APPENDIX 7-F

HYDROGRAPHS AND SEDIMENTATION PONDS

The peak runoff and the runoff hydrographs were generated by a computer program written by Derick Darby, P.E. of Plus III Software, Inc., P.O. Box 88276, Atlanta, Georgia 30338 and contained in a copyrighted program Hydro Plus III Stormwater Detension Programs. The specific element of the program used to generate the hydrographs is explained in more detail below.

SOIL CONSERVATION SERVICE HYDROGRAPH

PROGRAM DESCRIPTION

This program produces hydrographs by the methods of the U.S. Department of Agriculture, Soil Conservation Service. The hydrographs produced may be routed through a storage reservoir, combined with a previously generated hydrograph, or stored for later use.

LIMITATIONS

The methods of the Soil Conservation Service should be used for medium sized basins. The area range should generally be between 200 and 1000 acres. In some instances the methods may be successfully used for larger basins.

The S.C.S. Method uses several parameters bases on basin configuration to generate incremental hydrographs and produce an outflow hydrograph for the basin. The method is a volumetric determination; therefore, the selection of

the curve number (CN) is critical. The physical programming limitations are as follows:

1. The first outflow and the first storage volume must be set equal to zero (0).
2. The storage volume and outflow rate must increase with each subsequent set of data pairs.
3. Routing time is preselected at one half of the time to the peak of the incremental hydrograph.
4. Basin lag must be greater than 0.25 hours and less than 6.6 hours.

SYMBOLS AND EQUATIONS

Symbol	Description	Units
A	Basin Area	Acres
A$	Basin Identifier	-----
B$	Down Stream Identifier	-----
CN	Curve Number	-----
C$	Storage Pond Identifier	-----
D	Storm Duration	Hours
E	Storage Pond Elevations	Feet

SYMBOLS AND EQUATIONS (CONT'D

Symbol	Description	Units
H	Hydraulic Length	Feet
I	Storage Pond Inflows	CFS
Ia	Initial Abstraction	Inches
L	Basin Lag	Hours
O	Storage Pond Outflows	CFS
P-24	24-Hours Precipitation	Inches
P	Accumulated Rainfall	Inches
Q	Accumulated Direct Runoff	Inches
q	Incremental Peak Rate of Discharge	CFS
qp	Peak of Discharge	CFS
S	Storage Pond Volumes	Cu. Ft.
Tp	Time to Peak	Hours

H/C
6/15/85

T	Routing Period	Sec.
V	Incremental 2S/T + 0	CFS
Y	Average Basin Slope	%

EQUATIONS

Q = (P - Ia) 2 / ((P - Ia) + S)

Cn = 1000 / (10 +S)

Ia = 0.25

H = 209 * A 0.6

L = ((H 0.8) * (S +1) 0.7) / 1900 * Y 0.7

Tp = D/s + L

O2 = I1 + (2S1/T-01) - 2S2T

H/C
6/15/85

PROGRAM REFERENCES

1. Soil Conservation Service; SCS - TP - 149, A Method for Estimating Volume and Rate of Runoff in Small Watersheds, Revised April, 1973.

2. _____, Technical Release No. 55, Urban Hydrology for Small Watersheds, January, 1975.

3. _____, National Engineering Handbook, Section 4, Hydrology, August, 1972.

4. United States Department of the Interior, Bureau of Reclamation, Design of Small Dams, U.S. Government Printing Office, 2nd Edition 1973.

1. "National Symposium on Urban Hydrology, Hydraulics, and Sediment Control", Urban Runoff Hydrographs - Basic Principles, by Haan, C.T., 1976.

A Guide to Hydrologic Analysis Using SCS Methods
Richard H. McCuen

SECTION 5

CURVE NUMBER ESTIMATION

The volume and rate of runoff depends on both meteorologic and watershed characteristics, and the estimation of runoff requires an index to represent these two factors. The precipitation volume is probably the single most important meteorological characteristic in estimating the volume of runoff. The soil type, land use, and the hydrologic condition of the cover are the watershed factors that will have the most significant impact in estimating the volume of runoff. The antecedent soil moisture will also be an important determinant of runoff volume.

The SCS developed an index, which was called the runoff curve number (CN), to represent the combined hydrologic effect of soil, land use, agricultural land treatment class, hydrologic condition, and antecedent soil moisture. These factors can be assessed from soil surveys, site investigations, and land use maps; when using the SCS hydrologic methods for design the specification of the antecedent soil moisture condition is often a policy decision that suggests average watershed conditions rather than a recognition of a hydrologic condition at a particular time and place.

Soil Group Classification

SCS developed a soil classification system that consists of four groups, which are identified by the letters A, B, C, and D. Soil characteristics that are associated with each group are as follows:

Group A: deep sand, deep loess, aggregated silts

Group B: shallow loess, sandy loam

Group C: clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay

Group D: soils that swell significantly when wet, heavy plastic clays, and certain saline soils

The SCS soil group can be identified at a site using one of three ways:

1. soil characteristics
2. county soil surveys
3. minimum infiltration rate

The soil characteristics associated with each group are listed above. County soil surveys, where they are made available by Soil Conservation Districts, give a detailed description of the soils at locations within a county; these surveys are usually the best means of identifying the soil group. Soil

0000197

analyses can be used to estimate the minimum infiltration rates, which can be used to classify the soil using the following values:

Group	Minimum Infiltration Rate (in/hr)
A	0.30 - 0.45
B	0.15 - 0.30
C	0.05 - 0.15
D	0 - 0.05

Cover Complex Classification

The SCS cover complex classification consists of three factors: land use, treatment or practice, and hydrologic condition. There are approximately fifteen different land uses that are identified in the tables for estimating curve number. Agricultural land uses are often subdivided by treatment or practices, such as contoured or straight row; this separation reflects the different hydrologic runoff potential that is associated with variation in land treatment. The hydrologic condition reflects the level of land management; it is separated with three classes: poor, fair, and good. Not all of the land uses are separated by treatment or condition.

Curve Number Estimation

Table 2, which is a compilation of the CN tables provided in NEH-4 and TR-55, show the CN values for the different land uses, treatment, and hydrologic condition; separate values are given for each soil group. For example, the CN for a wooded area with good cover and soil group B is 55; for soil group C, the CN would increase to 70. If the cover (on soil group B) is poor, then the CN will be 66.

Antecedent Soil Moisture Condition

Antecedent soil moisture is known to have a significant effect on both the volume and rate of runoff. Recognizing that it is a significant factor, SCS developed three antecedent soil moisture conditions, which were labeled I, II, and III. The soil condition for each is as follows:

Condition I: soils are dry but not to wilting point; satisfactory cultivation has taken place.

Condition II: average conditions

Condition III: heavy rainfall, or light rainfall and low temperatures have occurred within the last 5 days; saturated soil.

The following table gives seasonal rainfall limits for the three antecedent soil moisture conditions:

	Total 5-day Antecedent Rainfall (inches)	
AMC	Dormant Season	Growing Season
I	Less than 0.5	Less than 1.4
II	0.5 to 1.1	1.4 to 2.1
III	over 1.1	over 2.1

TABLE 2. Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
(Antecedent Moisture Condition II, and $I_a = 0.2\ S$)

Land Use Description/Treatment/Hydrologic Condition			Hydrologic Soil Group			
Residential:[1]			A	B	C	D
Average lot size	Average % Impervious[2]					
1/8 acre or less	65		77	85	90	92
1/4 acre	38		61	75	83	87
1/3 acre	30		57	72	81	86
1/2 acre	25		54	70	80	85
1 acre	20		51	68	79	84
Paved parking lots, roofs, driveways, etc.[3]			98	98	98	98
Streets and roads:						
paved with curbs and storm sewers[3]			98	98	98	98
gravel			76	85	89	91
dirt			72	82	87	89
Commercial and business areas (85% impervious)			89	92	94	95
Industrial districts (72% impervious)			81	88	91	93
Open Spaces, lawns, parks, golf courses, cemeteries, etc.						
good condition: grass cover on 75% or more of the area			39	61	74	80
fair condition: grass cover on 50% to 75% of the area			49	69	79	84
Fallow	Straight row	---	77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured & terraced	Poor	66	74	80	82
	Contoured & terraced	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Contoured & terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close -seeded legumes[4] or rotation meadow	Straight row	Poor	66	77	85	89
	Straight row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured & terraced	Poor	63	73	80	83
	Contoured & terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods or Forest land		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		---	59	74	82	86

[1] Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

[2] The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[3] In some warmer climates of the country a curve number of 95 may be used.

[4] Close -drilled or broadcast.

HYDROLOGICAL STUDY FOR

CO-OP Mine Undisturbed Area

Undisturbed Run-off Diversions

Bear Canyon Mine Site

BY

HORROCKS/CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

April 25, 1984

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April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-1
BASIN DISCHARGES INTO D-11U

BASIN AREA	=	25.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	62.0	%
HYDRAULIC LENGTH	=	1,950.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.3	11.90	1.5
12.00	4.1	12.10	7.0	12.20	* 7.6	12.30	6.5
12.40	4.9	12.50	4.0	12.60	3.4	12.70	2.9
12.80	2.4	12.90	2.1	13.00	1.9	13.10	1.8
13.20	1.7	13.30	1.4	13.40	1.3	13.50	1.3
13.60	1.2	13.70	1.2	13.80	1.1	13.90	1.0
14.00	1.0	14.10	1.0	14.20	0.9	14.30	0.8
14.40	0.8	14.50	0.8	14.60	0.7	14.70	0.7
14.80	0.7	14.90	0.7	15.00	0.6	15.10	0.5
15.20	0.4	15.30	0.3	15.40	0.2	15.50	0.1
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

PAGE
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AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-2
BASIN DISCHARGES INTO C-1U & C-8U

BASIN AREA	=	28.70	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.35	INCHES
AVERAGE BASIN SLOPE	=	62.0	%
HYDRAULIC LENGTH	=	2,000.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.3	11.90	1.7
12.00	4.7	12.10	8.0	12.20	8.8	12.30	7.4
12.40	5.6	12.50	4.6	12.60	3.9	12.70	3.3
12.80	2.8	12.90	2.4	13.00	2.1	13.10	2.1
13.20	1.9	13.30	1.6	13.40	1.5	13.50	1.5
13.60	1.4	13.70	1.4	13.80	1.3	13.90	1.2
14.00	1.2	14.10	1.1	14.20	1.1	14.30	1.0
14.40	0.9	14.50	0.9	14.60	0.8	14.70	0.8
14.80	0.8	14.90	0.8	15.00	0.7	15.10	0.6
15.20	0.5	15.30	0.4	15.40	0.3	15.50	0.2
15.60	0.1	15.70	0.0	15.80	0.0	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-2B
BASIN DISCHARGES INTO D-1U

BASIN AREA	=	5.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	62.0	%
HYDRAULIC LENGTH	=	550.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.1	11.90	0.3
12.00	0.8	12.10	1.4	12.20	1.5	12.30	1.3
12.40	1.0	12.50	0.8	12.60	0.7	12.70	0.6
12.80	0.5	12.90	0.4	13.00	0.4	13.10	0.4
13.20	0.3	13.30	0.3	13.40	0.3	13.50	0.3
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.2
14.40	0.2	14.50	0.2	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.0	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-2C
BASIN DISCHARGES INTO D-9U

BASIN AREA	=	6.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	41.0	%
HYDRAULIC LENGTH	=	800.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.1	11.90	0.4
12.00	1.0	12.10	1.7	12.20	1.8	12.30	1.5
12.40	1.2	12.50	1.0	12.60	0.8	12.70	0.7
12.80	0.6	12.90	0.5	13.00	0.4	13.10	0.4
13.20	0.4	13.30	0.3	13.40	0.3	13.50	0.3
13.60	0.3	13.70	0.3	13.80	0.3	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.2
14.40	0.2	14.50	0.2	14.60	0.2	14.70	0.2
14.80	0.2	14.90	0.2	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

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April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-3
BASIN DISCHARGES INTO D-2U & C-2U

BASIN AREA	=	5.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	64.0	%
HYDRAULIC LENGTH	=	875.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.1	11.90	0.3
12.00	0.8	12.10	1.4	12.20	1.5	12.30	1.3
12.40	1.0	12.50	0.8	12.60	0.7	12.70	0.6
12.80	0.5	12.90	0.4	13.00	0.4	13.10	0.4
13.20	0.3	13.30	0.3	13.40	0.3	13.50	0.3
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.2
14.40	0.2	14.50	0.2	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.0	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-3 + AU-below portal
BASIN DISCHARGES INTO D-8U

BASIN AREA	=	7.50	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	64.0	%
HYDRAULIC LENGTH	=	1,100.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.1	11.90	0.4
12.00	1.2	12.10	2.1	12.20	2.3	12.30	1.9
12.40	1.5	12.50	1.2	12.60	1.0	12.70	0.9
12.80	0.7	12.90	0.6	13.00	0.6	13.10	0.5
13.20	0.5	13.30	0.4	13.40	0.4	13.50	0.4
13.60	0.4	13.70	0.4	13.80	0.3	13.90	0.3
14.00	0.3	14.10	0.3	14.20	0.3	14.30	0.3
14.40	0.2	14.50	0.2	14.60	0.2	14.70	0.2
14.80	0.2	14.90	0.2	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-4
BASIN DISCHARGES INTO C-3U

BASIN AREA	=	25.80	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	64.0	%
HYDRAULIC LENGTH	=	2,250.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.3	11.90	1.5
12.00	4.2	12.10	7.2	12.20	7.9	12.30	6.7
12.40	5.1	12.50	4.1	12.60	3.5	12.70	3.0
12.80	2.5	12.90	2.1	13.00	1.9	13.10	1.9
13.20	1.7	13.30	1.5	13.40	1.4	13.50	1.3
13.60	1.3	13.70	1.2	13.80	1.1	13.90	1.1
14.00	1.0	14.10	1.0	14.20	0.9	14.30	0.9
14.40	0.8	14.50	0.8	14.60	0.8	14.70	0.8
14.80	0.7	14.90	0.7	15.00	0.6	15.10	0.5
15.20	0.4	15.30	0.3	15.40	0.2	15.50	0.1
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

PAGE
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AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-3 + AU-4
BASIN DISCHARGES INTO D-7U & C-7U

BASIN AREA	=	33.70	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	64.0	%
HYDRAULIC LENGTH	=	2,250.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.4	11.90	2.0
12.00	5.5	12.10	9.4	12.20	10.3	12.30	8.7
12.40	6.6	12.50	5.4	12.60	4.6	12.70	3.9
12.80	3.2	12.90	2.8	13.00	2.5	13.10	2.4
13.20	2.3	13.30	1.9	13.40	1.8	13.50	1.7
13.60	1.7	13.70	1.6	13.80	1.5	13.90	1.4
14.00	1.4	14.10	1.3	14.20	1.2	14.30	1.1
14.40	1.1	14.50	1.0	14.60	1.0	14.70	1.0
14.80	1.0	14.90	1.0	15.00	0.9	15.10	0.8
15.20	0.7	15.30	0.6	15.40	0.5	15.50	0.4
15.60	0.3	15.70	0.2	15.80	0.1	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-5
BASIN DISCHARGES INTO D-3U & C-4U & C-5U

BASIN AREA	=	20.10	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	57.0	%
HYDRAULIC LENGTH	=	1,750.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.2	11.90	1.2
12.00	3.3	12.10	5.6	12.20	6.1	12.30	5.2
12.40	3.9	12.50	3.2	12.60	2.8	12.70	2.3
12.80	1.9	12.90	1.6	13.00	1.5	13.10	1.4
13.20	1.4	13.30	1.1	13.40	1.1	13.50	1.0
13.60	1.0	13.70	0.9	13.80	0.9	13.90	0.8
14.00	0.8	14.10	0.8	14.20	0.7	14.30	0.7
14.40	0.6	14.50	0.6	14.60	0.6	14.70	0.6
14.80	0.6	14.90	0.6	15.00	0.5	15.10	0.4
15.20	0.3	15.30	0.2	15.40	0.1	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-6
BASIN DISCHARGES INTO D-4U

BASIN AREA	=	38.70	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	67.0	%
HYDRAULIC LENGTH	=	2,250.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.5	11.90	2.3
12.00	6.4	12.10	10.8	12.20	* 11.8	12.30	10.0
12.40	7.6	12.50	6.2	12.60	5.3	12.70	4.5
12.80	3.7	12.90	3.2	13.00	2.9	13.10	2.8
13.20	2.6	13.30	2.2	13.40	2.1	13.50	2.0
13.60	1.9	13.70	1.8	13.80	1.7	13.90	1.6
14.00	1.6	14.10	1.5	14.20	1.4	14.30	1.3
14.40	1.2	14.50	1.2	14.60	1.1	14.70	1.1
14.80	1.1	14.90	1.1	15.00	1.0	15.10	0.9
15.20	0.8	15.30	0.7	15.40	0.6	15.50	0.5
15.60	0.4	15.70	0.3	15.80	0.2	15.90	0.1
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0
16.40	0.0	16.50	0.0	16.60	0.0	16.70	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-between road loop
BASIN DISCHARGES INTO D-5U & D-6U & C-6U

BASIN AREA	=	3.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	57.0	%
HYDRAULIC LENGTH	=	250.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.0	11.90	0.2
12.00	0.5	12.10	0.8	12.20	* 0.9	12.30	0.8
12.40	0.6	12.50	0.5	12.60	0.4	12.70	0.3
12.80	0.3	12.90	0.2	13.00	0.2	13.10	0.2
13.20	0.2	13.30	0.2	13.40	0.2	13.50	0.2
13.60	0.1	13.70	0.1	13.80	0.1	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.0	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HYDROLOGICAL STUDY FOR

CO-OP Mine Undisturbed Area

Main Access Road (Run-off Diversions)

Bear Canyon Mine Site

BY

HORROCKS/CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

REGISTERED PROFESSIONAL ENGINEER
No. 3535
HAROLD LEE WIMMER
STATE OF UTAH

April 25, 1984

0000213

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION RA (above main road)
BASIN DISCHARGES INTO D-1R & C-1R

BASIN AREA	=	33.43	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	61.0	%
HYDRAULIC LENGTH	=	1,975.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.4	11.90	2.0
12.00	5.5	12.10	9.3	12.20	*10.2	12.30	8.6
12.40	6.5	12.50	5.3	12.60	4.6	12.70	3.9
12.80	3.2	12.90	2.7	13.00	2.5	13.10	2.4
13.20	2.3	13.30	1.9	13.40	1.8	13.50	1.7
13.60	1.7	13.70	1.6	13.80	1.5	13.90	1.4
14.00	1.4	14.10	1.3	14.20	1.2	14.30	1.1
14.40	1.1	14.50	1.0	14.60	1.0	14.70	1.0
14.80	1.0	14.90	1.0	15.00	0.9	15.10	0.8
15.20	0.7	15.30	0.6	15.40	0.5	15.50	0.4
15.60	0.3	15.70	0.2	15.80	0.1	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION RB (above main road)
BASIN DISCHARGES INTO D-2R & C-2R

BASIN AREA	=	39.67	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	63.0	%
HYDRAULIC LENGTH	=	1,725.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.5	11.90	2.3
12.00	6.5	12.10	11.0	12.20	* 12.1	12.30	10.2
12.40	7.8	12.50	6.3	12.60	5.5	12.70	4.6
12.80	3.8	12.90	3.3	13.00	3.0	13.10	2.8
13.20	2.7	13.30	2.3	13.40	2.1	13.50	2.0
13.60	2.0	13.70	1.9	13.80	1.7	13.90	1.6
14.00	1.6	14.10	1.6	14.20	1.5	14.30	1.3
14.40	1.2	14.50	1.2	14.60	1.2	14.70	1.2
14.80	1.1	14.90	1.1	15.00	1.0	15.10	0.9
15.20	0.8	15.30	0.7	15.40	0.6	15.50	0.5
15.60	0.4	15.70	0.3	15.80	0.2	15.90	0.1
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0
16.40	0.0	16.50	0.0	16.60	0.0	16.70	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION RC (above main road)
BASIN DISCHARGES INTO D-3R & C-3R

BASIN AREA	=	33.87	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	63.0	%
HYDRAULIC LENGTH	=	1,110.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.4	11.90	2.0
12.00	5.6	12.10	9.4	12.20	* 10.4	12.30	8.7
12.40	6.6	12.50	5.4	12.60	4.7	12.70	3.9
12.80	3.3	12.90	2.8	13.00	2.5	13.10	2.4
13.20	2.3	13.30	1.9	13.40	1.8	13.50	1.7
13.60	1.7	13.70	1.6	13.80	1.5	13.90	1.4
14.00	1.4	14.10	1.3	14.20	1.2	14.30	1.1
14.40	1.1	14.50	1.0	14.60	1.0	14.70	1.0
14.80	1.0	14.90	1.0	15.00	0.9	15.10	0.8
15.20	0.7	15.30	0.6	15.40	0.5	15.50	0.4
15.60	0.3	15.70	0.2	15.80	0.1	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HYDROLOGICAL STUDY FOR

CO-OP Mine Undisturbed Area

Bear Creek Main Channel (60" CMP)

Bear Canyon Mine Site

BY

HORROCKS/CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

REGISTERED PROFESSIONAL ENGINEER
No. 3535
HAROLD LEE WINMILL
STATE OF UTAH

April 25, 1984

0000218

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION LA (Bear Creek Falls area)
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	953.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	19.0	%
HYDRAULIC LENGTH	=	11,000.0	FEET
BASIN LAG	=	0.61	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.74	0.0	10.98	0.0	11.22	0.0	11.47	0.0
11.71	0.5	11.96	23.0	12.20	84.8	12.44	139.6
12.69	153.6	12.93	132.0	13.18	105.1	13.42	84.3
13.66	69.1	13.91	57.9	14.15	49.5	14.40	42.7
14.64	37.3	14.88	32.6	15.13	29.9	15.37	28.7
15.62	28.1	15.86	27.9	16.10	27.6	16.35	26.4
16.59	24.1	16.84	21.6	17.08	19.7	17.32	18.7
17.57	18.2	17.81	17.9	18.06	17.7	18.30	17.7
18.54	17.6	18.79	17.5	19.03	17.4	19.28	17.3
19.52	17.2	19.76	17.1	20.01	17.0	20.25	16.9
20.50	16.7	20.74	15.2	20.98	14.0	21.23	13.3
21.47	12.9	21.72	12.7	21.96	12.6	22.20	12.6
22.45	12.5	22.69	12.4	22.94	12.3	23.18	12.2
23.42	12.1	23.67	11.9	23.91	9.5	24.16	6.3
24.40	3.7	24.64	2.1	24.89	1.2	25.13	0.7
25.38	0.4	25.62	0,2	25.86	0.1	26.11	0.0
26.35	0.0	26.60	0.0	26.84	0.0	27.08	0.0
27.33	0.0	27.57	0.0	27.82	0.0	28.06	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION LC (right-hand tributary)
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	481.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	32.0	%
HYDRAULIC LENGTH	=	6,600.0	FEET
BASIN LAG	=	0.61	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.74	0.0	10.98	0.0	11.22	0.0	11.47	0.0
11.71	0.3	11.96	11.6	12.20	42.8	12.44	70.5
12.69	77.5	12.93	66.6	13.18	53.1	13.42	42.6
13.66	34.9	13.91	29.2	14.15	25.0	14.40	21.6
14.64	18.8	14.88	16.4	15.13	15.1	15.37	14.5
15.62	14.2	15.86	14.1	16.10	14.0	16.35	13.3
16.59	12.2	16.84	10.9	17.08	10.0	17.32	9.4
17.57	9.2	17.81	9.0	18.06	9.0	18.30	8.9
18.54	8.8	18.79	8.7	19.03	8.6	19.28	8.5
19.52	8.4	19.76	8.3	20.01	8.2	20.25	8.1
20.50	8.0	20.74	7.7	20.98	7.1	21.23	6.7
21.47	6.5	21.72	6.4	21.96	6.4	22.20	6.3
22.45	6.3	22.69	6.2	22.94	6.1	23.18	6.0
23.42	5.9	23.67	5.8	23.91	4.8	24.16	3.2
24.40	1.8	24.64	1.1	24.89	0.6	25.13	0.3
25.38	0.2	25.62	0.1	25.86	0.0	26.11	0.0
26.35	0.0	26.60	0.0	26.84	0.0	27.08	0.0
27.33	0.0	27.57	0.0	27.82	0.0	28.06	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

BASIN IDENTIFIER LA + LC
DISCHARGES INTO Bear Creek (60" CMP)

10.74	0.0	10.98	0.0	11.22	0.0	11.47	0.0
11.71	0.8	11.96	34.6	12.20	127.7	12.44	210.1
12.69	* 231.2	12.93	198.7	13.18	158.2	13.42	126.9
13.66	104.0	13.91	87.1	14.15	74.5	14.40	64.3
14.64	56.1	14.88	49.0	15.13	45.1	15.37	43.2
15.62	42.3	15.86	42.0	16.10	41.6	16.35	39.8
16.59	36.2	16.84	32.5	17.08	29.7	17.32	28.2
17.57	27.3	17.81	26.9	18.06	26.7	18.30	26.6
18.54	26.4	18.79	26.2	19.03	26.0	19.28	25.8
19.52	25.6	19.76	25.4	20.01	25.2	20.25	25.0
20.50	24.7	20.74	22.9	20.98	21.1	21.23	20.0
21.47	19.4	21.72	19.1	21.96	19.0	22.20	18.9
22.45	18.9	22.69	18.7	22.94	18.5	23.18	18.3
23.42	18.1	23.67	17.8	23.91	14.3	24.16	9.5
24.40	5.5	24.64	3.2	24.89	1.8	25.13	1.0
25.38	0.6	25.62	0.3	25.86	0.1	26.11	0.1
26.35	0.0	26.60	0.0	26.84	0.0	27.08	0.0
27.33	0.0	27.57	0.0	27.82	0.0	28.06	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HYDROLOGICAL STUDY FOR

CO-OP Mine Disturbed Area

Disturbed Run-off Collection

Bear Canyon Mine Site

BY

HORROCKS/CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

April 25, 1984

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Area B
BASIN DISCHARGES INTO D-6D & C-3D

BASIN AREA	=	1.79	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	10.0	%
HYDRAULIC LENGTH	=	520.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.1	11.70	0.1	11.80	0.2	11.90	0.5
12.00	0.9	12.10	* 1.2	12.20	1.2	12.30	1.0
12.40	0.7	12.50	0.5	12.60	0.4	12.70	0.4
12.80	0.3	12.90	0.3	13.00	0.2	13.10	0.2
13.20	0.2	13.30	0.2	13.40	0.2	13.50	0.1
13.60	0.1	13.70	0.1	13.80	0.1	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-1
BASIN DISCHARGES INTO D-2D & C-1D

BASIN AREA	=	2.24	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	36.0	%
HYDRAULIC LENGTH	=	420.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.1	11.70	0.2	11.80	0.3	11.90	0.6
12.00	1.1	12.10	* 1.5	12.20	1.5	12.30	1.2
12.40	0.9	12.50	0.7	12.60	0.6	12.70	0.5
12.80	0.4	12.90	0.3	13.00	0.3	13.10	0.3
13.20	0.2	13.30	0.2	13.40	0.2	13.50	0.2
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-1S (substa. area)
BASIN DISCHARGES INTO D-1D

BASIN AREA	=	1.25	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	30.0	%
HYDRAULIC LENGTH	=	250.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.1	11.80	0.2	11.90	0.3
12.00	0.6	12.10	* 0.8	12.20	0.8	12.30	0.7
12.40	0.5	12.50	0.4	12.60	0.3	12.70	0.3
12.80	0.2	12.90	0.2	13.00	0.2	13.10	0.2
13.20	0.1	13.30	0.1	13.40	0.1	13.50	0.1
13.60	0.1	13.70	0.1	13.80	0.1	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-1
BASIN DISCHARGES INTO D-4D & C-2D also D-5D

BASIN AREA	=	2.24	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	36.0	%
HYDRAULIC LENGTH	=	420.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.1	11.70	0.2	11.80	0.3	11.90	0.6
12.00	1.1	12.10	*1.5	12.20	1.5	12.30	1.2
12.40	0.9	12.50	0.7	12.60	0.6	12.70	0.5
12.80	0.4	12.90	0.3	13.00	0.3	13.10	0.3
13.20	0.2	13.30	0.2	13.40	0.2	13.50	0.2
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-2 (upper road)
BASIN DISCHARGES INTO D-3D

BASIN AREA	=	1.50	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	14.0	%
HYDRAULIC LENGTH	=	600.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.1	11.70	0.1	11.80	0.2	11.90	0.4
12.00	0.7	12.10	* 1.0	12.20	1.0	12.30	0.8
12.40	0.6	12.50	0.5	12.60	0.4	12.70	0.3
12.80	0.3	12.90	0.2	13.00	0.2	13.10	0.2
13.20	0.2	13.30	0.1	13.40	0.1	13.50	0.1
13.60	0.1	13.70	0.1	13.80	0.1	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-2
BASIN DISCHARGES INTO D-4D & C-2D also D-5D

BASIN AREA	=	4.96	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	14.0	%
HYDRAULIC LENGTH	=	560.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.1	11.30	0.1	11.40	0.1	11.50	0.1
11.60	0.2	11.70	0.3	11.80	0.7	11.90	1.3
12.00	2.4	12.10	* 3.3	12.20	3.3	12.30	2.7
12.40	1.9	12.50	1.5	12.60	1.2	12.70	1.0
12.80	0.8	12.90	0.7	13.00	0.6	13.10	0.6
13.20	0.6	13.30	0.5	13.40	0.4	13.50	0.4
13.60	0.4	13.70	0.4	13.80	0.3	13.90	0.3
14.00	0.3	14.10	0.3	14.20	0.3	14.30	0.3
14.40	0.2	14.50	0.2	14.60	0.2	14.70	0.2
14.80	0.2	14.90	0.2	15.00	0.2	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER AD-1 + AD-2
DISCHARGES INTO D-4D & C-2D

10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.1
11.20	0.1	11.30	0.1	11.40	0.1	11.50	0.2
11.60	0.2	11.70	0.5	11.80	1.0	11.90	1.9
12.00	3.5	12.10	*4.8	12.20	4.8	12.30	3.9
12.40	2.8	12.50	2.2	12.60	1.8	12.70	1.5
12.80	1.2	12.90	1.0	13.00	0.9	13.10	0.9
13.20	0.8	13.30	0.7	13.40	0.6	13.50	0.6
13.60	0.6	13.70	0.5	13.80	0.5	13.90	0.5
14.00	0.5	14.10	0.4	14.20	0.4	14.30	0.4
14.40	0.3	14.50	0.3	14.60	0.3	14.70	0.3
14.80	0.3	14.90	0.3	15.00	0.3	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-3
BASIN DISCHARGES INTO D-5D

BASIN AREA	=	3.51	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	11.0	%
HYDRAULIC LENGTH	=	640.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.1	11.40	0.1	11.50	0.1
11.60	0.1	11.70	0.2	11.80	0.5	11.90	0.9
12.00	1.7	12.10	* 2.4	12.20	2.4	12.30	1.9
12.40	1.4	12.50	1.1	12.60	0.9	12.70	0.7
12.80	0.6	12.90	0.5	13.00	0.4	13.10	0.4
13.20	0.4	13.30	0.3	13.40	0.3	13.50	0.3
13.60	0.3	13.70	0.3	13.80	0.2	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.2
14.40	0.2	14.50	0.2	14.60	0.2	14.70	0.2
14.80	0.2	14.90	0.2	15.00	0.2	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER AD-1 + AD-2 + AD-3
DISCHARGES INTO D-5D

10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.1	11.10	0.1
11.20	0.1	11.30	0.2	11.40	0.2	11.50	0.2
11.60	0.4	11.70	0.7	11.80	1.5	11.90	2.9
12.00	5.2	12.10	* 7.2	12.20	7.2	12.30	5.7
12.40	4.2	12.50	3.3	12.60	2.7	12.70	2.2
12.80	1.8	12.90	1.5	13.00	1.4	13.10	1.3
13.20	1.2	13.30	1.0	13.40	0.9	13.50	0.9
13.60	0.8	13.70	0.8	13.80	0.7	13.90	0.7
14.00	0.7	14.10	0.7	14.20	0.6	14.30	0.6
14.40	0.5	14.50	0.5	14.60	0.5	14.70	0.5
14.80	0.5	14.90	0.5	15.00	0.5	15.10	0.2
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HYDROLOGICAL STUDY FOR

CO-OP Mine Disturbed Area

Reconstructed Sediment Pond "A"

Bear Canyon Mine Site

BY

HORROCKS & CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

February 28, 1984

REGISTERED PROFESSIONAL ENGINEER
No. 3535
HAROLD LEE WIMMER
STATE OF UTAH

0000234

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

BROAD CRESTED WEIR

WIDTH = 10.00 FEET

ELEV. (FT.)	FLOW (CFS)
94.20	0.00
94.30	1.20
94.40	3.40
94.50	6.24
94.60	9.61
94.70	13.44
94.80	17.66
94.90	22.26
95.00	27.19
95.10	32.44
95.20	38.00

3.0

FORMULA USED: Q = C * L * H^1.5

HORROCKS & CAROLLO ENGINEERS
AMERICAN FORK, UTAH
February 28, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER Reconstructed Sed. Pond "A" -Empty-

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
87.0	0.0	0.0	0.0
88.0	9284.0	0.0	41.3
89.0	19368.0	0.0	86.1
90.0	30284.0	0.0	134.6
91.0	42064.0	0.0	187.0
92.0	54740.0	0.0	243.3
93.0	68344.0	0.0	303.8
94.0	82908.0	0.0	368.5
94.2	85938.6	0.0	381.9
94.7	93691.6	13.4	429.8
95.2	101698.1	38.0	490.0

HORROCKS & CAROLLO ENGINEERS
AMERICAN FORK, UTAH
February 28, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER Reconstructed Sed. Pond "A" - Empty -

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
87.0		8892.0		0.0	0.0
	1.0		9284.0		
88.0		9676.0		9284.0	0.0
	1.0		10084.0		
89.0		10492.0		19368.0	0.0
	1.0		10916.0		
90.0		11340.0		30284.0	0.0
	1.0		11780.0		
91.0		12220.0		42064.0	0.0
	1.0		12676.0		
92.0		13132.0		54740.0	0.0
	1.0		13604.0		
93.0		14076.0		68344.0	0.0
	1.0		14564.0		
94.0		15052.0		82908.0	0.0
	0.2		3030.6		
94.2		15254.0		85938.6	0.0
	0.5		7753.0		
94.7		15758.0		93691.6	13.4
	0.5		8006.5		
95.2		16268.0		101698.1	38.0

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER Reconst. Sed. Pond "A" - with 3 years accumulated Sediment -

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
90.9		12176.0		0.0	0.00
	1.1		13286.7		
92.0		13132.0		13286.7	0.00
	1.0		13604.0		
93.0		14076.0		26890.7	0.00
	1.0		14564.0		
94.0		15052.0		41454.7	0.00
	0.2		3030.6		
94.2		15254.0		44485.3	0.00
	0.5		7753.0		
94.7		15758.0		52238.3	13.44
	0.5		8006.5		
95.2		16268.0		60244.8	35.19

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER Reconst. Sed. Pond "A" - With 3 years accumulated sediment -

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
90.9	0.0	0.0	0.0
92.0	13286.7	0.0	73.8
93.0	26890.7	0.0	149.4
94.0	41454.7	0.0	230.3
94.2	44485.3	0.0	247.1
94.7	52238.3	13.4	303.7
95.2	60244.8	35.2	369.9

HORROCKS & CAROLLO ENGINEERS
AMERICAN FORK, UTAH
February 28, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "A"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	14.35	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.60	INCHES
AVERAGE BASIN SLOPE	=	14.0	%
HYDRAULIC LENGTH	=	640.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
25 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.0
9.60	0.0	9.70	0.0	9.80	0.0	9.90	0.0
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.1	10.50	0.1	10.60	0.1	10.70	0.1
10.80	0.2	10.90	0.2	11.00	0.2	11.10	0.3
11.20	0.3	11.30	0.4	11.40	0.5	11.50	0.6
11.60	0.8	11.70	1.6	11.80	2.9	11.90	5.5
12.00	9.6	12.10	13.0	12.20	12.8	12.30	10.1
12.40	7.3	12.50	5.7	12.60	4.6	12.70	3.8
12.80	3.1	12.90	2.6	13.00	2.3	13.10	2.2
13.20	2.0	13.30	1.7	13.40	1.5	13.50	1.5
13.60	1.4	13.70	1.3	13.80	1.2	13.90	1.2
14.00	1.1	14.10	1.1	14.20	1.0	14.30	0.9
14.40	0.9	14.50	0.8	14.60	0.8	14.70	0.8
14.80	0.8	14.90	0.8	15.00	0.8	15.10	0.8
15.20	0.7	15.30	0.6	15.40	0.5	15.50	0.4
15.60	0.3	15.70	0.2	15.80	0.1	15.90	0.0
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "A"
POND IDENTIFIER Reconst. Sed. Pond "A"
25 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
11.40	0.0	0.5	0.0	0.0	0.5	0.0	0.5
11.50	0.5	0.6	0.5	0.0	1.6	0.0	1.6
11.60	0.6	0.8	1.6	0.0	3.0	0.0	3.0
11.70	0.8	1.6	3.0	0.0	5.4	0.0	5.4
11.80	1.6	2.9	5.4	0.0	9.9	0.0	9.9
11.90	2.9	5.5	9.9	0.0	18.4	0.0	18.4
12.00	5.5	9.6	18.4	0.0	33.6	0.0	33.6
12.10	9.6	13.0	33.6	0.0	56.1	0.0	56.1
12.20	13.0	12.8	56.1	0.0	81.8	0.0	81.8
12.30	12.8	10.1	81.8	0.0	104.7	0.0	104.7
12.40	10.1	7.3	104.7	0.0	122.2	0.0	122.2
12.50	7.3	5.7	122.2	0.0	135.2	0.0	135.2
12.60	5.7	4.6	135.2	0.0	145.5	0.0	145.5
12.70	4.6	3.8	145.5	0.0	153.9	0.0	153.9
12.80	3.8	3.1	153.9	0.0	160.8	0.0	160.8
12.90	3.1	2.6	160.8	0.0	166.4	0.0	166.4
13.00	2.6	2.3	166.4	0.0	171.3	0.0	171.3
13.10	2.3	2.2	171.3	0.0	175.8	0.0	175.8
13.20	2.2	2.0	175.8	0.0	180.0	0.0	180.0
13.30	2.0	1.7	180.0	0.0	183.7	0.0	183.7
13.40	1.7	1.5	183.7	0.0	186.9	0.0	186.9
13.50	1.5	1.5	186.9	0.0	189.9	0.0	189.9
13.60	1.5	1.4	189.9	0.0	192.8	0.0	192.8
13.70	1.4	1.3	192.8	0.0	195.6	0.0	195.6
13.80	1.3	1.2	195.6	0.0	198.1	0.0	198.1
13.90	1.2	1.2	198.1	0.0	200.6	0.0	200.6
14.00	1.2	1.1	200.6	0.0	202.9	0.0	202.9
14.10	1.1	1.1	202.9	0.0	205.1	0.0	205.1
14.20	1.1	1.0	205.1	0.0	207.2	0.0	207.2
14.30	1.0	0.9	207.2	0.0	209.2	0.0	209.2
14.40	0.9	0.9	209.2	0.0	211.0	0.0	211.0
14.50	0.9	0.8	211.0	0.0	212.7	0.0	212.7
14.60	0.8	0.8	212.7	0.0	214.4	0.0	214.4
14.70	0.8	0.8	214.4	0.0	216.0	0.0	216.0
14.80	0.8	0.8	216.0	0.0	217.6	0.0	217.6

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "A"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	14.35	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.90	INCHES
AVERAGE BASIN SLOPE	=	14.0	%
HYDRAULIC LENGTH	=	640.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
50 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
8.80	0.0	8.90	0.0	9.00	0.0	9.10	0.0
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.0
9.60	0.0	9.70	0.0	9.80	0.0	9.90	0.1
10.00	0.1	10.10	0.1	10.20	0.1	10.30	0.1
10.40	0.2	10.50	0.2	10.60	0.2	10.70	0.2
10.80	0.3	10.90	0.3	11.00	0.4	11.10	0.4
11.20	0.5	11.30	0.6	11.40	0.7	11.50	0.8
11.60	1.2	11.70	2.1	11.80	3.9	11.90	7.1
12.00	12.0	12.10	15.9	12.20	15.6	12.30	12.3
12.40	8.8	12.50	6.8	12.60	5.6	12.70	4.5
12.80	3.7	12.90	3.1	13.00	2.8	13.10	2.6
13.20	2.4	13.30	2.0	13.40	1.8	13.50	1.7
13.60	1.7	13.70	1.6	13.80	1.5	13.90	1.4
14.00	1.3	14.10	1.3	14.20	1.2	14.30	1.1
14.40	1.0	14.50	1.0	14.60	1.0	14.70	0.9
14.80	0.9	14.90	0.9	15.00	0.9	15.10	0.9
15.20	0.8	15.30	0.7	15.40	0.6	15.50	0.5
15.60	0.4	15.70	0.3	15.80	0.2	15.90	0.1
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0
16.40	0.0	16.50	0.0	16.60	0.0	16.70	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER Sediment Pond "A"
POND IDENTIFIER Reconst. Sed. Pond "A"
25 YEAR STORM FREQUENCY (CONT'D)

14.90	0.8	0.8	217.6	0.0	219.1	0.0	219.1
15.00	0.8	0.8	219.1	0.0	220.7	0.0	220.7
15.10	0.8	0.8	220.7	0.0	222.3	0.0	222.3
15.20	0.8	0.7	222.3	0.0	223.8	0.0	223.8
15.30	0.7	0.6	223.8	0.0	225.1	0.0	225.1

MAXIMUM OUTFLOW = 0.0 C.F.S.
MAXIMUM STORAGE = 44,485.3 CU FT.
MAXIMUM ELEVATION = 94.2 FEET

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "A"
POND IDENTIFIER Reconst. Sed. Pond "A"
50 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
11.20	0.0	0.5	0.0	0.0	0.5	0.0	0.5
11.30	0.5	0.6	0.5	0.0	1.7	0.0	1.7
11.40	0.6	0.7	1.7	0.0	3.1	0.0	3.1
11.50	0.7	0.8	3.1	0.0	4.6	0.0	4.6
11.60	0.8	1.2	4.6	0.0	6.7	0.0	6.7
11.70	1.2	2.1	6.7	0.0	9.9	0.0	9.9
11.80	2.1	3.9	9.9	0.0	15.9	0.0	15.9
11.90	3.9	7.1	15.9	0.0	26.8	0.0	26.8
12.00	7.1	12.0	26.8	0.0	45.9	0.0	45.9
12.10	12.0	15.9	45.9	0.0	73.7	0.0	73.7
12.20	15.9	15.6	73.7	0.0	105.2	0.0	105.2
12.30	15.6	12.3	105.2	0.0	133.1	0.0	133.1
12.40	12.3	8.8	133.1	0.0	154.2	0.0	154.2
12.50	8.8	6.8	154.2	0.0	169.9	0.0	169.9
12.60	6.8	5.6	169.9	0.0	182.3	0.0	182.3
12.70	5.6	4.5	182.3	0.0	192.4	0.0	192.4
12.80	4.5	3.7	192.4	0.0	200.6	0.0	200.6
12.90	3.7	3.1	200.6	0.0	207.3	0.0	207.3
13.00	3.1	2.8	207.3	0.0	213.1	0.0	213.1
13.10	2.8	2.6	213.1	0.0	218.5	0.0	218.5
13.20	2.6	2.4	218.5	0.0	223.5	0.0	223.5
13.30	2.4	2.0	223.5	0.0	227.8	0.0	227.8
13.40	2.0	1.8	227.8	0.0	231.6	0.0	231.6
13.50	1.8	1.7	231.6	0.0	235.2	0.0	235.2
13.60	1.7	1.7	235.2	0.0	238.6	0.0	238.6
13.70	1.7	1.6	238.6	0.0	241.8	0.0	241.8
13.80	1.6	1.5	241.8	0.0	244.9	0.0	244.9
13.90	1.5	1.4	244.9	0.0	247.7	0.1	247.6
14.00	1.4	1.3	247.6	0.1	250.1	0.7	249.4
14.10	1.3	1.3	249.4	0.7	251.3	1.0	250.3
14.20	1.3	1.2	250.3	1.0	251.8	1.1	250.7
14.30	1.2	1.1	250.7	1.1	251.9	1.1	250.8
14.40	1.1	1.0	250.8	1.1	251.8	1.1	250.7
14.50	1.0	1.0	250.7	1.1	251.6	1.1	250.5
14.60	1.0	1.0	250.5	1.1	251.4	1.0	250.4

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER Sediment Pond "A"
POND IDENTIFIER Reconst. Sed. Pond "A"
50 YEAR STORM FREQUENCY (CONT'D)

14.70	1.0	0.9	250.4	1.0	251.3	1.0	250.3
14.80	0.9	0.9	250.3	1.0	251.2	1.0	250.2
14.90	0.9	0.9	250.2	1.0	251.1	0.9	250.2
15.00	0.9	0.9	250.2	0.9	251.1	0.9	250.1
15.10	0.9	0.9	250.1	0.9	251.1	0.9	250.1
15.20	0.9	0.8	250.1	0.9	250.9	0.9	250.0
15.30	0.8	0.7	250.0	0.9	250.7	0.8	249.8
15.40	0.7	0.6	249.8	0.8	250.4	0.8	249.6
15.50	0.6	0.5	249.6	0.8	250.0	0.7	249.3
15.60	0.5	0.4	249.3	0.7	249.6	0.6	249.0
15.70	0.4	0.3	249.0	0.6	249.2	0.5	248.7

MAXIMUM OUTFLOW = 1.1 C.F.S.
MAXIMUM STORAGE = 45,140.6 CU FT.
MAXIMUM ELEVATION = 94.2 FEET

PAGE
HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "A"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	14.35	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	3.18	INCHES
AVERAGE BASIN SLOPE	=	14.0	%
HYDRAULIC LENGTH	=	640.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
8.00	0.0	8.10	0.0	8.20	0.0	8.30	0.0
8.40	0.0	8.50	0.0	8.60	0.0	8.70	0.0
8.80	0.0	8.90	0.0	9.00	0.0	9.10	0.0
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.1
9.60	0.1	9.70	0.1	9.80	0.1	9.90	0.1
10.00	0.1	10.10	0.2	10.20	0.2	10.30	0.2
10.40	0.2	10.50	0.3	10.60	0.3	10.70	0.4
10.80	0.4	10.90	0.5	11.00	0.5	11.10	0.6
11.20	0.7	11.30	0.8	11.40	1.0	11.50	1.1
11.60	1.5	11.70	2.7	11.80	4.8	11.90	8.6
12.00	14.2	12.10	18.8	12.20	18.3	12.30	14.4
12.40	10.3	12.50	7.9	12.60	6.5	12.70	5.2
12.80	4.2	12.90	3.5	13.00	3.2	13.10	3.0
13.20	2.7	13.30	2.2	13.40	2.1	13.50	2.0
13.60	1.9	13.70	1.8	13.80	1.7	13.90	1.6
14.00	1.5	14.10	1.5	14.20	1.4	14.30	1.3
14.40	1.2	14.50	1.1	14.60	1.1	14.70	1.1
14.80	1.1	14.90	1.1	15.00	1.1	15.10	1.1
15.20	1.0	15.30	0.9	15.40	0.8	15.50	0.7
15.60	0.6	15.70	0.5	15.80	0.4	15.90	0.3
16.00	0.2	16.10	0.1	16.20	0.0	16.30	0.0
[illegible].40	0.0	16.50	0.0	16.60	0.0	16.70	0.0

HORROCKS ENGINEERS
AMERICAN FORK, UTAH
February 27, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER Sediment Pond "A"
POND IDENTIFIER Reconst. Sed. Pond "A"
100 YEAR STORM FREQUENCY (CONT'D)

14.50	1.2	1.1	251.4	1.3	252.3	1.2	251.1
14.60	1.1	1.1	251.1	1.2	252.1	1.2	250.9
14.70	1.1	1.1	250.9	1.2	251.9	1.1	250.8
14.80	1.1	1.1	250.8	1.1	251.8	1.1	250.7
14.90	1.1	1.1	250.7	1.1	251.7	1.1	250.6
15.00	1.1	1.1	250.6	1.1	251.6	1.1	250.6
15.10	1.1	1.1	250.6	1.1	251.6	1.1	250.5
15.20	1.1	1.0	250.5	1.1	251.5	1.0	250.5
15.30	1.0	0.9	250.5	1.0	251.2	1.0	250.3
15.40	0.9	0.8	250.3	1.0	250.9	0.9	250.0
15.50	0.8	0.7	250.0	0.9	250.5	0.8	249.7
15.60	0.7	0.6	249.7	0.8	250.1	0.7	249.4
15.70	0.6	0.5	249.4	0.7	249.7	0.6	249.1
15.80	0.5	0.4	249.1	0.6	249.3	0.5	248.8
15.90	0.4	0.3	248.8	0.5	248.9	0.4	248.5

MAXIMUM OUTFLOW = 2.6 C.F.S.
MAXIMUM STORAGE = 45,975.2 CU FT.
MAXIMUM ELEVATION = 94.3 FEET

HYDROLOGICAL STUDY FOR

CO-OP Mine Disturbed Area

Sediment Pond "B"

Bear Canyon Mine Site

BY

HORROCKS/CAROLLO ENGINEERS

ONE WEST MAIN

AMERICAN FORK, UTAH 84003

April 25, 1984

REGISTERED PROFESSIONAL ENGINEER
No. 3535
HAROLD LEE
WIMMER
STATE OF UTAH

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

BROAD CRESTED WEIR

WIDTH = 4.00 FEET

ELEV. (FT.)	FLOW (CFS)
7075.00	0.00
7075.20	1.36
7075.40	3.85
7075.60	7.06
7075.80	10.88
7076.00	15.20

FORMULA USED: Q = C * L * H^1.5

C = 3.8

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER Sediment Pond "B" - Empty -

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
7069.0		728.0		0.0	0.00
	1.0		899.0		
7070.0		1070.0		899.0	0.00
	1.0		1250.0		
7071.0		1430.0		2149.0	0.00
	1.0		1619.0		
7072.0		1808.0		3768.0	0.00
	1.0		2006.0		
7073.0		2204.0		5774.0	0.00
	1.0		2411.0		
7074.0		2618.0		8185.0	0.00
	1.0		2834.0		
7075.0		3050.0		11019.0	0.00
	0.2		619.6		
7075.2		3140.0		11638.6	1.36
	0.2		636.1		
7075.4		3230.0		12274.7	3.85
	0.2		655.6		
7075.6		3320.0		12930.3	7.06
	0.2		672.0		
7075.8		3410.0		13602.3	10.88
	0.2		691.7		
7076.0		3500.0		14294.0	15.20

PAGE
HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER Sediment Pond "B" - Empty -

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
7069.0	0.0	0.0	0.0
7070.0	899.0	0.0	5.0
7071.0	2149.0	0.0	11.9
7072.0	3768.0	0.0	20.9
7073.0	5774.0	0.0	32.1
7074.0	8185.0	0.0	45.5
7075.0	11019.0	0.0	61.2
7075.2	11638.6	1.4	66.0
7075.4	12274.7	3.8	72.0
7075.6	12930.3	7.1	78.9
7075.8	13602.3	10.9	86.4
7076.0	14294.0	15.2	94.6

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER Sediment Pond "B" - With 3 years Sediment -

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
7071.0		1430.0		0.0	0.00
	1.0		1619.0		
7072.0		1808.0		1619.0	0.00
	1.0		2006.0		
7073.0		2204.0		3625.0	0.00
	1.0		2411.0		
7074.0		2618.0		6036.0	0.00
	1.0		2834.0		
7075.0		3050.0		8870.0	0.00
	0.2		619.6		
7075.2		3140.0		9489.6	1.36
	0.2		636.1		
7075.4		3230.0		10125.7	3.85
	0.2		655.6		
7075.6		3320.0		10781.3	7.06
	0.2		672.0		
7075.8		3410.0		11453.3	10.88
	0.2		691.7		
7076.0		3500.0		12145.0	15.20

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER Sediment Pond "B" - With 3 years Sediment -

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
7071.0	0.0	0.0	0.0
7072.0	1619.0	0.0	9.0
7073.0	3625.0	0.0	20.1
7074.0	6036.0	0.0	33.5
7075.0	8870.0	0.0	49.3
7075.2	9489.6	1.4	54.1
7075.4	10125.7	3.8	60.1
7075.6	10781.3	7.1	67.0
7075.8	11453.3	10.9	74.5
7076.0	12145.0	15.2	82.7

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

Hiawatha RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	0.84	1.56	1.92	2.76	3.12	3.72
6.0	0.79	1.49	1.84	2.63	2.98	3.55
7.0	0.74	1.42	1.76	2.50	2.84	3.38
8.0	0.69	1.35	1.68	2.37	2.70	3.21
9.0	0.64	1.28	1.60	2.24	2.56	3.04
10.0	0.60	1.20	1.50	2.10	2.40	2.88
11.0	0.58	1.16	1.45	2.03	2.32	2.78
12.0	0.56	1.12	1.40	1.96	2.24	2.68
13.0	0.54	1.08	1.35	1.89	2.16	2.58
14.0	0.53	1.04	1.30	1.82	2.08	2.48
15.0	0.52	1.00	1.24	1.76	2.00	2.40
20.0	0.47	0.90	1.11	1.59	1.80	2.16
25.0	0.42	0.80	0.98	1.42	1.60	1.92
30.0	0.36	0.70	0.86	1.24	1.40	1.68
40.0	0.32	0.61	0.76	1.09	1.23	1.48
50.0	0.28	0.52	0.66	0.94	1.06	1.28
60.0	0.23	0.44	0.55	0.78	0.88	1.06
120.0	0.20	0.31	0.38	0.50	0.56	0.65
180.0	0.18	0.26	0.31	0.40	0.44	0.51
240.0	0.17	0.24	0.28	0.36	0.40	0.46
300.0	0.16	0.22	0.25	0.32	0.36	0.41
360.0	0.16	0.20	0.23	0.28	0.32	0.35
480.0	0.14	0.18	0.20	0.25	0.28	0.31
600.0	0.12	0.16	0.17	0.22	0.24	0.27
720.0	0.11	0.13	0.15	0.18	0.20	0.22
1080.0	0.09	0.11	0.12	0.15	0.16	0.18
1440.0	0.07	0.08	0.09	0.11	0.12	0.13

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "B"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	1.82	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	6.5	%
HYDRAULIC LENGTH	=	600.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.1	11.70	0.1	11.80	0.2	11.90	0.5
12.00	0.9	12.10	1.2	12.20	1.2	12.30	1.0
12.40	0.7	12.50	0.6	12.60	0.5	12.70	0.4
12.80	0.3	12.90	0.3	13.00	0.2	13.10	0.2
13.20	0.2	13.30	0.2	13.40	0.2	13.50	0.1
13.60	0.1	13.70	0.1	13.80	0.1	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.0
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "B"
POND IDENTIFIER Sediment Pond "B"
10 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
12.00	0.0	0.9	0.0	0.0	0.9	0.0	0.9
12.10	0.9	1.2	0.9	0.0	3.0	0.0	3.0
12.20	1.2	1.2	3.0	0.0	5.4	0.0	5.4
12.30	1.2	1.0	5.4	0.0	7.6	0.0	7.6
12.40	1.0	0.7	7.6	0.0	9.3	0.0	9.3
12.50	0.7	0.6	9.3	0.0	10.6	0.0	10.6

MAXIMUM OUTFLOW = 0.0 C.F.S.
MAXIMUM STORAGE = 8,870.0 CU FT.
MAXIMUM ELEVATION = 7,075.0 FEET

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "B"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	1.82	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.60	INCHES
AVERAGE BASIN SLOPE	=	6.5	%
HYDRAULIC LENGTH	=	600.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
25 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.0
9.60	0.0	9.70	0.0	9.80	0.0	9.90	0.0
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.0
11.20	0.0	11.30	0.1	11.40	0.1	11.50	0.1
11.60	0.1	11.70	0.2	11.80	0.4	11.90	0.7
12.00	1.2	12.10	1.6	12.20	1.6	12.30	1.3
12.40	0.9	12.50	0.7	12.60	0.6	12.70	0.5
12.80	0.4	12.90	0.3	13.00	0.3	13.10	0.3
13.20	0.3	13.30	0.2	13.40	0.2	13.50	0.2
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.1
14.00	0.1	14.10	0.1	14.20	0.1	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "B"
POND IDENTIFIER Sediment Pond "B"
25 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
11.90	0.0	0.7	0.0	0.0	0.7	0.0	0.7
12.00	0.7	1.2	0.7	0.0	2.6	0.0	2.6
12.10	1.2	1.6	2.6	0.0	5.5	0.0	5.5
12.20	1.6	1.6	5.5	0.0	8.7	0.0	8.7
[illegible].30	1.6	1.3	8.7	0.0	11.7	0.0	11.7
[illegible].40	1.3	0.9	11.7	0.0	13.9	0.0	13.9
12.50	0.9	0.7	13.9	0.0	15.5	0.0	15.5
12.60	0.7	0.6	15.5	0.0	16.8	0.0	16.8

MAXIMUM OUTFLOW = 0.0 C.F.S.
MAXIMUM STORAGE = 8,870.0 CU FT.
MAXIMUM ELEVATION = 7,075.0 FEET

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "B"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	1.82	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	2.90	INCHES
AVERAGE BASIN SLOPE	=	6.5	%
HYDRAULIC LENGTH	=	600.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
50 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
8.80	0.0	8.90	0.0	9.00	0.0	9.10	0.0
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.0
9.60	0.0	9.70	0.0	9.80	0.0	9.90	0.0
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.0	10.90	0.0	11.00	0.0	11.10	0.1
11.20	0.1	11.30	0.1	11.40	0.1	11.50	0.1
11.60	0.1	11.70	0.3	11.80	0.5	11.90	0.9
12.00	1.5	12.10	2.0	12.20	2.0	12.30	1.6
12.40	1.1	12.50	0.9	12.60	0.7	12.70	0.6
12.80	0.5	12.90	0.4	13.00	0.3	13.10	0.3
13.20	0.3	13.30	0.2	13.40	0.2	13.50	0.2
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.1
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "B"
POND IDENTIFIER Sediment Pond "B"
50 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
11.90	0.0	0.9	0.0	0.0	0.9	0.0	0.9
12.00	0.9	1.5	0.9	0.0	3.3	0.0	3.3
12.10	1.5	2.0	3.3	0.0	6.8	0.0	6.8
12.20	2.0	2.0	6.8	0.0	10.8	0.0	10.8
12.30	2.0	1.6	10.8	0.0	14.4	0.0	14.4
12.40	1.6	1.1	14.4	0.0	17.1	0.0	17.1
12.50	1.1	0.9	17.1	0.0	19.0	0.0	19.0
12.60	0.9	0.7	19.0	0.0	20.6	0.0	20.6
12.70	0.7	0.6	20.6	0.0	21.9	0.0	21.9

MAXIMUM OUTFLOW = 0.0 C.F.S.
MAXIMUM STORAGE = 8,870.0 CU FT.
MAXIMUM ELEVATION = 7,075.0 FEET

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION Sediment Pond "B"
BASIN DISCHARGES INTO Spillway

BASIN AREA	=	1.82	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	3.18	INCHES
AVERAGE BASIN SLOPE	=	6.5	%
HYDRAULIC LENGTH	=	600.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
8.00	0.0	8.10	0.0	8.20	0.0	8.30	0.0
8.40	0.0	8.50	0.0	8.60	0.0	8.70	0.0
8.80	0.0	8.90	0.0	9.00	0.0	9.10	0.0
9.20	0.0	9.30	0.0	9.40	0.0	9.50	0.0
9.60	0.0	9.70	0.0	9.80	0.0	9.90	0.0
10.00	0.0	10.10	0.0	10.20	0.0	10.30	0.0
10.40	0.0	10.50	0.0	10.60	0.0	10.70	0.0
10.80	0.1	10.90	0.1	11.00	0.1	11.10	0.1
11.20	0.1	11.30	0.1	11.40	0.1	11.50	0.1
11.60	0.2	11.70	0.3	11.80	0.6	11.90	1.1
12.00	1.8	12.10	2.4	12.20	2.3	12.30	1.8
12.40	1.3	12.50	1.0	12.60	0.8	12.70	0.7
12.80	0.5	12.90	0.4	13.00	0.4	13.10	0.4
13.20	0.3	13.30	0.3	13.40	0.3	13.50	0.3
13.60	0.2	13.70	0.2	13.80	0.2	13.90	0.2
14.00	0.2	14.10	0.2	14.20	0.2	14.30	0.2
14.40	0.1	14.50	0.1	14.60	0.1	14.70	0.1
14.80	0.1	14.90	0.1	15.00	0.1	15.10	0.1
15.20	0.0	15.30	0.0	15.40	0.0	15.50	0.0
15.60	0.0	15.70	0.0	15.80	0.0	15.90	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER Sediment Pond "B"
POND IDENTIFIER Sediment Pond "B"
100 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
11.80	0.0	0.6	0.0	0.0	0.6	0.0	0.6
11.90	0.6	1.1	0.6	0.0	2.3	0.0	2.3
12.00	1.1	1.8	2.3	0.0	5.2	0.0	5.2
12.10	1.8	2.4	5.2	0.0	9.4	0.0	9.4
12.20	2.4	2.3	9.4	0.0	14.1	0.0	14.1
12.30	2.3	1.8	14.1	0.0	18.2	0.0	18.2
12.40	1.8	1.3	18.2	0.0	21.3	0.0	21.3
12.50	1.3	1.0	21.3	0.0	23.6	0.0	23.6
12.60	1.0	0.8	23.6	0.0	25.5	0.0	25.5
12.70	0.8	0.7	25.5	0.0	27.0	0.0	27.0
12.80	0.7	0.5	27.0	0.0	28.2	0.0	28.2

MAXIMUM OUTFLOW = 0.0 C.F.S.
MAXIMUM STORAGE = 8,870.0 CU FT.
MAXIMUM ELEVATION = 7,075.0 FEET

RUNOFF

DITCH SIZING

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
4.01	1.00	.50	.035000	.090000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.414	65668.4	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.83	.83	.83

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-1D 0.8 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.54	3.12	.75	.035000	.100000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.595	136057.0	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.30	1.30	1.30

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-2D 1.5 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.18	1.29	.50	.035000	.150000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.825	84777.6	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.91	.91	.91

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-3D 1.0 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.31	5.31	1.00	.035000	.062500	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.323	173736.9	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.94	.94	.94

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-4D 4.8 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
6.23	9.74	1.25	.035000	.064000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.389	255010.9	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
2.05	2.05	2.05

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

P-5D 7.2 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Disturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
4.38	2.46	.75	.035000	.062500	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.261	107562.5	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.19	1.19	1.19

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-6D 1.2 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
3.50	1.97	.75	.035000	.040000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.009	86050.0	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.09	1.09	1.09

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-10 1.5 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
3.92	2.20	.75	.035000	.050000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.128	96206.8	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.13	1.13	1.13

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-20 1.5 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.51	8.61	1.25	.035000	.050000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.228	225399.9	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.95	1.95	1.95

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-3U 6.1 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
6.22	14.00	1.50	.035000	.050000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.266	305437.6	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.38	1.38	1.38

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-4U 11.8 cfs required
D-7U 10.3 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
3.54	.88	.50	.035000	.070000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.247	57914.1	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.79	.79	.79

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-5U 0.9 cfs required
D-6U 0.9 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
4.38	2.46	.75	.035000	.062500	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.261	107562.5	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.19	1.19	1.19

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-80 2.3 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.05	2.84	.75	.035000	.083000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.453	123953.8	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.25	1.25	1.25

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-90 1.8 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
5.67	1.42	.50	.035000	.180000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
2.000	92869.2	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.95	.95	.97

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-100 1.5 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
7.94	7.94	1.00	.035000	.140000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.980	260025.6	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.10	1.69	1.91

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-11U 7.6 cfs required

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS
CO-OP Mine Undisturbed Area
PROJECT No. 8309-42
DATE: 4/30/84

CHANNEL IS TRIANGULAR

SOLVING FOR VELOCITY, DISCHARGE

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WITDH ft.
6.81	15.33	1.50	.035000	.060000	1.00	1.00	0.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.387	334590.1	.16582538	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.43	1.43	1.43

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

D-3R 10.4 cfs required
D-2R 12.1 cfs required
D-1R 10.2 cfs required

CMP CULVERTS SIZING

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
9.50	16.793	18.00	0.02300	0.08000	18.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.09	329962	0.00	0.00000	0.000

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-1R 10.2 cfs required
C-2R 12.1 cfs required
C-3R 10.4 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
12.32	10.722	7.00	0.02300	0.15000	30.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
3.38	393847	13.20	0.01335	35.939

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUPERCRITICAL TURBULENT

C-10 8.8 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
8.38	2.200	4.00	0.02300	0.15000	15.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
3.03	150185	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUPERCRITICAL TURBULENT

C-2U 1.5 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
5.73	4.503	12.00	0.02300	0.05000	12.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.06	132715	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C 3 U 7.9 cfs required
- 4.5
3.4 cfs Flows in ditch to next culvert

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
5.13	2.797	10.00	0.02300	0.05100	10.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.06	98912	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-40 6.1 cfs required
- 2.8
3.3 cfs flows in ditch to next culvert

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
4.97	2.713	10.00	0.02300	0.04800	10.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.06	95959	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-50 6.1 cfs required
-2.7
3.4 cfs flows in ditch to next culvert

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
4.37	2.382	10.00	0.02300	0.03700	10.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.05	84249	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-6U 0,9 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
9.68	17.105	18.00	0.02300	0.08300	18.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.09	336092	7.13	0.01732	6.475

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-70 10.3 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
13.01	22.995	18.00	0.02300	0.15000	18.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.12	451819	15.48	0.03473	23.894

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C -8U 8.8 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42

DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
8.04	9.865	15.00	0.02300	0.07300	15.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.08	232601	15.48	0.03473	23.894

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-9U 1.5 cfs reqused

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
10.93	3.914	5.00	0.02300	0.20000	15.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
3.49	235557	9.60	0.02101	12.079

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUPERCRITICAL TURBULENT

C-1D 1.5 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
9.56	4.931	6.00	0.02300	0.12000	18.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
2.79	247253	10.26	0.01793	12.756

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUPERCRITICAL TURBULENT

C-2D 4.8 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ----- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
5.25	4.127	12.00	0.02300	0.04200	12.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.06	121635	10.26	0.01793	12.756

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

C-3D 1.2 cfs required

UNIFORM FLOW IN CIRCULAR CONDUITS

HORROCKS ENGINEERS

CO-OP Mine - CMP Culverts

PROJECT No. : 8309-42 DATE : April 30, 1984

SUMMARY OF UNIFORM FLOW CALCULATIONS
CIRCULAR CONDUITS

*** 0=UNKNOWN ---- 1=KNOWN ***

VELOCITY	DISCHARGE	DEPTH	MANNING	SLOPE	DIAMETER
0	0	1	1	1	1

COMPUTED DATA :

VELOCITY (fps)	DISCHARGE (cfs)	DEPTH (inches)	MANNING	SLOPE	DIAMETER (inches)
13.82	271.436	60.00	0.02300	0.03400	60.0

FROUDE NUMBER	REYNOLDS NUMBER	CRITICAL DEPTH (inches)	CRITICAL SLOPE	CRITICAL DISCHARGE (cfs)
0.07	1600012	10.26	0.01793	12.756

FOR THE ABOVE LISTED CONDITIONS, THE FLOW IS SUBCRITICAL TURBULENT

60" CMP 231.2 cfs required

CMP CULVERTS

Headwater Depths

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 10.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.25	0.31
0.50	0.88
0.75	1.62
1.00	2.01
1.25	2.40
1.50	2.73
1.75	3.03
2.00	3.30
2.25	3.56
2.50	3.79
2.75	4.01
3.00	4.22

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0,60
D = 10 inches

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 12.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.25	0.38
0.50	1.06
0.75	1.95
1.00	2.67
1.25	3.28
1.50	3.78
1.75	4.23
2.00	4.63
2.25	5.00
2.50	5.35
2.75	5.67
3.00	5.98

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60
D = 12 inches

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 15.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.25	0.47
0.50	1.33
0.75	2.44
1.00	3.75
1.25	4.67
1.50	5.53
1.75	6.27
2.00	6.93
2.25	7.53
2.50	8.09
2.75	8.61
3.00	9.11
3.25	9.57
3.50	10.02
3.75	10.45
4.00	10.86

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60

D = 15 inches

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 18.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.25	0.56
0.50	1.59
0.75	2.92
1.00	4.50
1.25	6.29
1.50	7.37
1.75	8.51
2.00	9.51
2.25	10.42
2.50	11.26
2.75	12.03
3.00	12.76
3.25	13.45
3.50	14.11
3.75	14.74
4.00	15.34
4.25	15.92
4.50	16.48

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60
D = 18 inches

ORIFICE

ORIFICE = 24.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.50	2.12
1.00	6.00
1.50	11.02
2.00	15.13
2.50	18.53
3.00	21.39
3.50	23.92
4.00	26.20
4.50	28.30
5.00	30.25
5.50	32.09
6.00	33.82

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60

D = 24 inches

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 30.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.50	2.65
1.00	7.50
1.50	13.78
2.00	21.21
2.50	26.43
3.00	31.27
3.50	35.45
4.00	39.19
4.50	42.61
5.00	45.77
5.50	48.73
6.00	51.51

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60

D = 30 inches

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

ORIFICE

ORIFICE = 60.00 INCHES

ELEV. (FT.)	FLOW (CFS)
0.00	0.00
0.50	5.30
1.00	15.00
1.50	27.56
2.00	42.43
2.50	59.29
3.00	77.94
3.50	98.22
4.00	120.00
4.50	143.19
5.00	149.48
5.50	163.75
6.00	176.87
6.50	189.08
7.00	200.55
7.50	211.40
8.00	221.72
8.50	231.58
9.00	241.04
9.50	250.13
10.00	258.91
10.50	267.40
11.00	275.63
11.50	283.63
12.00	291.40
12.50	298.97
13.00	306.35
13.50	313.56
14.00	320.61
14.50	327.50
15.00	334.26

FORMULA USED Q = C * A * SQR 2gh HEAD > Dia

Q = 3 * D * HEAD^1.5 HEAD < Dia

C = 0.60

D = 60 inches

APPENDIX 7-G

RAINFALL
DISTRIBUTION COMPARISON

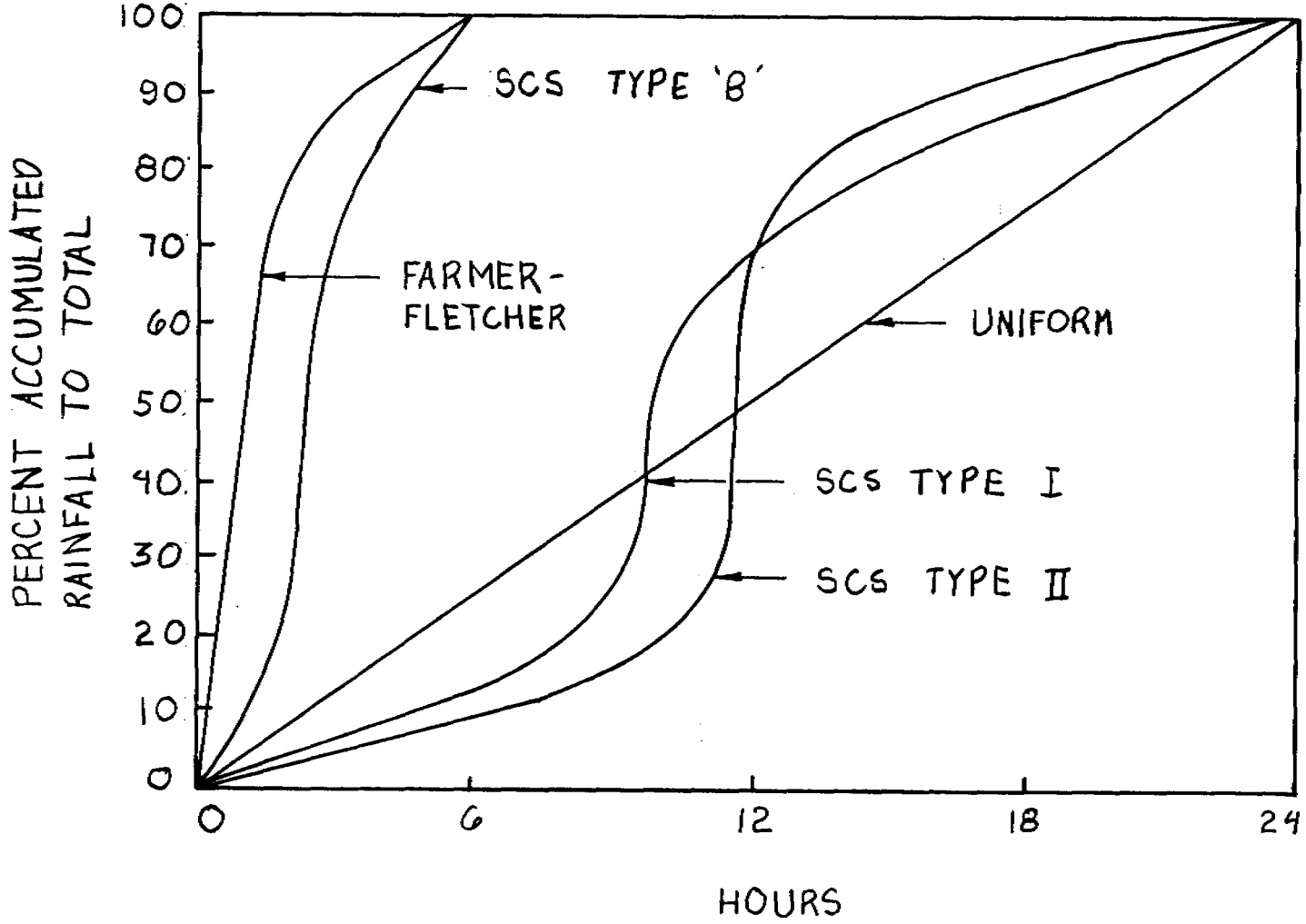


EXHIBIT 7-G-1
1/23/85 KDB

0000306

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
April 25, 1984

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION RB (above main road)
BASIN DISCHARGES INTO D-2R & C-2R

BASIN AREA	=	39.67	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.25	INCHES
AVERAGE BASIN SLOPE	=	63.0	%
HYDRAULIC LENGTH	=	1,725.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
10 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
11.20	0.0	11.30	0.0	11.40	0.0	11.50	0.0
11.60	0.0	11.70	0.0	11.80	0.5	11.90	2.3
12.00	6.5	12.10	11.0	12.20	* 12.1	12.30	10.2
12.40	7.8	12.50	6.3	12.60	5.5	12.70	4.6
12.80	3.8	12.90	3.3	13.00	3.0	13.10	2.8
13.20	2.7	13.30	2.3	13.40	2.1	13.50	2.0
13.60	2.0	13.70	1.9	13.80	1.7	13.90	1.6
14.00	1.6	14.10	1.6	14.20	1.5	14.30	1.3
14.40	1.2	14.50	1.2	14.60	1.2	14.70	1.2
14.80	1.1	14.90	1.1	15.00	1.0	15.10	0.9
15.20	0.8	15.30	0.7	15.40	0.6	15.50	0.5
15.60	0.4	15.70	0.3	15.80	0.2	15.90	0.1
16.00	0.0	16.10	0.0	16.20	0.0	16.30	0.0
16.40	0.0	16.50	0.0	16.60	0.0	16.70	0.0

Exhibit 7-G-2

Rainfall Distribution Comparison

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: SCS TYPE 2

DEPTH= 2.25 INCHES
DURATION= 24.00 HRS
NUMBER OF LINES= 1435

WATERSHED: DISTRIBUTED CN
AREA= 0.062 SM
LAND SLOPE= 63.0 PCT
CHANNEL= 1725.0 FT
AVG CN= 73.00
TIME CONC= 0.127 HRS
TIME INT= 0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.43789 INCHES
PEAK FLOW= 17.57 CFS (0.4392 IPH)
AT TIME= 12.024 HRS

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: SCS TYPE 1

DEPTH= 2.25 INCHES
DURATION= 24.00 HRS
NUMBER OF LINES= 1435

WATERSHED: DISTRIBUTED CN
AREA= 0.062 SM
LAND SLOPE= 63.0 PCT
CHANNEL= 1725.0 FT
AVG CN= 73.00
TIME CONC= 0.127 HRS
TIME INT= 0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.43789 INCHES
PEAK FLOW= 6.04 CFS (0.1510 IPH)
AT TIME= 10.028 HRS

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

24 Hr. Precip. in a 6 Hr. Storm

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: FARMER-FLETCHER

DEPTH= 2.25 INCHES
DURATION= 6.00 HRS
NUMBER OF LINES= 370

WATERSHED: DISTRIBUTED CN
AREA= 0.062 SM
LAND SLOPE= 63.0 PCT
CHANNEL= 1725.0 FT
AVG CN= 73.00
TIME CONC= 0.127 HRS
TIME INT= 0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.43789 INCHES
PEAK FLOW= 9.24 CFS (0.2309 IPH)
AT TIME= 1.235 HRS

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

24 Hr. Precip. in a 6 Hr. Storm

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: SCS TYPE 'B'

WATERSHED: DISTRIBUTED CN

		AREA=	0.062 SM
		LAND SLOPE=	63.0 PCT
		CHANNEL=	1725.0 FT
DEPTH=	2.25 INCHES	AVG CN=	73.00
DURATION=	6.00 HRS	TIME CONC=	0.127 HRS
NUMBER OF LINES=	370	TIME INT=	0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.43789 INCHES
PEAK FLOW= 13.99 CFS (0.3498 IPH)
AT TIME= 2.537 HRS

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

6 Hr. Storm

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: SCS TYPE 'B'

DEPTH= 1.40 INCHES
DURATION= 6.00 HRS
NUMBER OF LINES= 370

WATERSHED: DISTRIBUTED CN
AREA= 0.062 SM
LAND SLOPE= 63.0 PCT
CHANNEL= 1725.0 FT
AVG CN= 73.00
TIME CONC= 0.127 HRS
TIME INT= 0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.10002 INCHES
PEAK FLOW= 1.41 CFS (0.0354 IPH)
AT TIME= 3.518 HRS

DISTRIBUTED CURVE SUMMARY

1	73.00	39.67	100.00
0	73.00	39.67	100.00

6 Hr. Storm

CO-OP MINE D-2R

INPUT SUMMARY

STORM DISTRIBUTION: FARMER-FLETCHER

DEPTH= 1.40 INCHES

DURATION= 6.00 HRS

NUMBER OF LINES= 370

WATERSHED: DISTRIBUTED CN

AREA= 0.062 SM

LAND SLOPE= 63.0 PCT

CHANNEL= 1725.0 FT

AVG CN= 73.00

TIME CONC= 0.127 HRS

TIME INT= 0.017 HRS

OUTPUT SUMMARY

RUNOFF DEPTH= 0.10002 INCHES

PEAK FLOW= 2.01 CFS (0.0504 IPH)

AT TIME= 1.826 HRS

APPENDIX 7-H

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION LA (Bear Creek Falls Area)
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	953.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.60	INCHES
AVERAGE BASIN SLOPE	=	19.0	%
HYDRAULIC LENGTH	=	11,000.0	FEET
BASIN LAG	=	0.61	HOURS

HYDROGRAPH RUNOFF VALUES
25 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.67	0.0	10.83	0.0	11.00	0.0	11.17	0.0
11.33	0.0	11.50	0.0	11.67	0.1	11.83	2.1
12.00	15.0	12.17	56.3	12.33	134.1	12.50	210.6
12.67	248.6	12.83	248.1	13.00	218.6	13.17	180.3
13.33	149.9	13.50	126.1	13.67	106.8	13.83	92.5
14.00	81.2	14.17	72.0	14.33	64.6	14.50	58.5
14.67	54.2	14.83	53.3	15.00	52.7	15.17	48.3
15.33	43.0	15.50	40.6	15.67	39.6	15.83	38.9
16.00	38.6	16.17	38.4	16.33	37.8	16.50	36.5
16.67	34.1	16.83	31.4	17.00	29.0	17.17	27.1
17.33	25.9	17.50	25.1	17.67	24.7	17.83	24.4
18.00	24.2	18.17	24.1	18.33	24.0	18.50	24.0
18.67	24.0	18.83	24.0	19.00	24.0	19.17	24.0
19.33	24.0	19.50	24.0	19.67	24.0	19.83	24.0
20.00	23.9	20.17	23.9	20.33	23.9	20.50	23.3
20.67	22.1	20.83	20.7	21.00	19.5	21.17	18.5
21.33	17.9	21.50	17.5	21.67	17.2	21.83	17.1
22.00	16.9	22.17	16.9	22.33	16.9	22.50	16.8
22.67	16.8	22.83	16.8	23.00	16.8	23.17	16.8
23.33	16.8	23.50	16.8	23.67	16.8	23.83	16.7
24.00	16.3	24.17	14.7	24.33	12.1	24.50	9.1
24.67	6.4	24.83	4.3	25.00	3.0	25.17	2.1
25.33	1.5	25.50	1.1	25.67	0.8	25.83	0.6
26.00	0.5	26.17	0.4	26.33	0.4	26.50	0.4
26.67	0.3	26.83	0.1	27.00	0.0	27.17	0.0
27.33	0.0	27.50	0.0	27.67	0.0	27.83	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION LC (Right-hand Tributary)
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	481.00	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	2.60	INCHES
AVERAGE BASIN SLOPE	=	32.0	%
HYDRAULIC LENGTH	=	6,600.0	FEET
BASIN LAG	=	0.31	HOURS

HYDROGRAPH RUNOFF VALUES
25 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.67	0.0	10.83	0.0	11.00	0.0	11.17	0.0
11.33	0.0	11.50	0.0	11.67	0.4	11.83	7.1
12.00	51.3	12.17	157.8	12.33	203.9	12.50	155.1
12.67	109.0	12.83	81.8	13.00	61.4	13.17	50.2
13.33	45.2	13.50	43.0	13.67	35.8	13.83	31.6
14.00	28.8	14.17	26.6	14.33	24.2	14.50	21.6
14.67	19.9	14.83	19.2	15.00	19.0	15.17	18.9
15.33	18.8	15.50	18.8	15.67	18.8	15.83	18.8
16.00	18.8	16.17	18.8	16.33	17.2	16.50	14.7
16.67	13.1	16.83	12.4	17.00	12.1	17.17	12.0
17.33	12.0	17.50	12.0	17.67	11.9	17.83	11.9
18.00	11.9	18.17	11.9	18.33	11.9	18.50	11.8
18.67	11.8	18.83	11.8	19.00	11.8	19.17	11.8
19.33	11.8	19.50	11.8	19.67	11.8	19.83	11.8
20.00	11.8	20.17	11.7	20.33	11.3	20.50	9.9
20.67	9.1	20.83	8.7	21.00	8.5	21.17	8.5
21.33	8.4	21.50	8.4	21.67	8.4	21.83	8.4
22.00	8.4	22.17	8.4	22.33	8.4	22.50	8.3
22.67	8.3	22.83	8.3	23.00	8.3	23.17	8.3
23.33	8.3	23.50	8.3	23.67	8.3	23.83	8.3
24.00	8.2	24.17	6.1	24.33	3.3	24.50	1.5
24.67	0.8	24.83	0.4	25.00	0.3	25.17	0.2
25.33	0.2	25.50	0.0	25.67	0.0	25.83	0.0
26.00	0.0	26.17	0.0	26.33	0.0	26.50	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Undisturbed Area

BASIN IDENTIFIER LA + LC
DISCHARGES INTO Bear Creek (60" Pipe)

10.67	0.0	10.83	0.0	11.00	0.0	11.17	0.0
11.33	0.0	11.50	0.0	11.67	0.6	11.83	9.2
12.00	66.3	12.17	214.2	12.33	338.0	12.50	365.7
12.67	357.6	12.83	329.9	13.00	280.0	13.17	230.4
13.33	195.0	13.50	169.1	13.67	142.6	13.83	124.1
14.00	110.0	14.17	98.6	14.33	88.8	14.50	80.1
14.67	74.1	14.83	72.5	15.00	71.7	15.17	67.2
15.33	61.9	15.50	59.5	15.67	58.4	15.83	57.7
16.00	57.4	16.17	57.2	16.33	55.0	16.50	51.1
16.67	47.2	16.83	43.8	17.00	41.1	17.17	39.1
17.33	37.8	17.50	37.1	17.67	36.5	17.83	36.2
18.00	36.1	18.17	36.0	18.33	35.9	18.50	35.9
18.67	35.9	18.83	35.8	19.00	35.8	19.17	35.8
19.33	35.8	19.50	35.8	19.67	35.7	19.83	35.7
20.00	35.7	20.17	35.7	20.33	35.2	20.50	33.2
20.67	31.2	20.83	29.4	21.00	28.0	21.17	27.0
21.33	26.3	21.50	25.9	21.67	25.6	21.83	25.4
22.00	25.3	22.17	25.2	22.33	25.2	22.50	25.2
22.67	25.2	22.83	25.1	23.00	25.1	23.17	25.1
23.33	25.1	23.50	25.0	23.67	25.0	23.83	25.0
24.00	24.5	24.17	20.9	24.33	15.4	24.50	10.7
24.67	7.2	24.83	4.8	25.00	3.3	25.17	2.3
25.33	1.6	25.50	1.1	25.67	0.8	25.83	0.6
26.00	0.5	26.17	0.4	26.33	0.4	26.50	0.4
26.67	0.3	26.83	0.1	27.00	0.0	27.17	0.0
27.33	0.0	27.50	0.0	27.67	0.0	27.83	0.0

THEORY OF CALCULATION FOR WATERFLO/PLUS PROGRAM

This program was designed to produce water-surface profiles for flow through a reach of a natural river/stream channel. The basic method used in the computations is the "Standard Step Method for Natural Channels". This program is for tranquil (subcritical) flow only; therefore, computations start downstream and proceed in the upstream direction (see Figure 1).

A. STANDARD STEP METHOD FOR NATURAL SECTION

For gradually varied (tranquil) flow in a river, the Standard Step Method of computing the water surface profile is an iterative procedure. The water surface, ws, must be known at the starting (downstream) section. The total head at Section 1 (see Figure 2) is:

$$H1 = Z1 + Y1 + aVh1 = ws1 + aVh1 \qquad (1)$$

where:
- H = total head or energy (ft)
- Z = vertical distance above horizontal datum (ft)
- Y = water depth (ft) See Note
- ws = Z + Y = water surface elevation
- aVh = $a(V^2)/2g$, adjusted velocity head (ft)

- a = velocity head coefficient - See Equation (2)
- V = average velocity in the total area (ft/sec)
- g = acceleration due to gravity (ft/sec^2)

Note: The slope of the channel bottom is assumed to be small. Therefore, the vertical and normal distances to the channel bottom and water surface are considered equal.

The velocity head coefficient, a, is defined as

$$a = \frac{\text{Sum } (Ki)^3/(Ai)^2}{(Kt)^3/(At)^2} \qquad (2)$$

where:
- Ki = conveyance of the ith subsection of the total section - See Equation (4-C)
- Ai = area of ith subsection of the total section
- Kt = total conveyance of the section - See Equation (4-D)
- At = total area of the section - See Equation (5)

FIGURE 1

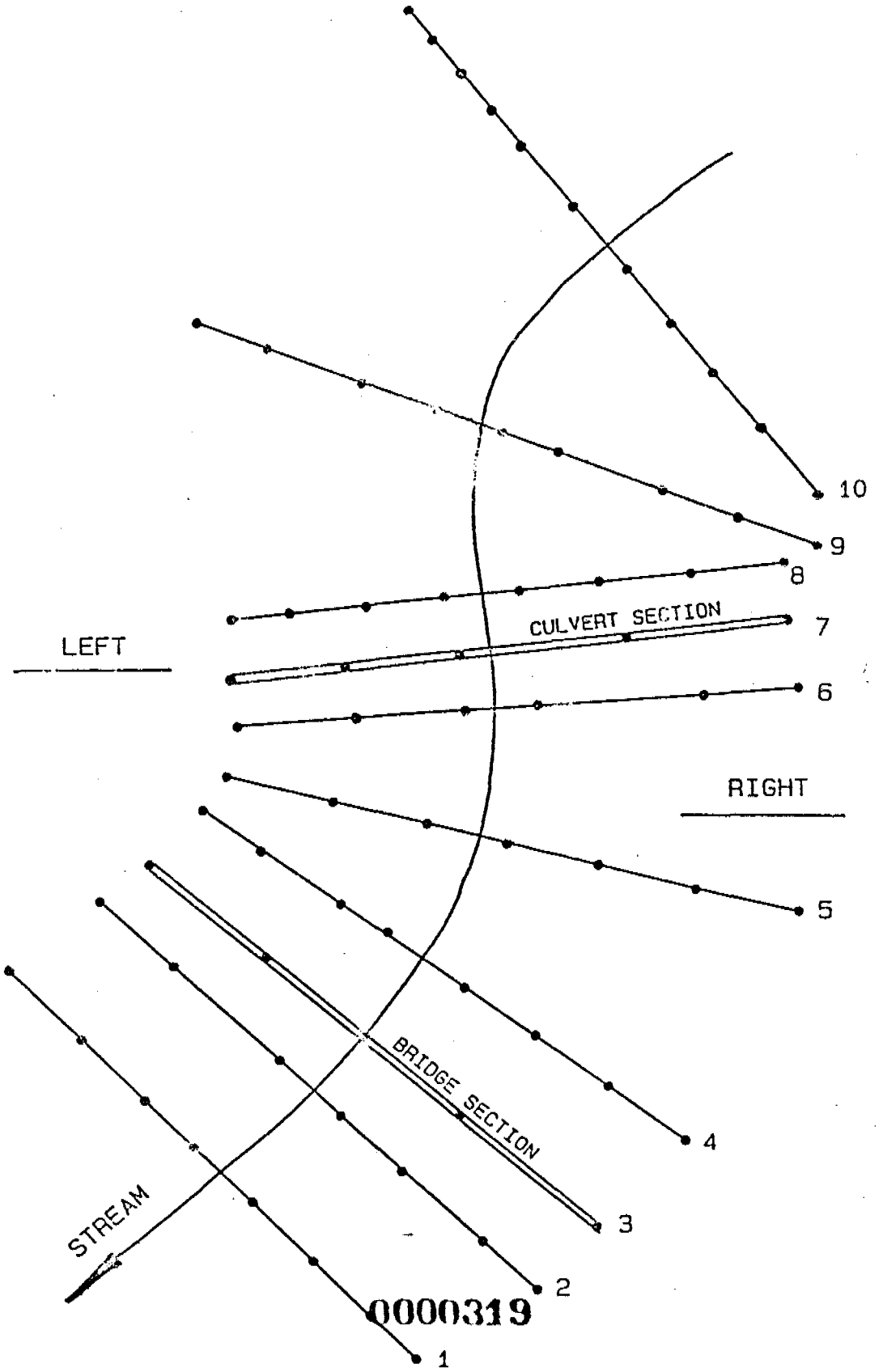
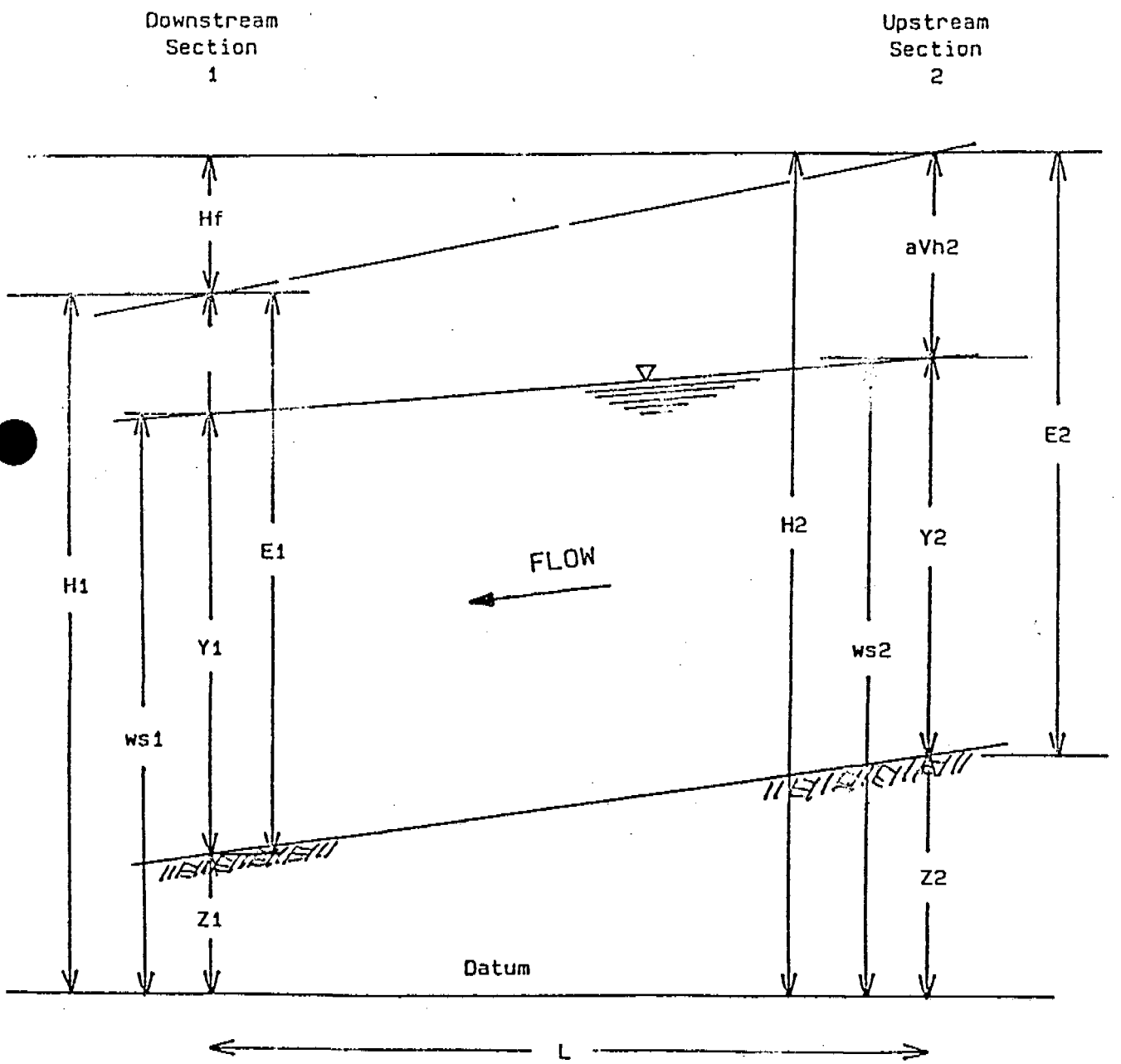

10
9
8
CULVERT SECTION
7
LEFT
6
RIGHT
5
BRIDGE SECTION
4
3
STREAM
2
1

FIGURE 2



Definition Sketch for Tranquil
Flow in an Open Channel

Conveyance, K, is from Manning's equation, which is

$$Q = (1.486/n)*(A)*(R)^{2/3}*(S)^{1/2} \qquad (3)$$

where: Q = discharge (volume rate of flow) (cfs)
n = Manning's n, a roughness coefficient
1.486 is a conversion factor such that values of n are identical for English and Metric units
A = cross sectional area of the section (ft^2)
R = hydraulic radius of the section (ft)
S = slope of energy gradient (ft/ft)

The definiton of conveyance is

$$K= (1.486/n)*(A)*(R)^{2/3} \qquad (4\text{-}A)$$

but often is used as

$$K = Q/(S)^{1/2} \qquad (4\text{-}B)$$

When subsections[1] exist, a conveyance can be obtained for each subsection. The numerical values of the Ki's of Equation (2) are computed from Equation (4-A); i.e.,

$$Ki = (1.486/ni)*(Ai)*(Ri)^{2/3} \qquad (4\text{-}C)$$

The total conveyance of the cross section is defined as the sum of the conveyances of the subsections; i.e.,

$$Kt = K1 + K2 + \ldots + Ki + \ldots Kn \qquad (4\text{-}D)$$

An obvious consequence is that the total area of the cross section should be equal to the sum of the subsectional areas; i.e.,

$$At = A1 + A2 + \ldots + Ai + \ldots An \qquad (5)$$

In the standard step method, a water surface is assumed at the next section upstream (Section 2 in Figure 2); thus the total head assumed is

$$Ha2 = Z2 + Y2 + aVh2 = ws2 + aVh2 \qquad (6)$$

where: ws = Z + Y = water surface elevation (ft)

[1] A subsection is a portion of the total area for which a single value of Manning's n can be assigned in the normal manner.

The total head at Section (2) can be computed from

$$Hc2 = H1 + Hf + He \qquad (7)$$

where: Hf = head loss through the reach due to boundary friction - See Equations (8-A) through (8-D)
He = eddy loss due to expansion/contraction of the reach - See Equation (11)

An iterative solution is continued until the absolute value of (Ha2-Hc2) is less than an allowable error[2]; e.g. 0.005 ft. When this error limit is reached, the values with a subscript 2 are restored with a subscript 1 and the upstream section data for the next section is read into the program with subscript 2. The iterative solution of Equations (6) and (7) is repeated again. This procedure is repeated for all of the reaches required to produce the water surface profile for the stream.

The value of Hf required for the solution of Equation (7) may be obtained several different ways; for example, Reed & Wolfkill (1976) discuss the merits of four methods. These are (a) average conveyance (b) average friction slope, (c) geometric mean friction slope and (d) harmonic mean friction slope. In equational form, these methods may be written:

a) Average Conveyance: $Hf = L*((Q1 + Q2)/(K1 + K2))^2$ (8-A)

b) Average Friction Slope: $Hf = L*(Sf1 + Sf2)/2$ (8-B)

c) Geometric Mean Friction Slope: $Hf = L*(Sf1*Sf2)^{1/2}$ (8-C)

d) Harmonic Mean Friction Sl: $Hf = L*(2*Sf1*Sf2)/(Sf1+Sf2)$ (8-D)

where: L = length of reach between Sections 1 and 2
Sf = friction slope - See Equation (9)
Q1 = discharge (cfs) leaving the reach
Q2 = discharge (cfs) entering the reach
K = total conveyance of the section; i.e., Kt of Equation (4-D)

The friction slope, Sf, is defined as the slope of the energy gradient. In the standard step method, Sf at a section is computed from a modification of Equation (4-B), namely

$$Sf = (Q/Kt)^2 \qquad (9)$$

[2] In some instances, there is no water surface for which Ha2 = Hc2; i.e., the iterative procedure does not converge on a solution. See Appendix A for a discussion of convergence techniques used in this program.

A simplifying assumption often is made that Sf is the same for all subsections; therefore, from Equations (4-D), and (3), we obtain

$$Q = (K1 + K2 + \ldots + Ki + \ldots Kn)*Sf^{1/2} \qquad (10\text{-}A)$$

and

$$Qi = (Ki)*Sf^{1/2} \qquad (10\text{-}B)$$

It is also apparent that

$$Q = Q1 + Q2 + \ldots + Qi + \ldots Qn \qquad (10\text{-}C)$$

The eddy loss used in Equation (7) is computed from

$$He = Ce*ABS(aVh1 - aVh2) \qquad (11)$$

where: Ce = expansion/contraction coefficient and $0<=Ce<=1.0$

Theoretically, Manning's equation is applicable for uniform flow only and uniform flow does not exist in natural channels. In Equation (3), S is the slope of the energy gradient (equal to the slope of the channel and the slope of the water surface for uniform flow). Thus for uniform flow, Hf is equal to L*S and He is zero. Manning's equation can be used for gradually varied flow if the sectional and flow properties of the reach are "averaged." Most of the numerical averaging techniques, including standard step method, obtain the averages based on the properties at the upstream and downstream sections of the reach.

As stated above, this program is for tranquil flow only. If the solution of the standard step method should produce a flow depth equal to or less than critical depth, a "critical" depth is computed and used to determine the water surface elevation for that section. A message will be printed to advise the User of this fact. If "critical" depth is detected too often, a "super-critical" profile should be computed and the final profile obtained based on engineering judgement from an analysis of the tranquil and supercritical profiles.

1. Critical Depth:

Critical depth is the depth for which the specific energy, E, is a minimum; i.e., when $dE/dY = 0$. Herein, critical depth is computed by an iterative procedure from

$$f = \frac{a(Q)^2 * T}{g(A)^3} \qquad (12)$$

where:
- f = 1 at critical depth (minimum specific energy)
- a = velocity head coefficient
- Q = discharge (volume rate of flow) (cfs)
- T = top width of channel at water surface (ft)
- g = acceleration due to gravity (ft/sec^2)
- A = cross-sectional area of the channel below T (ft^2)

This equation is an approximation because the velocity head coefficient, a, is also a function of depth, Y (See Equation (2)), but was held constant in taking the derivative of E with respect to Y, (Chow (1959)). Critical depth, Yc, is the depth at which f is equal to unity for a given discharge and thus the depth at which the specific energy is a minimum. Unfortunately, in some instances, f in Equation (12) is unity at three (3) different depths. See Appendix A for a further discussion and how convergence for critical depth is obtained in this program.

2. Normal Depth:

Another depth that is often important in the analysis of water-surface profiles is normal depth, Yn. Normal depth is obtained from Manning's equation and thus is applicable only for uniform flow. Nevertheless, the magnitude of Yn is a useful parameter in many gradually varied and rapidly varied flow problems. An iterative procedure is used to compute normal depth. See Appendix A for a discussion of the convergence technique used in the computation of normal depth.

In this program, normal depth is used for three reasons:

1) to obtain starting depths at the first section
2) required for channel-contraction ratio
3) required in determining the need of inserting "special" sections.

a. Starting Depth: The standard step method is an iterative-numerical technique and the water surface at the downstream section must be known. In this program, the User may input a known water surface for the first section or tell the program to start at "normal" depth or to start at "critical" depth.

A known critical depth control is the ideal starting place; however, it is not always present. In many instances, the starting water surface is evident from physical data. If neither of the above exist, experience has shown that a reasonable starting place is "normal" depth.

b. Channel-Contraction Ratio: This ratio is a function of normal depth and is a parameter in the bridge low flow control discussion which follows.

c. Special Sections: Special sections are inserted (by the program) under certain circumstances such as in a rapidly varied flow zone. The standard step method utilizes "averages" based on the properties obtained at the upstream and downstream sections of the reach. If the downstream section is at or near critical depth and the reach length is relatively long, the Hf computed from Equations (8-A) through (8-D) might be unreasonably high. To guard against this happening, special sections are inserted to keep the reach length short enough such that computed values of Hf are reasonable for the reach. One of the parameters required for the program to branch for the purpose of inserting special section(s) is normal depth.

For more detailed discussions of the standard step method, critical depth, specific energy diagrams, normal depth, etc., see standard texts on flow in open channels; e.g., Chow (1959) or Henderson (1966).

LIST OF SYMBOLS

Symbol	Definition	Units
a	velocity head coefficient = $\frac{\text{Sum}[(Ki^3)/(Ai^2)]}{(Kt^3)/(At^2)}$	
A	cross-sectional area	(ft^2)
aVh	= a*(V^2)/2g, adjusted velocity head	(ft)
Blc	bridge low chord elevation	(ft)
C	coefficient of discharge	
Cu	bridge coefficient correction (entered by user)	
Ce	coefficient of expansion/contraction	
dws	= (ws3-ws2) in bridge low flow routine	(ft)
Emin	lowest elevation of cross-section (Y=0)	(ft)
g	acceleration of gravity	(ft/sec^2)
H	total head = Emin+Y+aVh or ws+aVh	(ft)
Ha	= ws+aVh, used in iterative solutions (ws assumed)	(ft)
Hc	= H1+Hf+He, computed total head (in an iteration)	(ft)
He	= Ce*ABS(aVh1-aVh2). Head loss due to eddies caused by changes in sectional geometry through the reach.	(ft)
Hf	head loss due to boundary friction	(ft)
K	conveyance=(1.486/n)AR^(2/3) or Q/So^.5	
K*	= K/1000	
L	length of (bridge,culvert/reach/weir)	(ft)
Lc	= (bridge length)/(bridge opening width)	
m	channel constriction ratio = 1 -q/Q: (bridge)	
n	Manning's roughness coefficient	
q	discharge at Yn3 that could pass through bridge opening without contracting: (bridge)	(cfs)
Q	discharge	(cfs)
Qc	discharge computed for bridge with a trial ws3	(cfs)
Qeo	discharge of culvert (entrance orifice control)	(cfs)
Qew	discharge of culvert (entrance weir control)	(cfs)
Qw	discharge over roadway (bridge/culvert)	(cfs)
R	hydraulic radius = A/WP	(ft)
Rmin	minimum elevation of road profile	(ft)
Sf	slope of energy gradient = Hf/L for the reach and (Q/K)^2 at a section	
So	slope of the channel bottom	
Sta	Station	(ft)

LIST OF SYMBOLS

Symbol	Definition	Units
T	top width of cross-section at ws	(ft)
V	= Q/A, average velocity for cross-section	(ft/sec)
Vh	= V^2/2g, velocity head	(ft)
W	width of (bridge/culvert)	(ft)
WP	wetted perimeter of cross-section	(ft)
ws	water surface elevation	(ft)
ws*	= (ws3 - ws3@Yn3): (bridge)	(ft)
Y	water depth = ws-Emin	(ft)
Yc	critical depth	(ft)
Yn	normal depth	(ft)
Z	vertical distance	(ft)

SUBSCRIPTS

1 the downstream section the reach
2 the upstream section the reach
3 if 2 is either a bridge or a culvert, 3 is the section upstream of the bridge/culvert.

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 1

Natural Section:
Station: 0+ 0.00
Slope of channel bottom = 0.0541 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	15.5	69.8	2	22.8	71.6
3	38.6	68.9	4	47.4	65.7
5	62.7	63.7	6	65.2	62.5
7	68.8	64.4	8	77.8	67.2

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	8	0.0500

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 2

Natural Section:
Station: 0+88.40
Slope of channel bottom = 0.0513 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	52.8	66.6	2	68.5	63.9
3	77.3	60.7	4	93.3	61.2
5	98.8	59.2	6	103.2	61.6
7	111.7	64.7	8	129.3	65.0
9	133.9	64.1			

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	9	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 3

Natural Section:
Station: 0+89.40
Slope of channel bottom = 0.0513 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	76.6	67.5	2	87.1	61.2
3	96.1	61.2	4	102.0	59.2
5	106.4	61.6	6	115.6	64.7
7	134.0	65.0	8	138.9	64.1

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	8	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 4

Natural Section:
Station: 1+22.10
Slope of channel bottom = 0.0611 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	80.6	67.1	2	85.1	68.6
3	97.9	62.5	4	101.1	61.1
5	104.5	62.9	6	116.2	67.6
7	137.2	67.7			

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	7	0.0500

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 5

Natural Section:
Station: 1+48.30
Slope of channel bottom = 0.0632 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	89.4	68.1	2	94.2	67.9
3	101.3	64.7	4	105.4	64.2
5	108.5	62.8	6	110.0	63.8
7	111.5	68.8	8	125.1	69.6

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	8	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 6

Natural Section:
Station: 1+74.40
Slope of channel bottom = 0.0432 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	118.6	67.3	2	127.2	70.3
3	137.5	64.4	4	146.6	65.3
5	155.9	71.5	6	177.4	71.3

Manning's n

Sub-Section	Point	to	Point	Manning's n
1	1		1	0.0500
2	1		6	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 7

Natural Section:
Station: 2+ 6.20
Slope of channel bottom = 0.0496 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	0.0	71.8	2	9.8	66.9
3	18.4	65.3	4	25.4	66.9
5	35.3	73.7	6	61.7	74.9

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	6	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 8

Natural Section:
Station: 2+48.90
Slope of channel bottom = 0.0610 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	96.2	75.3	2	125.8	75.7
3	139.6	69.0	4	143.0	68.1
5	151.0	71.1	6	165.0	70.3
7	172.0	73.1	8	192.0	71.7
9	226.0	93.0			

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	9	0.0500

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 9

Natural Section:
Station: 2+93.00
Slope of channel bottom = 0.0640 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	74.2	85.4	2	132.7	84.6
3	144.3	80.2	4	168.7	70.6
5	171.8	72.5	6	183.9	74.2
7	207.0	75.1	8	214.0	80.9
9	237.0	94.3			

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	9	0.0500

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

Input Data for Section 10

Natural Section:
Station: 3+56.70
Slope of channel bottom = 0.0484 ft/ft (to compute Yn)

Discharge data

Field NO	Return Period (yrs)	Flow Rate (cfs)	Field #	Return Period (yrs)	Flow Rate (cfs)
1	25	365.7			

Ground Profile Data

Point	Distance (ft)	Elevation (ft)	Point	Distance (ft)	Elevation (ft)
1	114.0	90.8	2	118.3	88.3
3	121.4	89.4	4	162.0	86.9
5	173.0	83.7	6	188.0	75.2
7	192.1	75.0	8	197.2	75.4
9	242.0	85.3			

Manning's n

Sub-Section	Point	to Point	Manning's n
1	1	1	0.0500
2	1	9	0.0500

NESS COEFFICIENT n (*continued*)

	Minimum	Normal	Maximum
	0.016	0.018	0.020
	0.018	0.022	0.025
	0.022	0.025	0.030
	0.022	0.027	0.033
	0.023	0.025	0.030
	0.025	0.030	0.033
nts in	0.030	0.035	0.040
s	0.028	0.030	0.035
ks	0.025	0.035	0.040
s	0.030	0.040	0.050
	0.025	0.028	0.033
	0.035	0.050	0.060
	0.025	0.035	0.040
	0.035	0.040	0.050
ls and			
oth	0.050	0.080	0.120
	0.040	0.050	0.080
	0.045	0.070	0.110
	0.080	0.100	0.140
stag			
ifts or	0.025	0.030	0.033
es and	0.030	0.035	0.040
s and	0.033	0.040	0.045
ds and	0.035	0.045	0.050
, more	0.040	0.048	0.055
	0.045	0.050	0.060
pools	0.050	0.070	0.080
ols, or	0.075	0.100	0.150
of tim-			

Check, open channel hydraulics

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The n value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

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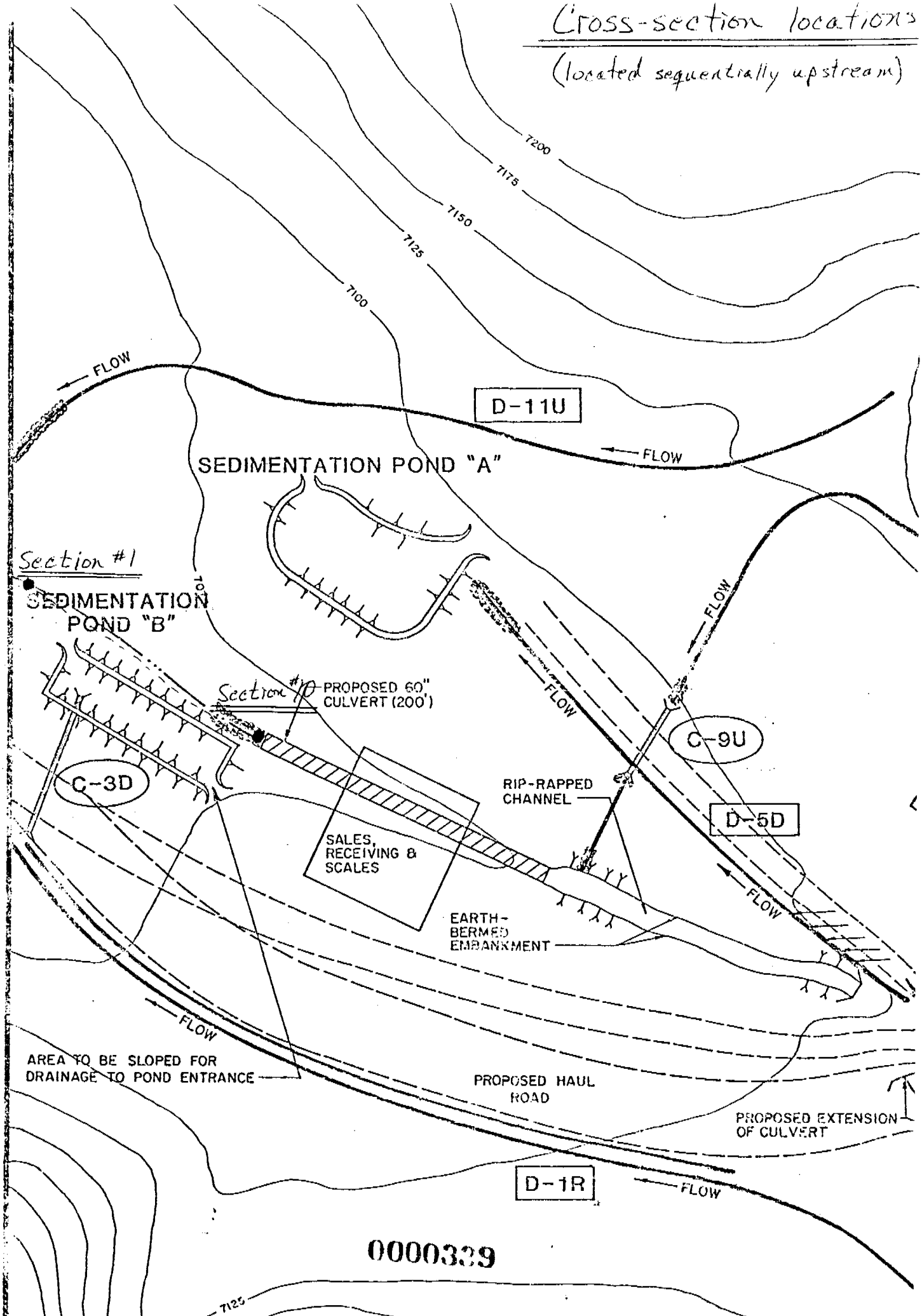
Cross-section locations
(located sequentially upstream)



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HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 1
SECTION SLOPE = 0.0541 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
62.50	0.0	0.0	0.0	0.0	0.0	0.0
63.00	0.5	2.2	2.0	0.0	1.3	2.5
64.00	4.7	8.3	7.6	0.1	22.4	4.7
65.00	17.4	18.9	18.0	0.5	113.6	6.5
66.00	40.6	28.5	27.4	1.5	354.4	8.7
67.00	70.9	34.8	33.3	3.4	787.4	11.1
68.00	106.2	39.2	36.7	6.1	1425.8	13.4
69.00	144.3	43.5	39.8	9.5	2220.4	15.4
70.00	187.1	51.2	46.4	13.3	3099.1	16.6
71.00	238.5	62.3	56.4	18.0	4192.1	17.6
72.00	299.0	69.4	62.3	23.5	5472.6	18.3

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 2
SECTION SLOPE = 0.0513 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
59.20	0.0	0.0	0.0	0.0	0.0	0.0
60.00	1.5	4.0	3.7	0.0	5.0	3.4
61.00	9.0	19.5	18.7	0.2	46.8	5.2
62.00	36.3	31.8	30.6	1.2	266.4	7.3
63.00	69.6	37.7	36.1	3.1	705.2	10.1
64.00	108.4	43.8	41.9	5.9	1335.0	12.3

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 3
SECTION SLOPE = 0.0513 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
59.20	0.0	0.0	0.0	0.0	0.0	0.0
60.00	1.5	4.2	3.8	0.0	5.3	3.5
61.00	7.7	9.4	8.6	0.2	46.0	5.9
62.00	25.6	23.0	21.8	0.8	185.2	7.2
63.00	49.8	28.1	26.5	2.2	490.1	9.8
64.00	78.5	33.2	31.1	4.1	938.7	12.0

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 4
SECTION SLOPE = 0.0611 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
61.10	0.0	0.0	0.0	0.0	0.0	0.0
62.00	1.7	4.2	3.8	0.0	6.8	4.0
63.00	7.5	8.8	7.9	0.2	49.8	6.6
64.00	17.7	13.8	12.5	0.6	153.8	8.7
65.00	32.5	18.8	17.1	1.4	343.8	10.6
66.00	51.9	23.8	21.7	2.6	640.4	12.3
67.00	75.8	28.8	26.2	4.3	1061.7	14.0
68.00	112.7	56.9	53.5	5.4	1332.8	11.8
69.00	168.4	61.2	56.6	9.8	2430.0	14.4

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 5
SECTION SLOPE = 0.0632 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
62.80	0.0	0.0	0.0	0.0	0.0	0.0
63.00	0.1	0.8	0.7	0.0	0.1	1.5
64.00	2.7	4.9	4.2	0.1	13.1	4.9
65.00	9.8	11.3	9.7	0.3	66.2	6.8
66.00	20.8	14.8	12.2	0.8	194.3	9.4
67.00	34.3	18.3	14.8	1.5	389.2	11.4
68.00	50.4	23.9	19.5	2.5	618.9	12.3
69.00	72.6	30.6	25.5	3.8	966.3	13.3
70.00	105.3	41.2	35.7	5.8	1470.4	14.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 6
SECTION SLOPE = 0.0432 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
64.40	0.0	0.0	0.0	0.0	0.0	0.0
65.00	2.1	7.3	7.1	0.0	5.8	2.7
66.00	13.1	13.6	12.9	0.4	78.5	6.0
67.00	27.6	17.4	16.2	1.1	232.0	8.4
68.00	46.1	23.4	21.4	2.3	468.0	10.1
69.00	70.6	30.2	27.6	3.9	809.3	11.5
70.00	101.3	37.1	33.7	6.2	1279.6	12.6
71.00	136.8	40.4	36.5	9.2	1906.7	13.9

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 7
SECTION SLOPE = 0.0496 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
65.30	0.0	0.0	0.0	0.0	0.0	0.0
66.00	2.4	7.0	6.8	0.0	7.7	3.2
67.00	14.1	16.3	15.9	0.4	84.2	6.0
68.00	31.7	20.3	19.4	1.3	282.6	8.9
69.00	52.9	24.3	22.9	2.6	586.9	11.1
70.00	77.4	28.3	26.3	4.5	1002.1	12.9
71.00	105.5	32.3	29.8	6.9	1535.7	14.6
72.00	136.9	35.9	32.8	9.9	2213.2	16.2
73.00	170.5	37.7	34.3	13.9	3088.4	18.1
74.00	206.4	45.5	41.9	16.8	3744.5	18.1
75.00	259.2	65.4	61.7	19.3	4296.2	16.6

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 8
SECTION SLOPE = 0.0610 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
68.10	0.0	0.0	0.0	0.0	0.0	0.0
69.00	2.6	6.1	5.8	0.0	10.9	4.2
70.00	10.8	11.2	10.5	0.3	77.0	7.1
71.00	28.6	30.5	29.3	1.0	239.9	8.4
72.00	62.7	42.4	40.6	2.6	637.6	10.2
73.00	113.5	63.6	61.0	5.6	1373.8	12.1
74.00	178.0	69.5	66.4	9.9	2446.9	13.7
75.00	246.2	73.6	70.0	16.4	4041.1	16.4
76.00	332.8	106.7	102.7	21.1	5213.3	15.7
77.00	436.2	108.6	104.3	32.8	8091.1	18.5
78.00	541.3	110.5	105.9	46.4	11460.9	21.2
79.00	647.9	112.4	107.5	61.9	15293.5	23.6
80.00	756.2	114.2	109.0	79.2	19566.9	25.9
81.00	866.0	116.1	110.6	98.2	24264.2	28.0
82.00	977.5	118.0	112.2	118.9	29371.5	30.0
83.00	1090.5	119.9	113.8	141.2	34878.0	32.0
84.00	1205.1	121.8	115.4	165.1	40774.5	33.8
85.00	1321.4	123.7	117.0	190.5	47053.3	35.6
86.00	1439.2	125.6	118.6	217.5	53708.1	37.3
87.00	1558.6	127.4	120.2	245.9	60733.5	39.0
88.00	1679.7	129.3	121.8	275.8	68125.0	40.6
89.00	1802.3	131.2	123.4	307.2	75878.8	42.1
90.00	1926.5	133.1	125.0	340.1	83991.5	43.6
91.00	2052.3	135.0	126.6	374.4	92460.6	45.1
92.00	2179.7	136.9	128.2	410.1	101283.6	46.5
93.00	2308.7	138.7	129.8	447.2	110458.7	47.8

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 9
SECTION SLOPE = 0.0640 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
70.60	0.0	0.0	0.0	0.0	0.0	0.0
71.00	0.3	1.9	1.7	0.0	0.8	2.4
72.00	4.1	6.5	5.8	0.1	22.6	5.5
73.00	12.7	13.8	12.8	0.4	90.5	7.1
74.00	30.3	23.7	22.4	1.1	268.2	8.9
75.00	63.5	48.4	46.9	2.3	571.7	9.0
76.00	114.6	55.1	53.1	5.5	1403.2	12.2
77.00	169.6	59.4	56.9	10.1	2564.9	15.1
78.00	228.3	63.7	60.6	15.9	4019.1	17.6
79.00	290.8	68.0	64.4	22.8	5758.6	19.8
80.00	357.0	72.3	68.1	30.8	7782.2	21.8
81.00	427.0	76.7	72.0	39.9	10082.7	23.6
82.00	501.2	81.5	76.3	50.0	12644.1	25.2
83.00	579.7	86.4	80.7	61.3	15511.1	26.8
84.00	662.6	91.2	85.0	73.9	18692.4	28.2
85.00	755.4	124.1	117.6	74.9	18936.6	25.1
86.00	897.3	155.3	148.6	85.9	21719.2	24.2
87.00	1046.7	157.3	150.3	110.0	27838.9	26.6
88.00	1197.8	159.3	152.0	136.6	34565.4	28.9
89.00	1350.7	161.3	153.7	165.5	41877.4	31.0
90.00	1505.2	163.3	155.4	196.7	49757.7	33.1
91.00	1661.5	165.3	157.1	230.0	58191.4	35.0
92.00	1819.5	167.2	158.9	265.5	67166.1	36.9
93.00	1979.2	169.2	160.6	303.1	76671.2	38.7
94.00	2140.6	171.2	162.3	342.7	86697.3	40.5

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

RATING CURVE FOR SECTION 10
SECTION SLOPE = 0.0484 ft/ft

Water Surface (ft)	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	K*	Flow Rate (cfs)	Velocity (ft/sec)
75.00	0.0	0.0	0.0	0.0	0.0	0.0
76.00	9.1	13.6	13.3	0.2	45.9	5.0
77.00	25.6	20.3	19.6	0.9	195.7	7.6
78.00	48.4	26.9	25.9	2.1	467.3	9.7
79.00	77.4	33.6	32.2	4.0	883.1	11.4
80.00	112.8	40.3	38.5	6.7	1464.9	13.0
81.00	154.4	46.9	44.8	10.2	2233.1	14.5
82.00	202.3	53.6	51.1	14.6	3207.2	15.9
83.00	256.5	60.3	57.4	20.0	4405.9	17.2
84.00	317.1	67.4	64.1	26.5	5822.4	18.4
85.00	385.2	75.6	72.1	33.9	7458.8	19.4
86.00	460.2	81.3	76.9	43.5	9560.0	20.8
87.00	538.9	87.1	81.6	54.0	11873.6	22.0
88.00	628.7	104.4	97.9	61.8	13605.5	21.6
89.00	735.8	125.2	117.3	72.4	15931.2	21.7
90.00	860.0	135.8	126.6	87.5	19242.8	22.4
91.00	987.4	138.4	128.0	108.7	23923.5	24.2

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 1	Natural		Station		0+ 0.00
Discharge	=	366 cfs	Return period	=	25 yrs
Water surface	=	66.33 ft	Total head	=	67.16 ft
Minimum Elev.	=	62.50 ft	Friction Slope	=	0.0319
Depth	=	3.83 ft	Bottom Slope	=	0.0541
Normal depth	=	3.53 ft	Critical Depth	=	3.82 ft

Data for Cross Section Sub-areas

	1	2	SUM
A	0	50	50
WP	0	31	31
T	0	29	29
K*	0	2	2
Q	0	366	366
V	0.0	7.3	

Average Velocity of Section (V=Q/A) = 7.35 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.84 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 2	Natural		Station		0+88.40
Discharge	=	366 cfs	Return period	=	25 yrs
Water surface	=	67.46 ft	Total head	=	67.47 ft
Minimum Elev.	=	59.20 ft	Friction Slope	=	0.0002
Depth	=	8.26 ft	Bottom Slope	=	0.0513

Data for Cross Section Sub-areas

	1	2	SUM
A	0	351	351
WP	1	87	88
T	0	81	81
K*	0	26	26
Q	0	366	366
V	0.0	1.0	

Average Velocity of Section (V=Q/A) = 1.04 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.02 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no =	3	Natural		Station		0+89.40	
Discharge	=	366	cfs	Return period	=	25	yrs
Water surface	=	67.46	ft	Total head	=	67.48	ft
Minimum Elev.	=	59.20	ft	Friction Slope	=	0.0004	
Depth	=	8.26	ft	Bottom Slope	=	0.0513	

Data for Cross Section Sub-areas

	1	2	SUM
A	0	265	265
WP	0	69	69
T	0	62	62
K*	0	19	19
Q	0	366	366
V	0.0	1.4	

Average Velocity of Section (V=Q/A) = 1.38 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.03 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 4	Natural		Station		1+22.10
Discharge	=	366 cfs	Return period	=	25 yrs
Water surface	=	67.35 ft	Total head	=	67.64 ft
Minimum Elev.	=	61.10 ft	Friction Slope	=	0.0053
Depth	=	6.25 ft	Bottom Slope	=	0.0611

Data for Cross Section Sub-areas

	1	2	SUM
A	0	85	85
WP	0	31	32
T	0	29	29
K*	0	5	5
Q	0	366	366
V	0.0	4.3	

Average Velocity of Section (V=Q/A) = 4.28 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.28 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 5	Natural		Station		1+48.30	
Discharge	=	366 cfs	Return period	=	25	yrs
Water surface	=	67.40 ft	Total head	=	68.67	ft
Minimum Elev.	=	62.80 ft	Friction Slope	=	0.0355	
Depth	=	4.60 ft	Bottom Slope	=	0.0632	
			Critical Depth	=	4.59	ft

Data for Cross Section Sub-areas

	1	2	SUM
A	0	40	40
WP	0	20	20
T	0	16	16
K*	0	2	2
Q	0	366	366
V	0.0	9.1	

Average Velocity of Section (V=Q/A) = 9.05 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 1.27 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no =	6	Natural		Station		1+74.40	
Discharge	=	366	cfs	Return period	=	25	yrs
Water surface	=	68.92	ft	Total head	=	69.36	ft
Minimum Elev.	=	64.40	ft	Friction Slope	=	0.0096	
Depth	=	4.52	ft	Bottom Slope	=	0.0432	

Data for Cross Section Sub-areas

	1	2	SUM
A	0	68	68
WP	2	30	31
T	0	27	27
K*	0	4	4
Q	0	366	366
V	0.0	5.3	

Average Velocity of Section (V=Q/A) = 5.35 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.44 ft

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 7	Natural		Station		2+ 6.20	
Discharge	=	366 cfs	Return period	=	25	yrs
Water surface	=	69.20 ft	Total head	=	69.83	ft
Minimum Elev.	=	65.30 ft	Friction Slope	=	0.0153	
Depth	=	3.90 ft	Bottom Slope	=	0.0496	

Data for Cross Section Sub-areas

	1	2	SUM
A	0	57	57
WP	0	25	25
T	0	24	24
K*	0	3	3
Q	0	366	366
V	0.0	6.4	

Average Velocity of Section (V=Q/A) = 6.37 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.63 ft

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 8	Natural		Station		2+48.90
Discharge	=	366 cfs	Return period	=	25 yrs
Water surface	=	71.75 ft	Total head	=	72.48 ft
Minimum Elev.	=	68.10 ft	Friction Slope	=	0.0323
Depth	=	3.65 ft	Bottom Slope	=	0.0610
			Critical Depth	=	3.54 ft

Data for Cross Section Sub-areas

	1	2	SUM
A	0	53	53
WP	0	37	37
T	0	35	35
K*	0	2	2
Q	0	366	366
V	0.0	6.9	

Average Velocity of Section (V=Q/A) = 6.88 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.74 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no = 9	Natural		Station		2+93.00
Discharge	=	366 cfs	Return period	=	25 yrs
Water surface	=	74.84 ft	Total head	=	75.49 ft
Minimum Elev.	=	70.60 ft	Friction Slope	=	0.0340
Depth	=	4.24 ft	Bottom Slope	=	0.0640
			Critical Depth	=	4.23 ft

Data for Cross Section Sub-areas

	1	2	SUM
A	0	56	56
WP	0	44	44
T	0	43	43
K*	0	2	2
Q	0	366	366
V	0.0	6.5	

Average Velocity of Section (V=Q/A) = 6.47 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.65 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section no =	10	Natural		Station		3+56.70	
Discharge	=	366	cfs	Return period	=	25	yrs
Water surface	=	77.98	ft	Total head	=	78.89	ft
Minimum Elev.	=	75.00	ft	Friction Slope	=	0.0307	
Depth	=	2.98	ft	Bottom Slope	=	0.0484	
				Critical Depth	=	2.97	ft

Data for Cross Section Sub-areas

	1	2	SUM
A	0	48	48
WP	0	27	27
T	0	26	26
K*	0	2	2
Q	0	366	366
V	0.0	7.7	

Average Velocity of Section (V=Q/A) = 7.66 ft/sec
Alpha (Velocity Head Coefficient) = 1.00
Adjusted Velocity Head (ALPHA(V^2)/2g) = 0.91 ft

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

Section	Station (ft)	Discharge (cfs)	Depth (ft)	Water Surface (ft)	Total Head (ft)	Remarks
1	0+ 0.00	366	3.83	66.33	67.16	
2	0+88.40	366	8.26	67.46	67.47	
3	0+89.40	366	8.26	67.46	67.48	
4	1+22.10	366	6.25	67.35	67.64	
5	1+48.30	366	4.60	67.40	68.67	
6	1+74.40	366	4.52	68.92	69.36	
7	2+ 6.20	366	3.90	69.20	69.83	
8	2+48.90	366	3.65	71.75	72.48	
9	2+93.00	366	4.24	74.84	75.49	
10	3+56.70	366	2.98	77.98	78.89	

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

CO-OP MINE - BEAR CREEK CANYON
BEAR CREEK BELOW 60" PIPE

BEAR CREEK BELOW 60" PIPE

SECTION	WATER SURFACE PROFILE SUMMARY MESSAGES
1	Computed depth is less than critical depth; therefore, depth set to critical + .01 ft. This is rapidly varied flow.
2	Left and elevation of ground profile extended.
2	Right and elevation of ground profile extended.
3	Right and elevation of ground profile extended.
4	Left and elevation of ground profile extended.
5	Convergence not achieved, water surface will be assumed. Water surface set to critical + .01 ft.
6	Left and elevation of ground profile extended.
8	Convergence not achieved, water surface will be assumed. Water surface set to critical + .01 ft.
9	Convergence not achieved, water surface will be assumed. Water surface set to critical + .01 ft.
10	Computed depth is less than critical depth; therefore, depth set to critical + .01 ft. This is rapidly varied flow.

APPENDIX 7-I

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-2
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	28.70	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	3.18	INCHES
AVERAGE BASIN SLOPE	=	62.0	%
HYDRAULIC LENGTH	=	2,000.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.17	0.0	10.33	0.0	10.50	0.0
10.67	0.0	10.83	0.0	11.00	0.0	11.17	0.0
11.33	0.1	11.50	0.2	11.67	0.7	11.83	2.8
12.00	10.5	12.17	22.6	12.33	19.8	12.50	11.9
12.67	8.4	12.83	6.1	13.00	4.8	13.17	4.5
13.33	3.5	13.50	3.0	13.67	2.9	13.83	2.5
14.00	2.3	14.17	2.2	14.33	1.9	14.50	1.7
14.67	1.7	14.83	1.6	15.00	1.6	15.17	1.6
15.33	1.6	15.50	1.6	15.67	1.6	15.83	1.6
16.00	1.6	16.17	1.5	16.33	1.4	16.50	1.1
16.67	1.1	16.83	1.0	17.00	1.0	17.17	1.0
17.33	1.0	17.50	1.0	17.67	1.0	17.83	1.0
18.00	1.0	18.17	1.0	18.33	1.0	18.50	0.9
18.67	0.9	18.83	0.9	19.00	0.9	19.17	0.9
19.33	0.9	19.50	0.9	19.67	0.9	19.83	0.9
20.00	0.9	20.17	0.8	20.33	0.8	20.50	0.8
20.67	0.7	20.83	0.7	21.00	0.7	21.17	0.7
21.33	0.7	21.50	0.7	21.67	0.7	21.83	0.7
22.00	0.7	22.17	0.7	22.33	0.7	22.50	0.6
22.67	0.6	22.83	0.6	23.00	0.6	23.17	0.6
23.33	0.6	23.50	0.6	23.67	0.6	23.83	0.6
24.00	0.6	24.17	0.5	24.33	0.2	24.50	0.1
24.67	0.0	24.83	0.0	25.00	0.0	25.17	0.0
25.33	0.0	25.50	0.0	25.67	0.0	25.83	0.0
26.00	0.0	26.17	0.0	26.33	0.0	26.50	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AU-3
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	7.50	ACRES
BASIN CURVE NUMBER	=	73.00	
24-HOUR PRECIPITATION	=	3.18	INCHES
AVERAGE BASIN SLOPE	=	64.0	%
HYDRAULIC LENGTH	=	1,100.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
10.00	0.0	10.17	0.0	10.33	0.0	10.50	0.0
10.67	0.0	10.83	0.0	11.00	0.0	11.17	0.0
11.33	0.0	11.50	0.1	11.67	0.2	11.83	0.7
12.00	2.7	12.17	5.9	12.33	5.2	12.50	3.1
12.67	2.2	12.83	1.6	13.00	1.2	13.17	1.2
13.33	0.9	13.50	0.8	13.67	0.7	13.83	0.7
14.00	0.6	14.17	0.6	14.33	0.5	14.50	0.5
14.67	0.4	14.83	0.4	15.00	0.4	15.17	0.4
15.33	0.4	15.50	0.4	15.67	0.4	15.83	0.4
16.00	0.4	16.17	0.4	16.33	0.3	16.50	0.3
16.67	0.3	16.83	0.3	17.00	0.3	17.17	0.3
17.33	0.3	17.50	0.3	17.67	0.3	17.83	0.2
18.00	0.2	18.17	0.2	18.33	0.2	18.50	0.2
18.67	0.2	18.83	0.2	19.00	0.2	19.17	0.2
19.33	0.2	19.50	0.1	19.67	0.1	19.83	0.1
20.00	0.1	20.17	0.1	20.33	0.1	20.50	0.1
20.67	0.1	20.83	0.1	21.00	0.1	21.17	0.0
21.33	0.0	21.50	0.0	21.67	0.0	21.83	0.0
22.00	0.0	22.17	0.0	22.33	0.0	22.50	0.0
22.67	0.0	22.83	0.0	23.00	0.0	23.17	0.0

HORROCKS/CAROLLO ENGINEERS
AMERICAN FORK, UTAH
June 17, 1985

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION AD-1
BASIN DISCHARGES INTO Bear Creek

BASIN AREA	=	2.24	ACRES
BASIN CURVE NUMBER	=	82.00	
24-HOUR PRECIPITATION	=	3.18	INCHES
AVERAGE BASIN SLOPE	=	36.0	%
HYDRAULIC LENGTH	=	420.0	FEET
BASIN LAG	=	0.25	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
8.00	0.0	8.17	0.0	8.33	0.0	8.50	0.0
8.67	0.0	8.83	0.0	9.00	0.0	9.17	0.0
9.33	0.0	9.50	0.0	9.67	0.0	9.83	0.0
10.00	0.0	10.17	0.0	10.33	0.0	10.50	0.0
10.67	0.0	10.83	0.1	11.00	0.1	11.17	0.1
11.33	0.1	11.50	0.2	11.67	0.3	11.83	0.6
12.00	1.7	12.17	3.0	12.33	2.5	12.50	1.4
12.67	1.0	12.83	0.7	13.00	0.5	13.17	0.5
13.33	0.4	13.50	0.3	13.67	0.3	13.83	0.3
14.00	0.2	14.17	0.2	14.33	0.2	14.50	0.2
14.67	0.2	14.83	0.2	15.00	0.2	15.17	0.2
15.33	0.2	15.50	0.2	15.67	0.1	15.83	0.1
16.00	0.1	16.17	0.1	16.33	0.1	16.50	0.1
16.67	0.1	16.83	0.1	17.00	0.1	17.17	0.1
17.33	0.0	17.50	0.0	17.67	0.0	17.83	0.0
18.00	0.0	18.17	0.0	18.33	0.0	18.50	0.0
18.67	0.0	18.83	0.0	19.00	0.0	19.17	0.0

HYDROLOGIC REPORT FOR

CO-OP Mine Disturbed Area

BASIN IDENTIFIER AU-3 + AD-1
DISCHARGES INTO Bear Creek

8.00	0.0	8.17	0.0	8.33	0.0	8.50	0.0
8.67	0.0	8.83	0.0	9.00	0.0	9.17	0.0
9.33	0.0	9.50	0.0	9.67	0.0	9.83	0.0
10.00	0.0	10.17	0.0	10.33	0.0	10.50	0.0
10.67	0.0	10.83	0.1	11.00	0.1	11.17	0.1
11.33	0.1	11.50	0.2	11.67	0.4	11.83	1.4
12.00	4.4	12.17	8.9	12.33	7.6	12.50	4.5
12.67	3.2	12.83	2.3	13.00	1.8	13.17	1.7
13.33	1.3	13.50	1.1	13.67	1.0	13.83	0.9
14.00	0.9	14.17	0.8	14.33	0.7	14.50	0.6
14.67	0.6	14.83	0.6	15.00	0.6	15.17	0.6
15.33	0.6	15.50	0.5	15.67	0.5	15.83	0.5
16.00	0.5	16.17	0.5	16.33	0.4	16.50	0.4
16.67	0.4	16.83	0.3	17.00	0.3	17.17	0.3
17.33	0.3	17.50	0.3	17.67	0.3	17.83	0.3
18.00	0.2	18.17	0.2	18.33	0.2	18.50	0.2
18.67	0.2	18.83	0.2	19.00	0.2	19.17	0.2
19.33	0.2	19.50	0.1	19.67	0.1	19.83	0.1
20.00	0.1	20.17	0.1	20.33	0.1	20.50	0.1
20.67	0.1	20.83	0.1	21.00	0.1	21.17	0.0
21.33	0.0	21.50	0.0	21.67	0.0	21.83	0.0
22.00	0.0	22.17	0.0	22.33	0.0	22.50	0.0
22.67	0.0	22.83	0.0	23.00	0.0	23.17	0.0

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS ENGINEERS

Co-op Mine Post-mining Drainage
PROJECT No. 8407-42
DATE: 6/17/85

CHANNEL IS TRAPEZOIDAL

SOLVING FOR VELOCITY, DEPTH

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WIDTH ft.
6.36	22.60	.91	.050000	.083300	1.00	1.00	3.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.304	375549.5	.17001661	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.07	1.25	1.27

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

AU-2 drainage channel, upper section.

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS ENGINEERS

Co-op Mine Post-mining Drainage
PROJECT No. 8407-42
DATE: 6/17/85

CHANNEL IS TRAPEZOIDAL

SOLVING FOR VELOCITY, DEPTH

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WIDTH ft.
5.30	8.90	.48	.050000	.113600	1.00	1.00	3.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.435	188831.8	.17001661	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.60	.74	.77

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS. THE FLOW REGIME IS SUPERCRITICAL TURBULENT

AU-3 + AD-1 drainage, upper section.

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS ENGINEERS

Co-op Mine Post-mining Drainage
PROJECT No. 8407-42
DATE: 6/17/85

CHANNEL IS TRAPEZOIDAL

SOLVING FOR VELOCITY, DEPTH

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WIDTH ft.
9.12	22.60	.67	.050000	.234400	1.00	1.00	3.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
2.130	426447.9	.17001661	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
1.07	1.58	1.88

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

All-2 drainage channel, lower section.

SUMMARY OF GENERAL UNIFORM FLOW CALCULATIONS

HORROCKS
ENGINEERS

Co-op Mine Post-mining Drainage
PROJECT No. 8407-42
DATE: 6/17/85

CHANNEL IS TRAPEZOIDAL

SOLVING FOR VELOCITY, DEPTH

VELOCITY fps	DISCHARGE cfs	DEPTH ft.	MANNING COEFF.	SLOPE ft/ft	SIDE SLOPES Z:1		WIDTH ft.
6.17	8.90	.42	.050000	.178600	1.00	1.00	3.00

FROUDE NUMBER	REYNOLDS NUMBER	LIMIT SLOPE	CRITICAL DISCHARGES	
1.774	196549.0	.17001661	0.00	0.00

CRITICAL DEPTH	SEQUENT DEPTH	ALTERNATE DEPTH
.60	.83	.92

THERE ARE NO EXISTING CRITICAL DISCHARGES FOR THIS CHANNEL SLOPE AND THE RANGE GIVEN.

FOR THE ABOVE-LISTED CONDITIONS, THE FLOW REGIME IS SUPERCRITICAL TURBULENT

AU-3 + AD-1 drainage channel, lower section.

ss Coefficient *n* (*continued*)

	Minimum	Normal	Maximum
	0.016	0.018	0.020
	0.018	0.022	0.025
	0.022	0.025	0.030
	0.022	0.027	0.033
	0.023	0.025	0.030
	0.025	0.030	0.033
s in	0.030	0.035	0.040
	0.028	0.030	0.035
	0.025	0.035	0.040
	0.030	0.040	0.050
	0.025	0.028	0.033
	0.035	0.050	0.060
	0.025	0.035	0.040
	0.035	0.040	0.050
and			
	0.050	0.080	0.120
	0.040	0.050	0.080
	0.045	0.070	0.110
	0.080	0.100	0.140
tage			
s or	0.025	0.030	0.033
and	0.030	0.035	0.040
and	0.033	0.040	0.045
and	0.035	0.045	0.050
more	0.040	0.048	0.055
	0.045	0.050	0.060
ools	0.050	0.070	0.080
s, or	0.075	0.100	0.150
tim-			

Cross, open channel hydraulics

Table 5-6. Values of the Roughness Coefficient *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The *n* value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

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APPENDIX 7-J

Probable Hydrologic Consequences Determination

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The following document has been contructed in accordance with the "Guidelines for Preparation of a Probable Hydrologic Consequences Determination (PHC)", Office of Surface Mining, Dec. 1985.

The document is written to include the PHC of the proposed mining of the lower (Hiawatha) seam, in addition to the existing, approved mining of the upper (Bear Canyon) seam.

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I. Description of the Bear Canyon Mine Plan and Adjacent Area.

A. Description of the mining operations.

1. The Bear Canyon Mine is an underground mine, located in the Bear Canyon Seam (upper) and in the Hiawatha Seam (lower).

2. Direction of mining and proposed mining plans are shown on Plate 3-4 and 3-4a of this M.R.P.

3. Overburden Handling - N/A.

4. The reclamation program for the mine area is described in detail in Sections 3.6 and 7.3 of this M.R.P.

5. Overburden analyses - N/A.

a. Analysis of the roof, coal and floor for the Hiawatha and Bear Canyon Seams are provided in Appendix 6-A of this M.R.P. No potential problems are noted as a result of these samples.

6. Geology of the Mine and Adjacent Areas.

*Co-Op Mining Company's Bear Canyon Mine is located along the eastern margin of the Wasatch Plateau Coal Field approximately 9.5 miles west of Huntington, Utah The eastern margin of the Wasatch Platear forms a rugged escarpment that overlooks Castle Valley and the San Rafael Swell to the east. Elevations along the eastern escarpment of the Wasatch Plateau range from approximately 6,500 to over 9,000 feet.

Outcropping rocks of the Wasatch Plateau Coal Field range from Upper Cretaceous to Quaternary in age.

The rock record reflects an overall regressive sequence from marine (Mancos Shale) through littoral and lagoonal (Blackhawk Formation) to fluvial (Castlegate Sandstone, Price River Formation and North Horn Formation) and lacustrine (Flagstaff Formation) depositional environments. Oscillating depositional environments within the overall regressive trend are represented by lithologies within the Blackhawk Formation and the Colton Formation. The major coal-bearing unit within the Wasatch Plateau Coal Field is the Blackhawk Formation.

Mining will be conducted in 2 coal seams: the Bear Canyon Seam (upper), and the Hiawatha Seam (lower). Complete mining plans for both seams are found in Section 3, and detailed geologic information for each of the seams is in Section 6 of this M.R.P.

7. Overburden Chemistry - N/A.

B. Description of the surface water system.

1. All ephemeral, intermittent, and perennial streams are described in Section 7.2 of this M.R.P. Locations are shown on Plate 2-2, 3.4-1 and 7-1 of this M.R.P., and on Figure 4 of the C.H.I.A. (10/25/85) for this mine.
2. Ponds and springs are also shown on Plates 2-2, 3.4-1 and 7-1, of this M.R.P. There are no lakes in the permit or adjacent areas.

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3. All surface water quality and quantity baseline data is summarized in Tables 7.2.-1 through 7.2.-4 of this M.R.P.

4. Water users and water rights are described in Appendix 7-C and shown on Plate 7-10 of this M.R.P.

C. Description of the ground water system.

1. Wells, seeps and other discharge points are shown on Plates 3.4-1, 7-4 and 7-4a of this M.R.P.

2. All ground water quality and quantity baseline data is found in Table 7.1-3 of this M.R.P.

*3. Ground water is present in all lithostratigraphic units that occur within and adjacent to the permit area. Ground water may occur under localized conditions that often form a system of perched aquifers and associated springs and/or seeps. The U.S. Geological Survey (USGS) has identified and formally designated the Star Point-Blackhawk aquifer as the only regional ground-water resource in the study area (Danielson, et. al. 1981 and Lines 1984).

*4. The ground-water regime within the CIA is dependent upon climatic and geologic parameters that establish systems of recharge, movement and discharge.

Snowmelt at higher elevations provide most of the ground water recharge, particularly where permeable lithologies

* Taken from C.H.I.A. (10/25/85).

be associated with permeable lithologies of the Blackhawk Formation. Both Bear Spring (Huntington Municipal) and Birch Spring (North Emery Water Users) have been developed as culinary water sources. During 1978 and 1979, flow averaged 140 gpm for Bear Canyon Spring and 17 gpm for Birch Spring. Discharge data for Bear Canyon Spring indicate a delayed flow response to seasonal runoff. COP Development Spring flows intermittently in response to precipitation or seasonal runoff.

Mine inflow totals approximately 9 to 15 gpm from three roof areas that flow continuously. An extensive area of small roof drips occurs in close proximity to the fault located several hundred feet in by the access portal. Mine inflow may be attributed to dewatering of localized aquifers and the intersection of mine workings with flow along fault/fracture conduits.

5. Ground water users and well locations are described in Section 7.1.3.2.4 of this M.R.P.

D. Description of climatic conditions.

1. Precipitation data is shown in Section 11.3.1 of this M.R.P.
2. Temperature and snowfall data are shown in Sections 11.3.2 and 11.3.1, respectively, of this M.R.P.
3. Rainfall frequency data for storms in the mine area are shown on Table 11-1 of this M.R.P. Frequency data

for the area were based on E. Arlo Richardson's "Estimated Return Period for Short Duration Precipitation in Utah" (Hiawatha Area), as described in Section 7.2.5.2.5 of this M.R.P.

4. Premining estimates of runoff, evapotranspiration and storage for the mine plan and adjacent areas are the same as the present and post-mining estimates described in Sections 7.2 and 7.3 of this M.R.P.

E. Geomorphic descriptions of the mine plan and adjacent area.

1. Premining soil loss is not applicable since this is a pre-law disturbance. Sediment yield from the mine plan and adjacent areas is shown in Section 7.2.5.2.5 of this M.R.P.

2. Data on stream stability during periods of normal and high flow is presented in Section 7.2.2 of this M.R.P.

3. Section 7.2.3 of this M.R.P. describes possible effects of mining on surface water.

II. Baseline Data Collection Program.

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A. Overburden - N/A

B. Surface Water

1. Existing data is summarized in Tables 7.2-1 through 7.2-4 of this M.R.P.

2. Monitoring plans are described in Section 7.2.4 of this M.R.P.

3. Monitoring points are shown on Plates 7-4 and 7-4a of this M.R.P.

4. See Section 7.2.4 of this M.R.P. (No problems have been encountered).

5. Baseline data is presented in Tables 7.2-1 through 7.2-4 of this M.R.P.

C. Ground Water

1. Existing data is summarized in Table 7.1-3 of this M.R.P

2. Existing domestic wells are shown on Plate 3.4-1 (Ch.7) and described in Section 7.1.3.2.4 of this M.R.P.

3. Additional drilling has been performed as described in Section 7.1.3.2.1 of this M.R.P. Future proposed drilling is described in Section 7.1.6 of this M.R.P.

4. Ground water baseline data is presented in Table 7.1-3 of this M.R.P.

D. Soil loss and sediment yield.

1. Onsite erosion concerns were identified and predicted according to Figures 7.2-4 and 7.2-5 of this M.R.P. Additional information was obtained from the 10/25/85 C.H.I.A. for this property.

2. Stream and riparian zones are shown on Plates 2-2, 7-4, and 10-1, and described in Section 10.6 and 7.3 of this M.R.P. Further discussion of the streams in the C.I.A. can be found in the 10/25/85 C.H.I.A. for this area.

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3. Information on Alluvial Valley Floor Determination is presented in Section 3.6.8 of this M.R.P.

4. Data on soil loss and sediment yield is presented at the following locations of the M.R.P.:

(a) Figure 7.2-3

(b) Figure 7.2-4

(c) Tables 7.2-1 through 7.2-4.

(d) Plates 7-5, 7-7, 7-8 and 7-8a.

The following additional data on sediment loading os streams in the area has been taken from the 10/25/85 C.H.I.A. for this property:

"The two major drainages found within the CIA are Trail Creek and Bear Creek (Figure 4). Both are perennial drainages flowing into Huntington Creek. Four ephemeral drainages, designated ED-A, ED-B, ED-C and ED-D (Figure 4) are also found in the CIA and flow to Huntington Creek between Bear Creek and Trail Creek.

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Surface disturbance related to coal mining occurs in both Trail Canyon and Bear Canyon. Interaction between these surface disturbances and the streams are minimized due to sediment control facilities in place at each location. Bear Creek transports large quantities of suspended sediment due to springs emerging from the North Horn Formation in the headwaters of Bear Creek which continuously erodes the shales and mudstone and permits sloughing of large amounts of fine-grained material from the escarpments. Observed suspended sediment

loads in Bear Creek have been measured as high as 28,092 milligrams per liter (mg/l) in 1984."

III. Prediction of Probable Hydrologic Consequences of the Mining Operation.

A. Prediction of mining impacts (Surface Water).

1. Rationale for selection of the hydrologic techniques is discussed under Section 7.2 of this M.R.P.

2. The predicted impacts of mining in the Bear Canyon Mine by Co-Op Mining Company on the surface water in this area are discussed in Section 7.2.3 of this M.R.P. In addition, the following assessment of potential hydrologic impacts to surface water is taken from the 10/25/8 CHIA on this area:

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"Bear Creek and Trail Creek. The main concern in terms of water quality deterioration downstream is suspended sediments. The suspended sediment concentrations in Bear Creek in 1984 varied from a high of 28,092 (mg/l) in May of 1984 to a low of 122 (mg/l) in September of 1984 with five monthly readings within the 1-2,000 mg/l range. The suspended sediment concentrations in Trail Creek in 1984 varied from 1,400 mg/l in May of 1984 to a low of 1.0 mg/l in February of 1984 with seven monthly readings below 100 mg/l. These high suspended sediment values are associated primarily with natural climatic and geologic processes, although a proportion may be attributed to surface disturbances

from roads and mine pads. Sediment controls do exist for all surface disturbances in both canyons. Therefore, the impact associated with mining in Trail and Bear canyons is minimized by surface controls (i.e., sediment ponds, diversion ditches, filter fences, dugout ponds, etc.).

No known surface disturbances occur with any of the ephemeral drainages within the CIA boundary other than Birch Spring development work in ED-C which has been reclaimed by North Emery Water Users to prevent future impacts.

Future development in the Wild Horse Ridge and Mohrland areas and/or the recommencement of mining at the Trail Canyon Mine may result in further dewatering of the ground-water system. The permitting process will require implementation of sediment control measures and impacts to surface water should be minimized.

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The operational design proposed for the Bear Canyon Mine is herein determined to be consistent with preventing damage to the hydrologic balance outside the mine plan area."

Proposed mining in the lower seam (Hiawatha) will be conducted within the present disturbed area bound-

aries, and will share common surface facilities with the existing mine; therefore, no additional impact to surface water is expected as a result of the lower seam mining.

B. Prediction of mining impacts (Ground Water)

1. Techniques for prediction of potential ground water impacts are discussed under Section 7.1 of this M.R.P.

2. The predicted impacts of mining on the ground water in this area are discussed under Section 7.1.5 of this M.R.P. In addition, the following assessment of potential hydrologic impacts to ground water is taken from the 10/25/85 C.H.I.A on this area:

"Dewatering and subsedence related to mining have the greatest potential for impacting ground-water resources in the CIA.

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Dewatering. Mine inflow is currently 9 to 15 gpm. Of this total, approximately 50 gpd are discharged to Bear Creek. The remainder is utilized for dust control and pumped to a water storage tank. Ground water storage for the Blackhawk Formation has been estimated to be 43,000 acre-feet (ac-ft). The value for mine inflow (approximately 19 ac-ft/yr) is considered insignificant in comparison to derived values for ground-water storage and recharge (65 ac-ft/hr). However, continued inter-

ception of mine inflow may potentially dewater certain localized aquifers not only during the first five year permit term, but also throughout the life-of-mine as the workings are further developed (Figure 5B). Flow to Bear Canyon Spring may in the future be impacted as mine workings encroach upon the fault that conducts recharge to the spring.

<u>Subsidence.</u> Subsidence impacts are largely related to extension and expansion of the existing fracture system and upward propagation of new fractures. In as much as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of ground-water flow. Potential changes include increased flow rates along fractures that have "opened" and diverting flow along new fractures or permeable lithologies. Subsurface flow diversions may cause the depletion of water in certain localized aquifers, whereas increased flow rates along fractures would reduce ground-water residence time and potentially improve water quality."

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The proposed mining in the lower seam is not expected to cause additional significant impacts to the ground water regime for the following reasons:

(a) The Star Point aquifer is below the Hiawatha (lower) seam;

(b) In-mine and other drilling in the area (Sections 7.1.3 and 7.1.4 and Plate 3.4-1), have encountered very little water in the vicinity of the Hiawatha Seam, and in most cases, only far below the coal in the Star Point Sandstone;

(c) The ground water recharge is primarily from snow-melt at higher elevations, and appears to be controlled by permeable lithologies or faults and fractures. Since the upper seam is to be mined ahead of the lower, any such affects from fracturing, subsidence, etc. should show up as a result of the upper seam mining, not the lower;

(d) The recharge area appears to be primarily to the north of the mine permit area, and ground water movement to the south is likely fault-controlled. Mining in either or both seams should have little, if any, impact on such geologic controlled water movement;

(e) There is no present evidence that the Hiawatha Seam will encounter water in the mine in any quantities appreciably greater than those encountered in the upper seam; however, as a precaution, 3 additional drill holes are proposed to be drilled from future development in the upper seam as described in Section 7.1.7 of this M.R.P.

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C. Predictions of Mining Impacts on Stream Morphology.

1. Changes in stream stability are expected to be negligible since the reclamation plan calls for restoration of all channels to sizes and slopes comparable to existing, natural channels.

2. No upland stability problems are anticipated as a result of mining and reclamation of this property.

3. Based on the assessments of possible impacts to surface and ground water listed above, there are no significant impacts to water uses anticipated from this mining. Any other impacts to land uses, etc. are discussed under Appendix 3-H of this M.R.P. This discussion also indicates no significant impacts.

4. No permanent structures are proposed to be left at this site upon completion of mining, except the restored stream channels. These channels have been designed to carry the projected flows with long-term stability; therefore, no impacts are expected.

D. Combined Impacts of Mining.

1. Potential impacts of mining to local and regional water users could occur in the form of reduced flow to springs or wells as discussed under B.2 above; however, it is expected that such impacts will be minor based on the location of the coal seams, and the fault fracture controlled nature of the ground water discharges in the area.

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2. Impacts on the total hydrologic balance or cycle are expected to be minimal for the following reasons:

(a) Any major amount of water encountered by the mines will be pumped out of the mine, thus returning the water to the surface for use;

(b) Any water loss to springs or seeps through mine-induced fractures will likely find its way to the surface at another location;

(c) The fault/fracture controlled nature of the ground water, and the high elevation recharge area increase the likelyhood that ground water will still find its way to existing discharge locations, regardless of mining activity.

(d) Surface waters are controlled and cleaned within the mine property; therefore, sediment loading to streams is not considered a likely impact.

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IV. Summary and Conclusions

A. Summary - The 10/25/85 C.H.I.A. and the Hydrologic Sections of this M.R.P. provide adequate data to make a determination of Probable Hydrologic Consequences from mining of this property. The C.H.I.A. was originally written just for the upper (Bear Canyon) Seam mining; however, additional submittals and data in the M.R.P. provide for the PHC determination to extend to the lower seam mining as well.

B. Conclusions - The Findings Document and the C.H.I.A. for this original M.R.P. (10/25/85) made the following assessment:

"The assessment of the probable cumulative impacts of all anticipated coal mining in the general area on the hydrologic balance has been made by the regulatory authority, The mining operation proposed under the application has been designed to prevent damage to the hydrologic balance outside the proposed mine plan area (UMC 786.19[c]). (See Cumulative Hydrologic Impact Analysis [C.H.I.A.] Section, attached to this Findings Document. (Also, see Huntington Creek Basin C.H.I.A., May 29, 1984, prepared by Simons, Li & Associates for the Office of Surface Mining [OSM]."

Information presented in Sections III.A.2. and III.B.2 of this PHC has shown that the probable hydrologic consequences of the proposed mining of the lower (Hiawatha) seam are not expected to be any more significant than those from mining the upper (Bear Canyon) seam.

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