Loss Coefficient	----
Tailwater Depth (ft)	----
Notch Angle (degrees)	----
Weir Width (ft)	----
Siphon Crest Elevation	----
Siphon Tube Diameter (in)	----
Siphon Tube Length (ft)	----
Manning's n of Siphon	----
Siphon Inlet Elevation	----
Siphon Outlet Elevation	----
Emergency Spillway Elevation	98.0
Crest Length (ft)	10.0
Z:1 (Left and Right)	2 2
Bottom Width (ft)	6.0

POND RESULTS:

Permanent Pool (ac-ft)
1.5

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	0.89	3.10
OUT	0.89	2.96

Peak Elevation	Hydrograph Detention Time (hrs)
98.3	0.00

****

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Storm: 1.60 inches, 25 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-DISCHARGE TABLE

J1, B1, S1
POND 011

Drainage Area from J1, B1, S1, SWS(s)1-2: 45.0 acres
Total Contributing Drainage Area: 45.0 acres

Elevation	Emergency Spillway (cfs)	Total Discharge (cfs)
81.00	0.0	0.0
81.50	0.0	0.0
82.00	0.0	0.
82.50	0.0	0.
83.00	0.0	0.0
83.50	0.0	0.
84.00	0.0	0.0
84.50	0.0	0.0
85.00	0.0	0.0
85.50	0.0	0.0
86.00	0.0	0.0
86.50	0.0	0.0
87.00	0.0	0.0
87.50	0.0	0.0
88.00	0.0	0.0
88.50	0.0	0.0
89.00	0.0	0.0
89.50	0.0	0.0
90.00	0.0	0.0
90.50	0.0	0.0
91.00	0.0	0.0
91.50	0.0	0.0
92.00	0.0	0.0
92.50	0.0	0.0
93.00	0.0	0.0
93.50	0.0	0.0
94.00	0.0	0.0
94.50	0.0	0.
95.00	0.0	0.
95.50	0.0	0.
96.00	0.0	0.
96.50	0.0	0.0
97.00	0.0	0.0
97.50	0.0	0.0
98.00	0.0	

98.50	5.9	5.9
98.60	7.1	7.1
98.70	9.5	9.5
98.80	12.3	12.3
98.90	15.4	15.4
99.00	18.4	18.4

****

Company Name: EarthFax Engineering INC.
Filename: D:\UC150\P011ESON User: ANTHONY MAGLIOCCHINO
Date: 08-27-1992 Time: 10:32:32
POND 011 - EMERGENCY SPILLWAY ONLY
Storm: 1.60 inches, 25 year- 6 hour, SCS 6 Hour
Hydrograph Convolution Interval: 0.1 hr

ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

J1, B1, S1
POND 011

Drainage Area from J1, B1, S1, SWS(s)1-2: 45.0 acres
Total Contributing Drainage Area: 45.0 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
81.00	0.00	0.02	0.00	0.00	
81.50	0.50	0.02	0.01	0.00	
82.00	1.00	0.03	0.02	0.00	
82.50	1.50	0.03	0.03	0.00	
83.00	2.00	0.03	0.05	0.00	
83.50	2.50	0.03	0.06	0.00	
84.00	3.00	0.04	0.08	0.00	
84.50	3.50	0.04	0.10	0.00	
85.00	4.00	0.04	0.12	0.00	
85.50	4.50	0.05	0.15	0.00	
86.00	5.00	0.05	0.17	0.00	
86.50	5.50	0.06	0.20	0.00	
87.00	6.00	0.06	0.23	0.00	
87.50	6.50	0.06	0.26	0.00	
88.00	7.00	0.07	0.29	0.00	
88.50	7.50	0.07	0.33	0.00	
89.00	8.00	0.08	0.37	0.00	
89.50	8.50	0.08	0.41	0.00	
90.00	9.00	0.09	0.45	0.00	
90.50	9.50	0.09	0.50	0.00	
91.00	10.00	0.10	0.54	0.00	
91.50	10.50	0.10	0.59	0.00	
92.00	11.00	0.10	0.64	0.00	
92.50	11.50	0.11	0.70	0.00	
93.00	12.00	0.12	0.76	0.00	
93.50	12.50	0.12	0.82	0.00	
94.00	13.00	0.13	0.88	0.00	
94.50	13.50	0.14	0.95	0.00	
95.00	14.00	0.14	1.02	0.00	
95.50	14.50	0.15	1.09	0.00	
96.00	15.00	0.16	1.17	0.00	
96.50	15.50	0.17	1.25	0.00	
97.00	16.00	0.18	1.33	0.00	
97.50	16.50	0.19	1.42	0.00	
98.00	17.00	0.20	1.52	0.00	Stage of SW#1

98.25	17.25	0.20	1.58	2.96	Peak Stage
[illegible].50	17.50	0.22	1.63	5.88	
[illegible]60	17.60	0.22	1.65	7.06	
[illegible].70	17.70	0.22	1.67	9.52	
.80	17.80	0.22	1.69	12.29	
[illegible].90	17.90	0.23	1.72	15.35	
99.00	18.00	0.23	1.74	18.37	

****

RECLAMATION POND INLETS / OUTLETS
(25-YEAR 6-HOUR STORM EVENT)

	DEPTH (FT)	BOTTOM WIDTH (FT)	SIDE SLOPES H:V	FLOW (CFS)	SLOPE (FT/FT)	DEPTH OF FLOW (FT)	FLOW VELOCITY (FPS)	REQ'D RIPRAP D50 (IN)	EXIST RIPRAP D50 (IN)
POND 011									
N. INLET	2	2.5	2:1	1.8	0.26	0.13	5.1	3"	6
S. INLET	0.83	2	1.2:1	1.7	0.43	0.12	6.4	4"	8
PRINCIPLE OVERFLOW	1.5 ø	–	–	2.82	0.015	0.63	4.0	2"	18 (END OF PIPE)
EMERGENCY SPILLWAY	1.5	6	2:1	2.96	0.33	0.1	5.0	3"	6
POND 012									
N. INLET	1.4	3	3:1	5.99	0.05	0.36	4.1	2"	–
S. INLET									
SPILLWAY	1.0	6	2:1	3.26	0.50	0.09	5.9	4"	9"

n = 0.035 FOR ALL CHANNELS
n = 0.022 FOR POND 011 PRINCIPLE OVERFLOW CULVERT (CMP)

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT LC-90-19 PAGE 52 OF 60
COMPUTED [signature] DATE 8/27/92
CHECKED DATE

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POND 011 - N. INLET

Comment: RECLAMATION POND 011 - NORTH INLET

Solve For Depth

Given Input Data:

Bottom Width.....	2.50 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.2600 ft/ft
Discharge.....	1.80 cfs

Computed Results:

Depth.....	0.13 ft
Velocity.....	5.11 fps
Flow Area.....	0.35 sf
Flow Top Width...	3.01 ft
Wetted Perimeter.	3.07 ft
Critical Depth...	0.24 ft
Critical Slope...	0.0317 ft/ft
Froude Number....	2.63 (flow is Supercritical)

5 4/12

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POND 011 - S. INLET

Comment: RECLAMATION POND 011 - SOUTH INLET

Solve For Depth

Given Input Data:

Bottom Width.....	2.00 ft
Left Side Slope..	1.20:1 (H:V)
Right Side Slope.	1.20:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.4300 ft/ft
Discharge.....	1.70 cfs

Computed Results:

Depth.....	0.12 ft
Velocity.....	6.43 fps
Flow Area.....	0.26 sf
Flow Top Width...	2.30 ft
Wetted Perimeter.	2.38 ft
Critical Depth...	0.27 ft
Critical Slope...	0.0318 ft/ft
Froude Number....	3.34 (flow is Supercritical)

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: POND 011 - OUTLET

Comment: RECLAMATION POND 011 - PRINCIPLE OVERFLOW

Solve For Actual Depth

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0150 ft/ft
Manning's n.....	0.022
Discharge.....	2.82 cfs

Computed Results:

Depth.....	0.63 ft
Velocity.....	3.98 fps
Flow Area.....	0.71 sf
Critical Depth....	0.64 ft
Critical Slope....	0.0146 ft/ft
Percent Full.....	42.17 %
Full Capacity.....	7.60 cfs
QMAX @.94D.....	8.18 cfs
Froude Number.....	1.02 (flow is Supercritical)

Open Channel Flow Module, Version 3.2 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POND 011 - SPILLWAY

Comment: RECLAMATION POND 011 - EMERGENCY SPILLWAY

Solve For Depth

Given Input Data:

Bottom Width.....	6.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.3300 ft/ft
Discharge.....	2.96 cfs

Computed Results:

Depth.....	0.10 ft
Velocity.....	4.98 fps
Flow Area.....	0.59 sf
Flow Top Width...	6.38 ft
Wetted Perimeter.	6.43 ft
Critical Depth...	0.19 ft
Critical Slope...	0.0321 ft/ft
Froude Number....	2.88 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POND012 INLET

Comment: RECLAMATION POND 012 - INLET

Solve For Depth

Given Input Data:

Bottom Width.....	3.00 ft
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0500 ft/ft
Discharge.....	5.94 cfs

Computed Results:

Depth.....	0.36 ft
Velocity.....	4.05 fps
Flow Area.....	1.47 sf
Flow Top Width...	5.16 ft
Wetted Perimeter.	5.28 ft
Critical Depth...	0.43 ft
Critical Slope...	0.0268 ft/ft
Froude Number....	1.34 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POND012 SPILLWAY

Comment: RECLAMATION POND 012 - SPILLWAY OUTLET

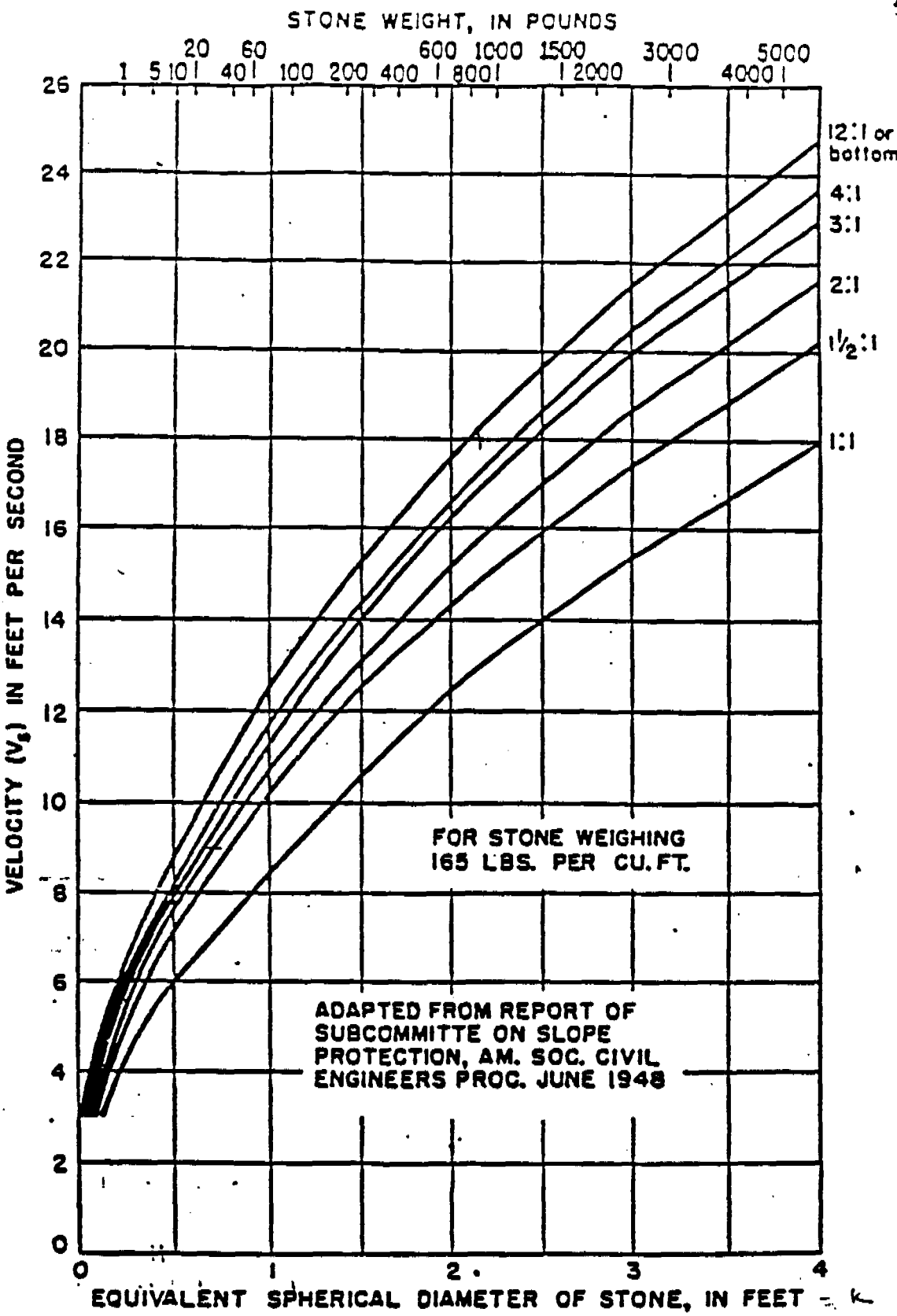
Solve For Depth

Given Input Data:

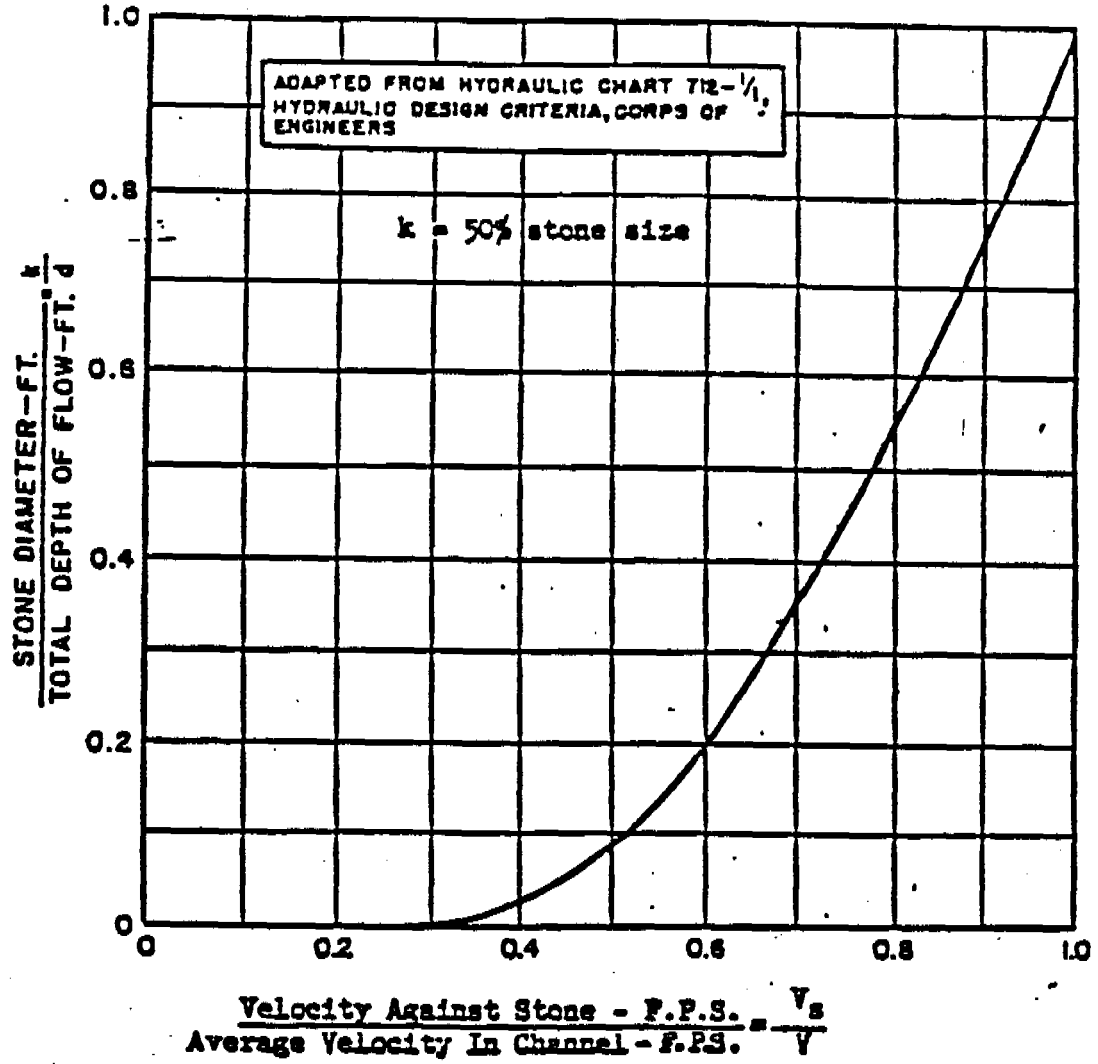
Bottom Width.....	6.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.5000 ft/ft
Discharge.....	3.26 cfs

Computed Results:

Depth.....	0.09 ft
Velocity.....	5.88 fps
Flow Area.....	0.55 sf
Flow Top Width...	6.36 ft
Wetted Perimeter.	6.40 ft
Critical Depth...	0.20 ft
Critical Slope...	0.0315 ft/ft
Froude Number....	3.51 (flow is Supercritical)



SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES



VELOCITY AGAINST STONE ON CHANNEL BOTTOM

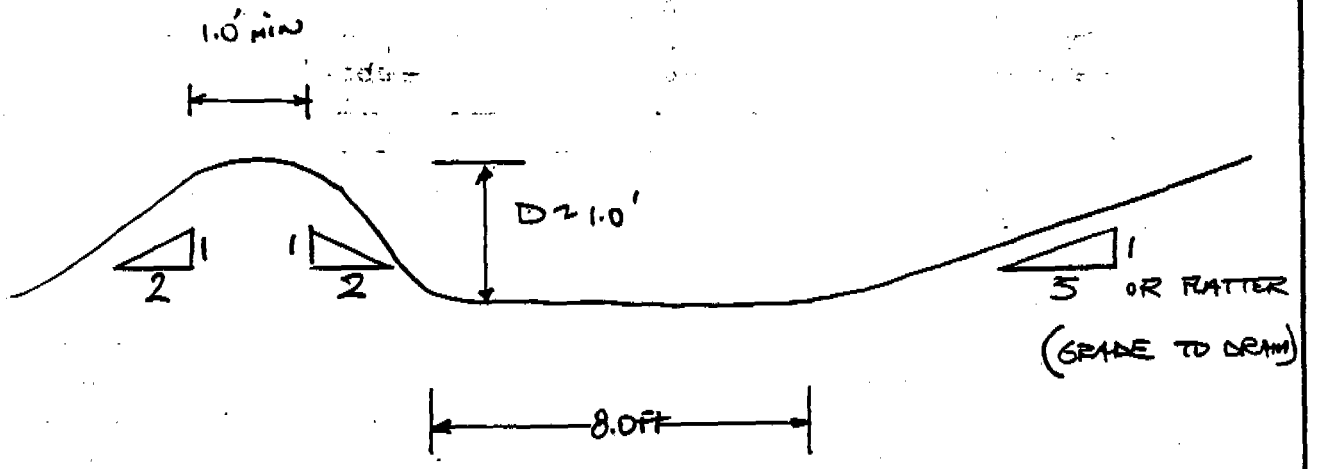
TYPICAL DIVERSION/BERM DESIGN.

- DESIGN A DITCH/BERM SYSTEM TO CONVEY THE RUNOFF TO SEDIMENT POND 012
- RUNOFF FROM CGRWS-U9, R3 → 10-YR, 6-HOUR STORM.

CGRWS-U9
CN = 75
AREA = 29.38 AC
T_c = 0.102 HR
Q = 1.92 CFS

CGRWS-R3
CN = 80
AREA = 11.58 AC
T_c = 0.301 HR
Q = 1.51 CFS

DIVERSION/BERM GEOMETRY.



CONSTRUCT A BERM WITH 1.0' TOPWIDTH AND A HEIGHT OF 1.0', SIDE SLOPES 2H:1V. ADJACENT TO THE BERM, GRADE A BROAD SWALE TO CONVEY THE RUNOFF.

BOTTOM WIDTH = 8.0 FT.
CHANNEL SLOPE ⇒ MAX = 3%
MIN = 1%
MAX. FLOW DEPTH = 0.23 FT.
MAX. VELOCITY = 2.45 FPS

NO RIPRAP REQUIRED FOR V = 2.45 FPS.

60 c

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: CASTLEGATE AREA

Comment: TYPICAL DIVERSION/BERM DESIGN

Solve For Depth

Given Input Data:

Bottom Width.....	8.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0100 ft/ft
Discharge.....	3.43 cfs

Computed Results:

Depth.....	0.23 ft
Velocity.....	1.73 fps
Flow Area.....	1.99 sf
Flow Top Width...	9.58 ft
Wetted Perimeter.	9.66 ft
Critical Depth...	0.17 ft
Critical Slope...	0.0242 ft/ft
Froude Number....	0.67 (flow is Subcritical)

607/c

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: CASTLEGATE AREA

Comment: TYPICAL DIVERSION/BERM DESIGN

Solve For Depth

Given Input Data:

Bottom Width.....	8.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0300 ft/ft
Discharge.....	3.43 cfs

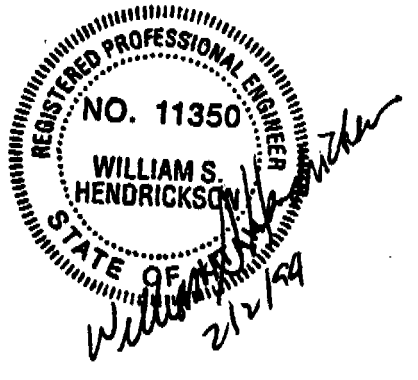
Computed Results:

Depth.....	0.16 ft
Velocity.....	2.45 fps
Flow Area.....	1.40 sf
Flow Top Width...	9.14 ft
Wetted Perimeter.	9.20 ft
Critical Depth...	0.17 ft
Critical Slope...	0.0242 ft/ft
Froude Number....	1.10 (flow is Supercritical)

February 1994

APPENDIX 3.4N

ALTERNATIVE SEDIMENT CONTROL MEASURES CALCULATIONS



RECLAMATION ALTERNATIVE SEDIMENT CONTROL MEASURES SUMMARY AND CALCULATIONS

CASTLE GATE PREPARATION PLANT CARBON COUNTY, UTAH

Prepared for

AMAX COAL COMPANY
Castle Gate Mine
Carbon County, Utah

Prepared by

EARTHFAX ENGINEERING, INC.
Midvale, Utah

September 4, 1992

RECLAMATION ALTERNATIVE SEDIMENT CONTROL MEASURES - SUMMARY

Three sedimentation ponds will be used within the disturbed area of the Preparation Plant during reclamation. However, it is not feasible to route the storm runoff from the entire reclaimed area to those three ponds (011, 012 and 013). Therefore, silt fences will be used as alternative sediment control (ASC) structures, along with other ASC measures to protect reaches of streams/channels whose precipitation runoff crosses reclaimed areas but does not flow to one of the ponds. ASC measures involving soil preparation and seeding will be used throughout the reclaimed area. An explanation of all the ASC measures is included in section 3.4-4(4). Calculations were performed using the Universal Soil Loss Equation to quantify the benefits of implementing the various ASC measures. Those calculations form the majority of this appendix.

The Universal Soil Loss Equation (A = RKLSCP), combined with the concept of delivery ratio (Y = A * D), was developed under specific limitations. Although its application to the Preparation Plant area stresses those limitations in regard to area, slope, and land use, this evaluation method is widely accepted for the purposes of evaluating potential sheet flow and rill sediment erosion. Erosion within natural stream channels and the reclaimed channels was not considered in this analysis. It is assumed that the structure of the undisturbed channels and the riprap in the reclamation channels will prevent appreciable scour during a 10-year 6-hour storm event. The goal of this analysis was not to quantify the total sediment loads to the reclamation channels, but only to asses the relative benefit of implementing the various ASC options.

Two stream reaches were selected as being representative in terms of the sediment load from both undisturbed and reclaimed areas that can be expected along channels in the Preparation Plant area. A 700 foot reach along the upper section of CGRD-5 in Barn Canyon was evaluated. The south side of reclamation channel CGRD-3C was also analyzed to

ascertain relative sediment loads to the stream. Only erosion from a portion of watershed CGRWS-R4 travels to the south side of the channel, with no undisturbed contributing watershed areas (See Exhibit 3.A-3A).

Two sets of comparisons were performed to evaluate the ASC measures. Sediment erosion was calculated for a discrete storm event of six hour duration and a return period of ten years, and also on an annual basis. The rainfall 'R' factors selected were 17 (Barfield et. al., 1983, Fig.5.11) and 11 (Israelson et. al., 1984) respectively. A summary of these comparisons comprises Table 3.4N - A1.

The erodibility factor, 'K', was determined from a map entitled "State of Utah Soil Erodibility Index (K)". A value of 0.15 corresponds to the location of the Preparation Plant. The LS factor was calculated using the following formula from Barfield et. al. (1983, Eq. 5.10):

$$LS = (l/72.6)^m * ((430x^2 + 30x + 0.43)/6.613)$$

where x = sin(slope angle)

l = length of the slope along which deposition will not occur

m = 0.5 for slopes greater than or equal to 5%

The following cover factors, 'C', were chosen to reflect the characteristics of each sediment control measure:

- Bare soil, C = 1.3 (Barfield et. al., 1983, Table 5.8)
- Ripped soil, C = 0.8 (Barfield et. al., 1983, Table 5A)
- Wood fiber mulch slurry, C = 0.05 (Barfield et. al., 1983, Table 5.8)
- Undisturbed native soil, C = 0.07 (SCS, 1977)

An efficiency of 75% was assumed for filter fabric (silt) fences (Mirafi, Inc., Product #100x).

TABLE 3.4N-A1

CASTLE GATE PREPARATION PLANT RECLAMATION ALTERNATIVE SEDIMENT CONTROL MEASURES

WATERSHED	Area (Ac)	Height of Rise (ft)	Horiz. Proj. of Slope Length (ft)	Slope Angle (%)	Slope Angle (deg)	Field Slope Length (ft)	Slope Factor m	LS Factor	K Factor	Undisturbed Sed. Prod.	Silt to stream – Bare ground (Tons)	Silt to stream – Ripped (Tons)	Silt to stream – Mulched (Tons)	Silt to stream – Silt fence (Tons)	Silt trapped by silt fence (Tons)	Silt trapped by silt fence (Cu Ft)
10–YEAR 6–HOUR STORM																
PREPARATION PLANT																
EAST SIDE OF UPPER CGRD–5																
RECLAIMED AREA	2.10	40.0	220.0	18.2	10.3	224	0.5	5.2	0.15	1.9	36.1	22.2	1.4	0.3	1.0	22
UNDISTURBED AREA (U7)	7.30	200.0	450.0	64.4	32.8	535	0.5	56.7	0.15	76.4	76.4	76.4	76.4	19.1	57.3	1273
TOTAL										78.4	112.6	98.7	77.8	19.4	58.3	1296
CGRD–3C – SOUTH SIDE																
RECLAIMED AREA	0.73	50.0	300.0	16.7	9.5	304	0.5	5.3	0.15	0.7	12.7	7.8	0.5	0.1	0.4	9
ANNUAL EROSION																
PREPARATION PLANT																
EAST SIDE OF UPPER CGRD–5																
RECLAIMED AREA	2.10	40.0	220.0	18.2	10.3	224	0.5	5.2	0.15	1.3	23.4	14.4	0.9	0.2	0.7	16
UNDISTURBED AREA (U7)	7.30	200.0	450.0	64.4	32.8	535	0.5	56.7	0.15	49.5	49.5	49.5	49.5	12.4	37.1	824
TOTAL										50.7	72.8	63.8	50.4	12.6	37.8	840
CGRD–3C – SOUTH SIDE																
RECLAIMED AREA	0.73	50.0	300.0	16.7	9.5	304	0.5	5.3	0.15	0.4	8.2	5.1	0.3	0.1	0.2	4

SOIL CONDITION	'C' FACTOR
BARE	1.3
RIPPED	0.6
MULCHED	0.05
UNDISTURBED	0.07

'P' FACTOR
1.0

DELIVERY RATIO	
UNDISTURBED AREA	1.0
RECLAIMED AREA	1.0

ERODIBILITY FACTOR, K	0.15
RAINFALL FACTORS	
10–YR 6–HR STORM	17
ANNUAL	11

The control practice factor, 'P', was assumed equal to 1.0 since the land use is not for crops (SCS, 1977). A conservative sediment delivery ratio, 'D', of 1.0 was assumed for all undisturbed and reclaimed areas, since they are smaller than ten acres in area.

Conclusions

Table 3.4N-A1 summarizes the results of the above described calculations. The implementation of each sediment control measure substantially reduces the amount of sediment erosion from the reclaimed areas, to the point that the mulch theoretically inhibits soil loss more effectively than the undisturbed ground cover. The silt fences provide additional protection to the streams by trapping an additional 75% of sediment. In general, the undisturbed areas contributing sediment to the stream channels through silt fences are larger than the reclaimed areas. Accordingly, most of the sediment erosion will occur from the undisturbed area. In the case of the upper reach of CGRD-5, approximately 98% of the sediment loss trapped by the silt fences is from the undisturbed areas. Thus, the background sediment loss overshadows the sediment loss from the reclaimed areas once the wood fiber mulch is in place. It should be noted that the combination of the surface sediment controls on the reclaimed areas and the silt fences along the channels reduces the silt load from the reclaimed areas to the streams by 84% from what it would naturally be if the same reclaimed areas were undisturbed and in their natural state.

Calculations to determine the adequacy of a single layer fence system were performed. The results indicate that a single layer system will be adequate. The spacing of the fences will have to vary depending on location and the grade of the reclaimed ground surface adjacent to the channel. In all cases, the silt fences shall generally be constructed in accordance with Figures 3.4-1 and 3.4-2 with the fences parallel to the contours. Additionally, the fences should be constructed with sufficient projected overlap, and the length of the fence segments should correspond to the spacing and orientation of those segments along the channel.

REFERENCES

U.S. Department of Agriculture. Soil Conservation Service. July 1977. Preliminary Guidance for Estimating Erosion on Areas Disturbed by Surface Mining Activities in the Interior Western United States.

Barfield, B.J., Warner, R.C., and Hann, C.T.. 1983. Applied Hydrology and Sedimentology for Disturbed Areas. Oklahoma Technical Press. Stillwater, Oklahoma.

Simons, Li and Associates, Inc. May 1983. Design of Sediment Control Measures for Small Areas in Surface Coal Mining. Office of Surface Mining.

Israelson, C. Earl, Fletcher, Joel E., Haws, Frank W., and Israelson, Eugene K.. Erosion and Sedimentation in Utah: A Guide for Control. February 1984. Utah State University. Logan, Utah.

Mirafi Civil Engineering Fabrics. Mirafi, Inc. Charlotte, N.C..

CASTLE GATE
PREPARATION PLANT

RECLAMATION PLAN - ALTERNATIVE SEDIMENT CONTROL

A TYPICAL AREA CONTRIBUTING TO A STREAM CHANNEL PROTECTED BY SILT FENCES IS ON THE SOUTHEAST SIDE OF THE INTERSECTION OF CCRD-5, BOTH RECLAIMED AND UNDISTURBED AREA RUNOFF CONTRIBUTE TO THIS REACH OF CHANNEL. A SECOND TYPICAL REACH IS THE SOUTH SIDE OF CCRD-3C, WHICH ONLY RECEIVES FLOW FROM A RECLAIMED AREA. EVALUATE THESE TWO STREAM REACHES TO DETERMINE RELATIVE SEDIMENT LOADS WITH VARIOUS BCM'S IN PLACE. CONSIDER BOTH A DISCRETE STORM EVENT AND EROSION ON A YEARLY BASIS.

NOTE: THERE ARE SEVERAL LOCATIONS WHERE RUNOFF FROM PRIMARILY UNDISTURBED AREAS FLOWS THROUGH SILT FENCES, WITH VERY LITTLE RECLAIMED AREA RUNOFF CONTRIBUTING. SINCE THE PURPOSE OF THE FENCES IS TO COLLECT ERODED SEDIMENTS FROM RECLAIMED AREAS, THE REACHES JUST MENTIONED WERE NOT EVALUATED.

REFERENCE EXHIBIT 3.4-3A.

A SAMPLE CALCULATION FOLLOWS WITH ALL ASSUMPTIONS LISTED. THE RESULTS OF THE BALANCE OF THE CALCULATIONS IS CONTAINED IN TABLE 1 OF THIS APPENDIX.

USE UNIVERSAL SOIL LOSS EQUATION.

$A = RKLSCP$

$Y = D A$

Y = SEDIMENT YIELD
D = DELIVERY RATIO

A = COMPUTED SOIL LOSS PER UNIT AREA (TONS/ACRE)
R = RAINFALL FACTOR
K = ERODIBILITY FACTOR
LS = LENGTH SLOPE FACTOR
C = COVER FACTOR
P = CONTROL PRACTICE FACTOR

ASSUME EROSION IS NOT RESTRAINED BY SEDIMENT TRANSPORT CAPACITY. THUS, THERE IS NO INTERMEDIATE DEPOSITION AND DELIVER RATIO = 1.0 SO $Y = A$.

REFERENCE FOR USE:

BARFIELD ET AL, 1983 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS. OKLAHOMA.

R: FOR DISCRETE STORM EVENT 10-YR 6-HR: ACCORDING TO MILLER ET AL, PRECIPITATION-FREQUENCY ATLAS OF THE WESTERN UNITED STATES, NOAA, 1973.

10-YEAR 6-HOUR EVENT IN THE PREP PLANT AREA

P = 1.9"

USING BARFIELD ET AL, 1983 FIG 5.11

WITH P = 1.9" AND Hr = 6 HOURS

$R_{10-6} = 17$ (THIS COULD BE READ AS 18, BUT CONSIDERING A LOW ANNUAL 'R' FACTOR COMPARED TO SURROUNDING AREA, R=17 WAS SELECTED.)

FOR ANNUAL BASIS:

REFERENCE: ISRAELSON ET AL, 1984, PRICE AREA MAP ENTITLED "MEAN ANNUAL 150-EROSION 'R' VALUE"

R_A = 11 FOR PREP PLANT

K: PER ISRAELSON ET AL, 1984, MAP ENTITLED "STATE OF UTAH SOIL ERODIBILITY INDEX (K)"

K = 0.15 FOR PREP PLANT

CONSIDER THE EAST SIDE OF THE UPPER REACH OF CGRD-5. SEE EXHIBIT 3.4-3A

RECLAIMED AREA = 2.1 ACRES

UNDISTURBED AREA = 7.3 ACRES (CATENA W7)

LS:

$$LS = \left(\frac{\lambda}{72.6}\right)^m \left(\frac{430x^2 + 30x + 0.43}{6.613}\right)$$

λ = FIELD SLOPE LENGTH (FT)
(LENGTH OF SLOPE FROM POINT OF ORIGIN OF OVERLAND FLOW UNTIL SLOPE DECREASES SUCH THAT DEPOSITION OCCURS OR UNTIL FLOW ENTERS A DEFINED CHANNEL)

$x = \sin\theta$

θ = ANGLE OF SLOPE (°)

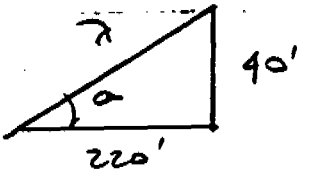
$m = 0.5$ IF $\theta \geq 5$ %

RECLAIMED:
USING EXHIBIT 3.4-3A

THE ~~HORIZ~~ PROJECTED AREA OF THE LONGEST RECLAIMED SLOPE IS 220'.

ΔELEV. = 6240 - 6200 = 40'

$\tan\theta = \frac{40}{220}$ $\theta = 10.3°$



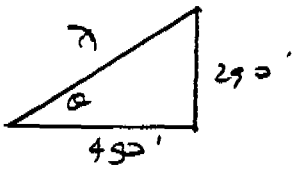
$\sin 10.3° = \frac{40}{\lambda}$ $\lambda = 224'$

LS CONT:

FOR THE UNDISTURBED AREA

$x = 450'$

$\Delta ELEV = 6530 - 6240 = 290'$



$TAN\ \theta = \frac{290}{450}$ $\theta = 32.8°$

$SIN\ 32.8° = \frac{290}{r}$ $r = 535'$ (AGREES WITH TABLE 1)

OK

RECLAIMED:

$$LS = \left(\frac{224'}{72.6}\right)^{0.5}\left(\frac{430(\sin 10.3)^2 + 30(\sin 10.3) + 0.43}{6.613}\right)$$

$LS = 5.2$

UNDIST: $$LS = \left(\frac{535}{72.6}\right)^{0.5}\left(\frac{430(\sin 32.8)^2 - 30(\sin 32.8) + 0.43}{6.613}\right)$$

$= 58.6$ (TABLE 1 ⇒ 58.7 OK)

'C' FACTOR:

BARE SOIL (DOZED UP & DOWN)	C = 1.3	BARFIELD ET AL, 1983 TABLE 5.8
RIPPED SOIL	C = 0.8	BARFIELD ET AL, 1983 TABLE 5.A.1
WOOD FIBER SLURRY MULCH	C = 0.05	BARFIELD, 1983 TABLE 5.8

(ALSO NOTE: TEMPORARY SEEDINGS AFTER 60 DAYS, C = 0.05 PER BARFIELD TABLE 5.A.1)

SILT FENCE EFFICIENCY 75% (MIRAFI, PRODUCT 100 x)

'C' FACTOR CONT:

UNDISTURBED AREA: C = 0.07 SCS, 1977. TABLE 4 *

* THIS IS BASED ON TYPE AND DENSITY OF CANOPY AND GROUND COVER VEGETATION. SAGE, LOW BRUSH AND GRASSES ARE SIMILAR TO THOSE FOUND IN HANDSCRABBLE CANYON WHERE A C = 0.07 WAS USED. REFERENCE APPENDIX 3.3-E.

'P' FACTOR:

SINCE LAND IS NOT USED FOR CROPS,

P = 1

REFERENCE: SCC, 1977.

CALCULATE 'A' FOR A DISCRETE STORM EVENT OF 10 YR 6 HR.

RECLAIMED:

$A = RKLSCP$

$= (17)(0.15)(5.2)\,C\,(1.0)$

$= 13.26\,C$

$A_{TOTAL} = (A)\,(AREA)$

$= (13.26C)(2.1 \text{ ACRES})$

$= 27.8\,C$

FOR C = 1.3 $\Rightarrow$ $A_{TOTAL} = (27.8)(1.3)$ = 36.2 TONS/EVENT

FOR C = 0.8 $\Rightarrow$ $A_{TOTAL} = (27.8)(0.8)$ = 22.2 TONS/EVENT

FOR C = 0.05 $\Rightarrow$ $A_{TOTAL} = (27.8)(0.05)$ = 1.4 TONS/EVENT

UNDISTURBED AREA

A_{TOTAL} = RKLSCP (AREA)

= (17)(0.15)(58.6)(0.07)(1)(7.3 ACRES)

= 76.4 TONS/EVENT

TOTAL LOAD TO EAST SIDE OF CGRD-5 (UPPER REACH)

$A_{TOTAL(UNDIST)} + A_{TOTAL(RECL)}$ = 1.4 + 76.4 = 77.8 TONS

↑ WITH MULCH IN PLACE

WITH SILT FENCE IN PLACE:

TRAPPED SEDIMENT = (0.75)(77.8) = 58.4 TONS

SILT TO STREAM = (0.25)(77.8) = 19.4 TONS

77.8 TONS ✓

FOR THAT REACH OF STREAM,

TRAPPED VOLUME OF SEDIMENT = 58.4 TONS × 2000 lbs / 1 TON × CF / 90 lbs

= 1298 CF SAY 1300 CF

TO PLACE SILT FENCES PARALLEL TO CONTOURS, THEY WILL HAVE TO BE AT AN ANGLE OF APPROXIMATELY 45° TO THE CHANNEL CENTERLINE. USING 50' FENCE SEGMENTS AND 10' OF PROJECTED OVERLAP,

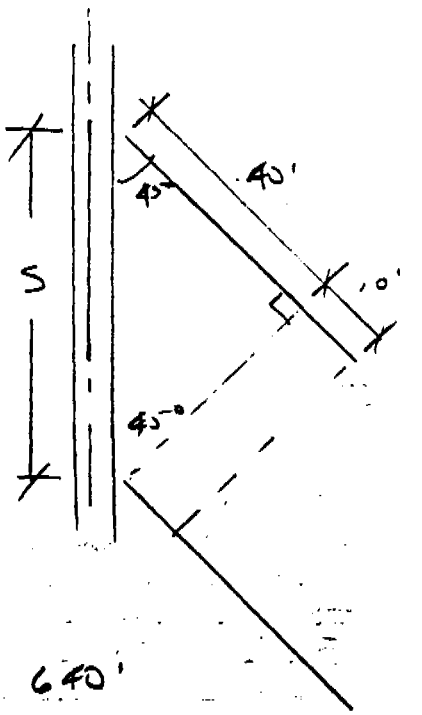
CALCULATE SPACING OF SEGMENTS.

$\cos 45° = \frac{40}{S}$

$S = 56.6$ FT

SAY 55'

USE 50' OF FENCE FOR EVERY 55' OF CHANNEL (ONE SIDE ONLY)



TOTAL LENGTH OF FENCE =

REACH LENGTH $\times \frac{50'}{55'}$

$700 \times \frac{50}{55} = 636$ SAY 640'

TOTAL VOLUME TO FENCE = 1300 CF (FROM PG 6)

$\frac{1300 \text{ CF}}{640 \text{ FT}} = 2.0$ SF

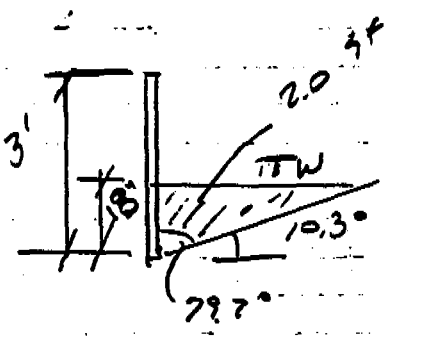
ALLOWING SILT TO BUILD UP TO 18");

MAX CAPACITY OF FENCE:

$A = 1/2 (1.5')(8.25')$

$= 6.78$ SF >> 2.0 SF

↑ ALLOWABLE ↑ ACTUAL



$\tan 79.7° = \frac{TW}{1.5'}$

$TW = 8.25'$

OK

FENCE WILL NOT OVERLOAD AFTER A 10 YR 6 HR STORM.

USING VALUES FROM TABLE 1 OF THIS APPENDIX,

RECLAIMED AREA:

$\frac{1.9 - 0.3}{1.9}$ = 84% REDUCTION FROM BASELINE LEVEL WITH MULCH AND SILT FENCE IN PLACE.

TOTAL AREA.

$\frac{0.3}{1.9}$ = 22% OF SEDIMENT IS FROM RECLAIMED AREA

CONCLUSION:

THE IMPLEMENTATION OF VARIOUS ALTERNATIVE SEDIMENT CONTROL MEASURES ON THE RECLAIMED AREAS SIGNIFICANTLY REDUCES THE SILT LOAD TO THE CHANNELS, IN FACT, THERE IS AN 84% REDUCTION IN SEDIMENT LOAD TO THE STREAMS FROM THE RECLAIMED AREAS, COMPARED TO THOSE SAME AREAS IN THEIR NATURAL STATE.

ALSO, FOR THOSE CHANNEL REACHES THAT RECEIVE EROSION FROM UNDISTURBED AREAS, THE SEDIMENT FROM THE RECLAIMED AREAS (WITH MULCH AND FENCES IN PLACE) CONSTITUTES < 10% OF THE TOTAL SEDIMENT TO THE STREAM CHANNEL.

CASTLE GATE PREPARATION PLANT RECLAMATION ALTERNATIVE SEDIMENT CONTROL MEASURES

WATERSHED	Area (Ac)	Height of Rise (ft)	Horiz. Proj. of Slope Length (ft)	Slope Angle (%)	Slope Angle (deg)	Field Slope Length (ft)	Slope Factor m	LS Factor	K Factor	Undisturbed Sed. Prod.	Silt to stream – Bare ground (Tons)	Silt to stream – Ripped (Tons)	Silt to stream – Mulched (Tons)	Silt to stream – Silt fence (Tons)	Silt trapped by silt fence (Tons)	Silt trapped by silt fence (Cu Ft)
10-YEAR 6-HOUR STORM																
PREPARATION PLANT																
EAST SIDE OF UPPER CGRD-5																
RECLAIMED AREA	2.10	40.0	220.0	18.2	10.3	224	0.5	5.2	0.15	1.9	36.1	22.2	1.4	0.3	1.0	22
UNDISTURBED AREA (U7)	7.30	290.0	450.0	64.4	32.8	535	0.5	58.7	0.15	76.4	76.4	76.4	76.4	19.1	57.3	1273
TOTAL										78.4	112.6	98.7	77.8	19.4	58.3	1296
CGRD-3C – SOUTH SIDE																
RECLAIMED AREA	0.73	50.0	300.0	16.7	9.5	304	0.5	5.3	0.15	0.7	12.7	7.8	0.5	0.1	0.4	9
ANNUAL EROSION																
PREPARATION PLANT																
EAST SIDE OF UPPER CGRD-5																
RECLAIMED AREA	2.10	40.0	220.0	18.2	10.3	224	0.5	5.2	0.15	1.3	23.4	14.4	0.9	0.2	0.7	16
UNDISTURBED AREA (U7)	7.30	290.0	450.0	64.4	32.8	535	0.5	58.7	0.15	49.5	49.5	49.5	49.5	12.4	37.1	824
TOTAL										50.7	72.8	63.8	50.4	12.6	37.8	840
CGRD-3C – SOUTH SIDE																
RECLAIMED AREA	0.73	50.0	300.0	16.7	9.5	304	0.5	5.3	0.15	0.4	8.2	5.1	0.3	0.1	0.2	4

SOIL CONDITION	'C' FACTOR
BARE	1.3
RIPPED	0.8
MULCHED	0.05
UNDISTURBED	0.07

'P' FACTOR
1.0

DELIVERY RATIO	
UNDISTURBED AREA	1.0
RECLAIMED AREA	1.0

ERODIBILITY FACTOR, K	0.15
RAINFALL FACTORS	
10-YR 6-HR STORM	17
ANNUAL	11

10/17

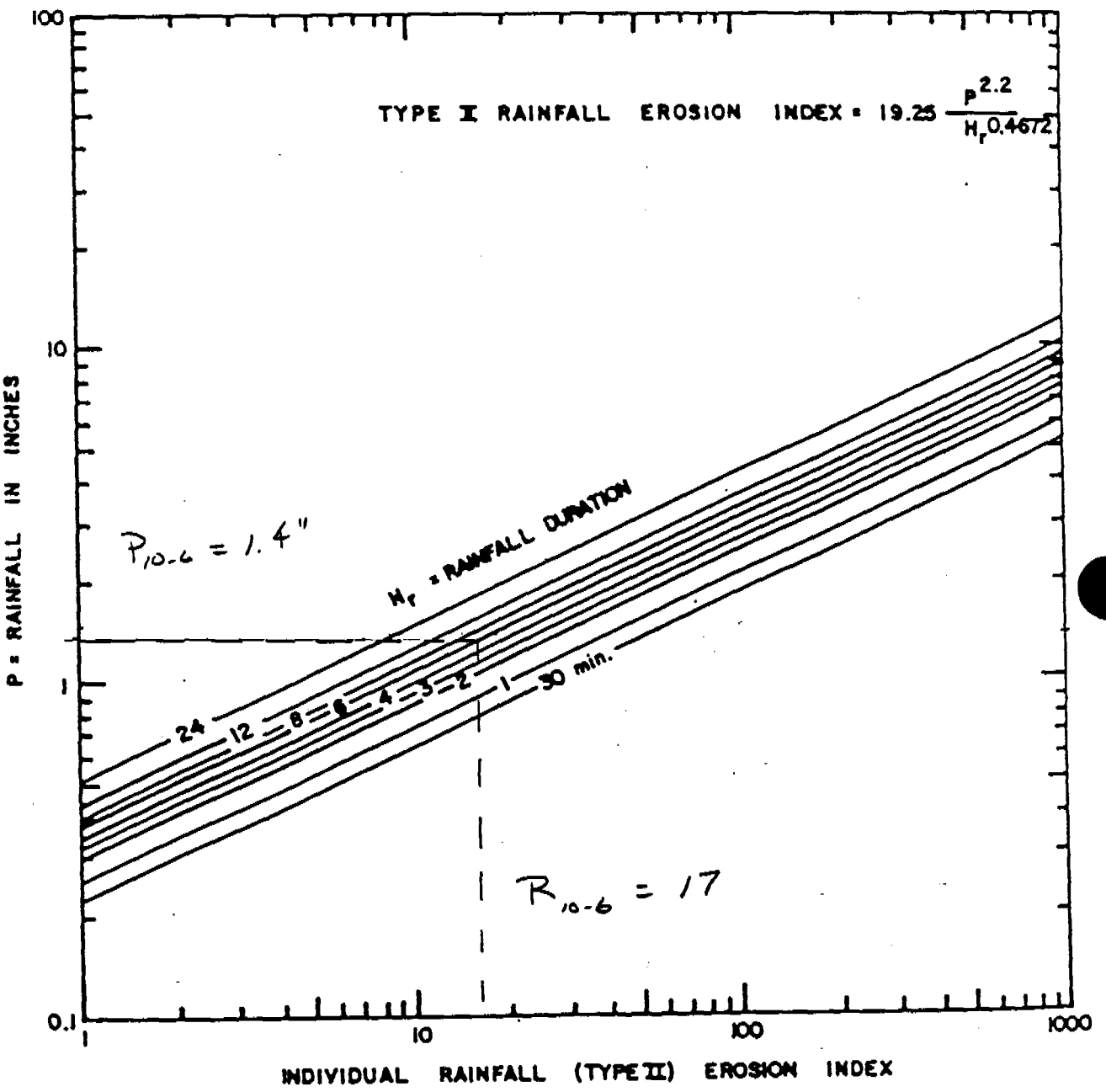
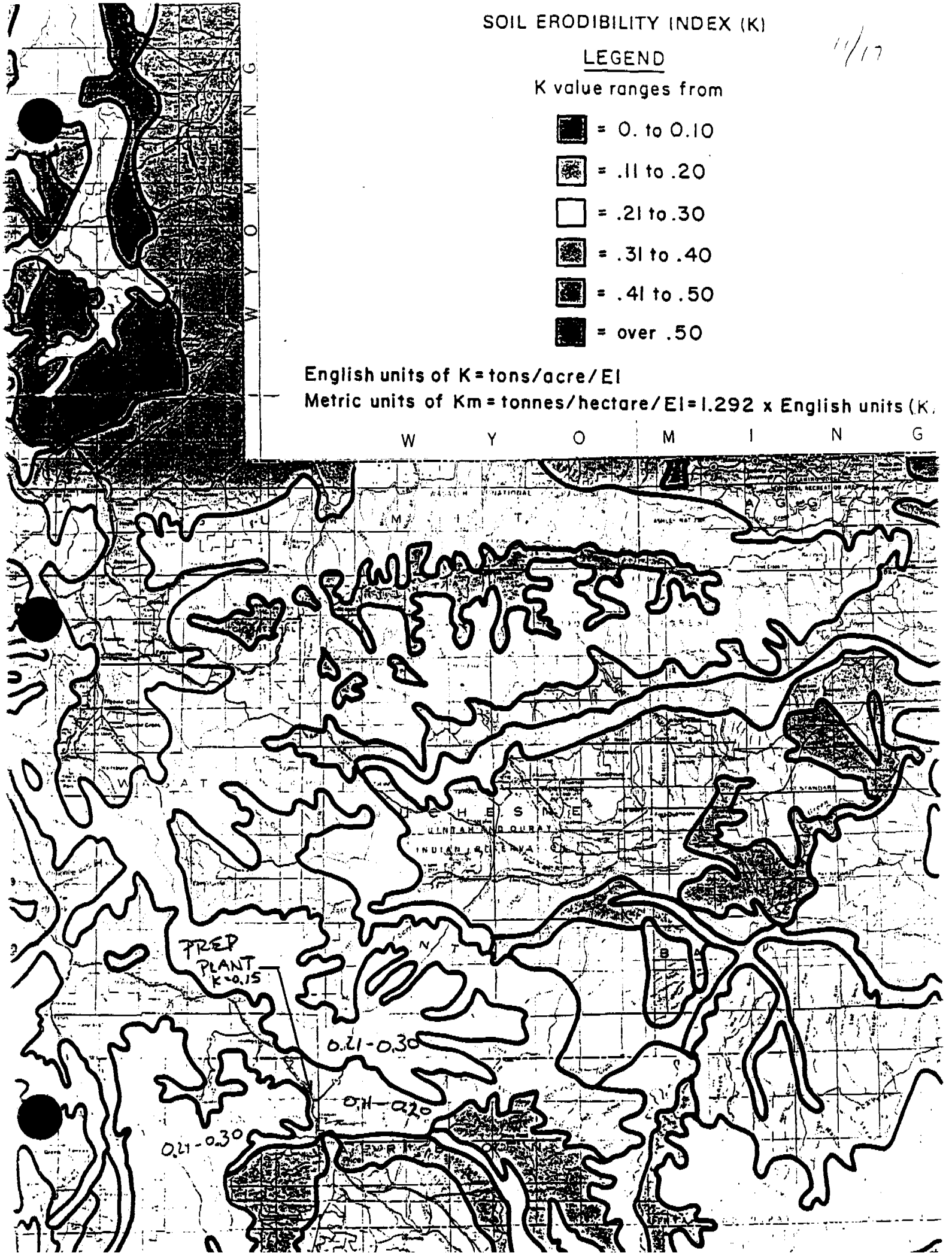
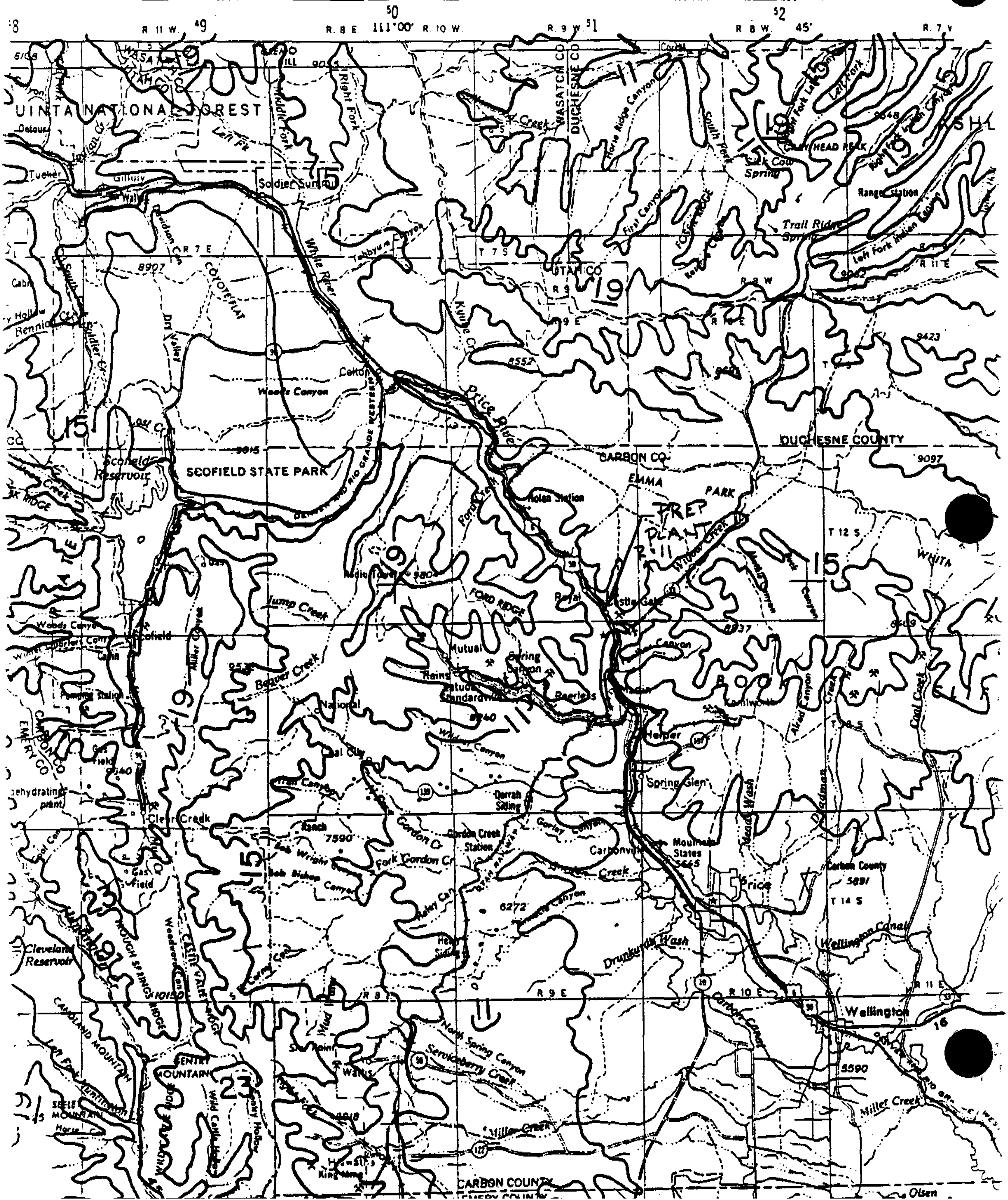


Figure 5.11. Relation between depths and duration of Type II rainfall and single storm erosion index. (Hotes et al., 1973)

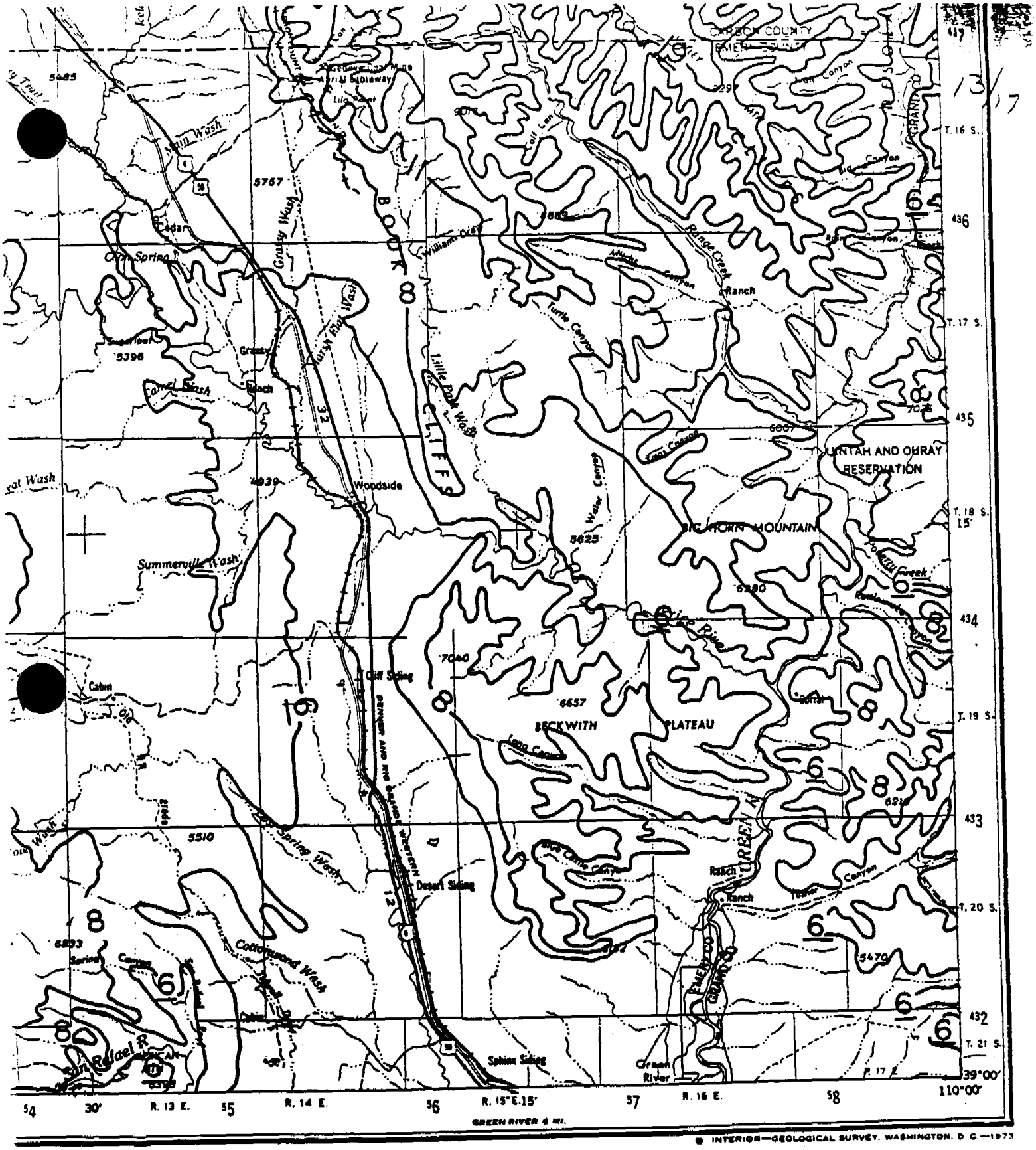

SOIL ERODIBILITY INDEX (K)
LEGEND
K value ranges from
= 0. to 0.10
= .11 to .20
= .21 to .30
= .31 to .40
= .41 to .50
= over .50
English units of K = tons/acre/EI
Metric units of Km = tonnes/hectare/EI = 1.292 x English units (K.
WYOMING
PREP PLANT K=0.15
0.21-0.30
0.11-0.20
0.21-0.30

PRICE

12/17



R. 11 W.
R. 8 E.
111°00'
R. 10 W.
R. 9 W.
R. 8 W.
45'
UINTA NATIONAL FOREST
WASATCH CO
UTAH CO
DUCHESNE CO
Soldier Summit
Tucker
Gilluly
White River
Price River
Colton
Woods Canyon
COYOTE FLAT
Dry Valley
SCOFIELD STATE PARK
Scofield Reservoir
DENVER AND RIO GRANDE WESTERN
DUCHESNE COUNTY
CARBON CO
EMMA
PARK
Nolan Station
Willow Creek
Royal
Castle Gate
Jump Creek
FORD RIDGE
Radio Tower
Beaver Creek
Mutual
Spring Canyon
Rains
Standardville
Peerless
National
Kenilworth
Helper
Spring Glen
Coal City
Scofield
Woods Canyon
Clear Creek
EMERY CO
CARBON CO
Gas Field
Dehydrating plant
Gordon Creek
Gordon Creek Station
Fork Gordon Cr
Bob Wright Canyon
Bob Bishop Canyon
Ranch
7590
Carbonville
Mountain States
Price
Carbon County
5891
T 14 S
T 12 S
Drunkards Wash
Wellington Canal
Wellington
Carbon Canal
North Spring Canyon
Serviceberry Creek
Miller Creek
Wattis
SENTRY MOUNTAIN
CASTLE VALLEY RIDGE
ROUGH SPRINGS RIDGE
CANDLAND MOUNTAIN
Cleveland Reservoir
CARBON COUNTY
EMERY COUNTY
Olsen
5590
GRAY HEAD PEAK
Ranger Station
Trail Ridge Spring
Left Fork Indian Canyon
Meads Wash
Deadman
Coal Creek
Alrad Canyon
TREE PLANT



INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1973

MEAN ANNUAL ISO-ERODENT (R) VALUES

e:
alues shown are for rain and
t together. R value for
elt alone = $R_s = 0.23881\,R$
.34328.

Units of R
English R = foot tons/acre/hour
Metric Rm = meter tonnes/hectare/hour
$Rm = 1.735 \times R$

AH WATER RESEARCH LABORATORY UTAH STATE UNIVERSITY LOGAN, UTAH 1983

Appendix 5A

Table 5.A.1 Typical C Factor Values Reported in the Literature.*

	Condition	C factor
1.	Bare soil conditions	
	freshly disked to 6-8 inches	1.00
	after one rain	0.89
	loose to 12 inches smooth	0.90
	loose to 12 inches rough	0.80
	compacted root raked	1.20
	compacted bulldozer scraped across slope	1.20
	same except root raked across	0.90
	rough irregular tracked all directions	0.90
	seed and fertilize, fresh, unprepared seedbed	0.64
	same after six months	0.54
	seed, fertilize and 12 months chemical	0.38
	not tilled algae crusted	0.01
	tilled algae crusted	0.02
	undisturbed except scraped	0.66 - 1.30
	scarified only	0.76 - 1.31
	sawdust 2 inches deep, disked in	0.61
2.	Asphalt emulsion	
	1210 gallons/acre	0.01 - 0.019
	605 gallons/acre	0.14 - 0.57
	302 gallons/acre	0.28 - 0.60
3.	Dust binder	
	605 gallons/acre	1.05
	1210 gallons/acre	0.29 - 0.78
4.	Other chemicals	
	1000 lb fiber glass roving with 60-150 gallons/acre	0.01 - 0.05
	Aquatain	0.68
	Aerospray 70, 10 percent cover	0.94
	Curasol AE	0.30 - 0.48
	PVA	0.71 - 0.90
	Terra-Tack	0.66
	wood fiber slurry, 1400 lb/acre fresh	0.01 - 0.02
	wood fiber slurry, 3500 lb/acre fresh	0.10
5.	Seedings[1]	
	temporary, 0 to 60 days[2]	0.40
	temporary, after 60 days	0.05
	permanent, 2 to 12 months	0.05
6.	Brush	0.35

1. If plantings are used with mulches, use the minimum C values.
2. If dry weather occurs at planting and emergence is a problem, extend the 0-60 days to a period when rainfall normally occurs.

* National Cooperative Highway Research Program, 1976.

BARFIELD ET AL, 1981.

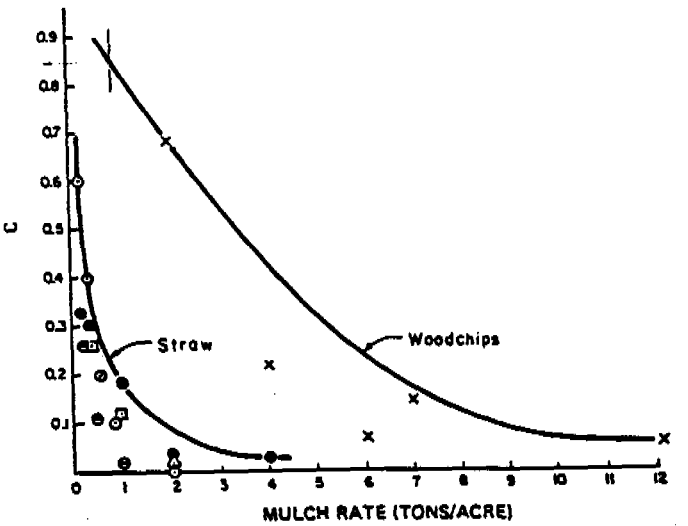


Figure 5.16b. Control factor, C, of surface mulching. (Chen, 1974)

Chemicals are also available for stabilizing the soil surface. C values for selected chemicals are tabulated in Table 5.8. A more complete listing can be found in Table 5.A.1.

Table 5.8 Selected C Values reported in the literature. A comprehensive list is given in Appendix 5A.

Condition	C factor
1. Bare soil conditions	
compacted bulldozer scraped up and down	1.30
compacted fill	1.24 – 1.71
2. Asphalt emulsion	
1250 gallons/acre	0.02
151 gallons/acre	0.65 – 0.70
3. Other chemicals	
Petroset SB	0.40 – 0.66
wood fiber slurry, 1000 lb/acre fresh	0.05
4. Seedings[1]	
permanent, 0 to 60 days[2]	0.40
permanent, after 12 months	0.01
5. Excelsior blanket with plastic net	0.04 – 0.10

1. If plantings are used with mulches, use the minimum C values.
2. If dry weather occurs at planting and emergence is a problem, extend the 0-60 days to a period when rainfall normally occurs.

BARFIELD ET AL, 1981.

Table 4. "C" Factors for Permanent Pasture and Rangeland

Vegetative Canopy			Cover That Contacts the Surface 1/						
Type and Height of Raised Canopy 2/	Canopy Cover 3/	Type 4/	Percent Ground Cover						
			0	10	20	40	60	80	95-1
No appreciable canopy		G	1.0	.45	.20	.10	.042	.013	.0
		W	1.0	.45	.24	.15	.090	.043	.0
Canopy of tall forbs or short brush (0.5 m fall ht.)	25	G	1.0	.36	.17	.09	.038	.012	.0
		W	1.0	.36	.20	.13	.082	.041	.0
	50	G	1.0	.26	.13	.07	.035	.012	.0
		W	1.0	.26	.16	.11	.075	.039	.0
	75	G	1.0	.17	.10	.06	.031	.011	.0
		W	1.0	.17	.12	.07	.067	.038	.0
Appreciable brush or brushes (2 m fall ht.)	25	G	1.0	.40	.18	.09	.040	.013	.0
		W	1.0	.40	.22	.14	.085	.042	.0
	50	G	1.0	.34	.16	.085	.038	.012	.0
		W	1.0	.34	.19	.13	.081	.041	.0
	75	G	1.0	.28	.14	.08	.036	.012	.0
		W	1.0	.28	.17	.12	.077	.040	.0
Trees but no appreciable low brush (4 m fall ht.)	25	G	1.0	.42	.19	.10	.041	.013	
		W	1.0	.42	.23	.14	.087	.042	
	50	G	1.0	.39	.18	.09	.040	.013	.0
		W	1.0	.39	.21	.14	.085	.042	
	75	G	1.0	.36	.17	.09	.039	.012	

1/ All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff, or litter.

W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface, and/ undecayed residue.)

Table 5. Factor "C" for Various Quantities of Mulch

Mulch—adequately crimped into soil	"C" Factor
bare areas	1.0
¼ ton straw mulch per acre	.52
½ " " " " "	.35
¾ " " " " "	.24
1 " " " " "	.18
1½ " " " " "	.10
2 " " " " "	.06
3 " " " " "	.03
4 " " " " "	.02

SCS, 1977

MIRAFI®

17/17

TABLE 1: GUIDE SPECIFICATION FOR SILT FENCE FABRIC

General Description: The fabric shall be a woven or nonwoven fabric consisting of synthetic filaments or yarns formed into a stable network such that the filaments or yarns retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals and conform to the properties in the following table.

FABRIC PROPERTY	TEST METHOD*	FABRIC REQUIREMENTS
I. RESISTANCE TO INSTALLATION STRESSES		
a. Grab Tensile Strength, lbs	ASTM-D-1682	90
b. Grab Tensile Elongation, %	ASTM-D-1682	20
c. Mullen Burst Strength, psi	ASTM-D-751	180
d. Trapezoid Tear Strength, lbs	ASTM-D-2263	60
II. PERFORMANCE CRITERIA DURING SERVICE LIFE		
a. Slurry Flow Rate, gal/min/ft^2	VTM-51-79	0.3
b. Retention Efficiency,%	VTM-51-79	75
III. RESISTANCE TO ENVIRONMENT FACTORS		
a. Mildew, Rot Resistance, % Strength Retention	AATCC-30-74	100
b. Insect, Rodent Resistance, % Strength Resistance	AATCC-24-74	100
c. Ultraviolet Resistance, % Strength Retention	ASTM-D-1682 after 500 Xenon Weatherometer Hrs.	80

* TEST METHOD DESIGNATIONS:

ASTM: American Society of Testing and Materials

VTM: Virginia Dept. of Highways & Transportation test method per Reference (3).

AATCC: American Association of Textile Colorist and Chemists

APPENDIX 3.40

AS-BUILT POND SURVEY AND CONSTRUCTION METHOD CERTIFICATIONS

POND CONSTRUCTION METHODS

CASTLE GATE COAL COMPANY

SEDIMENT POND 011

The following is a list of pertinent information concerning the above referenced pond and the procedures used in the reconstruction of the pond by E.I.S. Co.:

(1) The pond is incised - no embankments.

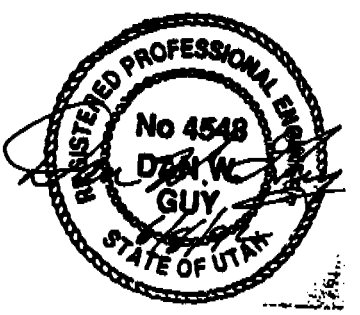
(2) The pond was cleaned out, deepened and widened. The removed material was saturated and stored beneath the plant beltline until dry enough to haul to the refuse pile.

(3) Work to the pond consisted of enlarging the pond, rip-rapping the inlets, lowering the primary overflow, and adding an emergency spillway and channel from the spillway to the natural drainage to the north.

(4) No decant was added to the pond.

(5) Equipment used on the pond reconstruction was:

(a) Poclane 160 Trackhoe.
(b) International 100 Loader.
(c) Gas-powered hand compactor.
(d) International 150 Loader.
(e) Cat D-9 Dozer.
(f) 2 - 10 cu. yd. dump trucks.



SEDIMENT POND CERTIFICATION

Company Name and Address	CASTLE GATE COAL COMPANY P.O. BOX 449 HELPER, UTAH 84526
Permit Number	ACT/007/004
Pond Location	CASTLE GATE
Pond Identification	011

Certification Statement:

I hereby certify that I am experienced in the construction of impoundments; I am qualified and authorized in the State of Utah to inspect and certify the construction of impoundments in accordance with the certified and approved design for this structure; the materials and conditions required for construction are in accordance with approved design and meet or exceed the minimum design requirements; and, that inspections of the impoundment were made during critical periods of the construction by or under my direction in accordance with the requirements of regulation R645-301-514.300.

REGISTERED PROFESSIONAL ENGINEER
No. 4548
(Signature)
GUY
10/29/91
(Date)
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(FINAL INSPECTION)

POND: 011 LOCATION: CASTLE GATE (Upper)

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Steep interior. Pond mostly incised.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Pond cleaned and deepened. Emerg. Spillway added.
(5) Recommendations/Comments	Surveyed 10/6/91. Capacity at Principle O.F.- 44,505 cu.ft. Pond appears to meet design requirements.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

10/6/91
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(CONSTRUCTION INSPECTION)

POND: 011 LOCATION: CASTLE GATE (Upper)

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Pond slopes appear stable. Steep interior.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Removing material to deepen pond & install spillway.
(5) Recommendations/Comments	Appears to meet reconstruction design.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

10/3/91
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND CONSTRUCTION METHODS

CASTLE GATE COAL COMPANY

SEDIMENT POND 012A

The following is a list of pertinent information concerning the above referenced pond and the procedures used in the reconstruction of the pond by E.I.S. Co.:

(1) The pond is incised - no embankments.

(2) The pond was cleaned. The removed material was saturated and stored beneath the plant beltline until dry enough to haul to the refuse pile.

(3) Work to the pond consisted of cleaning the pond, lowering the principle overflow and adding an emergency spillway on the south end.

(4) The pond had an existing decant.

(5) Equipment used on the pond reconstruction was:

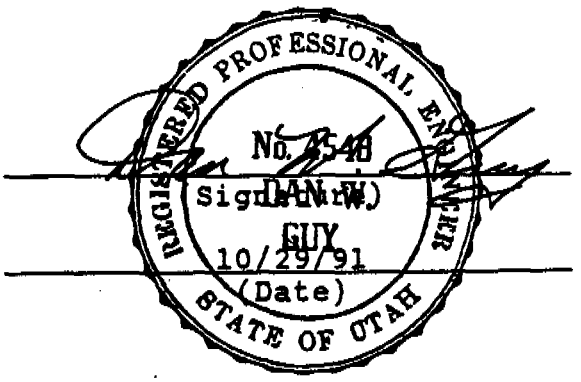
(a) Poclane 160 Trackhoe.
(b) Case 580C Backhoe.
(c) Gas-powered hand compactor.
(d) International 100 Loader.
(e) 2 - 10 cu. yd. dump trucks.

SEDIMENT POND CERTIFICATION

Company Name and Address	CASTLE GATE COAL COMPANY P.O. BOX 449 HELPER, UTAH 84526
Permit Number	ACT/007/004
Pond Location	CASTLE GATE
Pond Identification	012 A

Certification Statement:

I hereby certify that I am experienced in the construction of impoundments; I am qualified and authorized in the State of Utah to inspect and certify the construction of impoundments in accordance with the certified and approved design for this structure; the materials and conditions required for construction are in accordance with approved design and meet or exceed the minimum design requirements; and, that inspections of the impoundment were made during critical periods of the construction by or under my direction in accordance with the requirements of regulation R645-301-514.300.



(Signature)

10/29/91
(Date)

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(FINAL INSPECTION)

POND: 012A

LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Steep bank from upper road on east side.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Open-notch spillway added on south end.
(5) Recommendations/Comments	Surveyed 9/29/91. Capacity at Principle O.F.- 54,203 cu.ft. Meets or exceeds design.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

9/29/91
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(CONSTRUCTION INSPECTION)

POND: 012A

LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Steep bank from upper road on east side.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	O.K. - Spillway under construction.
(5) Recommendations/Comments	90% complete. Dress up berm.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

9/27/91
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND CONSTRUCTION METHODS

CASTLE GATE COAL COMPANY

SEDIMENT POND 012B

The following is a list of pertinent information concerning the above referenced pond and the procedures used in the reconstruction of the pond by E.I.S. Co.:

(1) The pond is incised on east side, with embankments on west and south. Inlet is from north.

(2) The pond was partially cleaned. The removed material was stored beneath the plant beltline until dry enough to haul to the refuse pile.

(3) The pond was widened toward the road side. The embankment was raised on the railroad side and shifted to the west toward the railroad. The embankment was compacted in 12" lifts by running over the placed material with the loader and a full bucket.

(4) The pond was deepened approximately 2' and lenthened by about 1/3. This was due to the presence of 3 separate water lines within the pond construction area which prevented further deepening or widening.

(5) The principle overflow was removed. A decant and emergency spillway were added. All small cut areas were compacted with the hand compactor.

(6) The embankment on the west was later raised again and extended to the north. Native fill material was hauled in to raise embankments. The material was compacted in 12" lifts with a 5-ton roller.

(7) Equipment used on the pond reconstruction was:

(a) Poclane 160 Trackhoe.
(b) Case 580C Backhoe.
(c) Gas-powered hand compactor.
(d) International 100 Loader.
(e) 2 - 10 cu. yd. dump trucks.
(f) Cat D-3 Dozer.
(g) Rex 5-ton roller.

REGISTERED PROFESSIONAL ENGINEER No 4548 DANIEL GUY STATE OF UTAH

SEDIMENT POND CERTIFICATION

Company Name and Address	CASTLE GATE COAL COMPANY P.O. BOX 449 HELPER, UTAH 84526
Permit Number	ACT/007/004
Pond Location	CASTLE GATE
Pond Identification	012 B

Certification Statement:

I hereby certify that I am experienced in the construction of impoundments; I am qualified and authorized in the State of Utah to inspect and certify the construction of impoundments in accordance with the certified and approved design for this structure; the materials and conditions required for construction are in accordance with approved design and meet or exceed the minimum design requirements; and, that inspections of the impoundment were made during critical periods of the construction by or under my direction in accordance with the requirements of regulation R645-301-514.300.

(Signature)

5/16/92
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(FINAL INSPECTION)

POND: 012B

LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Near vertical on east side. Mostly incised-shallow pond.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Pond completed. Embankment raised approx. 2', and extended to north along inlet.
(5) Recommendations/Comments	Surveyed 5/16/92. Capacity at Spillway - 53,730 cu. ft. Pond appears to meet design.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

5/16/92
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(CONSTRUCTION INSPECTION)

POND: 012B

LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Near vertical on east side. Mostly incised-shallow pond.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Embankment being raised and compacted with roller. Bank along inlet also being raised to north.
(5) Recommendations/Comments	Under reconstruction. Compaction looks good. Pond interior not modified.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

4/20/92
(Date)

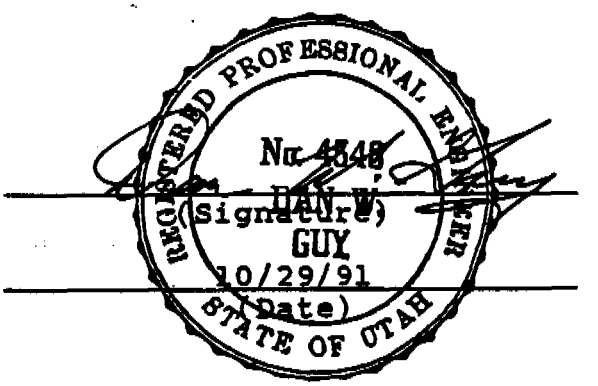
REGISTERED PROFESSIONAL ENGINEER
No 4548
DAN W. GUY
STATE OF UTAH

SEDIMENT POND CERTIFICATION

Company Name and Address	CASTLE GATE COAL COMPANY P.O. BOX 449 HELPER, UTAH 84526
Permit Number	ACT/007/004
Pond Location	CASTLE GATE
Pond Identification	012 B

Certification Statement:

I hereby certify that I am experienced in the construction of impoundments; I am qualified and authorized in the State of Utah to inspect and certify the construction of impoundments in accordance with the certified and approved design for this structure; the materials and conditions required for construction are in accordance with approved design and meet or exceed the minimum design requirements; and, that inspections of the impoundment were made during critical periods of the construction by or under my direction in accordance with the requirements of regulation R645-301-514.300.



DAN W. GUY
(Signature)

10/29/91
(Date)

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(FINAL INSPECTION)

POND: 012B

LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Near vertical on east side. Mostly incised-shallow pond.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Pond completed. Emergency spillway and decant added.
(5) Recommendations/Comments	Surveyed 10/6/91. Capacity at Spillway - 53,730 cu. ft. Pond appears to meet design, although it is longer.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

10/6/91
(Date)

REGISTERED PROFESSIONAL ENGINEER
No. 4548
DAN W. GUY
STATE OF UTAH

POND INSPECTION REPORT
CASTLE GATE COAL COMPANY
(CONSTRUCTION INSPECTION)

POND: 012B LOCATION: CASTLE GATE

ITEM	REMARKS
(1) Potential Safety Hazards	None noted.
(2) Slope Stability	Slopes appear stable. Near vertical on east side.
(3) Erosion	None evident.
(4) Construction and Maintenance Performance Standards	Pond under reconstruction. Water and sewer lines are limiting enlargement.
(5) Recommendations/Comments	Lengthen pond to compensate for inability to deepen due to lines.

I have performed the above inspection on this pond and do hereby certify it to be a true and accurate representation of the pond at this time.

(Signature)

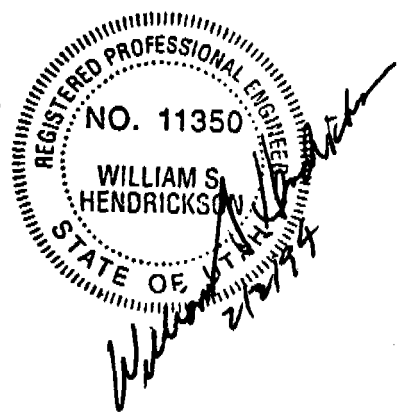
10/3/91
(Date)

REGISTERED PROFESSIONAL ENGINEER AND LAND SURVEYOR
No. 4548
DAN W. GUY
STATE OF UTAH

February 1994

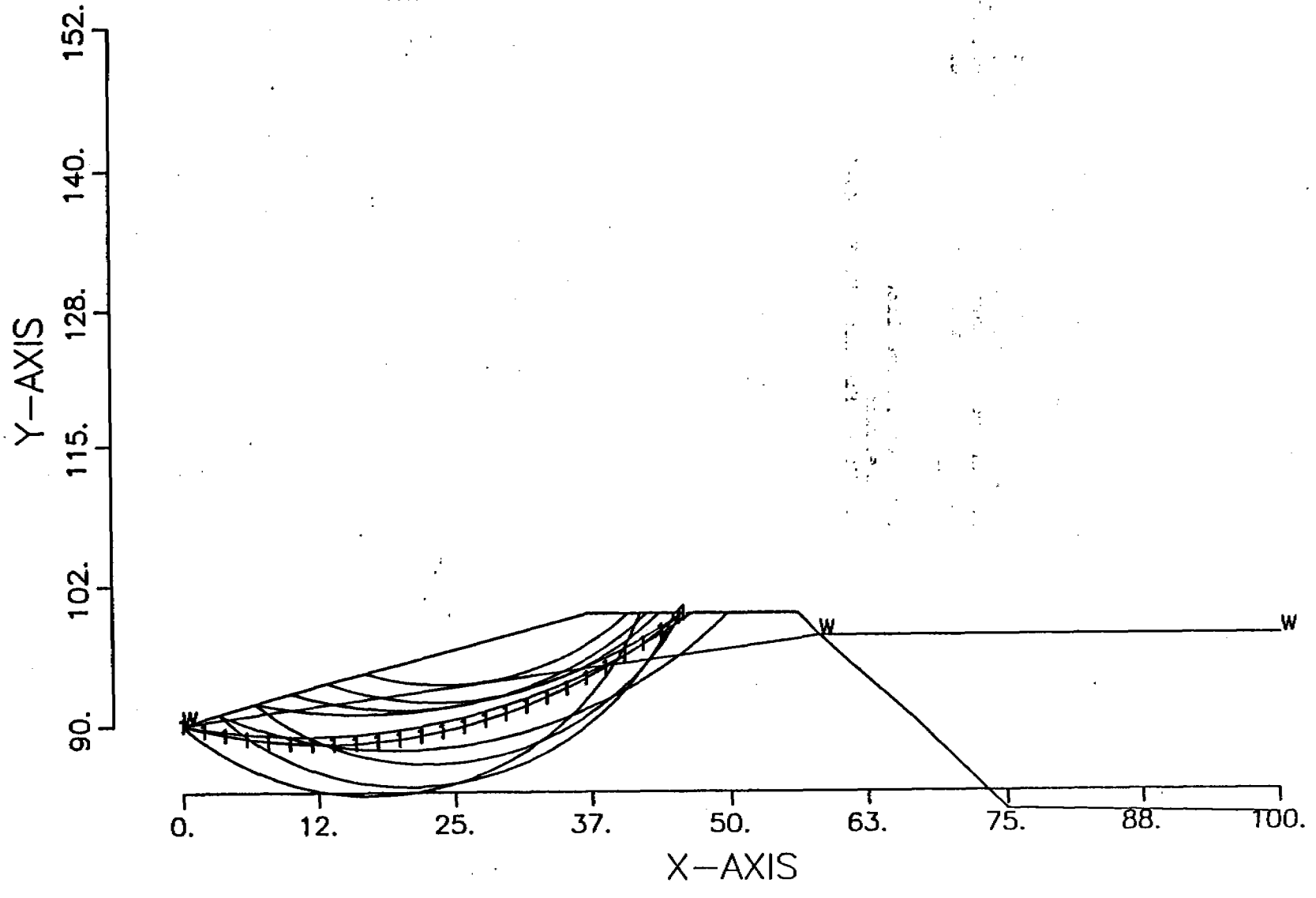
APPENDIX 3.4P-1

EMBANKMENT STABILITY ANALYSIS FOR POND 011
COMPUTER OUTPUT



Earth Tax Engineering
7321 S.Union Park Midvale, UTAH 8[illegible]7

CASTLE GATE COAL – PREPARATION PLANT
POND 011 OUTSLOPE C – C'
100 SURFACES HAVE BEEN GENERATED
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 4.035



GEOSLOPE
Version 4.20

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

GEOSLOPE is based on the program, STABL3, 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.

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7324 S.Union Park Midvale, UTAH 84047

EarthFax Engineering
7324 S.Union Park Midvale, UTAH 84047

--SLOPE STABILITY ANALYSIS--
MODIFIED BISHOP METHOD OF SLICES
CIRCULAR FAILURE SURFACES

PROBLEM DESCRIPTION CASTLE GATE COAL - PREPARATION PLANT
POND 011 OUTSLOPE C - C'

BOUNDARY COORDINATES

7 TOP BOUNDARIES
7 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT	Y-LEFT	X-RIGHT	Y-RIGHT	SOIL TYPE BELOW BND
1	.00	90.00	14.00	94.00	1
2	14.00	94.00	37.00	100.00	1
3	37.00	100.00	56.00	100.00	1
4	56.00	100.00	58.00	98.00	1
5	58.00	98.00	67.00	90.00	1
6	67.00	90.00	75.00	82.00	1
7	75.00	82.00	100.00	81.50	1

ISOTROPIC SOIL PARAMETERS

1 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT.	SATURATED UNIT WT.	COHESION INTERCEPT	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT	PIEZOMETRIC SURFACE NO.
1	115.0	135.0	100.0	34.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-WATER	Y-WATER
1	.00	90.00
2	58.00	98.00
3	100.00	98.00

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 = .00
AND X = 30.00

EACH SURFACE TERMINATES BETWEEN X = 40.00

AND X = 65.00

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00

2.00 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.

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FAILURE SURFACE # 1 SPECIFIED BY 26 COORDINATE POINTS

SAFETY FACTOR = 4.035

X-CENTER = 13.17
Y-CENTER = 138.78
RADIUS = 50.53

POINT NO.	X-SURF	Y-SURF	ALPHA (DEG)
1	.00	90.00	-13.98
2	1.94	89.52	-11.71
3	3.90	89.11	-9.44
4	5.87	88.78	-7.18
5	7.86	88.53	-4.91
6	9.85	88.36	-2.64
7	11.85	88.27	-.37
8	13.85	88.26	1.90
9	15.85	88.32	4.17
10	17.84	88.47	6.43
11	19.83	88.69	8.70
12	21.81	89.00	10.97
13	23.77	89.38	13.24
14	25.72	89.83	15.51
15	27.64	90.37	17.77
16	29.55	90.98	20.04
17	31.43	91.66	22.31
18	33.28	92.42	24.58
19	35.10	93.26	26.85
20	36.88	94.16	29.11
21	38.63	95.13	31.38
22	40.33	96.17	33.65
23	42.00	97.28	35.92
24	43.62	98.45	38.19
25	45.19	99.69	40.45
26	45.55	100.00	

SLICE NO.	X	DX	DW	DQ	DU	DN	DSr
1	.97	1.94	115.80	.00	.00	137.39	72.53

2	2.92	1.96	342.41	.00	.00	372.89	111.90
3	4.89	1.97	555.65	.00	.00	587.87	147.84
4	6.86	1.98	753.82	.00	.00	782.48	180.37
5	8.85	1.99	935.41	.00	.00	956.83	209.52
6	10.85	2.00	1099.06	.00	.00	1111.07	235.30
7	12.85	2.00	1243.64	.00	.00	1245.33	257.74
8	13.92	.15	100.38	.00	.00	99.75	20.46
9	14.92	1.85	1262.94	.00	.00	1255.16	255.60
10	16.84	1.99	1455.73	.00	.00	1438.46	290.03
11	18.83	1.99	1526.89	.00	.00	1502.66	300.76
12	20.82	1.98	1576.58	.00	.00	1547.75	308.30
13	22.79	1.96	1604.72	.00	.00	1573.98	312.68
14	24.74	1.95	1611.48	.00	.00	1581.61	313.96
15	26.68	1.93	1597.21	.00	.00	1570.93	312.17
16	28.60	1.90	1562.48	.00	.00	1542.26	307.38
17	30.49	1.88	1508.06	.00	.00	1495.96	299.64
18	32.35	1.85	1434.91	.00	.00	1432.42	289.02
19	34.19	1.82	1344.19	.00	.00	1352.07	275.59
20	35.99	1.78	1237.23	.00	.00	1255.38	259.42
21	36.94	.12	80.01	.00	.00	82.05	17.12
22	37.81	1.63	995.81	.00	.00	1019.23	216.54
23	38.84	.42	226.82	.00	.00	234.42	51.26
24	39.69	1.29	626.87	.00	.00	645.59	145.41
25	41.17	1.66	626.63	.00	.00	647.69	157.84
26	42.81	1.62	397.15	.00	.00	405.40	117.34
27	44.41	1.57	167.64	.00	.00	154.04	75.32
28	45.37	.36	6.44	.00	.00	-1.40	11.57

```
PROFIL
CASTLE GATE COAL - PREPARATION PLANT          POND 011  OUTSLOPE  C - C'
 7
0.0 90.0 14.0 94.0 1
14.0 94.0 37.0 100.0 1
37.0 100.0 56.0 100.0 1
56.0 100.0 58.0 98.0 1
58.0 98.0 67.0 90.0 1
67.0 90.0 75.0 82.0 1
75.0 82.0 100.0 81.5 1
SOIL
1
115.0 135.0 100.0 34.0 0.0 0.0 0
WATER
1 0.0
3
0.0 90.0
58.0 98.0
100.0 98.0
CIRCL2
10 10
0.0 30.0
40.0 65.0
0.0
2.0
0.0
0.0
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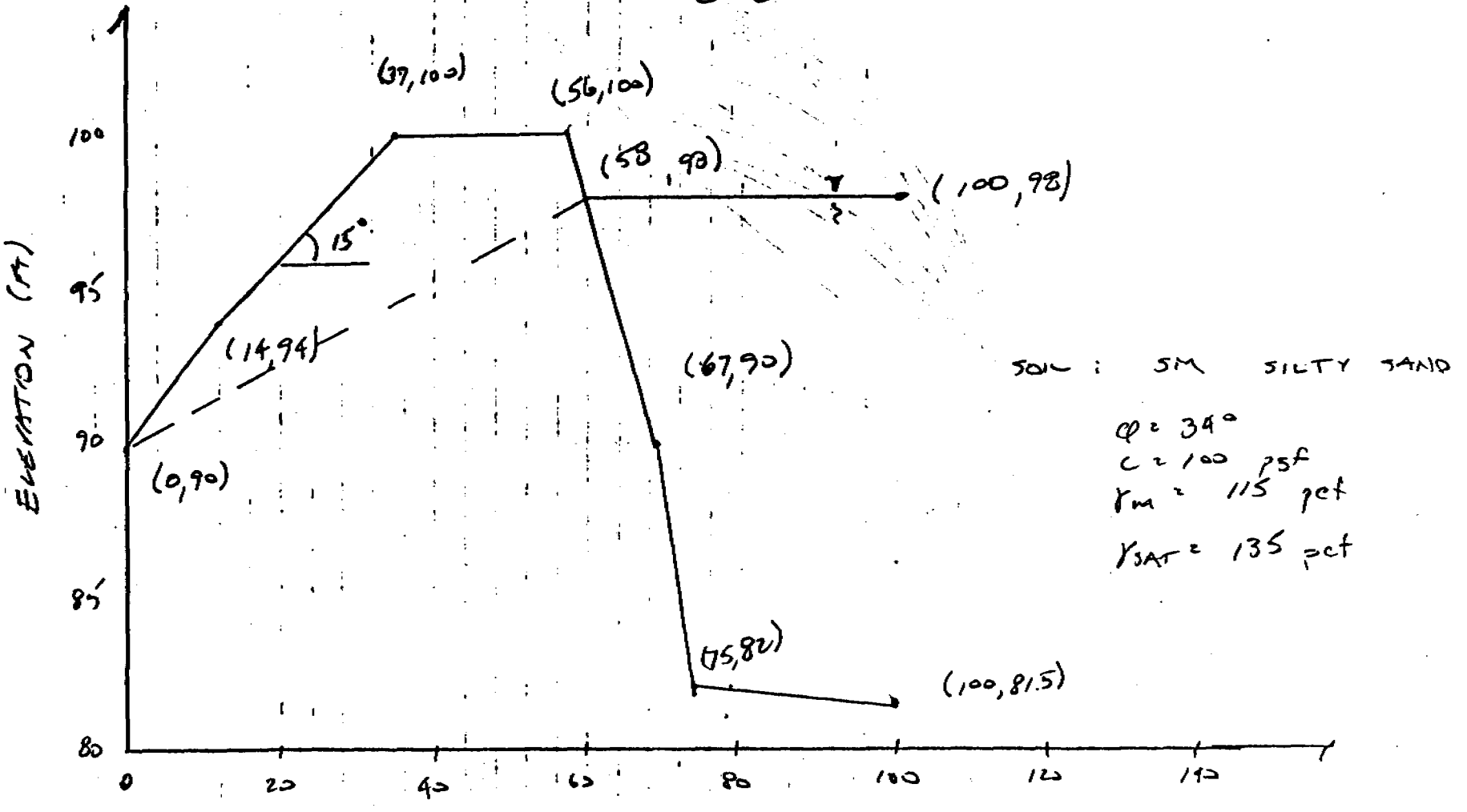
ENGINEERS / SCIENTISTS

PROJECT 46-150-07 PAGE ___ OF ___
COMPUTED [illegible] DATE 6/92
CHECKED ___ DATE ___

POND 011
OUTSLOPE
C-C'



SOIL : SM SILTY SAND

$\phi = 34°$
$C = 100$ psf
$\gamma_m = 115$ pcf
$\gamma_{SAT} = 135$ pcf

NOTE: ELEVATIONS ARE RELATIVE

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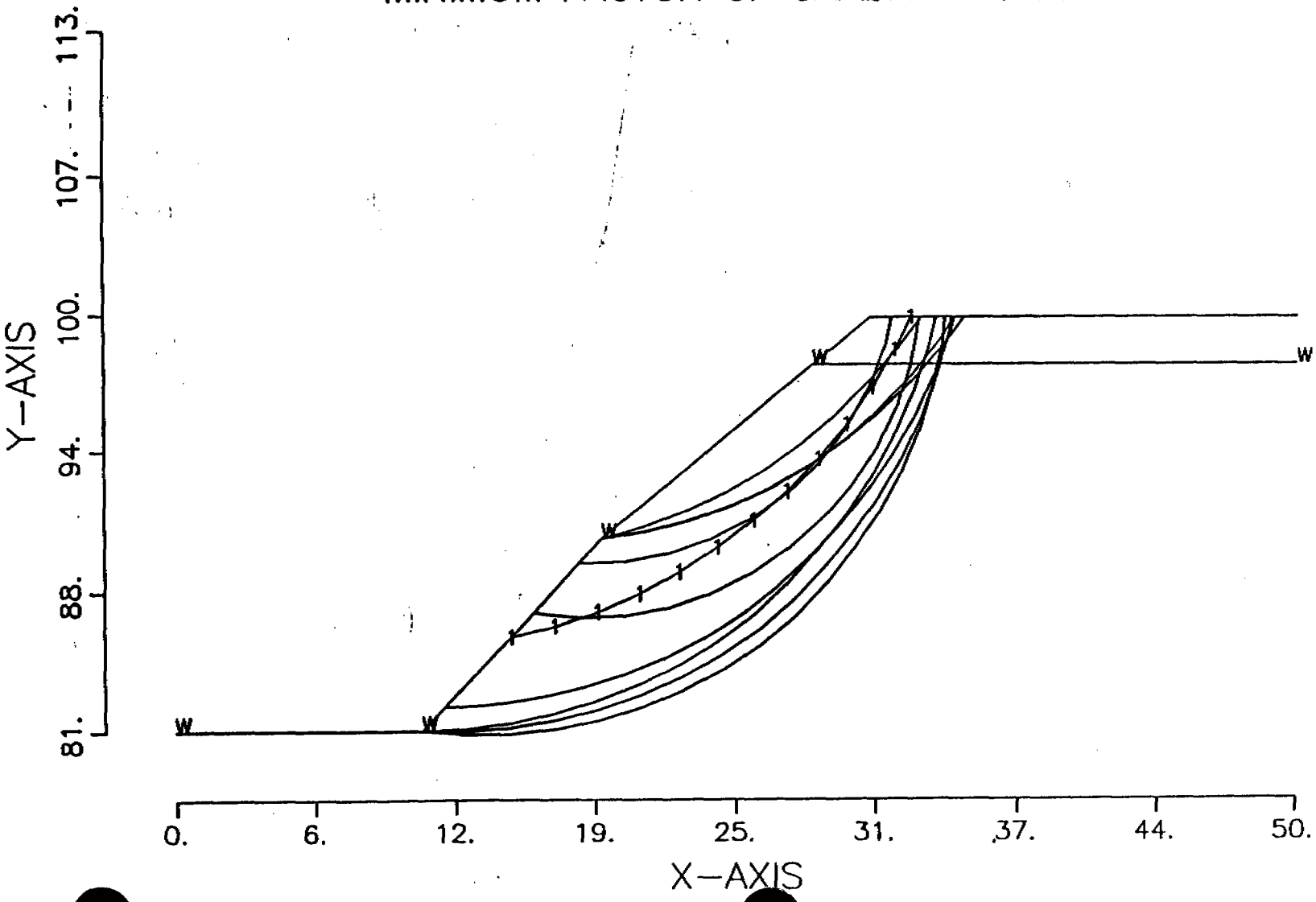
CASTLE GATE COAL – PREPARATION PLANT
POND 011 INSLOPE D – D'
100 SURFACES HAVE BEEN GENERATED
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.161



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--SLOPE STABILITY ANALYSIS--
MODIFIED BISHOP METHOD OF SLICES
CIRCULAR FAILURE SURFACES

PROBLEM DESCRIPTION CASTLE GATE COAL - PREPARATION PLANT
POND 011 INSLOPE D - D'

BOUNDARY COORDINATES

5 TOP BOUNDARIES
6 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT	Y-LEFT	X-RIGHT	Y-RIGHT	SOIL TYPE BELOW BND
1	.00	81.50	11.00	81.50	1
2	11.00	81.50	19.00	90.00	1
3	19.00	90.00	28.40	97.80	1
4	28.40	97.80	31.00	100.00	2
5	31.00	100.00	50.00	100.00	2
6	28.40	97.80	50.00	97.80	1

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT.	SATURATED UNIT WT.	COHESION INTERCEPT	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT	PIEZOMETRIC SURFACE NO.
1	135.0	135.0	25.0	34.0	.00	.0	0
2	115.0	115.0	200.0	34.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-WATER	Y-WATER
1	.00	81.50
2	11.00	81.50
3	19.00	90.00
4	28.40	97.80
5	50.00	97.80

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 = 11.00

AND X = 20.00

EACH SURFACE TERMINATES BETWEEN X = 31.00
AND X = 50.00

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00

2.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND 20.0 DEG.

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.

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7324 S.Union Park Midvale, UTAH 84047

FAILURE SURFACE # 1 SPECIFIED BY 13 COORDINATE POINTS

SAFETY FACTOR = 1.161

X-CENTER = 10.16
Y-CENTER = 110.04
RADIUS = 24.76

POINT NO.	X-SURF	Y-SURF	ALPHA (DEG)
1	15.00	85.75	13.58
2	16.94	86.22	18.21
3	18.84	86.85	22.84
4	20.69	87.62	27.47
5	22.46	88.54	32.09
6	24.16	89.61	36.72
7	25.76	90.80	41.35
8	27.26	92.12	45.98
9	28.65	93.56	50.61
10	29.92	95.11	55.24
11	31.06	96.75	59.87
12	32.06	98.48	64.49
13	32.79	100.00	

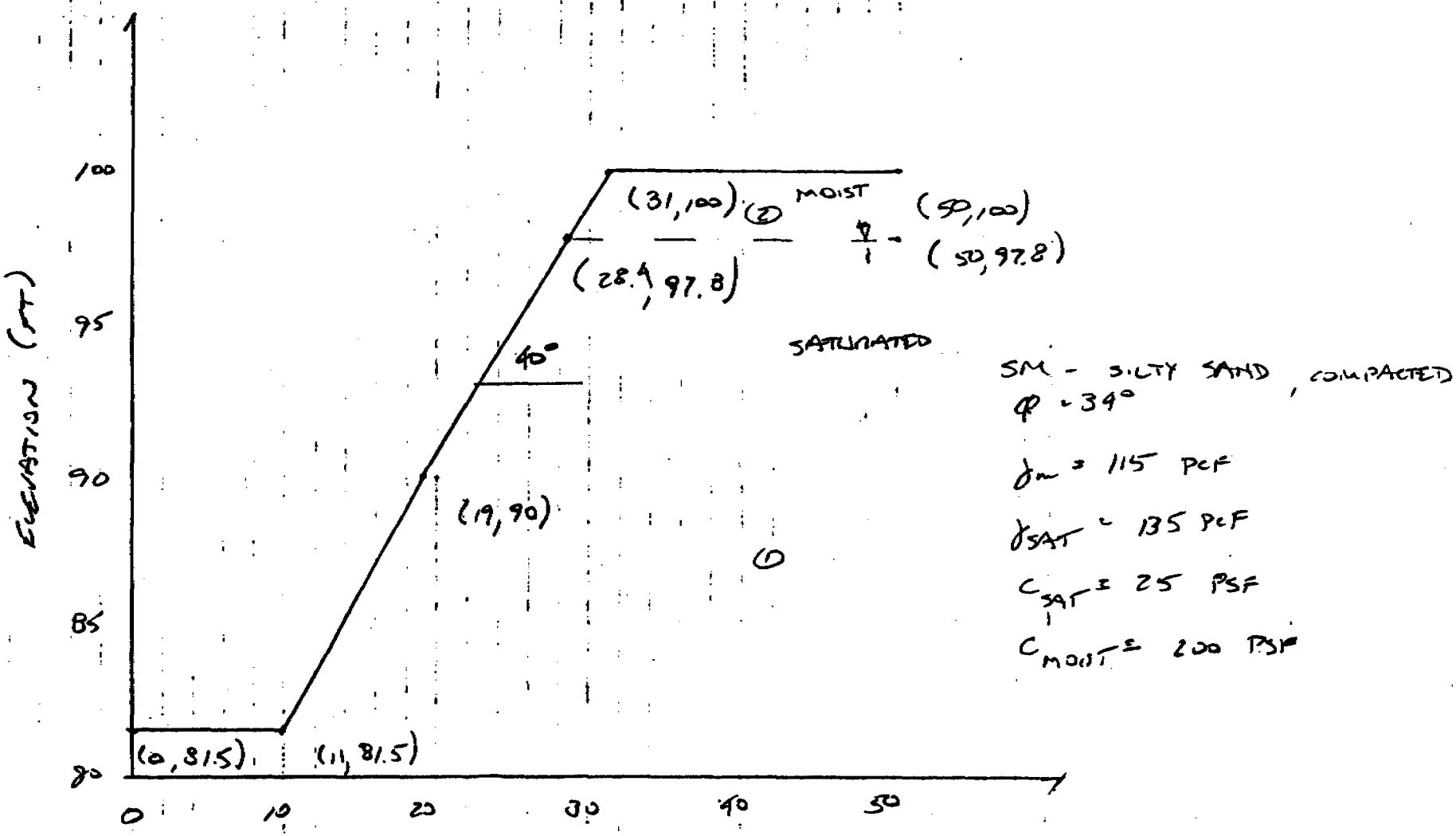
SLICE NO.	X	DX	DW	DQ	DU	DN	DSr
1	15.97	1.94	209.44	.00	.00	179.81	147.59
2	17.89	1.90	588.07	.00	.00	507.81	338.22
3	18.92	.16	63.83	.00	.00	54.41	35.26
4	19.84	1.69	782.46	.00	.00	668.72	428.10
5	21.57	1.77	971.26	.00	.00	823.47	521.67
6	23.31	1.69	1029.53	.00	.00	870.82	549.19

7	24.96	1.60	1025.76	.00	.00	870.28	548.88
8	26.51	1.50	966.62	.00	.00	826.83	523.63
9	27.83	1.14	709.54	.00	.00	614.78	392.61
10	28.53	.25	151.00	.00	.00	130.67	83.72
11	29.29	1.27	703.16	.00	.00	618.09	402.31
12	30.46	1.08	495.60	.00	.00	441.07	297.14
13	31.03	.06	24.23	.00	.00	21.34	14.69
14	31.37	.61	197.32	.00	.00	173.89	127.21
15	31.87	.39	84.44	.00	.00	-32.60	116.57
16	32.43	.73	63.37	.00	.00	-207.87	169.40

PROFIL
[redacted]LE GATE COAL - PREPARATION PLANT POND 011 INSLOPE D - D'

0.0 81.5 11.0 81.5 1
11.0 81.5 19.0 90.0 1
19.0 90.0 28.4 97.8 1
28.4 97.8 31.0 100.0 2
31.0 100.0 50.0 100.0 2
28.4 97.8 50.0 97.8 1
SOIL
2
135.0 135.0 25.0 34.0 0.0 0.0 0
115.0 115.0 200.0 34.0 0.0 0.0 0
WATER
1 0.0
5
0.0 81.5
11.0 81.5
19.0 90.0
28.4 97.8
50.0 97.8
CIRCL2
10 10
11.0 20.0
31.0 50.0
0.0
2.0
[redacted].0

POND 011 - INSLOPE
D - D'



SM - SILTY SAND, COMPACTED

$\phi = 34°$

$\gamma_m = 115$ PCF

$\gamma_{SAT} = 135$ PCF

$C_{SAT} = 25$ PSF

$C_{MOIST} = 200$ PSF

CASTLE GATE COAL
POND EMBANKMENTS
UNIT WEIGHT CALCULATIONS

REFERENCE: ① NAVFAC DM-7 DESIGN MANUAL SOIL MECHANICS, FOUNDATIONS AND EARTH STRUCTURES, MARCH 1971.

② HOEK, EVERT & BRAY, JOHN. ROCK SLOPE ENGINEERING. 1981. THIRD EDITION

SILTY GRAVEL (GM):

SATURATED γ_{SAT} = 120 pcf ② SAND & GRAVEL MIXED GRAIN (NOT NECESSARILY COMPACTED) TABLE 1

DRY γ_{DRY} = 110 pcf

DRY: γ_{DRY} 120 - 135 ① TABLE 9-1 COMPACTED MATERIALS

RANGE OF OPTIMUM MOISTURE 8 - 12 %.

$\gamma_{WET} = \gamma_{DRY}(1+w)$

ASSUME: γ_{DRY} = 125 PCF LOW END OF "COMPACTED" RANGE BUT ABOVE HOEK VALUE

ASSUME: $G_s = 2.65$ G_s = SPECIFIC GRAVITY OF SOLIDS

$w = S\left(\rho_w/\rho_d = 1/G_s\right)$ $\rho_w = \gamma_w$ = DENSITY OF WATER

$\rho_d = \gamma_d$ = DRY DENSITY OF SOIL

S = DEGREE OF SATURATION

w = WATER CONTENT

IN SATURATED CONDITION

$w = 1.0\left(\frac{62.4}{125} - \frac{1}{2.65}\right)$

$= 0.122$ OR 12.2 %

REFERENCE: CIVIL ENG. REFERENCE MANUAL MICHAEL LINDEBURG 1986. PG 9-7

$\gamma_{WET} = \gamma_{DRY}(1+w)$

@ $w = 12.2$, $\gamma_{DRY} = 125$ $\gamma_{WET} = \gamma_{SAT}$

$\gamma_{SAT} = 125(1+0.122)$

$\gamma_{SAT} = 140.2$ pcf SAY 140 PCF

GM: SILTY GRAVEL	γ_{DRY} = 125 PCF	
	γ_{SAT} = 140 PCF	

SM: SILTY SAND

② HOEK

LOOSE SAND, MIXED GRAIN — γ_{DRY} 99 — γ_{SAT} 125

DENSE SAND, MIXED GRAIN — 116 — 135

① NAVFAC

SILTY SAND, SM, COMPACTED 110-125

OPT MOISTURE 11-16%

USE $\gamma_{DRY} = 115$ PCF

ASSUME $G_s = 2.65$

$w = S\left(\frac{\gamma_w}{\gamma_{DRY}} - \frac{1}{G_s}\right)$ $\gamma_w = \gamma_{WATER}$

$= 1.0\left(\frac{62.4}{115} - \frac{1}{2.65}\right)$

$w = 16.5\%$

$\gamma_{SAT} = \gamma_{WET}$ @ $S = 1$ $(w = 16.5\%)$

$\gamma_{SAT} = \gamma_{DRY}(1+w)$

$= 115(1+.165)$

$\gamma_{SAT} = 134$ PCF SAY 135 PCF

SILTY SAND, SM	$\gamma_{DRY} = 115$ PCF $\gamma_{SAT} = 135$ PCF

GP (SANDY GRAVEL)

	γ_{SAT}	γ_{DRY}
② HOEK GRAVEL, UNIFORM	140	130
① NAVFAC GRAVEL, SAND MIX, GP COMPACTED		115-125

USE $\gamma_{DRY} = 130$ pcf

$G_s = 2.65$

$w = S\left(\frac{\gamma_{WATER}}{\gamma_{DRY}} - \frac{1}{G_s}\right)$

$w_{SAT} = 1.0\left(\frac{62.4}{130} - \frac{1}{2.65}\right)$

$w_{SAT} = 10.32$

$\gamma_{SAT} = 130(1+.103)$

$\gamma_{SAT} = 143.4$

SAY 145 PCF

GP:	$\gamma_{DRY} = 130$ pcf $\gamma_{SAT} = 145$ PCF

Allow. Bearing Values 7-11-12
Prop. of Compacted Mat'ls 7-9-2
Friction Factors 7-10-7

DESIGN MANUAL

SOIL MECHANICS, FOUNDATIONS, AND EARTH STRUCTURES

NAVFAC DM-7
March 1971

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA. 22332

KLEBBA

TABLE 9-1
Typical Properties of Compacted Materials

Group symbol	Soil type	Range of maximum dry unit weight, pcf	Range of optimum moisture, percent	Typical value of compression (percent of original height)		Typical strength characteristics				Typical coefficient of permeability ft/min.	Range of CBR values	Range of subgrade modulus k lb/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective stress envelope) degrees	Tan ϕ			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix.	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	5×10^{-5}	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	2×10^{-6}	.....	
SC	Clayey sands, poorly graded sand-clay mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	5×10^{-7}	5 - 20	100 - 300
ML	Inorganic silts and clayey silts .	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	10^{-5}	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	5×10^{-7}	.....	
CL	Inorganic clays of low to med. plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	10^{-7}	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	5×10^{-7}	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	10^{-7}	15 or less	50 - 150
OH	Organic clays and silty clays ...	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
   (....) indicates insufficient data available for an estimate.

FROM NAVFAC DM-7

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Rock Slope Engineering

Revised third edition

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1981

Friction, cohesion and unit weight

The material properties which are most relevant to the discussion on slope stability presented in this book are the *angle of friction*, the *cohesive strength* and the unit weight of the rock and soil masses.

Friction and cohesion are best defined in terms of the plot of shear stress versus normal stress given in Figure 9. This plot is a simplified version of the results which would be obtained if a rock specimen containing a geological discontinuity such as a joint is subjected to a loading system which causes sliding along the discontinuity. The shear stress τ required to cause sliding increases with increasing normal stress σ. The slope of the line relating shear to normal stress defines the angle of friction ϕ. If the discontinuity surface is initially cemented or if it is rough, a finite value of shear stress τ will be required to cause sliding when the normal stress level is zero. This initial value of shear strength defines the cohesive strength c of the surface.

The relationship between shear and normal stresses for a typical rock surface or for a soil sample can be expressed as :

$$\tau = c + \sigma \tan \phi \qquad (1)$$

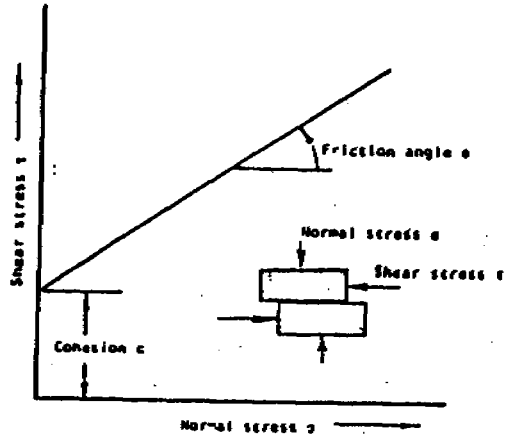


Figure 9 : Relationship between the shear stress τ required to cause sliding along a discontinuity and the normal stress σ acting across it.

HOEK & BRAY, 1981

TABLE 1 - TYPICAL SOIL AND ROCK PROPERTIES

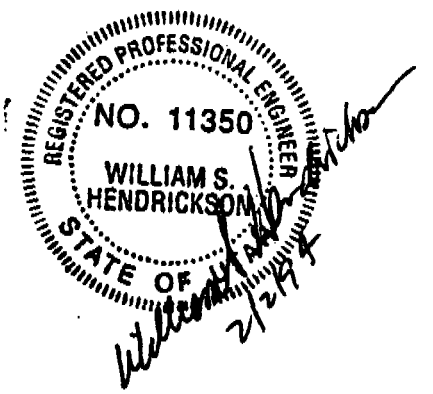
Description			Unit weight (Saturated/dry)		Friction angle	Cohesion	
Type		Material	lb/ft³	kN/m³	degrees	lb/ft²	kPa
Cohesionless	Sand	Loose sand, uniform grain size	118/90	19/14	28-34*		
		Dense sand, uniform grain size	130/109	21/17	32-40*		
		Loose sand, mixed grain size	124/99	20/16	34-40*		
		Dense sand, mixed grain size	135/116	21/18	38-46*		
	Gravel	Gravel, uniform grain size	140/130	22/20	34-37*		
		Sand and gravel, mixed grain size	120/110	19/17	48-45*		
	Stiff/Broken rock	Basalt	140/110	22/17	40-50*		
		Chalk	80/62	13/10	30-40*		
		Granite	125/110	20/17	45-50*		
		Limestone	120/100	19/16	35-40*		
		Sandstone	110/80	17/13	35-45*		
		Shale	125/100	20/16	30-35*		
Cohesive	Clay	Soft bentonite	80/30	13/6	7-13	200-400	10-20
		Very soft organic clay	90/40	14/6	12-16	200-600	10-30
		Soft, slightly organic clay	100/60	16/10	22-27	400-1000	20-50
		Soft glacial clay	110/76	17/12	27-32	600-1500	30-73
		Stiff glacial clay	130/105	20/17	30-32	1500-3000	70-150
		Glacial till, mixed grain size	145/130	23/20	32-35	3000-5000	150-250
	Rock	Hard igneous rocks - granite, basalt, porphyry	160 to 190**	25 to 30	35-45	720000-1150000	35000-55000
		Metamorphic rocks - quartzite, gneiss, slate	160 to 180	25 to 28	30-40	400000-600000	20000-40000
		Hard sedimentary rocks - limestone, dolomite, sandstone	150 to 180	23 to 28	35-45	200000-600000	10000-30000
		Soft sedimentary rock - sandstone, coal, chalk, shale	110 to 150	17 to 23	25-35	20000 - 400000	1000-20000

* Higher friction angles in cohesionless materials occur at low confining or normal stresses as discussed in Chapter 5.

** For intact rock, the unit weight of the material does not vary significantly between saturated and dry states with the exception of materials such as porous sandstones.

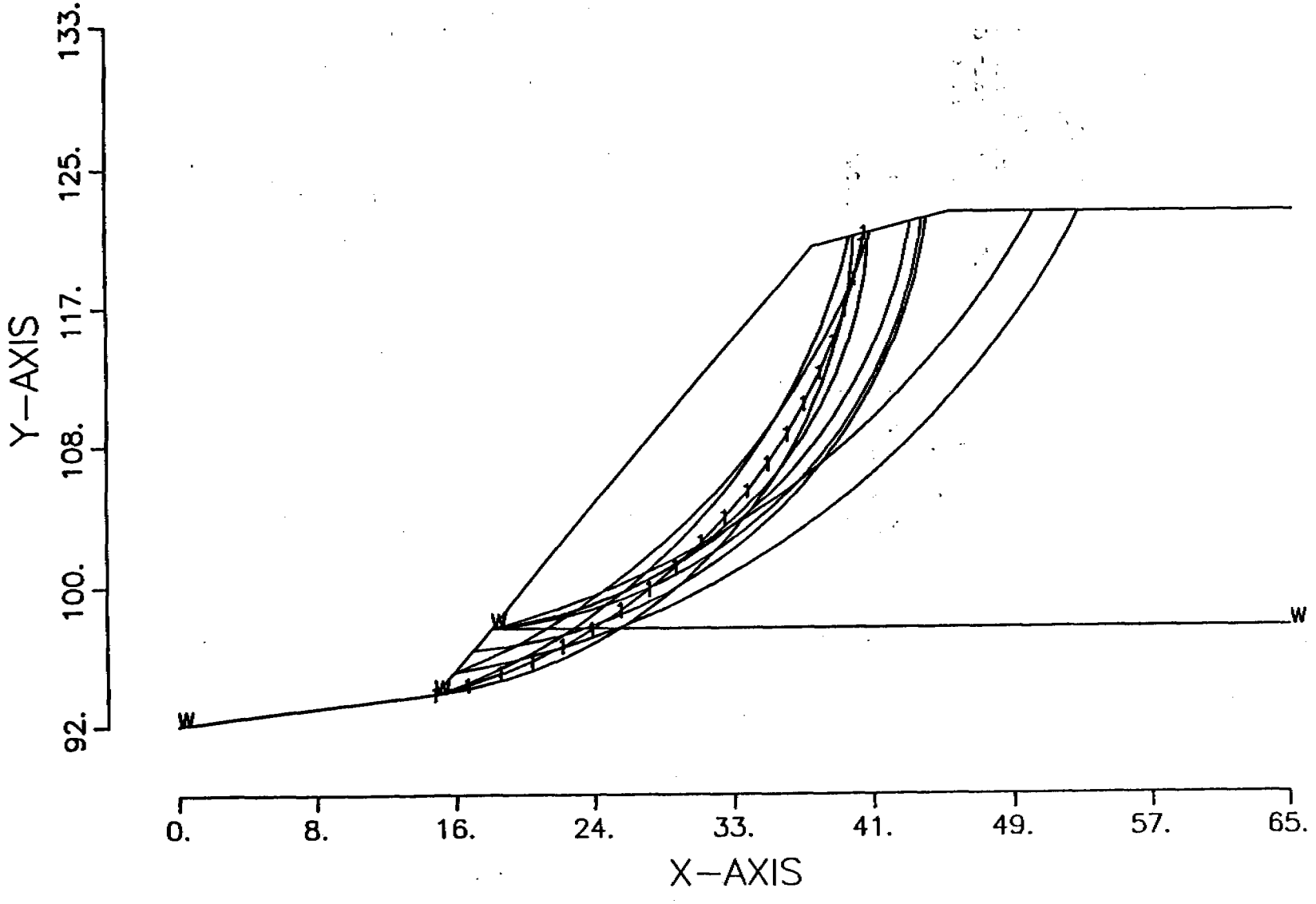
APPENDIX 3.4P-2

EMBANKMENT STABILITY ANALYSIS FOR POND 012A COMPUTER OUTPUT



Ea[illegible]x Engineering
7324 S.Union Park Midvale, UTAH 8+0[illegible]

CASTLE GATE COAL – PREPARATION PLANT
POND 012A INSLOPE G – G'
100 SURFACES HAVE BEEN GENERATED
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.199



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--SLOPE STABILITY ANALYSIS--
MODIFIED BISHOP METHOD OF SLICES
CIRCULAR FAILURE SURFACES

PROBLEM DESCRIPTION CASTLE GATE COAL - PREPARATION PLANT
POND 012A INSLOPE G - G'

BOUNDARY COORDINATES

6 TOP BOUNDARIES
7 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT	Y-LEFT	X-RIGHT	Y-RIGHT	SOIL TYPE BELOW BND
1	.00	92.20	15.00	94.00	1
2	15.00	94.00	18.30	97.90	1
3	18.30	97.90	20.00	100.00	2
4	20.00	100.00	37.00	120.00	2
5	37.00	120.00	45.00	122.00	2
6	45.00	122.00	65.00	122.00	2
7	18.30	97.90	65.00	97.90	1

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT.	SATURATED UNIT WT.	COHESION INTERCEPT	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT	PIEZOMETRIC SURFACE NO.
1	135.0	135.0	25.0	34.0	.00	.0	0
2	115.0	115.0	200.0	34.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-WATER	Y-WATER
1	.00	92.20
2	15.00	94.00
3	18.30	97.90
4	65.00	97.90

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 = 15.00
AND X = 25.00

EACH SURFACE TERMINATES BETWEEN X = 35.00
AND X = 65.00

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00

2.00 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.

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FAILURE SURFACE # 1 SPECIFIED BY 21 COORDINATE POINTS

SAFETY FACTOR = 1.199

X-CENTER = 6.68
Y-CENTER = 126.86
RADIUS = 33.90

POINT NO.	X-SURF	Y-SURF	ALPHA (DEG)
1	15.00	94.00	15.90
2	16.92	94.55	19.28
3	18.81	95.21	22.66
4	20.66	95.98	26.04
5	22.45	96.86	29.42
6	24.20	97.84	32.80
7	25.88	98.92	36.19
8	27.49	100.10	39.57
9	29.03	101.38	42.95
10	30.50	102.74	46.33
11	31.88	104.19	49.71
12	33.17	105.71	53.09
13	34.37	107.31	56.47
14	35.48	108.98	59.85
15	36.48	110.71	63.23
16	37.38	112.49	66.61
17	38.18	114.33	70.00
18	38.86	116.21	73.38
19	39.43	118.13	76.76
20	39.89	120.07	80.14
21	40.01	120.75	

SLICE NO.	X	DX	DW	DQ	DU	DN	DSr
1	15.96	1.92	224.00	.00	.00	190.52	148.84
2	17.61	1.38	426.83	.00	.00	368.97	237.90
3	18.56	.51	210.73	.00	.00	183.25	114.36

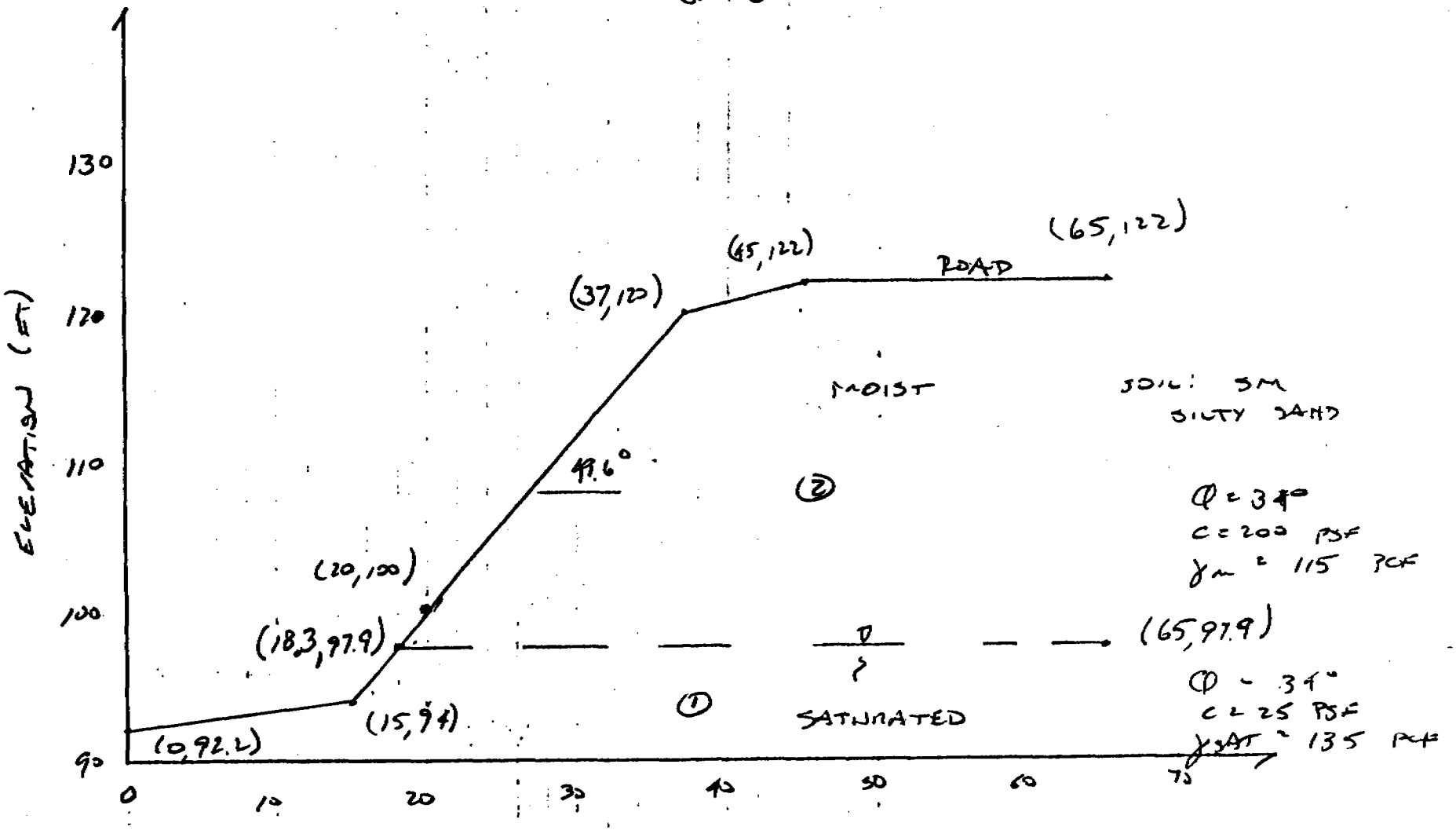
4	19.41	1.19	578.55	.00	.00	498.65	307.29
5	20.33	.66	370.63	.00	.00	320.24	194.95
6	21.56	1.80	1171.61	.00	.00	1006.91	607.99
7	23.33	1.74	1334.06	.00	.00	1144.93	685.61
8	24.24	.09	76.22	.00	.00	65.47	39.13
9	25.08	1.59	1382.23	.00	.00	1057.90	910.04
10	26.68	1.61	1550.08	.00	.00	1187.87	1001.59
11	28.26	1.54	1592.05	.00	.00	1221.83	1020.70
12	29.77	1.46	1587.42	.00	.00	1219.71	1019.51
13	31.19	1.38	1540.23	.00	.00	1183.78	999.29
14	32.53	1.29	1455.35	.00	.00	1116.48	961.44
15	33.77	1.20	1338.45	.00	.00	1020.49	907.46
16	34.93	1.10	1195.86	.00	.00	898.79	839.01
17	35.98	1.00	1034.47	.00	.00	754.69	757.97
18	36.74	.52	504.70	.00	.00	350.08	388.69
19	37.19	.38	349.15	.00	.00	233.71	273.17
20	37.78	.79	619.17	.00	.00	342.82	526.33
21	38.52	.68	402.03	.00	.00	101.81	390.78
22	39.15	.57	221.66	.00	.00	-118.69	266.77
23	39.66	.46	82.51	.00	.00	-311.83	158.15
24	39.95	.12	4.41	.00	.00	-150.09	30.57

PROFIL
CASTLE GATE COAL - PREPARATION PLANT POND 012A INSLOPE G - G

0.0 92.2 15.0 94.0 1
15.0 94.0 18.3 97.9 1
18.3 97.9 20.0 100.0 2
20.0 100.0 37.0 120.0 2
37.0 120.0 45.0 122.0 2
45.0 122.0 65.0 122.0 2
18.3 97.9 65.0 97.9 1
SOIL
2
135.0 135.0 25.0 34.0 0.0 0.0 0
115.0 115.0 200.0 34.0 0.0 0.0 0
WATER
1 0.0
4
0.0 92.2
15.0 94.0
18.3 97.9
65.0 97.9
CIRCL2
10 10
15.0 25.0
35.0 65.0
0.0
2.0
0 0

POND 012A - INSLOPE

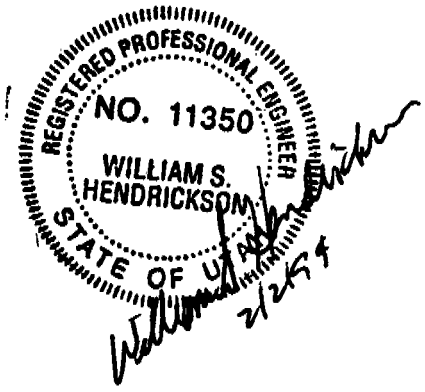
G = 6'



February 1994

APPENDIX 3.4P-3

EMBANKMENT STABILITY ANALYSES FOR POND 012B COMPUTER OUTPUT



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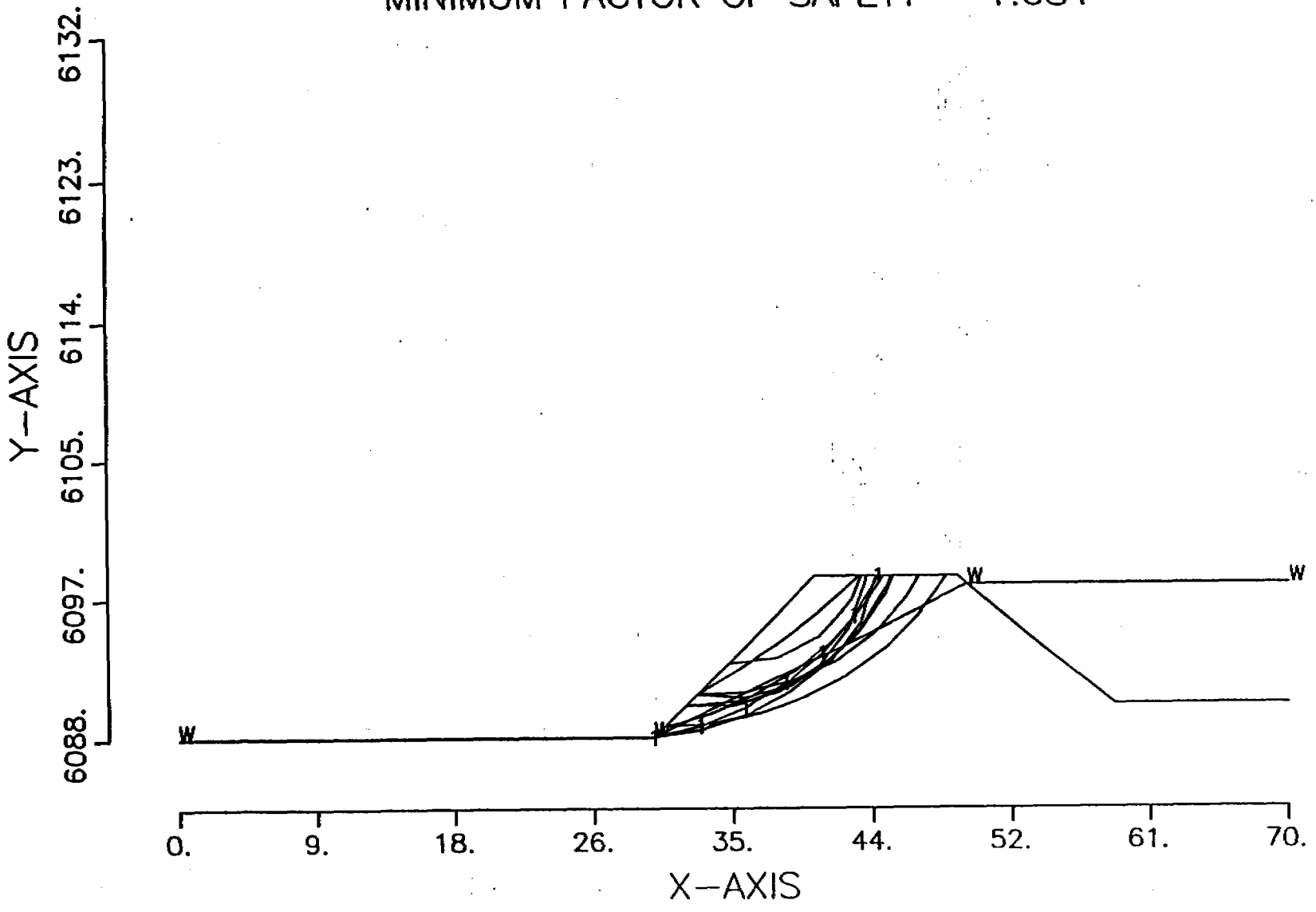
732 S.Union Park Midvale, UTAH 8[illegible]7

CASTLE GATE COAL – PREPARATION PLANT
POND 012B OUTSLOPE F – F'
100 SURFACES HAVE BEEN GENERATED
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.681



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--SLOPE STABILITY ANALYSIS--
MODIFIED BISHOP METHOD OF SLICES
CIRCULAR FAILURE SURFACES

PROBLEM DESCRIPTION CASTLE GATE COAL - PREPARATION PLANT
POND 012B OUTSLOPE F - F'

BOUNDARY COORDINATES

6 TOP BOUNDARIES
6 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT	Y-LEFT	X-RIGHT	Y-RIGHT	SOIL TYPE BELOW BND
1	.00	6088.00	30.00	6088.00	1
2	30.00	6088.00	40.00	6098.00	1
3	40.00	6098.00	49.00	6098.00	1
4	49.00	6098.00	49.60	6097.50	1
5	49.60	6097.50	59.00	6090.00	1
6	59.00	6090.00	70.00	6090.00	1

ISOTROPIC SOIL PARAMETERS

1 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT.	SATURATED UNIT WT.	COHESION INTERCEPT	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT	PIEZOMETRIC SURFACE NO.
1	115.0	135.0	100.0	34.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-WATER	Y-WATER
1	.00	6088.00
2	30.00	6088.00
3	49.60	6097.50
4	70.00	6097.50

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 = 30.00
AND X = 36.00

EACH SURFACE TERMINATES BETWEEN X = 42.00

AND X = 59.00

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00

3.00 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.

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FAILURE SURFACE # 1 SPECIFIED BY 7 COORDINATE POINTS

SAFETY FACTOR = 1.681

X-CENTER = 27.14
Y-CENTER = 6106.81
RADIUS = 19.03

POINT NO.	X-SURF	Y-SURF	ALPHA (DEG)
1	30.00	6088.00	13.16
2	32.92	6088.68	22.20
3	35.70	6089.82	31.24
4	38.26	6091.37	40.27
5	40.55	6093.31	49.30
6	42.51	6095.59	58.34
7	44.00	6098.00	

SLICE NO.	X	DX	DW	DQ	DU	DN	DSr
1	30.00	.00	.00	.00	.00	-.02	.09
2	31.46	2.92	375.91	.00	.00	314.80	304.71
3	34.31	2.78	977.46	.00	.00	844.55	517.40
4	36.98	2.57	1294.05	.00	.00	1130.14	632.00
5	39.13	1.74	1002.84	.00	.00	895.31	494.61
6	40.01	.01	5.99	.00	.00	5.36	2.94
7	40.28	.54	307.33	.00	.00	273.81	152.24
8	41.53	1.96	798.79	.00	.00	693.78	456.89
9	43.25	1.49	206.53	.00	.00	72.64	197.86

PROFILE
CLEAR GATE COAL - PREPARATION PLANT POND 012B OUTSLOPE F - F'

0.0 6088.0 30.0 6088.0 1
30.0 6088.0 40.0 6098.0 1
40.0 6098.0 49.0 6098.0 1
49.0 6098.0 49.6 6097.5 1
49.6 6097.5 59.0 6090.0 1
59.0 6090.0 70.0 6090.0 1
SOIL
1
115.0 135.0 100.0 34.0 0.0 0.0 0
WATER
1 0.0
4
0.0 6088.0
30.0 6088.0
49.6 6097.5
70.0 6097.5
CIRCL2
10 10
30.0 36.0
42.0 59.0
0.0
3.0
0.0
0

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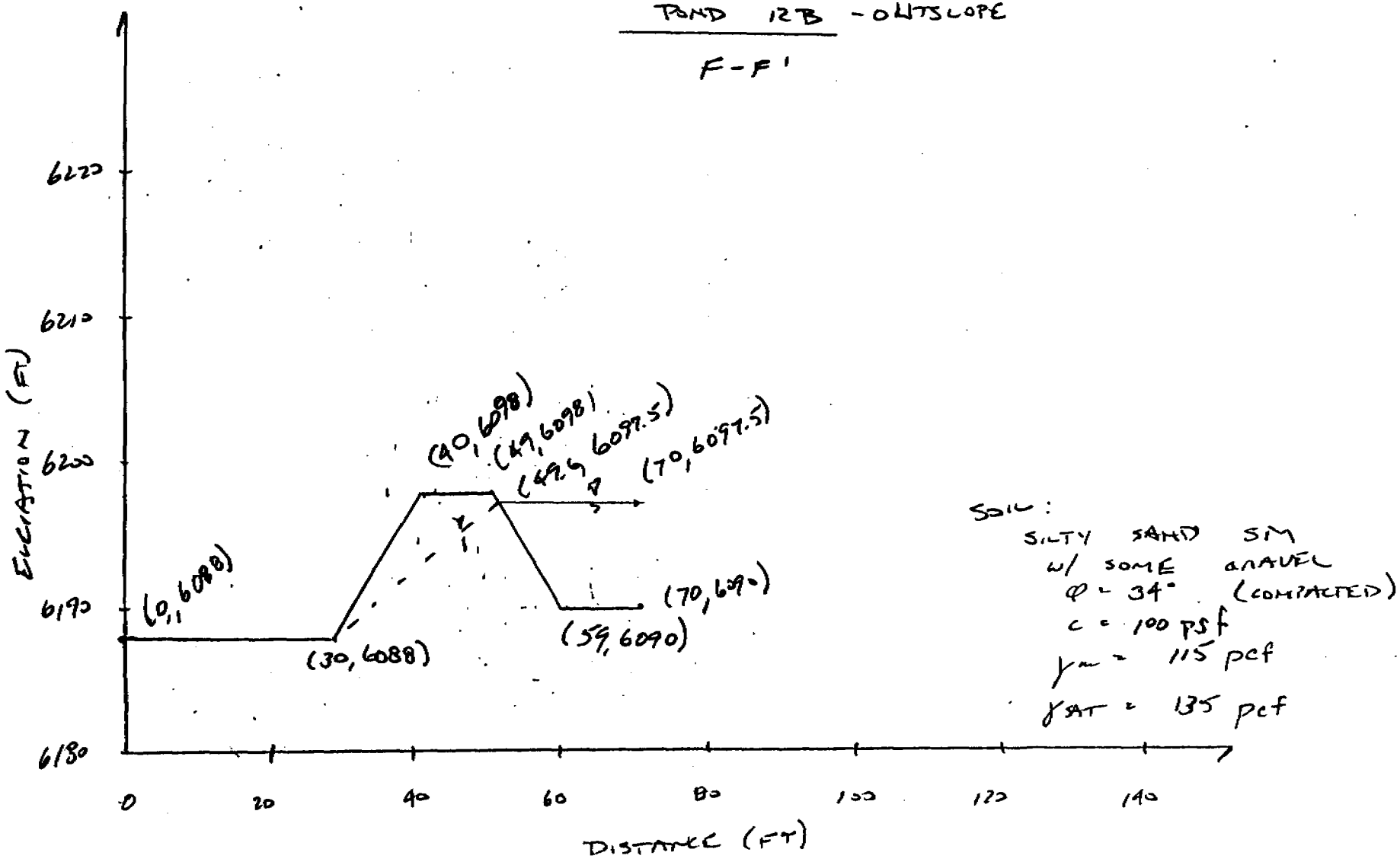
ENGINEERS / SCIENTISTS

PROJECT 150-07 PAGE ___ OF ___
COMPUTED [illegible] DATE 6/92
CHECKED ___ DATE ___

POND 12B - OUTSLOPE

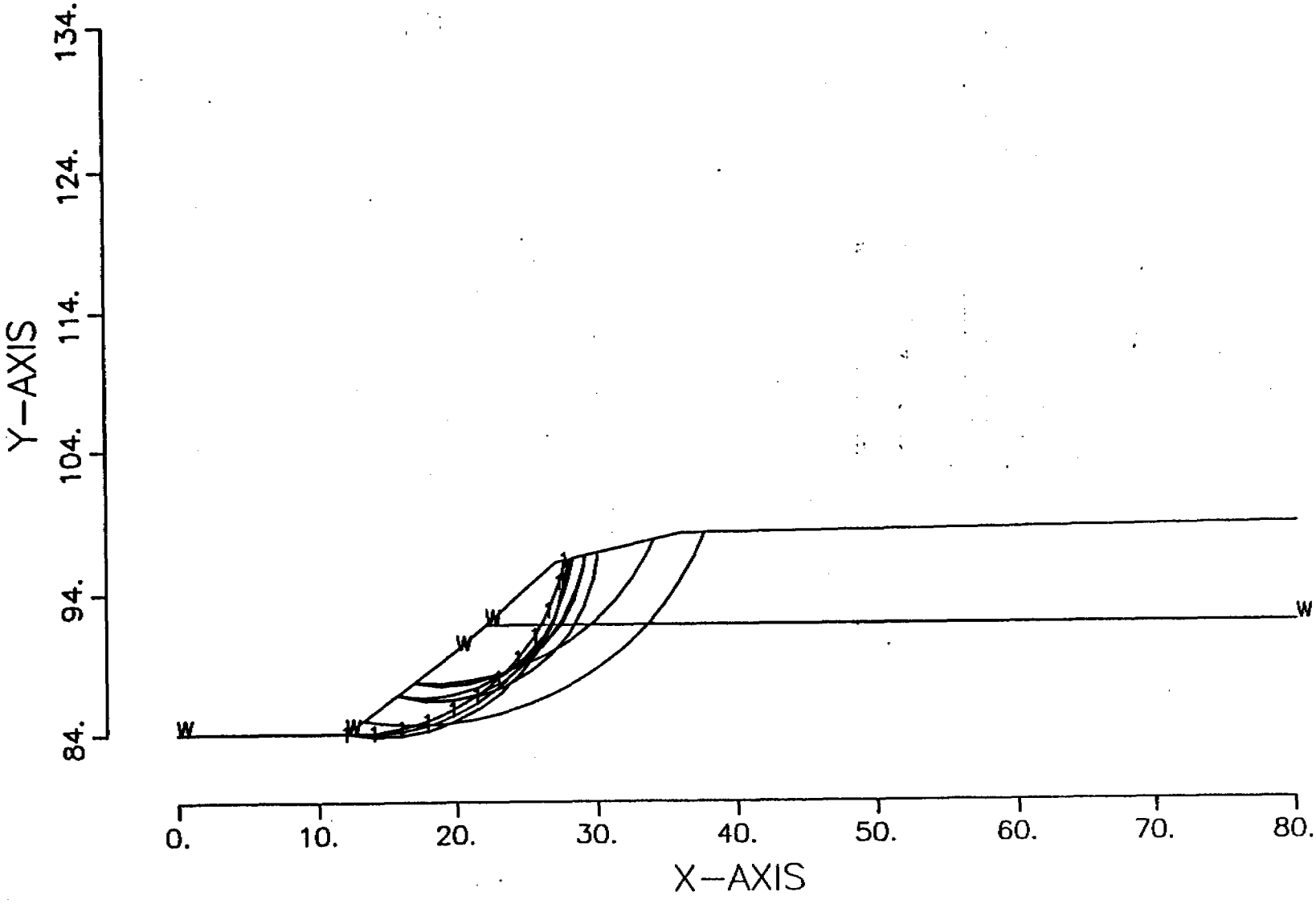
F-F'



SOIL:
SILTY SAND SM
w/ SOME GRAVEL
ϕ = 34° (COMPACTED)
c = 100 psf
γ_m = 115 pcf
γ_{SAT} = 135 pcf

Ear[illegible]x Engineering
7324 S.Union Park Midvale, UTAH 84[illegible]

CASTLE GATE COAL – PREPARATION PLANT
POND 012B INSLOPE H – H'
100 SURFACES HAVE BEEN GENERATED
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.461



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--SLOPE STABILITY ANALYSIS--
MODIFIED BISHOP METHOD OF SLICES
CIRCULAR FAILURE SURFACES

PROBLEM DESCRIPTION CASTLE GATE COAL - PREPARATION PLANT
POND 012B INSLOPE H - H'

BOUNDARY COORDINATES

6 TOP BOUNDARIES
7 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT	Y-LEFT	X-RIGHT	Y-RIGHT	SOIL TYPE BELOW BND
1	.00	84.00	12.00	84.00	1
2	12.00	84.00	20.00	90.00	1
3	20.00	90.00	22.10	91.80	1
4	22.10	91.80	27.00	96.00	2
5	27.00	96.00	36.00	98.00	2
6	36.00	98.00	80.00	98.50	2
7	22.10	91.80	80.00	91.80	1

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT.	SATURATED UNIT WT.	COHESION INTERCEPT	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT	PIEZOMETRIC SURFACE NO.
1	135.0	135.0	25.0	34.0	.00	.0	0
2	115.0	115.0	200.0	34.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-WATER	Y-WATER
1	.00	84.00
2	12.00	84.00
3	20.00	90.00
4	22.10	91.80
5	80.00	91.80

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 = 12.00
AND X = 23.00

EACH SURFACE TERMINATES BETWEEN X = 25.00
AND X = 50.00

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00

2.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -40.0 AND 20.0 DEG.

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.

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FAILURE SURFACE # 1 SPECIFIED BY 12 COORDINATE POINTS

SAFETY FACTOR = 1.461

X-CENTER = 12.72
Y-CENTER = 99.28
RADIUS = 15.29

POINT NO.	X-SURF	Y-SURF	ALPHA (DEG)
1	12.00	84.00	1.06
2	14.00	84.04	8.56
3	15.98	84.33	16.06
4	17.90	84.89	23.55
5	19.73	85.69	31.05
6	21.45	86.72	38.55
7	23.01	87.97	46.05
8	24.40	89.41	53.55
9	25.59	91.01	61.04
10	26.56	92.76	68.54
11	27.29	94.63	76.04
12	27.67	96.15	

SLICE NO.	X	DX	DW	DQ	DU	DN	DSr
1	13.00	2.00	197.44	.00	.00	195.18	124.30
2	14.99	1.98	548.85	.00	.00	514.17	271.54
3	16.94	1.92	802.46	.00	.00	728.42	370.43
4	18.82	1.83	946.66	.00	.00	847.30	425.30
5	19.87	.27	148.81	.00	.00	133.41	66.91
6	20.72	1.45	846.95	.00	.00	760.01	379.68
7	21.77	.65	400.50	.00	.00	366.07	183.26
8	22.56	.91	557.02	.00	.00	509.11	254.91
9	23.70	1.39	803.29	.00	.00	758.67	384.39

10	24.99	1.19	594.06	.00	.00	586.82	305.07
11	25.80	.44	181.95	.00	.00	189.75	102.96
12	26.29	.53	190.63	.00	.00	66.13	181.27
13	26.78	.44	126.78	.00	.00	-35.19	150.05
14	27.14	.29	58.51	.00	.00	-52.13	83.36
15	27.48	.38	31.31	.00	.00	-256.97	96.14

```
PROFIL
CASTLE GATE COAL - PREPARATION PLANT                POND 012B  INSLOPE  H - H'
  5
0.0 84.0 12.0 84.0 1
12.0 84.0 20.0 90.0 1
20.0 90.0 22.1 91.8 1
22.1 91.8 27.0 96.0 2
27.0 96.0 36.0 98.0 2
36.0 98.0 80.0 98.5 2
22.1 91.8 80.0 91.8 1
SOIL
2
135.0 135.0 25.0 34.0 0.0 0.0 0
115.0 115.0 200.0 34.0 0.0 0.0 0
WATER
1 0.0
5
0.0 84.0
12.0 84.0
20.0 90.0
22.1 91.8
80.0 91.8
CIRCL2
10 10
12.0 23.0
25.0 50.0
0.0
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-40.0
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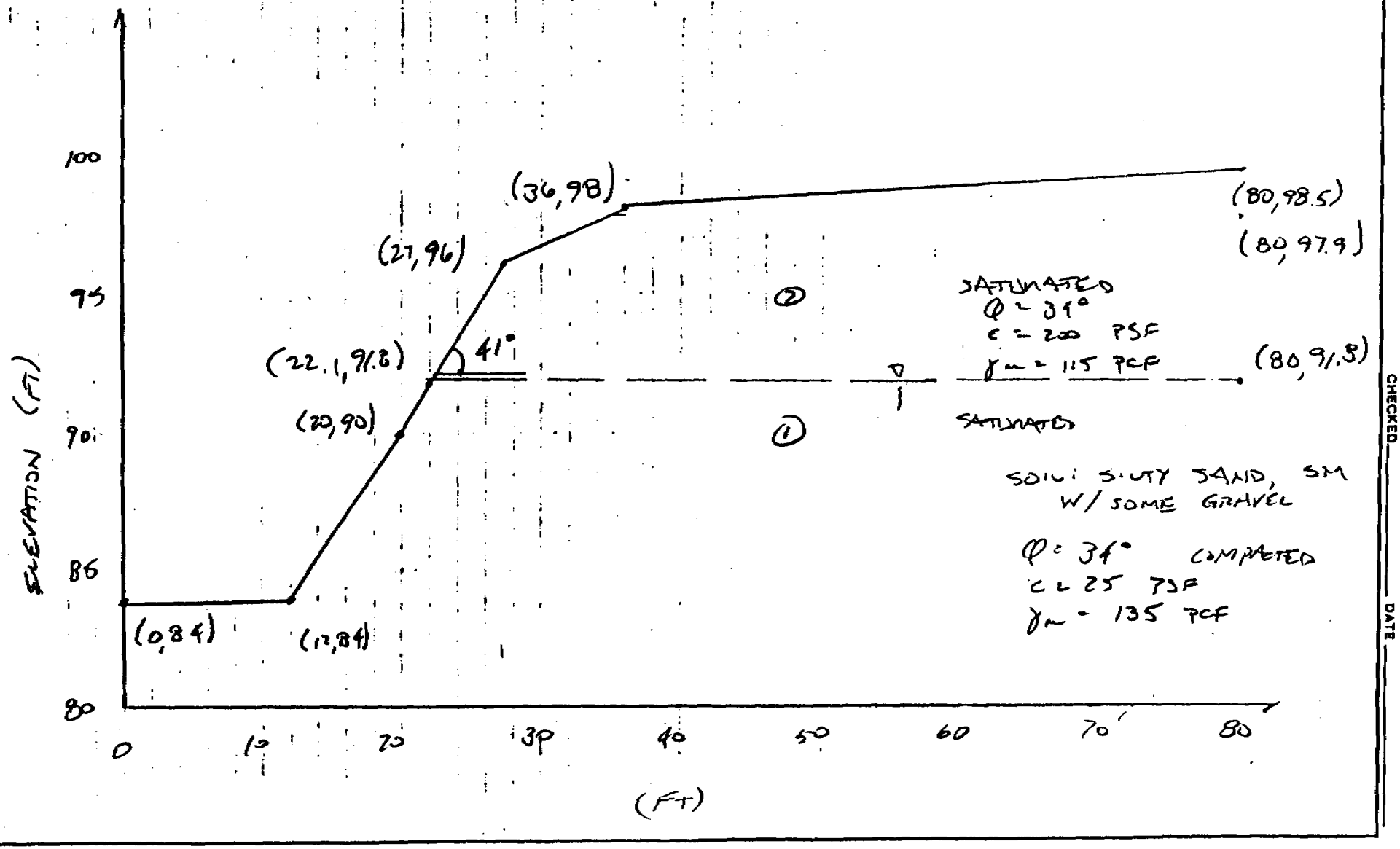
EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT LC-(SW)-07 PAGE
COMPUTED [illegible] DATE 7/3/12
CHECKED DATE

POND 012B - INSLOPE
H-H'



SECTION 3.10

CASTLE GATE SLURRY INJECTION WELLS

SECTION 3.10

CASTLE GATE SLURRY INJECTION WELLS

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SECTION 3.10

CASTLE GATE SLURRY DISPOSAL WELLS

3.10-1 General Description of the Facility

One injection well and one return well will be used to dispose of coal processing wastes in an abandoned underground mine. Replacement wells will be necessary as portions of the underground mine are successfully backfilled. The location of each replacement well will be reported to the Department of Health after it is completed and ready for use. All wells will be used by Castle Gate Coal Co. only to facilitate disposal of coal processing waste into the abandoned Utah Fuels #3 Mine (D Seam). No wells will be located outside the Mine Permit Area. (See Exhibit No. 3.4-1).

Plans for construction, monitoring, reporting, operating and abandonment of all wells are contained in later sections of this application.

Monitoring the nature of injection fluid will comply with applicable analytical methods cited and described in Table IB of 40 CFR 136.3 or in Appendix III of 40 CFR 261 or in certain circumstances by other methods that have been approved in advance by the Executive Secretary of the Bureau of Water Pollution Control.

a) Sampling Sources. Castle Gate will collect representative water quality samples at least once each quarter from the following sources:
   1) Injection Wellhead. Samples are to be collected during periods of injection well operation.
   2) Recovery Wellhead. Samples will be collected during periods of pumping.
b) Analysis Parameters. Injection fluid analysis parameters shall include:
   1) Inorganics: Nitrate*, Sodium, Sulfate*, Chloride.
   2) General Quality: Total Dissolved Solids*, Biochemical Oxygen Demand (5-day), Chemical Oxygen Demand, Turbidity, Specific Conductance, Total Organic Carbon.
   3) Metals: Arsenic*, Barium*, Cadmium*, Chromium*, Lead*, Mercury*, Selenium*, Silver*, Copper, Iron, Zinc.
c) Field determinations to be made on all water quality samples, immediately upon collection shall include: 1) ph, 2) temperature, and 3) conductivity.
d) The fluid monitoring will be quarterly by April 30, July 30, October 30, January 30.
e) The Division will be notified of any changes in the quality of injection fluid or violations of drinking water regulations.

*=MCL's under the Safe Drinking Water Act.

UMC 817.13 and 817.15 Casing and Sealing Underground Openings

An eight inch diametered well casing will be installed between the land surface and the abandoned works in both the injection wells and the return wells. As shown in Figure 3.10-1, the annulus in all wells will be sealed with a cement grout.

At the time of abandonment, all wells used to facilitate injection of slurry into the deep mine will be cut off just below the land surface and plugged with cement between the top of the slurry and the well head. All land surface disturbance will be backfilled, graded and seeded according to approved post mining land use plan.

UMC 817.21- 817.25 Top Soil Requirements

See Section 8.3 of the MRP.

UMC 817.50 Hydrologic Balance

The proposed slurry system is a closed system that will not discharge into local surface or groundwater resources. The circuit will actually be dependent upon an external source of water to make up for lost water that remains on the coal after it is washed.

The injection and return wells will be cased down to solid rock to prevent possible contamination of the ground water in the Price River Alluvium.

Within the abandoned mine, shales of Blackhawk Formation act as effective barriers to groundwater movement, particularly perpendicular to the bedding plane of the shale. Rocks in the coal base area are capable of yielding only 10 gal./min. The entire Blackhawk formation is extremely tight having transmissivities on the order of 17 gpd/ft. over a test zone of 808 feet and 65 gpd/ft. over a test zone of 651 feet. A test conducted over a 233 foot zone, including multiple layers of coal, yielded a trasmissivity equal to 5 gpd/ft. Therefore, the coal is just as impermeable as other portions of the formation. Further discussion of the impermeable nature of the Blackhawk Formation can be found in Chapter VII of the M.R.P.

In the unlikely event that a failure in the closed circuit should occur, all surface runoff from the areas where well heads or piplines are to be constructed will be contained by an existing sedimentation pond that must comply with the NPDES discharge criteria.

UMC 817.55 Discharge of Water into an Underground Mine

Slurry, which includes water, suspended solids and dissolved solids in excess of normal effluent limitations, will be injected into an abandoned underground mine. Containment of these materials below the surface will reduce the amount of coal wastes that need to be disposed of above ground and, therefore, reduce the impact on surface hydrology and surface distrubance necessary to reclaim disposal areas.

The slurry will be pumped at low pressures (below 100 psi at well head) through a 6 inch diametered pipeline to injection wells located within the currently approved permit area. Actual injection to the mine will be essentially a gravity feed process through an 8 inch diameter well casing. Once in the mine, the suspended solids will settle to the mine floor. Clarified make-up water used at the coal preparation plant will then be pumped from the mine at a rate of 150-250 gallons per minute 6" diameter pipe buried 4-5 feet below the surface. In the long run, water withdrawals will approximate the volumes injected. In the short term, the actual amounts will vary somewhat according to process needs and water volumes available in the abandoned mine.

If there should be a discharge from the system, it will be contained by an existing sedimentation pond and not be discharged from the pond unless it meets the approved effluent standards. Movement of the slurry components from the abandoned works is discussed in UMC 817.50.

UMC 817.59 Coal Recovery and 817.21 Subsidence Control

There will be no coal extraction from the abandoned mine, but there will be back storing of materials that should provide additional roof stability and less potential for subsidence. Mechanical support of the roof by the water already in the mine will remain fairly constant. The volume of water withdrawals will approximate the volume of slurry injectioned into the mine.

UMC 817.181 Support Facilities and Utility Installations

The sites affected by the disturbance necessary for operation of the wells will be contained within the currently approved permit area. Surface disturbance will be restricted to a minimal area in order to prevent unnecessary damage to fish, wildlife and related environmental values. Reclamation according to the currently approved standards will attempt to restore environmental values lost through mining activities. All surface runoff from the injection facilities will be contained by existing sedimentation ponds.

A small area exemption has been requested for the runoff from the return water well site.

The following information is required pursuant to requirements for a Permit Revision in UMC 788.12

UMC 782.11 Legal Financial Compliance

See Chapter II of the MRP and Appendix 3.10-2a for demonstration of the right to dispose of slurry into the abandoned works.

UMC 783.12 General Environmental Resources Information

a) The injection and withdrawal wells will be less than 400 square feet in size. They will remain in use until portions of the underground mine are successfully backfilled and replacements are necessary. Total life of the slurry injection plan is approximately 10 years.

b) Cultural information can be found in Section 5.1 of the MRP.

UMC 783.13 Description of Hydrology and Geology

a) See Section 1.2-2 of the MRP.

UMC 783.14 Geology Description

a) See Chapter VII of the MRP.

UMC 783.15 Ground Water Information

a) See Section 7.7-1 to 7.7-10 of the MRP.

UMC 783.15 Surface Water Information

a) See Section 7.2 of the MRP.

UMC 783.17 Alternative Water Supply

a) See Section 7.4 of the MRP.

UMC 783.18 Climatological Information

a) See Section 11.0 of the MRP.

UMC 783.19 Vegetation Information

a) See Section 9.1 of the MRP.

UMC 783.20 Fish and Wildlife

a) The impact on the fish and wildlife will be minimal since all sites are already included in the areas where mining activities are taking place according to the approved MRP. Fish and wildlife resources information is located in Chapter 10 of the MRP.

UMC 783.21 Soil Resources Information

a) All sites are located on areas previously disturbed by mining.

UMC 783.22 Land Use Information

a) The approved premining and post mining land use is wildlife. See Chapter IX for a detailed discussion.

UMC 783.27 Prime Farmland Investigation

a) The area has never been used for cropland. Therefore, according to UMC 783.27(b)(1), this land cannot be considered prime farmland.

UMC 784.11 Operations Plan

The coal preparation plant will have one feed source and four final product streams. The four streams are:

1) Clean coal ranging from 4 inch to 200 mesh in size.

2) Refuse and fine refuse ranging from 4 inch to zero.

3) Clarified water which is recirculated back to the head of the process.

4) Slurry waste ranging from 60 mesh to 400 mesh in size (average of -200 mesh).

Stream one will be sold as coal. Stream two will be disposed of on the existing permitted refuse pile. Stream three will be recirculated back to the head of the process. Stream four will be processed to produce a commercially valuable resin. Waste product from the resin process will be injected into the abandoned underground works.

The average amount of material in stream four to be disposed of in the old workings is estimated at 20 tons/hr (minimum 0 tons/hr; maximum 30 tons/hr) of 200 mesh material and 200 gal/min (minimum 0 gal/min; maximum 300 gal/min) of process water. This slurry is estimated to be about 20% to 35% solids.

In order to characterize the material to be injected into the abandoned mine, a slurry sample was prepared and sent to Commercial Testing and Engineering for analysis. At the laboratory, the slurry sample was filtered and the solids dried. Results of the analysis are presented in Table 3.10-1. Water samples were also collected from the proposed injection well, the slurry itself, and Price River (Station B-5). These samples were analyzed by Inter-Mountain Labs. Results are given in Table 3.10-2. These tables show that the slurry solids will not cause any significant deterioration of water quality in the olds works. Some parameters may be a little higher but others a little lower due to the injected water. Overall, not much change in dissolved solids is expected.

The slurry will be pumped at low pressure (less than 100 psi at well head) through a 6 inch diameter pipeline to an injection well. Actual injection through the well head will be essentially by gravity feed through an eight inch diameter well casing sealed above the old works by a cement grouted annulus (See Figure 3.10-1). A significant volume of water will be pumped into the old works along with the solids described in Table 3.10-1. Water will be returned to the preparation plant from the abandoned mine works at a rate of 150-250 gal/min in order to provide enough water for the coal

preparation plant to continue to operate. The return well will have an 8 inch steel casing sealed above the old works by a cement grouted annulus (See Figure 3.10-1).

Water withdrawals from the mine may not occur immediately or continuously depending upon the process water needs and water volumes available in the abandoned mine. If needed, process water may be drawn from the 100 acre feet of water rights on the Price River that is currently available for use by Castle Gate Coal Company. No water will be discharged into the Price River drainage unless more water must temporarily be pumped from the return well in order for the system to operate efficiently. Any such surplus water will be routed through an existing NPDES point to assure satisfactory water quality.

UMC 784.12 Existing Structures

a) See Chapter III of the MRP.

UMC 784.13 Reclamation Plan

All wells used to facilitate injection of slurry into the abandoned deep mine will be plugged with cement between the top of the slurry and the land surfaces. Casings will also be cutoff at the surface and covered with earthen materials. The 4" slurry line will be removed from the site. The 4" buried return water line will be left in place. The ends of the buried line which protrude above the surface will be cut off and covered with earthen materials. Final reclamation will be according to the approved plan contained in Chapter 9 of the MRP.

UMC 784.14 Protection of the Hydrologic Balance

(a) The slurry will be pumped from the preparation plant through a 6-inch diameter pipeline to the injection well. There it will essentially flow by gravity into the much larger 8-inch diameter well casing. The pump will be sized to assure no more than 100 psi pressure would ever exist in the discharge line at the well head. This means that such pressure could only occur if the well or old works should become "plugged," which is quite unlikely. Further, the return well will be pumped to assure that no hydraulic pressure builds up in the old works to a point that the old works water level is above land surface at

the return well. This will be assured by monitoring the old works water level or pressure at the return well site if the water level rises to within 20 feet of the land surface sometime in the future. If such conditions develop, the return well can be equipped with a well head seal to prevent slurry discharge to the land surface in the event of a power or pump failure.

As shown in Figure 3.10-1, the annulus in all wells will be sealed with a cement grout. As shown in Figure 3.10-3 (Hydrogeologic Cross Section for Slurry Injection Project, See Exhibit 3.10-1 for location), there exists over 100 feet of solid, low permeability, bedrock above the old works where they lie beneath Price River. Therefore, properly cementing the casing annulus in all wells will prevent migration of slurry wastes into any other formations, whether or not they are or could be used for drinking water.

The receiving formation for the slurry is the mined out "D" seam. The coal removed from this mine typically has a moisture content of 2.54%, an ash content of 8.12% and sulfur of 0.54%.

The roof can typically be described as very light gray and medium gray mottled, fine grained carbonaceous sandstone. Siltstone or siltstone lamina may be present. The floor of the coal is typically very light gray and medium gray mottled, fine grained carbonaceous sandstone. Boney shale or siltstone may also be present. Refer to Figure 3.10-2 for a strata section showing 20 feet of roof and floor, as well as the D Seam, in the old works area.

As indicated in Section XIII, the coals and the confining strata are nearly impermeable. Current water discharge into the Castle Gate No. 3 Mine is only 33 gpm or 0.04 gpm/acre and current discharge into the No. 5 Mine in the "D" seam is 3.5 gpm or 0.015 gpm/acre. However, the abandoned mine workings are filling with water and, although the accumulations are substantial, they have taken years to accumulate. Chemical analysis of a water sample taken from the abandoned Utah Fuels #3 Mine can be found in Table 3.10-2. The geochemical characteristics of the floor and roof are described in the following table.

CHEMICAL TEST RESULTS OF ROOF AND FLOOR

	pH	EC	SAT%	SAR	Na	Ca	Mg	B	ABP
Mine 5 (D Seam)									
1st West Floor	8.1	1.12	51.8	6.1	7.36	2.22	3.17	1.9	6
2nd West Roof	8.6	1.49	56.3	9.6	12.67	2.18	2.73	1.6	21
Crosscut, 24, Roof	8.7	2.00	61.2	11.2	19.56	0.89	2.63	0.8	30
Crosscut, 3, Roof	6.4	4.08	43.1	5.9	23.83	18.55	12.00	0.9	0

pH - Paste pH
EC - Electric Conductivity, MMHOS/CC
SAT - Saturation, Percent
Ca - Calcium, MEQ/L
Mg - Magnesium, MEQ/L
Na - Sodium, MEQ/L
SAR - Sodium Absorption Ratio
B - Boron (Soluble), PPM
ABP - Acid/base Potential (Smith Hydrogen Peroxide)
\- - Acid T/1,000T
\+ - Base T/1,000T

Tests performed in July 1979 by Agricultural Consultants, Inc., 240 South First Avenue, Brighton, Colorado 80601

Although some of the slurry may travel down dip into the west portion of the old works through the relatively narrow main entry, a precise projection of the available volume for slurry disposal cannot be made. However, the above conservative estimate indicated sufficient volume to make this disposal method attractive.

(a)(2) See Section 7.4 of the MRP.

(a)(3) See Section 7.3-5 and 7.4 of the MRP.

(a)(4) Not applicable.

(b)(1) In the unlikely event that a failure should occur, all surface runoff from the areas where well heads or pipelines have been constructed will be contained by an existing sedimentation pond or originate from the site of an approved small area exemption.

(b)(2) See Section 7.2 of the MRP.

(b)(3) The injected slurry will be confined by the limits of the abandoned deep mine. The chemical characteristics of the injection solids are very

similar to those found in the olds works "D" Seam coals. The quality of water in the old works is very similar to that to be injected. Therefore, no additional monitoring is proposed. See Section 7.5 of the MRP for the approved monitoring program.

UMC 784.15 Postmining Reclamation Plan

See Chapter 10 of the MRP for a discussion of the approved postmining reclamation plan.

UMC 784.16 Reclamation Plan: Ponds, Impoundments, Dams

No additional ponds, impoundments or dams are proposed for this revision.

UMC 784.17 Protection of Public Parks

(a) Not applicable.

UMC 784.18 Public Roads

(a) Not applicable.

UMC 784.19 Underground Development Wastes

(a) See Section UMC 784.11 of this submittal.

The following measurements, data and assumptions were used to determine the volume of storage available in the old works:

Old works area east of Price River	=	49 acres
Old works area west of Price River	=	105 acres
Average thickness of D Seam extracted	=	8 feet
Average percent recovery (room and pillar)	=	50 percent
Volume not available for slurry due to seals, pillar robbing, etc.	=	50 percent
Weight of settled slurry solids per cubic foot	=	50 pounds
Annual amount of slurry solids to be disposed	=	20,000 tons
Estimated life of disposal area east of Price River	=	5.3 years

(b) See response for UMC 784.14 (a) of this revision for character of the bedrock and Section 7.1-3 of the MRP for discussion on springs, seepage and ground water flow.

There will be no coal extraction from the abandoned mine, but there will be back storing of materials that should provide additional roof stability and less potential for subsidence. Mechanical support of the roof by the water already in the mine will remain fairly constant. The volume of water withdrawals will approximate the volume of slurry injectioned into the mine.

(c) No applicable. UMC 724.20 Subsidence Control Plan

(a) There will be no activities that could cause subsidence. See UMC 784.19(b) of this revision for further discussion.

UMC 784.21 Fish and Wildlife Plan.

(a) See UMC 783.20 of the revision.

UMC 784.23 Operations Plan: Maps and Plans

(a) See Table of Contents.

UMC 784.24 Transportation Facilities

(a) Not applicable.

UMC 784.25 Return of Coal Processing Waste to Abandoned Underground Workings

(a) Slurry waste from a coal preparation plant will be pumped at low pressures (below 100 psi at well head) through a 6 inch diameter pipeline to injection wells located within permit area approved by the Utah Department of Oil, Gas and Mining. Actual injection into the mine will be essentially a gravity feed process through an 8 inch diameter well casing. Once in the mine, the suspended solids will settle to the mine floor. Clarified make-up water used at the coal preparation plant will then be pumped from the mine through return wells at a rate of 150-250 gallons per minute. In the long run, water withdrawals will approximate the volumes injected. However, in the short term, the actual amounts will vary somewhat according to process needs and water volumes available in the abandoned mine.

(b) See UMC 784.19 of this Revision.

(c) See UMC 784.19 of this Revision.

(d) Not applicable. See UMC 784.14(b)(3) for further discussion.

UMC 784.26 Air Pollution Control Plan

a) See Section 11.2 of the MRP.

3.10-3 Small Area Exemption: The following information is being submitted pursuant to UMC 817-42 requesting a small area exemption for the control of drainage from the site of the return water well.

UMC 817.42(3)(b) Hydrologic Balance

Castle Gate Coal will insure that the water quality in the Price River will not be degraded by using the following measures:

1. During construction, the site will be bermed to insure that runoff from the site is contained or the site will be perimetered with a straw bale dike.

2. Drilling mud and cuttings will be stored in a tank which will be emptied at the Castle Gate refuse site.

3. The pipeline from the well will be buried 4 to 5 feet below the ground.

4. After construction, the area will be seeded, fertilized and mulched.

UMC817.42(3)(ii)(A)

The return water well site will be about 10'x10' in size. Both during construction and operation of sites, the disturbance would be less than .1% of the permitted area.

No water from the underground works would be mixed with surface runoff from the return well site.

3.10-4 Reclamation Bond Calculation

a) Reclamation cost per drill site

The maximum disturbances at each site will be 100' x 100' or .23 AC. After the drilling is complete, each site will be regraded, seeded and mulched. The casing will be cut-off below the groundline and the well plugged from the bottom to top with concrete. The estimated cost is as follows:

Regrading .23 Acres - 4 hrs. with D-6 @ $60/hr.	$240
Revegetation .23 acres at $705/AC Note: Most revegetation contractors require a 1 acre minimum so use $705	$705
Excavating, cutting and plugging well - 2 men 8 hrs at $20	$320
Concrete 400' of 8" dia. well Volume = 3.1416 r^2h - 27 = $\frac{(3.1416)(.66)^2(1000)}{27}$ = 20 yd^3 20 yd^3 x $60/$yd^3$ =	$1,200
Total Bond Per Site =	$2,465

b) Removal of 4" injection and return pipes

Removal of slurry line (800 feet)	$640
Cut off of return line 2 ends at $40/end	80
Covering cut off ends 2 ends at $60/end	120
Total	$840
Grand Total	$3,305

Table 3.10-1. Quality Data for Castle Gate Slurry Solids

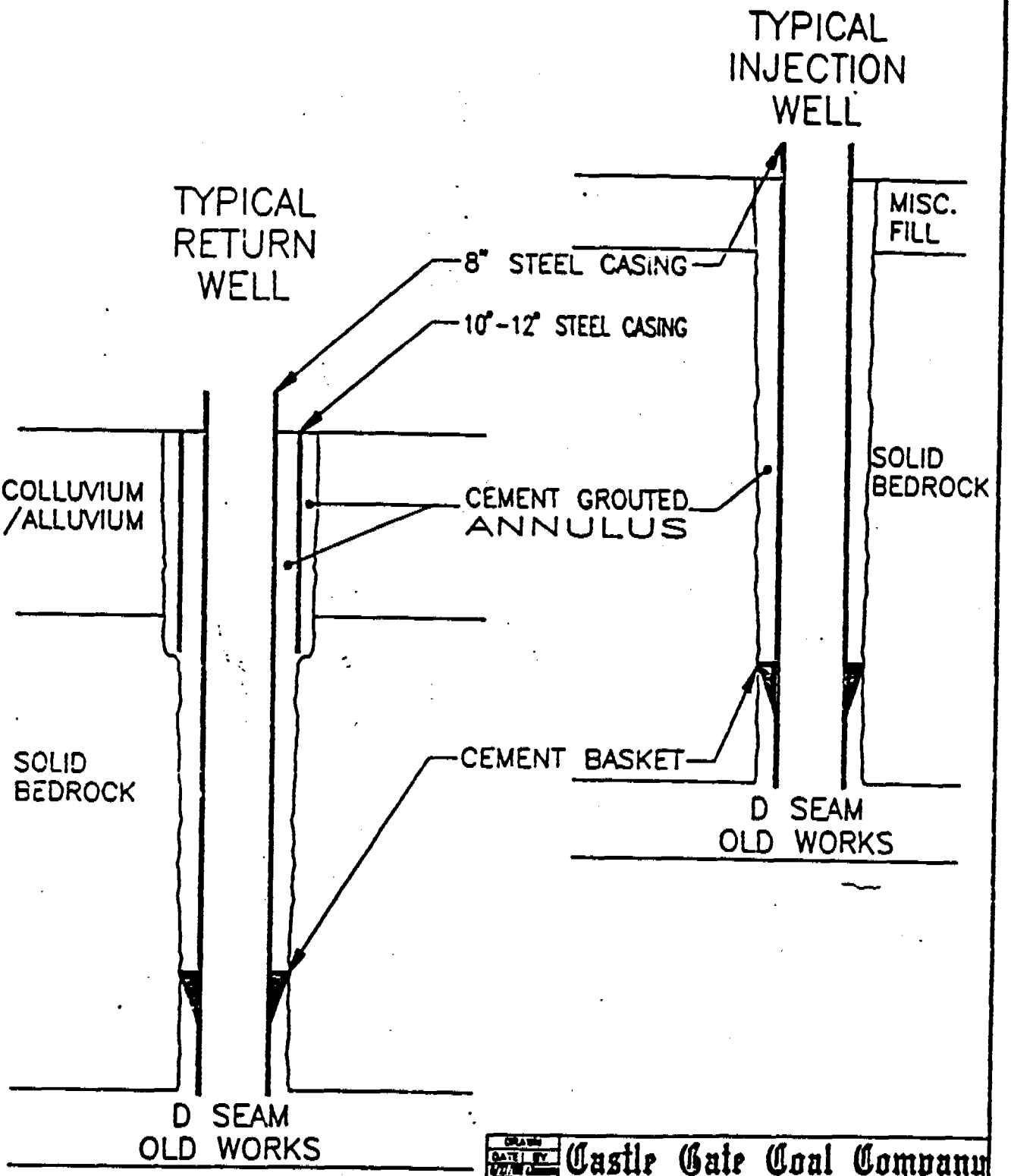
Moisture, 105 degrees C, as received, percent	48.00
Ash, percent	14.16
Paste pH, units	8.0
Soluble Aluminum, Al	0.34
Soluble Calcium, Ca	47.
Soluble Magnesium, Mg	15.
Soluble Sodium, Na	135.
Saturation, percent	65.4
Sodium Adsorption Ratio, SAR	4.39
Carbonate, CO3	3.05
Nitrate-Nitrogen	< 0.02
Inherent Neutralization Potential, tons CaCO3 eq./1000 tons	50.4
Acid Production Potential, (pyritic sulfur) tons CaCO3 eq./1000 tons	0.9
Net Neutralization Potential, tons CaCO3 eq./1000 tons	49.5
Pyritic Sulfur, percent	0.03
Total Sulfur, percent	0.49
Arsenic, As	0.8
Barium, Ba	265.
Boron, B	110.
Cadmium, Cd	< 0.6
Calcium, Ca	16346.
Chlorine, Cl	528.
Chromium, Cr	15.
Copper, Cu	6.0
Iron, Fe	6779.
Lead, Pb	4.3
Manganese, Mn	28.
Mercury, Hg	0.03
Molybdenum, Mo	< 3.
Nickel, Ni	3.7
Selenium, Se	1.4
Silicon, Si, percent	1.16
Silver, Ag	< 0.6
Zinc, Zn	16.

Notes: All units micrograms per gram (ug/g) except where noted. Analytical results by procedures in EPA SW-846 and EPA 600/2-78-054. Analysis by Commercial Testing and Engineering Co., 490 Orchard St., Golden, CO 80401.

Table 3.10-2. Water Quality Data for Slurry Injection Project

	Old Works Water	Injection Water	Price River Water (B-5)
Water Level/Flow, feet/cfs	6148.	n/a	> 10.
pH, units	7.2	8.4	8.2
Conductivity, umhos/cm	1820.	1490.	357.
Total Dissolved Solids (180)	1340.	922.	242.
Total Dissolved Solids (calc.)	1180.	878.	216.
Total Hardness, as CaCO3	870.	66.	192.
Acidity, as CaCO3	< 1.	< 1.	< 1.
Alkalinity, as CaCO3	423.	356.	173.
Biochemical Oxygen Demand, BOD	2.23	15.69	2.57
Chemical Oxygen Demand, COD	20.	215.	35.
Total Organic Carbon, TOC	4.0	9.2	4.0
Aluminum, Al	0.2	< 0.1	2.5
Arsenic, As	< 0.005	< 0.005	< 0.005
Barium, Ba	< 0.5	< 0.5	< 0.5
Boron, B	< 0.01	1.14	0.08
Carbonate, CO3	0.	3.	0.
Bicarbonate, HCO3	516.	428.	211.
Cadmium, Cd	< 0.002	< 0.002	< 0.002
Calcium, Ca	145.	9.	51.
Chloride, Cl	73.	173.	9.
Chromium, Cr	< 0.02	< 0.02	< 0.02
Copper, Cu	< 0.01	< 0.01	< 0.01
Fluoride, F	1.42	1.09	0.43
Iron, Fe	0.25	< 0.05	2.06
Lead, Pb	< 0.02	< 0.02	< 0.02
Magnesium, Mg	124.	11.	16.
Manganese, Mn	0.06	0.03	0.07
Mercury, Hg	< 0.001	< 0.001	< 0.001
Molybdenum, Mo	< 0.02	0.04	< 0.02
Nickel, Ni	0.01	< 0.01	0.04
Nitrate, NO3	0.14	0.09	16.49
Nitrite, NO2	< 0.01	< 0.01	0.01
Nitrogen-Ammonia, NH3	0.03	0.05	0.02
Potassium, K	12.	5.	1.
Phosphate, PO4	0.10	0.24	0.37
Selenium, Se	< 0.005	< 0.005	0.027
Silver, Ag	< 0.01	< 0.01	< 0.01
Sodium, Na	84.	316.	8.
Sulfate, SO4	488.	153.	27.
Sulfide, S	< 0.04	< 0.04	< 0.04
Zinc, Zn	0.15	< 0.01	0.02
Cation-Anion Balance, % difference	1.62	0.03	0.23

Notes: All units milligrams per liter (mg/l) except where noted. Injection water sample collected 7-12-88. Other samples collected 7-14-88. n/a = not applicable or not available. Analysis by Inter-Mountain Labs, 2506 West Main Street, Farmington, NM 87401, according to procedures in 40 CFR 136.



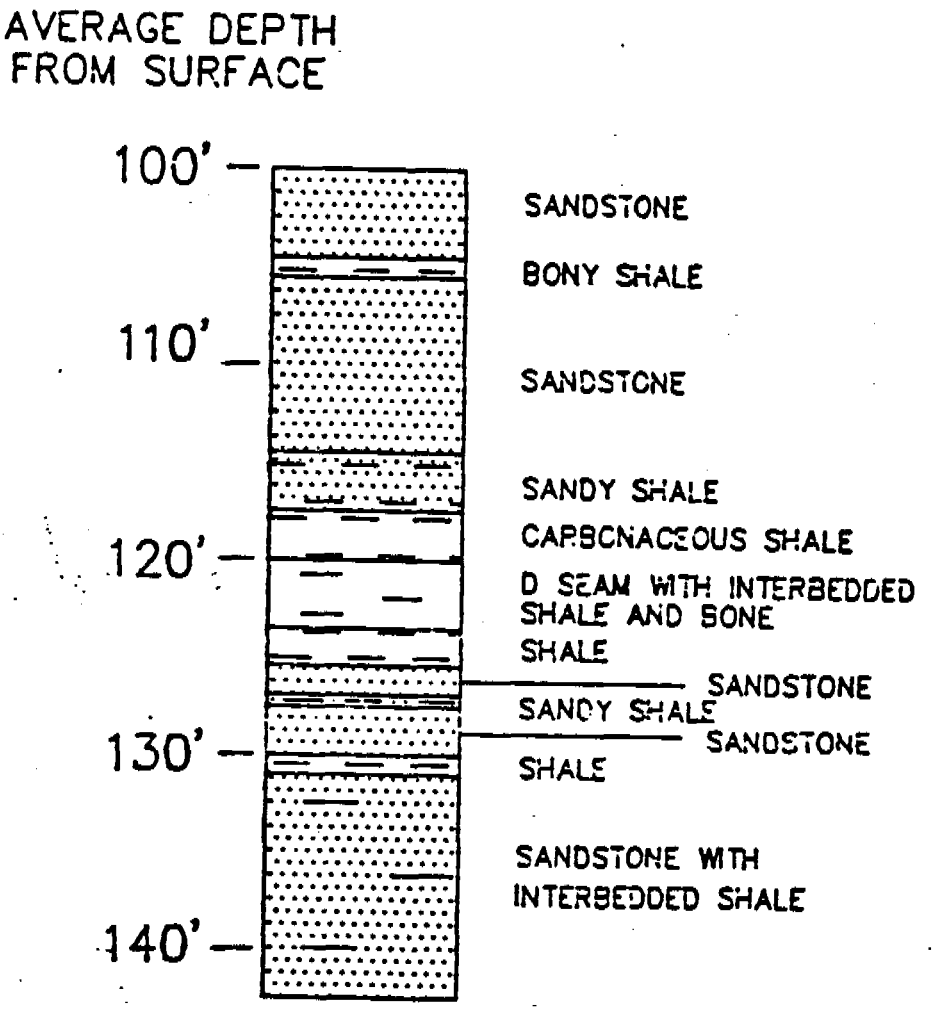
Castle Gate Coal Company

TYPICAL CROSS SECTION OF SLURRY INJECTION & RETURN WELLS

FIGURE 3.10-1

NOT TO SCALE

POST OFFICE BOX NUMBER 449, HELPER, UTAH 84526



Vertical Scale : 1" =10'

Figure 3.10–2

Generalized Strata Section Showing 20 Feet Roof, D Seam, And 20 Feet Floor For Slurry Injection Project In Utah Fuels No. 3 Mine Old Works.

General Office
P.O. Box 700
Lancaster, OH 43130-0700
614 687 1440

AEP
FUEL SUPPLY

Castle Gate Coal Company and
Meadowlark Utah, Inc.
P. O. Box 967
Indianapolis, IN 46206-0967

September 7, 1988

Re: Slurry Injection Into Abandoned Underground Works Project

Gentlemen:

To the extent any consent or permission of Blackhawk Coal Company (Blackhawk) and/or Price River Coal Company (Price River) is required:

a) under any of the documents relating to the Lease Transaction Agreement dated January 31, 1986, as amended, by and among Blackhawk and Price River, as Lessors, and Castle Gate Coal Company (Castle Gate) and Meadowlark Utah, Inc. (Meadowlark), as Lessees; or

b) by any federal or state governmental agency under any document described in a) above

with respect to securing authorization for, and implementation by, Castle Gate and/or Meadowlark of a Slurry Injection Into Abandoned Underground Works Project within the three (3) areas shown outlined in solid blue lines on the map attached hereto identified as "Castle Gate Coal Company, Slurry Injection Project Area, Exhibit 3.10-1, Scale 1"=200, Drawn 8/88 By E. Pops" (Project), Blackhawk and/or Price River grant such consent or permission provided Castle Gate and Meadowlark jointly and individually agree tc, and by their execution in the space provided below, do hereby indemnify, defend and save harmless Blackhawk and Price River and their respective affiliates, officers, directors, employees and agents from and against any losses, liabilities, damages, demands, obligations, fines or civil penalties, expenses, costs and fees (including, but not limited to, court costs and reasonable attorney's fees) which Blackhawk and/or Price River are obligated to pay based upon any claim by any third party arising under or as a result of said Project.

The consent and permission granted shall become effective as of the date the enclosed copy hereof is executed by Castle Gate and Meadowlark and mailed to the undersigned.

Very truly yours,

J. E. Katlic
President and Chief
Operating Officer
Blackhawk Coal Company
Price River Coal Company

Indemnification executed this
19th day of September, 1988.

Castle Gate Coal Company

By _____
President

Meadowlark Utah, Inc.

By _____
President

AFFIDAVIT OF PUBLICATION

STATE OF UTAH
County of Carbon, } ss.

I, Dan Stockburger, on oath, say that I am the General Manager of the The Sun-Advocate, a weekly newspaper of general circulation, published at Price, State and County aforesaid, and that a certain notice, a true copy of which is hereto attached, was published in the full issue of such newspaper for .... Four (4) .....cons-ecutive issues, and that the first publication was on the

22nd day of November, 19 88

and that the last publication of such notice was in the issue of such newspaper dated the

13th day of December, 19 88

Dan Stockburger

Subscribed and sworn to before me this

28th day of March, 19 89

Holly Jo Baker
Notary Public.

My Commission expires October 2, 1990

Publication fee, $ 69.60

NOTARY PUBLIC
My Commission Expires October 2, 1990
HOLLY JO BAKER
76 West Main
Price,
UT 84501
STATE OF UTAH

NOTICE OF APPLICATION FOR AMENDMENT OF A PERMIT

Notice is hereby given that Castle Gate Coal Company, P.O. Box 449, Helper, Utah 84526, has submitted to the State of Utah, Department of Natural Resources an amendment to Underground Coal Mining Permit No. ACT/007/004. The addition to the underground permit area is located under U.S. Highway 6 and Price River in Carbon County, Utah as follows:

Township 12 South, Range 9 East, SLB&M
S½ NW¼, N½ SW¼, Section 26
SE¼ NE¼, Section 35

The project area is shown on the following U.S. Geological Survey 7.5 minute maps.
Helper, Utah
Standardville, Utah

A copy of the permit amendment is located at the Division of Oil, Gas and Mining Area Office on the College of Eastern Utah Campus in Price, Utah. Comments or objections must be filed no later than 23 December, 1988 with:

State of Utah
Department of Natural Resources
Division of Oil, Gas and Mining
355 West North Temple
3 Triad, Suite 350
Salt Lake City, Utah 84180

Published in the Sun Advocate November 22, 29 and December 6 and 13, 1988.