CANYON FUEL COMPANY, LLC

DUGOUT CANYON MINE
PACE CANYON FAN PORTAL FACILITIES
AMENDMENT
C/007/039

FEBRUARY 2005

CHAPTER 2

SOILS

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210 INTRODUCTION

This chapter and associated appendices of this M&RP contain all pertinent information relating to identification, management, and reclamation activities associated with the soil resources present in the disturbed area of the Dugout Canyon Mine and the Pace Canyon Fan Portal Breakout. The information has been compiled from the previously approved soil sections for the Sage Point-Dugout Canyon Mine and Soldier Canyon Mine permits, ACT/007/009 and ACT/007/018, respectively, as well as new soil survey information gathered as part of this permit application. The soil studies were conducted in accordance with the Utah Division of Oil, Gas, and Mining guidelines that were in effect at the time each study was conducted. All previous surveys fulfilled the requirements established by the U.S. Soil Conservation Service (SCS). The site specific soil survey conducted for this permit application was conducted in accordance with the standards set by the National Cooperative Soil Survey and analyzed by horizon according to Table 1 of the Division's "Guidelines for the Management of Topsoil and Overburden for Underground and Surface Coal Mining" (Leatherwood, 1988).

Additional information can be found in the following amendments: Methane Degassification Amendment (August 2003), Refuse Pile Amendment (February 2003), and the Leachfield Addendum A-1 (March 2001). The remainder of the State Lease ML-48435-OBA (SITLA Lease) was incorporated into the Dugout Canyon Mine permit area in 2005.

A base map of the soils in the permit area has been created by compiling maps from the "Soil Survey of Carbon Area, Utah" prepared by the SCS (Jensen, 1988). The base map illustrates the locations and areal extent of the endemic soil resources within the permit area at an Order III level (Plate 2-1). In the disturbed area of the permit area, an Order I survey was conducted. The locations and areal extent of the endemic soil resources within the disturbed area identified during the Order I survey are illustrated on Plate 2-2.

This chapter provides a description of the pre-mining resources as specified under R645-301-221. Topsoil and subsoil to be saved under R645-301-232 will be removed and segregated from other material. After removal, topsoil will be immediately redistributed in accordance with R645-301-242, stockpiled pending redistribution under R645-301-234, or if demonstrated that an alternative procedure will provide equal or more protection for the topsoil, the Applicant will seek approval from the Division.

220 ENVIRONMENTAL DESCRIPTION

The Dugout Canyon Mine facilities are ~~is~~ located in the northern Book Cliffs - Roan Plateau region. More specifically, the mine is located within Dugout Canyon and Pace Canyon. The majority of the disturbed area is located in Dugout Canyon, with fan portal facilities located in Pace Canyon ~~on the northwest side of the canyon~~ (Plate 2-1 and PC5-2). The elevation of the disturbed area ranges between approximately 7000 and 7150 feet above MSL. Soils in the mine area are not cultivated due to their thin nature and relatively steep slopes on which they lie. These soils have formed in colluvium derived from sandstone and shale. Soils in the area are usually shallow and consist predominantly of stony to gravelly sandy loams with moderate permeability. The soils are highly susceptible to water erosion. Rock outcrops consist of alternating layers of sandstone and shale. Subordinate amounts of coal are also present.

The Pace Canyon Fan Portal Breakout is located in Pace Canyon (T13S. R13E, Section 30, N1/2NW14). The elevation of the disturbed area ranges between approximately 6950 and 7060 feet above MSL. Soils in the mine area are not cultivated due to their thin nature and relatively steep slopes on which they lie. These soils have been previously disturbed by various activities in the canyon, such as road construction, exploration, mining, logging, etc. The fan area encompasses steep rocky canyon walls with unconsolidated sediment benches.

221 Prime Farmland Investigation

As part of the application for the Sage Point-Dugout Canyon Mine permit, ACT/007/009, a reconnaissance of the disturbed areas was conducted in 1980 to determine if prime farmland was present, and if present, whether it would be impacted by mining activities. The reconnaissance included the presently-proposed disturbed area within the Dugout Canyon Mine permit area. Copies of the applicable pages from the prime farmland investigation for the Sage Point-Dugout Canyon Mine permit and correspondence with the Soil Conservation Service have been included as Appendix 2-1. One area within the previous area of investigation was determined to potentially be prime farmland. However, this area was located near the mouth of Soldier Creek Canyon, outside of the presently proposed permit area. No prime farmland was found in Dugout Canyon or anywhere else within the presently-proposed permit area during the previous investigation.

As part of this permit application, a survey of the disturbed area of the Dugout Canyon Mine was conducted to determine whether the soils could be considered as prime farmland. The Dugout Canyon Mine disturbed area lies within the Rock outcrop-Rubbleland-Travessilla complex and Croydon loam soils area (Plates 2-1 and 2-2). Neither of these soils are considered suitable prime farmland as described by the SCS (Jensen, 1988). No evidence of past cultivation of the soils in the disturbed area was found during the site investigation. Hence, based on the results of both detailed investigations conducted within the area, it is concluded that no prime farmland exists within the proposed permit area.

The survey for prime farmland investigation for the fan portal site was completed by Leland Sasser of the NRCS. The area planned for disturbance is not considered prime farmland. Refer to Appendix 2-1 for a copy of Mr. Sasser's letter.

222 Soil Survey

Soil survey information for those portions of the permit area to be affected by surface operations at the Dugout Canyon Mine is presented in Sections 222.100 through 222.300.

222.100 Soils Map

A map delineating the areal extent of the endemic soils resources within the permit area at an Order III survey level is presented on Plate 2-1. A description of these soils has been reproduced from the SCS "Soil Survey of the Carbon County Area" (Jensen, 1988), and has been included as Appendix 2-2. An Order I soil survey was conducted of the Dugout Canyon Mine disturbed area in October and November 1995. Plate 2-2 illustrates the areal extent of the soils studied as part of the Order I soil survey, the location of the soil test pits excavated during the survey, and the extent of the identified soils.

Dan Larsen , Soil Scientist performed a survey of the Fan Portal area in 2003 and 2004. The 2003 survey was done in conjunction with a BLM environmental assessment for coal exploration holes. The 2004 survey was done on November 5, in conjunction with the proposed installation of the fan. A copy of the 2004 survey and a map showing the location of 2003 -2004 test pit locations is in Appendix 2-3.

222.200 Soil Identification

Following is a list of the soils found in and adjacent to the permit area. Their corresponding map units as illustrated on Plate 2-1 are also listed.

Map Unit	Soil Identification
3	Badland-Rubbleland-Rock outcrop complex
6	Beje-Comodore complex
7	Beje-Trag complex
13	Cabba family-Guben-Rock outcrop complex
21	Croydon loam, 8 to 30 percent slopes
23	Curecanti family - Pathead complex
32	Frandsen-Gullied land complex
33	Gerst-Badland-Rubbleland complex, 15 to 50 percent slopes
36	Gerst-Strych-Badland complex, 3 to 50 percent slopes
37	Gerst-Strych-Badland complex, 50 to 70 percent slopes

46	Guben-Pathead extremely stony loams
47	Guben-Rock outcrop complex
50	Haverdad loam, moist, 1 to 5 percent slopes
52	Hernandez family, 3 to 8 percent slopes
53	Hernandez family, moist, 1 to 6 percent slopes
62	Midfork family-Comodore complex
66	Mivida gravelly fine sandy loam, 3 to 8 percent slopes
72	Pathead-Corecanti family association
75	Perma family, 15 to 40 percent slopes
81	Persayo-Greybull complex
84	Podo-Rock outcrop complex
86	Rabbitex-Doney family-Midfork family complex
88	Rabbitex family-Datino Variant complex
96	Rock outcrop-Rubbleland-Travessilla complex
97	Rottulee family-Trag complex
100	Senchert loam, 3 to 15 percent slopes
101	Senchert loam, 30 to 50 percent slopes
103	Senchert-Toza family complex
105	Senchert family-Senchert complex
107	Supert-Winetti complex
109	Silas-Brycan loams
113	Strych very stony loam, 3 to 15 percent slopes

According to the SCS (Jensen, 1988), soils present on the east facing slopes of Dugout Canyon are part of the Rock outcrop-Rubbleland-Travessilla complex while those on the west facing slopes are part of the Croydon loam and Midfork family-Comodore complex.

However, observation of the soils present on the west and northwest facing slopes suggest that inclusions of the Comodore-Datino Variant complex are prevalent throughout. The conclusion that Comodore-Datino Variant complex soils are present in this area is based on the presence of characteristics typical of these soils such as: 40 to 60 percent slopes, elevations of slopes between 6800 and 8100 feet, 40 to 60 percent slopes, Douglas-fir and related vegetation, and very stony, relatively shallow soils. A telephone conversation between Mr. Chris D. Hansen of Canyon Fuel Company, LLC, Ms. Vicky Bailey of EarthFax Engineering, Inc. and Mr. Leland Sausser of the Natural Resources Conservation Service concerning the presence of Comodore-Datino Variant complex soils within areas mapped as Croydon loam occurred on March 3, 1998. Mr. Sausser

briefly reviewed available maps and photos and agreed that this may indeed occur but the maps in the Soil Survey of Carbon Area, Utah (Jensen, 1988) are generally correct as published.

Soils present in the narrow V-shaped Dugout Canyon that lie within the disturbed area of the mine have been identified and characterized. A large portion of the mine area is covered with overburden that consists of soil mixed with coal waste and/or waste rock from previous mining operations at the site. In these areas, the original soil structure has been obliterated or the native soils have been deeply covered. The remainder of the disturbed area has soils that appear to be in-place or have been only slightly disturbed. The approximate boundary between the overburden and in-place and/or slightly disturbed soils is illustrated on Plate 2-2. The overburden has been labeled on Plate 2-2 as OB while the in-place soils have been labeled as TS.

The overburden is a mixture of rock and/or coal waste with Travessilla soils. The Travessilla soils are classified as loamy, mixed (calcareous) mesic, Lithic Ustic Torriorthents (Jensen, 1988). Soil type TS is a loamy, mixed, Typic Haploboroll.

In Pace Canyon the site is mapped as being soil map Unit 96 and the adjacent soils being map Units 21, 84 and 97 (SCS, 1988).

222.300 Soil Description

The description of the soils has been based on the following information: taxonomic classification, horizon name and depth, color, texture (percent sand, silt, and clay), class, structure, percent rock fragments and organic matter, pH, EC, and solubility of calcium, magnesium, and sodium. This information is included in the soil test pit logs in Appendix 2-3 and the lab data sheets included in Appendix 2-4. The description of soils outside the disturbed area boundary or on the steep slopes within the boundary have been taken from the SCS (Jensen, 1988).

Overburden. The overburden (disturbed soils) are located both east and west of Dugout Creek in areas where previous mining activities have occurred (Plate 2-2). Much of the Dugout Canyon

Mine disturbed area is covered with overburden. Four test soil pits, TP-2, 3, 9, and 11 were excavated in overburden areas and their locations are illustrated on Plate 2-2. The overburden material could loosely be termed a "gravelly loam" that generally consist of loam mixed with coal debris, wood fragments, bricks and rock. The rock concentration varies between 10 and 40 percent and varies in size from gravel to boulder. Rock fragments are composed of sandstone with some siltstone blocks. This material is found in the relatively flat areas and on most of the steep slopes; is moderately well drained; and supports sagebrush, juniper, rabbit brush, and a variety of grasses. Thickness of this material varies from a few feet to more than eight feet. Select samples of the soil mixed with the rock were obtained and analyzed for the following parameters.

pH
Electrical Conductivity (EC)
Saturation Percent
Calcium (soluble)
Magnesium (soluble)
Sodium (soluble)
Sodium Absorption Ratio (SAR)
Total Sulfur
Acid/Base Potential
Total Organic Carbon
Phosphate
Nitrogen (nitrate)
Boron
Selenium
Available Sodium
Exchangeable Sodium
Alkalinity
Total Kjeldahl Nitrogen
Water Holding Capacity
Percent Coarse Fragment, Sand, Silt, and Clay

Results of the laboratory analyses of the samples have been summarized in Table 2-1.

A typical profile of this overburden was compiled from the soil descriptions from three soil test pits TP-2, TP-3, and TP-11. A fourth pit, TP-9, was excavated adjacent to the mine access road in an area labeled as overburden. However, within a few feet of ground surface and beneath the road

base, the material appeared to be undisturbed. Therefore, the information from this pit was not used to describe the overburden present at the mine.

The overburden consists of very dark gray (2.5Y 3/1) loam mixed with coal, wood, gravel, and cobble from 0 to 3 feet. The loam is dry to slightly damp, slightly alkaline with an average pH of 7.3, and an average concentration of the following parameters: EC value of 0.38 mmhos/cm, soluble calcium concentration of 1.78 meq/l, soluble magnesium concentration of 1.47 meq/l, soluble. sodium concentration of 0.51 meq/l, SAR value of 0.40, acid/base potential of 72.3 tons of calcium carbonate/tons of material, boron concentration of 0.42, selenium concentration less than 0.02 ppm, and water holding capacity of 8.6%. The percentage of rock is approximately 20% or more. This unit overlies brown (7.5YR 4/4) to dark grayish brown (10YR 4/2) loam with some coal waste, gravel and cobbles, and some wood fragments. This underlying unit extends to depth of at least eight feet in portions of the disturbed area. The concentration of coal waste appears to decrease with depth while rockiness increases. The percentage of rockiness ranges from 20 to 40%. The loam is dry to moist, slightly alkaline with a pH of 7.4, has an EC value of 0.37 mmhos/cm, soluble calcium concentration of 1.10 meq/l, soluble magnesium concentration of 2.00 meq/l, soluble sodium concentration of 0.50 meq/l, an SAR value of 0.40, an acid/base potential of 16.6 tons of calcium carbonate/tons of material, a boron concentration of 0.48 ppm, a selenium concentration less than 0.02 ppm, and a water holding capacity of 7.9%.

Soil Type TS. Soil type TS is found on both sides of Dugout Creek in the northeastern portion of the disturbed area and in the southwestern portions of the disturbed area by the sediment pond (Plate 2-2). TS soils in the sediment pond area appear to have been previously disturbed, resulting in the mixing of the soil horizons. The TS soils are found in flat lying areas and on slopes with grades up to 40% or more (Plate 2-2). The soil supports vegetation consisting of sagebrush, cottonwood, gambel oak, grass, pinyon, and fir. This soil consists of well drained soils that have formed in colluvium and residuum from sandstone, siltstone, and shale. Samples from this soil were obtained from soil pits TP-1, 4, 5, 6, 7, and 8. Soil test pits 14 and 14A were excavated and described and soil thickness were used to estimate available borrow material. However, soil

sample analysis results are not available for TP-14 and TP-14A and, therefore, have not been included in the M&RP. The samples obtained from TP-1, 4, 5, 6, 7, and 8 were analyzed for the same parameters listed for the overburden samples. Results of the analyses are summarized in Table 2-1. This soil type is undoubtedly a unit of the Datino Variant (Jensen, 1988).

The following description of the TS soil has been condensed from the information from soil test pit TP-4, TP-6 and the lower sections of TP-1. Similar soils were found in TP-5 and TP-8 but portions of the soil profile appeared to have been reworked by Dugout Creek. Also, the upper four feet of the soil profile in TP-1 appear to have been disturbed.

The TS soil generally has a surficial O1 horizon that is approximately 1 inch thick and is comprised of leaves, twigs, roots, silt, and sand. No samples of this horizon were obtained for analysis.

The A1 soil horizon occurs from 1 inch to a depth of 5 inches. This soil horizon is a gravelly loam composed of approximately 50% sand, 35% silt, and 15% clay; rock fragments compose about 36% (gravels) of its volume. The A1 horizon has a dark gray color (10YR 3/1) when moist. The soil is slightly acidic with a pH of 6.9 and has an EC value of 0.52 mmhos/cm, soluble calcium concentration of 4.30 meq/l, soluble magnesium concentration of 0.91 meq/l, soluble sodium concentration of 0.30 meq/l, an SAR value of 0.19, an acid/base potential of 78.4 tons of calcium carbonate/tons of material, a boron concentration of 0.51 ppm, a selenium concentration less than 0.02 ppm, and a water holding capacity of 11.4%.

The A1 soil is underlain by a very dark gray (10YR 3/1) B2 soil horizon. The B2 soil occurs at a depth of 5 to 14 inches. It is also a gravelly loam with approximately 48% sand, 35% silt, and 17% clay. Rock fragments compose about 30% by volume (gravel) of this soil horizon. The soil has a neutral acidity/alkalinity with a pH of 7.0 and has an EC value of 0.53 mmhos/cm, soluble calcium concentration of 3.84 meq/l, soluble magnesium concentration of 1.24 meq/l, soluble sodium concentration of 0.35 meq/l, an SAR value of 0.22, an acid/base potential of 79.0 tons of calcium

TABLE 2-1

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-1 0.1-0.5	TP-1 0.5-2.2	TP-1 2.2-4.2	TP-1 4.2-4.7
pH		4.5 - 9.0	6.9	7.1	7.3	7.3
EC	mmhos/cm	0 - 15	0.54	0.37	0.33	0.31
SATURATION	%	25 - 80%	41.4	32.8	33.6	32.1
SAR		0 - 12, 15	0.23	0.37	0.4	0.4
CALCIUM	meq/l	na	3.42	2.31	1.90	1.89
MAGNESIUM	meq/l	na	1.37	0.80	0.85	0.78
SODIUM	meq/l	na	0.36	0.46	0.47	0.46
COARSE FRAGMENTS	%	na	17.8	35.2	22.6	72.9
SAND	%	na	50.2	47.2	38.2	45.2
SILT	%	na	36.0	33.8	41.8	35.0
CLAY	%	na	13.8	19.0	20.0	19.8
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	7.3	9.4	9.3	10.4
BORON	mg/kg	< 5.0	0.32	0.32	0.27	0.25
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.04	0.02	0.03	0.04
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	19.8	16.2	95.5	101
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	18.5	15.5	94.5	99.4
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	L	L	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-1 4.7-8.0	TP-2 1.3-4.3	TP-3 0.6-3-3	TP-3 3.3-8.0
pH		4.5 - 9.0	7.4	7.4	7.1	7.4
EC	mmhos/cm	0 - 15	0.29	0.39	0.37	0.37
SATURATION	%	25 - 80%	29.1	28.7	31.3	32.1
SAR		0 - 12, 15	0.37	0.46	0.34	0.40
CALCIUM	meq/l	na	1.59	1.71	1.85	1.10
MAGNESIUM	meq/l	na	0.89	1.53	1.42	2.00
SODIUM	meq/l	na	0.41	0.58	0.44	0.50
COARSE FRAGMENTS	%	na	35.9	50.6	25.1	59.1
SAND	%	na	44.2	50.4	43.4	36.4
SILT	%	na	39.0	30.8	37.8	39.8
CLAY	%	na	16.8	18.8	18.8	23.8
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	11.5	13.0	10.2	11.0
BORON	mg/kg	< 5.0	0.12	0.25	0.54	0.48
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.03	0.02	0.07	0.03
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	79.8	96.8	50.7	17.5
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	78.9	96.2	48.5	16.6
SAMPLE TYPE [4]		na	TOPSOIL	OB	OB	OB
TEXTURE [5]		na	L	L	L	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-4 0.1-0.4	TP-4 0.4-1.2	TP-4 1.2-2.3	TP-5 0.3-1.4
pH		4.5 - 9.0	6.9	7.0	7.2	7.0
EC	mmhos/cm	0 - 15	0.52	0.53	0.36	0.41
SATURATION	%	25 - 80%	40.9	37.8	32.9	38.4
SAR		0 - 12, 15	0.19	0.22	0.30	0.40
CALCIUM	meq/l	na	4.30	3.84	2.25	2.44
MAGNESIUM	meq/l	na	0.91	1.24	1.02	0.80
SODIUM	meq/l	na	0.30	0.35	0.38	0.38
COARSE FRAGMENTS	%	na	35.7	30.5	21.8	0.0
SAND	%	na	50.4	48.6	53.2	48.6
SILT	%	na	34.8	34.6	31.8	34.4
CLAY	%	na	14.8	16.8	15.0	17.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	11.8	13.8	9.2	11.8
BORON	mg/kg	< 5.0	0.51	0.63	0.88	0.80
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.08	0.07	0.01	0.02
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	80.9	81.2	115	27.6
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	78.4	79.0	115	26.9
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	L	SL	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-5 1.4-2.7	TP-5 2.7-5.2	TP-5 2.7-5.2
pH		4.5 - 9.0	7.3	7.3	7.5
EC	mmhos/cm	0 - 15	0.36	0.33	0.34
SATURATION	%	25 - 80%	30.7	30.6	27.9
SAR		0 - 12, 15	0.50	0.50	0.50
CALCIUM	meq/l	na	1.95	1.73	1.62
MAGNESIUM	meq/l	na	0.71	0.76	0.80
SODIUM	meq/l	na	0.46	0.55	0.56
COARSE FRAGMENTS	%	na	0.0	14.7	7.0
SAND	%	na	47.6	56.6	50.4
SILT	%	na	36.4	27.4	32.6
CLAY	%	na	16.0	16.0	17.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	11.6	11.8	10.3
BORON	mg/kg	< 5.0	0.72	0.42	0.33
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.02	0.01	0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	116	85.2	174
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	116	84.9	174
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	SL	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-6 0.0-7.0	TP-6 7.0-30.0	TP-6 30.0-49.0	TP-6 49.0-81.0
pH		4.5 - 9.0	7.5	7.8	7.8	7.9
EC	mmhos/cm	0 - 15	0.59	0.40	0.34	0.39
SATURATION	%	25 - 80%	37.7	30.6	33.1	34.2
SAR		0 - 12, 15	0.40	0.51	0.62	0.58
CALCIUM	meq/l	na	3.82	2.27	1.77	1.63
MAGNESIUM	meq/l	na	1.19	0.77	0.71	1.34
SODIUM	meq/l	na	0.64	0.63	0.69	0.71
COARSE FRAGMENTS	%	na	11.9	25.0	6.9	0.00
SAND	%	na	56.0	59.0	45.0	52.0
SILT	%	na	32.0	29.0	39.0	31.0
CLAY	%	na	12.0	12.0	16.0	17.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	10.6	8.6	10.2	9.5
BORON	mg/kg	< 5.0	0.39	0.33	0.30	0.42
SELENIUM	mg/kg	< 0.1	0.02	0.02	0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	0.06	0.03	0.04	0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	90.9	69.8	95.4	159
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	89.0	68.8	94.1	158
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	SL	SL	L	SL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-7 0-3.0	TP-7 3.0-10.0	TP-7 10.0-20.0
pH		4.5 - 9.0	7.3	7.8	7.8
EC	mmhos/cm	0 - 15	1.51	0.68	0.40
SATURATION	%	25 - 80%	43.5	30.9	25.8
SAR		0 - 12, 15	0.20	0.46	0.44
CALCIUM	meq/l	na	8.36	3.43	2.25
MAGNESIUM	meq/l	na	3.56	1.19	0.98
SODIUM	meq/l	na	0.48	0.70	0.56
COARSE FRAGMENTS	%	na	26.2	61.6	58.2
SAND	%	na	50.0	50.0	51.0
SILT	%	na	33.0	31.0	31.0
CLAY	%	na	17.0	19.0	18.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	14.6	9.6	9.2
BORON	mg/kg	< 5.0	0.47	0.44	0.22
SELENIUM	mg/kg	< 0.1	0.02	0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	0.05	0.04	0.03
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	51.4	80.0	85.1
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	49.9	78.7	84.1
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	L	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-7 20.0-74.0	TP-7 74.0-84.0	TP-7 84.0-144.0
pH		4.5 - 9.0	7.9	8.2	8.3
EC	mmhos/cm	0 - 15	0.34	0.47	0.45
SATURATION	%	25 - 80%	27.9	36.8	27.4
SAR		0 - 12, 15	0.91	0.64	0.65
CALCIUM	meq/l	na	1.36	1.33	1.03
MAGNESIUM	meq/l	na	0.83	2.61	2.87
SODIUM	meq/l	na	0.95	0.90	0.91
COARSE FRAGMENTS	%	na	53.0	49.1	72.3
SAND	%	na	52.0	46.0	52.5
SILT	%	na	29.0	33.0	28.7
CLAY	%	na	19.0	21.0	18.8
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	10.3	16.2	13.1
BORON	mg/kg	< 5.0	0.19	0.44	0.45
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	<0.01	0.03	0.04
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	66.6	76.2	108.0
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	66.6	75.3	107.0
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	SL	L	SL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-8 2.0-8.0	TP-8 8.0-15.0	TP-8 15.0-25.0
pH		4.5 - 9.0	7.7	7.8	7.7
EC	mmhos/cm	0 - 15	0.47	0.43	0.38
SATURATION	%	25 - 80%	41.8	29.5	29.8
SAR		0 - 12, 15	0.43	0.36	0.33
CALCIUM	meq/l	na	2.78	2.76	2.63
MAGNESIUM	meq/l	na	0.66	0.61	0.55
SODIUM	meq/l	na	0.56	0.47	0.42
COARSE FRAGMENTS	%	na	0.0	20.4	18.3
SAND	%	na	33.0	62.0	70.0
SILT	%	na	49.0	27.0	20.0
CLAY	%	na	18.0	11.0	10.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	9.1	7.0	8.2
BORON	mg/kg	< 5.0	0.65	0.35	0.51
SELENIUM	mg/kg	< 0.1	0.02	0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	0.05	0.03	0.02
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	85.2	89.2	91.8
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	83.6	88.3	91.1
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	SL	SL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-8 25.0-33.5	TP-8 33.5-48.0	TP-8 48.0-56.0
pH		4.5 - 9.0	7.7	7.8	7.9
EC	mmhos/cm	0 - 15	0.36	0.33	0.36
SATURATION	%	25 - 80%	35.8	36.1	33.9
SAR		0 - 12, 15	0.46	0.63	0.52
CALCIUM	meq/l	na	2.13	1.76	1.84
MAGNESIUM	meq/l	na	0.58	0.54	0.71
SODIUM	meq/l	na	0.53	0.67	0.58
COARSE FRAGMENTS	%	na	18.6	6.9	19.7
SAND	%	na	51.0	50.0	48.0
SILT	%	na	37.0	34.0	38.0
CLAY	%	na	12.0	16.0	14.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	11.0	8.70	10.2
BORON	mg/kg	< 5.0	0.65	0.59	0.49
SELENIUM	mg/kg	< 0.1	<0.02	0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.02	0.02	0.03
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	21.7	70.0	70.0
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	21.1	69.3	69.1
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	L	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-9 0.0-23.0	TP-9 23.0-37.0	TP-9 37.0-58.0
pH		4.5 - 9.0	7.8	8.1	8.0
EC	mmhos/cm	0 - 15	0.35	0.37	0.28
SATURATION	%	25 - 80%	27.7	23.3	34.2
SAR		0 - 12, 15	0.52	0.69	0.62
CALCIUM	meq/l	na	2.08	1.27	1.35
MAGNESIUM	meq/l	na	0.48	1.19	0.66
SODIUM	meq/l	na	0.59	0.76	0.62
COARSE FRAGMENTS	%	na	14.0	0.0	0.0
SAND	%	na	71.0	72.0	47.0
SILT	%	na	21.0	20.0	39.0
CLAY	%	na	38.0	8.0	14.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	6.8	6.5	10.2
BORON	mg/kg	< 5.0	0.22	0.18	0.21
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.03	0.01	0.03
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	123	185	74.2
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	122	185	73.3
SAMPLE TYPE [4]		na	OB	TOPSOIL	TOPSOIL
TEXTURE [5]		na	SL	SL	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-11 0.0-6.0	TP-11 6.0-25.0	TP-11 25.0-75.0	TP-11 75.0-84.0
pH		4.5 - 9.0	7.7	7.7	6.6	8.0
EC	mmhos/cm	0 - 15	0.43	0.30	0.46	0.34
SATURATION	%	25 - 80%	32.2	31.1	48.5	27.7
SAR		0 - 12, 15	0.54	0.73	0.54	0.69
CALCIUM	meq/l	na	2.12	1.36	2.11	1.19
MAGNESIUM	meq/l	na	0.80	0.71	2.03	1.56
SODIUM	meq/l	na	0.65	0.75	0.78	0.81
COARSE FRAGMENTS	%	na	0.0	0.0	0.0	0.0
SAND	%	na	62.0	54.0	62.0	56.0
SILT	%	na	26.0	32.0	26.0	30.0
CLAY	%	na	12.0	14.0	12.0	14.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	11.5	13.0	10.2	11.0
BORON	mg/kg	< 5.0	0.12	0.25	0.54	0.48
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.04	0.04	0.16	<0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	21.1	34.0	18.6	78.7
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	19.9	32.8	13.6	78.7
SAMPLE TYPE [4]		na	TOPSOIL	OB	OB	OB
TEXTURE [5]		na	L	L	L	L

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]		
			TP-13 0.0-38.0	TP-13 38.0-62.0	TP-13 62.0-80.0
pH		4.5 - 9.0	7.5	7.6	7.7
EC	mmhos/cm	0 - 15	0.56	0.52	0.59
SATURATION	%	25 - 80%	26.6	32.5	23.2
SAR		0 - 12, 15	0.47	0.39	0.36
CALCIUM	meq/l	na	3.70	3.31	4.02
MAGNESIUM	meq/l	na	1.15	1.12	1.04
SODIUM	meq/l	na	0.57	0.58	0.75
COARSE FRAGMENTS	%	na	5.8	4.9	5.6
SAND	%	na	46.0	45.0	58.8
SILT	%	na	37.0	36.0	25.0
CLAY	%	na	17.0	19.0	16.2
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	12.2	13.7	4.9
BORON	mg/kg	< 5.0	0.30	0.32	0.17
SELENIUM	mg/kg	< 0.1	0.02	0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.02	<0.01	<0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	6.95	22.7	46.4
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	6.32	22.7	46.4
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	L	SL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-15 2.0-8.0	TP-16 0.0-1.5	TP-16 1.5-3.5	TP-16 3.5-12.0
pH		4.5 - 9.0	7.7	7.2	7.3	7.2
EC	mmhos/cm	0 - 15	0.55	0.77	0.50	0.68
SATURATION	%	25 - 80%	30.6	30.3	31.5	30.2
SAR		0 - 12, 15	0.38	0.31	0.49	0.39
CALCIUM	meq/l	na	3.75	4.15	2.71	3.90
MAGNESIUM	meq/l	na	0.89	1.77	1.00	1.05
SODIUM	meq/l	na	0.58	0.54	0.67	0.62
COARSE FRAGMENTS	%	na	18.4	6.0	5.4	20.0
SAND	%	na	44.0	52.0	49.0	44.0
SILT	%	na	37.0	29.0	26.0	25.0
CLAY	%	na	19.0	19.0	25.0	31.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	12.3	11.6	8.3	8.7
BORON	mg/kg	< 5.0	0.16	0.27	0.23	0.31
SELENIUM	mg/kg	< 0.1	0.02	<0.02	0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	0.04	0.02	0.02	0.02
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	73.0	9.20	6.32	7.19
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	71.7	8.57	5.70	6.56
SAMPLE TYPE [4]		na	TOPSOIL	TOPSOIL	TOPSOIL	TOPSOIL
TEXTURE [5]		na	L	SL	SCL	CL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH [1]			
			TP-17 0.7-1.7	TP-17 1.7-4.7	TP-17 4.7-9.7	TP-17 9.7-29.5
pH		4.5 - 9.0	7.3	7.1	7.2	7.3
EC	mmhos/cm	0 - 15	0.50	0.50	0.47	0.34
SATURATION	%	25 - 80%	26.2	32.5	33.2	24.4
SAR		0 - 12, 15	0.51	0.45	0.47	0.54
CALCIUM	meq/l	na	2.45	3.14	3.18	1.94
MAGNESIUM	meq/l	na	0.78	0.80	0.88	0.49
SODIUM	meq/l	na	0.64	0.64	0.66	0.59
COARSE FRAGMENTS	%	na	19.1	0.9	0.7	1.4
SAND	%	na	70.0	66.0	64.0	68.0
SILT	%	na	14.0	16.0	18.0	14.0
CLAY	%	na	16.0	18.0	18.0	18.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	3.3	3.4	4.8	3.6
BORON	mg/kg	< 5.0	0.16	0.21	0.23	0.11
SELENIUM	mg/kg	< 0.1	<0.02	<0.02	<0.02	<0.02
ACID POTENTIAL (% SULFUR)	%	na	0.02	0.03	<0.01	<0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) [2]	tons $CaCO_3$/ 1,000 tons material	na	250	177	151	144
ACID/BASE POTENTIAL [3]	tons $CaCO_3$/ 1,000 tons material	> -5	250	176	151	144
SAMPLE TYPE [4]		na	SOIL	SOIL	SOIL	SOIL
TEXTURE [5]		na	SL	SL	SL	SL

TABLE 2-1 (Continued)

SELECT DUGOUT CANYON MINE SOIL ANALYTICAL DATA

PARAMETER	UNITS	UDOGM ACCEPTABLE RANGE	SAMPLE NUMBER AND DEPTH (1)		
			TP-17 29.5-31.0	TP-17 31.0-46.3	TP-17 46.3-60.0
pH		4.5 - 9.0	7.1	7.3	7.3
EC	mmhos/cm	0 - 15	0.55	0.38	0.40
SATURATION	%	25 - 80%	43.6	27.5	31.80
SAR		0 - 12, 15	0.48	0.65	0.59
CALCIUM	meq/l	na	4.00	2.37	2.73
MAGNESIUM	meq/l	na	0.75	0.51	0.52
SODIUM	meq/l	na	0.73	0.78	0.75
COARSE FRAGMENTS	%	na	0.0	0.2	4.7
SAND	%	na	27.0	55.0	48.0
SILT	%	na	47.0	25.0	28.0
CLAY	%	na	26.0	20.0	24.0
AVAILABLE WATER HOLDING CAPACITY	%	5 - 15%	9.3	5	5
BORON	mg/kg	< 5.0	0.29	0.14	0.22
SELENIUM	mg/kg	< 0.1	0.02	<0.02	0.02
ACID POTENTIAL (% SULFUR)	%	na	<0.01	0.01	0.01
NEUTRALIZATION POTENTIAL (% $CaCO_3$) (2)	tons $CaCO_3$/ 1,000 tons material	na	116	159	143
ACID/BASE POTENTIAL (3)	tons $CaCO_3$/ 1,000 tons material	> -5	116	159	143
SAMPLE TYPE (4)		na	SOIL	SOIL	SOIL
TEXTURE (5)		na	L	SCL	SCL

(1) Depth of sample in inches below ground surface.
(2) $CaCO_3$ shown on IML lab data sheets as Neut. Pot. X 0.10. (i.e. Sample 129266 $CaCO_3$ = 19.8 X 0.1 = 1.98)
(3) Acid/Base potential (ABP) calculation based on ABP = NP - AP, where NP is neutralization potential and AP is acid potential, NP = % $CaCO_3$ X 10 = tons of $CaCO_3$/tons of material, and AP = % S X 31.24 = tons of $CaCO_3$/tons of material.
(4) OB - Overburden
(5) Textural Classes: L - loam; SL - sand loam; LS - loamy sand, CL - clayey loam, SCL - sandy clayey loam.

carbonate/tons of material, a boron concentration of 0.63 ppm, a selenium concentration less than 0.02 ppm, and a water holding capacity of 9.8 %.

The B2 soil is underlain by a dark yellowish brown (10YR 4/4) B3 soil horizon. The B3 soil occurs at a depth of 14 to 28 inches. It is a gravelly sandy loam with approximately 53% sand, 32% silt, and 15% clay. Rock fragments compose about 22% by volume (gravel) of this soil horizon. The soil is slightly alkaline with a pH of 7.2 and has an EC value of 0.36 mmhos/cm, soluble calcium concentration of 2.25 meq/l, soluble magnesium concentration of 1.02 meq/l, soluble sodium concentration of 0.38 meq/l, an SAR value of 0.30, an acid/base potential of 115 tons of calcium carbonate/tons of material, a boron concentration of 0.88 ppm, a selenium concentration less than 0.02 ppm, and a water holding capacity of 6.5%.

The B3 soil is underlain by a pale brown (10YR 6/3) to brown (10YR 4/3) C soil horizon. The C soil occurs at 28 inches to at least 9 feet in the area of TP-4 and TP-5. It is typically a gravelly sandy loam to cobbly sandy loam. The sand and coarse fraction increase with depth. A sample of the C horizon was obtained from TP-1 for analysis. The results indicate that the soil is slightly alkaline with a pH of 7.4 and has an EC value of 0.29 mmhos/cm, soluble calcium concentration of 1.59 meq/l, soluble magnesium concentration of 0.89 meq/l, soluble sodium concentration of 0.41 meq/l, an SAR value of 0.37, an acid/base potential of 78 tons of calcium carbonate/tons of material, a boron concentration of 0.12 ppm, a selenium concentration less than 0.02 ppm, and a water holding capacity of 5.3%.

Croydon loam, 8 to 30 percent slopes. This loam has been mapped by the SCS (Jensen, 1988) as being present on the west, north, and east facing slopes of lower Dugout Canyon and it tributaries. According to the SCS (Jensen, 1988), this unit generally consists of a surface layer of dark yellowish brown and yellowish brown loam about 16 inches thick. The subsurface layer is approximately 7 inches of very pale brown loam. The subsoil to a depth of 48 inches is light yellowish brown clay loam over weathered sandstone. Vegetation
typically consists of quaking aspen, blue wildrye, slender wheatgrass, peavine, bearded wheatgrass, and silver sagebrush. The soil is typically found at elevations between 7800 to 9500 feet. A description of the Croydon loam has been included in Appendix 2-2.

Comodore-Datino Variant complex. This soil type appears to be present as inclusions within areas mapped by the SCS (Jensen, 1988) as Croydon loam on the west facing slopes of Dugout Canyon. This unit is 50 percent Comodore very stoney fine sandy loam, moist, 50 to 60 percent slopes; 35 percent Datino Variant extremely stoney fine sandy loam, 40 to 60 percent slopes; and 15 percent other soils. The Comodore soil is on the side slopes while the Datino Variant is on the toe slopes. The Comodore is shallow and well drained. It formed in colluvium derived dominantly from sandstone and shale. The Datino Variant soil is very deep and well drained. It formed in colluvium derived dominantly from sandstone and shale. A description of the Comodore and Datino Variant units has been included in Appendix 2-2.

Rock outcrop-Rubbleland-Travessilla complex. This soil type is present on the east facing slopes of Dugout Canyon and Pace Canyon. It is 35 percent Rock outcrop; 30 percent Rubbleland; 25 percent Travessilla very gravelly fine sandy loam, 30 to 70 percent slopes; and 10 percent other soils. The Rock outcrop is typically exposed sandstone. Rubbleland is areas of stones and boulders that are virtually free of vegetation. The Travessilla soil is shallow and well drained. It formed in residuum and colluvium derived dominantly from sandstone. A description of the Travessilla complex soil has been included in Appendix 2-2.

222.400 Soil Productivity

In areas where soils have been significantly disturbed by previous mining activities, the soils have lost their native identities and now typically contain waste rock and/or coal waste. As discussed in Section 222.300, these soils are referred to as overburden. Analysis of the loam within the overburden indicates that this material, with proper treatment, could be considered as productive soil. As illustrated in Table 2-1, with the exception of the percentage of rock fragments, the overburden has physical and chemical properties that are within the current "acceptable range" for the parameters listed on Table 2, "Overburden Evaluation for Vegetative Root Zone" which is contained in the Division's "Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining" (Leatherwood, 1988). The treatments proposed to improve the productivity of the overburden are discussed in Section 224.

The undisturbed or slightly disturbed soils in the mine area currently sustain good vegetative cover. The results of the soil analyses indicate these soils also have physical and chemical characteristics that are within the Division's "acceptable range" for vegetative root zones (Leatherwood, 1988). Vegetation associated with these soils and the overburden is discussed in Chapter 3 of this M&RP. Refer to Section 321.100 which contains 1996 reported living cover percentages, representative of the productivity of the land prior to this mining operation.

The majority of the soils at the fan portal site have been significantly disturbed by previous activities, the soils have lost their native identities and now typically contain a percentage of coal and waste rock. The site soils to be striped and used as topsoil are representative of the area and there is no evidence of any unusual properties that would cause problems with reclamation revegetation. Vegetation associated with these fan portal area soils is discussed in Chapter 3 of this M&RP and in the report prepared by Mt. Nebo Scientific (April 2004) located in Appendix 3-4.

223 Soil Characterization

The soil survey described in this chapter was performed in accordance with the standards of the National Cooperative Soil Survey.

224 Substitute Topsoil

SCM proposes to use the soils from the water tank area, coal storage area, the sediment pond area and the slope between the sediment pond and facilities pad as substitute topsoil/growth media during reclamation in Dugout Canyon. This material will be used, in conjunction with topsoil salvaged and stored during the operational phase of the mine, for reclamation of the disturbed area. Waste will be segregated from the material. Material heavily contaminated with coal waste will not be used as substitute topsoil but will be properly disposed of. It is anticipated that during the reclamation of the disturbed area, approximately 6,504 CY of substitute topsoil could be generated from the overburden within the facilities areas (Area #1, Plate 2-2). The material from these areas would only be utilized for substitute topsoil after they have been deemed suitable for

use. The suitability of the soils will be determined through sampling and analysis as discussed in Section 233.200. It is important to note that the potential volume of material from this area has not been included in the calculations of available topsoil/growth media presented in Section 242.

The B anc C horizon soils from the area adjacent to the water tank area and west slope of Dugout Creek (Area #2, Plate 2-2), coal storage area (Area #3, Plate 2-2), and the sediment pond area and the slope between the pond and facilities area (Area # 4A, Plate 2-2), will also be used as substitute topsoil material. As discussed in Section 222.400, with the exception of the coarse fragment concentration, the physical and chemical properties of the overburden and B and C horizon soils fall within the current "acceptable range" for substitute topsoil (Leatherwood, 1988). At the time of final reclamation, these soil resources will be supplemented with appropriate fertilizers and amendments (Section 230).

Pace Canyon fan portal site will be reclaimed with soils salvaged at the site prior to construction, as noted above the site is previously disturbed and the majority of the soils contain coal and waste rock.

230 OPERATION PLAN

231 General Requirements

231.100 Removing and Storing Soil Methods

The Dugout Canyon Mine area has been the site of infrequent mining activities since 1925. At the time of the initial disturbances, topsoil was apparently not salvaged. Therefore, only a small percentage of the mine area can be considered undisturbed. As illustrated on Plate 2-2, much of the area is covered with overburden. The methods described for topsoil salvage herein will be followed when removing and storing soil resources necessitated as a result of construction of new surface operations in undisturbed areas.

In the areas designated on Plate 2-2, soil salvage will take place where disturbances are anticipated to occur or where removal of the resource would provide the best method of protection.

Where possible, the removal of salvaged soils will be as follows: the first lift will include the A horizon material (topsoil) and the second lift will include the B and C horizons. Each of these lifts will be stored as noted in Section 231.400. These materials will be stored in stockpiles graded to maximum slopes of 2:1 and seeded to promote surface stabilization. The seed mix to be used will be the interim seed mix described in Chapter 3.

In Area #2 , the operator will endeavor to remove and store as much topsoil and/or substitute topsoil as possible. Material suitable for reclamation removed from this area will be stored in the designated topsoil stockpile.

The soils removed as part of the Dugout Creek culvert construction will be handled by first removing the large or coarse vegetation (i.e. trees and thick shrubs), followed by removal of the topsoil and remaining vegetation, then finally the removal of the underlying horizons. The soils removed during culvert construction and labeled as Area #5 on Plate 2-2 will be stored either separately from soils salvaged from the remainder of the area or within a designated location of the stockpile. Soils present on steep slopes will be removed as part of the culvert construction process only where doing so does not jeopardize the stability of the entire slope within or outside the disturbed area boundary or create safety hazards during culvert installation. Decisions regarding the removal of soil from steep slopes will be made in the field by a qualified soils scientist in agreement with the construction supervisor. This decision will be made based on the steepness of the slope, the potential for slope failure uphill of the disturbed area if soils are removed at the slope toe, and the timing within the construction sequence (i.e. can backfill be placed against the slope immediately after topsoil is removed to support the slope). Additional information regarding the location of the steep slopes and the areas of soil removal associated with the construction of the Dugout Creek culvert is provided in Appendix 2-5. After construction of the culvert, an as-built map will be submitted illustrating the locations where steep slope soils were removed.

In areas where topsoil thicknesses of less than 6 inches are encountered, the topsoil and underlying unconsolidated materials will be removed and stockpiled together, including the soil salvaged in Pace Canyon during construction of the fan portal site. The entire mixture will be treated as topsoil in compliance with R614-201-234.300. The recovery of topsoil and substitute topsoil will be maximized in both disturbed and undisturbed soils.

The substitute topsoil generated during mine construction, as discussed in Section 224, will be treated as topsoil and stored accordingly.

No facilities will be constructed and no soil disturbance is planned in conjunction with the incorporation of the SITLA lease (T13S R13E, Section 29, Portions of Section 17, 20, 21, 28 and 30) into the Dugout Canyon Mine permit area.

231.200 Suitability of Topsoil Substitutes/Supplements

See Section 233.200.

231.300 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation

SCM will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability of topsoil on graded slopes. Erosion control measures will include surface roughing and erosion mat placement on slope areas thought to be unstable. SCM will fill, regrade, or otherwise stabilize any rills or gullies deeper than nine (9) inches which form in areas which have been regraded and topsoiled. The areas adjacent to any rills or gullies which have been filled, regraded or otherwise stabilized, will be reseeded or stabilized accordingly.

Methods used to evaluate success of Revegetation and stabilization are discussed in Chapters 3 and 5.

231.400 Construction, Modification, Use, and Maintenance of Topsoil Storage Piles

Topsoil and substitute topsoil removed from the Dugout Canyon Mine will be transported and stockpiled at the Soldier Canyon Mine soils stockpile area (Plate 2-3). The estimated volumes of topsoil and substitute topsoil to be stockpiled are presented in Table 2-2.

It is anticipated that the pile will be constructed in horizontal lifts of 1.5 to 2.0 feet. Tracked equipment will be used to reduce compaction. As described in Section 231.100, the stockpile will be graded to a maximum slope of 2:1 and seeded to promote surface stabilization. Some of the vegetation removed during the construction of the Dugout Canyon Mine will be incorporated into or placed on top of the stockpile. The interim reclamation seed mix described in Chapter 3 will be used for this purpose. Volume calculations for the amount of topsoil to be removed and placed in the storage pile are included in Appendix 2-6.

The Dugout Canyon Mine topsoil will be labeled and kept separate from the Soldier Canyon Mine soils. A description of the Soldier Canyon Mine topsoil stockpile area can be found in that M&RP. The Soldier Canyon Mine M&RP will be modified to allow for the storage of Dugout Canyon Mine substitute topsoil prior to the transport of the soil. The stockpiles will be isolated from the main surface area to protect the material from contaminants and unnecessary compaction that would interfere with vegetation. A sign will be installed at the base of each stockpile to identify it as a topsoil storage area. The stockpiles will be protected from wind and water erosion by being revegetated with a quick growing vegetative cover (proposed interim reclamation seed mix) and by installing berms and/or silt fence below the stockpiles to help trap sediment coming off the stockpile. These stockpiled soils will not be moved or disturbed until required for redistribution during final reclamation.

Topsoil/growth medium salvaged from the Pace Canyon fan portal site will be stockpiled at the site (Plate PC5-2). Approximately ~~1,900~~ 2,128 cubic yards of topsoil will be stripped from the site. The Topsoil Stockpile has been designed to hold approximately ~~over~~ 2,195 ~~000~~ cubic yards in case additional topsoil is discovered during stripping. Should the quantity of salvagable topsoil exceed the pile designs, the additional soil will be stored at the Dugout Canyon Mine topsoil storage area. Topsoil volume calculations and topsoil stockpile design calculations can be found in Appendix 2-9.

232 Topsoil and Subsoil Removal

232.100 Topsoil Removal and Segregation

All topsoil thicker than 6 inches will be removed as a separate layer from the subsoil, segregated, and stockpiled separately, if necessary. Topsoil less than 6 inches thick will be removed according to Section 232.300.

TABLE 2-2

TOPSOIL AND SUBSTITUTE TOPSOIL VOLUMES

AREA	MATERIAL TYPE	VOLUME
NORTHWEST FACILITIES AREA (AREA 2)	TOPSOIL/OVERBURDEN	1,653 CY
COAL STORAGE AREA (AREA 3)	TOPSOIL/SUBSOIL	4,869 CY
SEDIMENT POND, SLOPE AREA, AREAS BETWEEN ROAD AND CREEK (AREAS 4, 6, 7)	TOPSOIL/SUBSOIL	20,118 CY
WATER TANK AREA (AREA 8)	TOPSOIL/SUBSOIL	247 CY
SLOPE EAST OF COAL STORAGE PILE (AREA 9)	TOPSOIL/SUBSOIL	333 CY
GILSON WATER WELL*	TOPSOIL/SUBSOIL	191 CY
	TOTAL	27,411 CY

* Refer to Appendix 2-8 for volume calculations and location of soil.

Soil from the Dugout Creek channel walls removed during culvert construction will be stored separately from soils removed from other areas within the disturbed area or within designated areas of the stockpile.

If during construction activities additional topsoil is found, this material will be removed and stockpiled for use during reclamation activities. It is likely that material will be found in some areas marked on Plate 2-2 as OB.

As requested by the Division, a non-biased, third party, professional soil scientist will be on-site when available at the Dugout Canyon Mine facilities during soil salvage to monitor and supervise soil salvage operations for the purpose of maximizing soil salvage volumes and quantities.

At the Pace Canyon fan portal site, the topsoil and underlying unconsolidated materials will be removed and stockpiled together. The entire mixture will be treated as topsoil in compliance with R614-201-234.300. The recovery of topsoil/growth medium will be maximized at the site.

232.200 Poor Topsoil

Topsoil that is of an insufficient quantity, or of poor quality (for sustaining vegetation) will be removed as a separate layer and segregated. Such operations will be done with approval of the Division, and in compliance with R614-301-233.100 (Section 233.100).

232.300 Thin Topsoil

Topsoil to be removed that is less than 6 inches thick will be removed with the immediately underlying unconsolidated materials. This material mixture will be treated as topsoil.

232.400 Minor Disturbances Not Requiring Topsoil Removal

Small Structures. Topsoil will not be removed prior to construction that would result in only minor disturbances. Such construction activity includes work on small structures such as power poles, signs, fence lines, and other small structures.

Vegetation. The operator will not remove topsoil for minor disturbances where such activity will not destroy vegetation or cause erosion.

232.500 Subsoil Segregation

The B and C soil horizons removed during construction of the site will be stockpiled as described in Section 231.400.

232.600 Timing

Soil removal will take place after all vegetation that could interfere with soil salvage has been removed. Surface disturbance activities will take place after the topsoil has been removed.

232.700 Topsoil and Subsoil Removal Under Adverse Conditions

In areas of surface disturbance, topsoil and subsoil will each be removed separately and segregated, except where natural conditions render operations hazardous or detrimental to soils outside the disturbed area. ~~The only~~ One location within the permit area where soil is to be removed under adverse conditions is in the area of the culvert. This has been discussed in more detail in Section 231.100.

Conventional Machines. In localities where steep grades, adverse terrains, severe rockiness, limited depth of soils, or other adverse conditions exist that render soil removal and segregation activities using conventional machines hazardous, soils will not be salvaged and stockpiled.

Substitute Topsoil. Importing of substitute topsoil is not anticipated (Section 224). However, it is anticipated that fill will be imported to the site during construction. This material will be sampled and analyzed for acid and toxic characteristics prior to placement. Material found to be acid- and/or toxic-forming will not be imported.

233 Topsoil Substitutes and Supplements

233.100 Overburden Materials Supplementing and/or Replacing Topsoil

Selected overburden materials will be used as a supplement to topsoil during reclamation operations. Where overburden materials are used, the operator commits to demonstrating to the Division prior to topsoil emplacement that the resultant soil is suitable for supporting Revegetation efforts.

233.200 Suitability of Topsoil Substitutes and Supplements

At the time the Dugout Canyon area was first mined, no topsoil was segregated and saved. Topsoil and other fill material was apparently used in construction of the surface facilities pads and roads. Much of the topsoil appears to have been mixed with mining wastes (including the topsoil/growth medium in Pace Canyon). During the construction phase of the Dugout Canyon Mine facilities in Dugout Canyon, this material will be excavated and, where suitable, stockpiled for use as a topsoil substitute/growth media after treatment. The substitute topsoil/growth media will be placed after recontouring of the site has occurred during reclamation activities. The exact quantity of the substitute topsoil/growth media available for use is not known at this time but has been estimated to be at least 27,411 CY. Approximately 1,568 CY of soil will be removed during culvert construction. The majority of this soil will be returned to the channel area during final reclamation and will not be used in other areas unless excess material is available (Appendix 2-6). Soil will be placed in accordance with the methods described in Chapter 5 of this M&RP.

Fill that had been imported as part of the pad and culvert construction activities may be used as backfill against highwall and cutslopes and backfill during portal closure or in depressions to aid in the achievement of AOC. If the imported material is to be used as subsoil, it will be characterized in accordance with the Division's guidelines for topsoil and overburden. This characterization will occur at the time of reclamation.

The topsoil/growth medium salvaged at the Pace Canyon fan portal site will be characterized in accordance with the Division's guidelines for topsoil and overburden. This characterization will occur once topsoil has been salvaged.

233.300 Physical and Chemical Analyses

Physical and chemical analyses of the soil material will be conducted while generating substitute topsoil. Samples of the soils will be obtained after physical segregation has occurred. The rate of sampling will be one sample per every 500 CY (approximate) of material generated. Additional samples maybe obtained if the quality of the soils generated is questionable. This material will be analyzed for the following parameters. Reference Section 233.200 for Pace Canyon information.

pH
Electrical Conductivity (EC)
Saturation Percent
Calcium (soluble)
Magnesium (soluble)
Sodium (soluble)
Sodium Absorption Ratio (SAR)
Total Sulfur
Acid/Base Potential
Total Organic Carbon
Phosphate
Nitrogen (nitrate)

Boron
Selenium
Available Sodium
Exchangeable Sodium
Alkalinity
Total Kjeldahl Nitrogen
Water Holding Capacity
Percent Coarse Fragment, Sand, Silt, and Clay

The applicant will utilize the substitute topsoil for reclamation purposes only subsequent to approval by the Division.

Certification of Reclamation Topsoil Suitability. The suitability of the substitute topsoil will be certified by an approved laboratory in accordance with at least one of the following: Soil Conservation Service published data and technical guides, state agricultural agency, Tennessee Valley Authority, BLM - USFS published data, physical and chemical analyses results, field-site trials, or greenhouse tests.

233.400 Testing of Substitute Topsoil

Only the substitute topsoil used in lieu of, or in conjunction with, on-site overburden and topsoil will be tested as described in Section 233.300. Hereafter, references to topsoil will include substitute topsoil unless noted otherwise.

234 Topsoil Storage

234.100 Topsoil Stockpiling

Topsoil removed will be stockpiled for later use in reclamation operations when it is impractical to promptly redistribute the topsoil on regraded areas.

234.200 Stockpiled Topsoil

Stable Stockpile Site. Stockpiled materials will be placed on a stable site as described in Section 231.400.

Protection from Contaminants and Compaction. Stockpiled topsoil/growth media will be protected from contaminants and unnecessary compaction. To protect the topsoil/growth media from contaminants and unnecessary compaction that could interfere with vegetation, the stockpiles will be isolated ~~with no means of access from the main surface area~~ (Section 231.400). A topsoil storage sign will be installed at ~~the base of~~ the stockpiles.

Soils removed from the Dugout Canyon Mine will be stockpiled in the Soldier Canyon Mine topsoil stockpiles. The Dugout Canyon Mine soil stockpiles will be constructed in such a manner as to allow equipment access to the existing Soldier Canyon Mine soil stockpiles without causing disturbance to the Dugout Canyon Mine soils. Specifically, the piles will be separated by a distance great enough for equipment to access any stockpile. Furthermore, a continuous berm will be constructed around the stockpile to further separate the soils from the two mines. The berm will be constructed as specified in Appendix 7-9.

Cheat grass has apparently invaded much of the area adjacent to the designated Dugout Canyon Mine stockpile area. The operator will endeavor to maintain, to the extent possible, the stockpile's interim vegetation in a noxious weed- and cheatgrass-free state. Measures that can be taken to ensure this include treating areas with a commercially available selective herbicide that targets

undesirable weeds and/or grasses. If infestations of undesirable vegetation are extensive, treatment of the infested areas with nonselective systemic herbicides may be necessary. If the later case occurs, the areas treated will be reseeded with the appropriate interim seed mix designated for the stockpile and/or adjacent disturbed area. Additionally, application of pre-emergent herbicides may be necessary to control cheatgrass and/or noxious weeds. Since pre-emergent herbicides can stop the germination of desirable vegetation, reapplication of these species may be necessary. The proper treatment method of the infested areas will be discussed with the Division prior to implementation.

Wind and Water Erosion Protection. All stockpiles will be protected from wind and water erosion by prompt establishment and maintenance of a vegetative cover. Berms will be constructed around the stockpile to help trap sediment runoff from the stockpiles.

The Pace Canyon fan portal site topsoil stockpiles will have a full containment berm (constructed of subsoil) around it capable of holding the 10-year, 24-hour storm event. The design of this full containment berm can be found at the end of the calculations in Appendix 7-12.

Topsoil Redistribution. All stockpiled soil will not be moved until redistributed during reclamation operations unless approved by the Division.

234.300 Topsoil Stockpile Relocation

Stockpiled soil in jeopardy of being detrimentally affected in terms of its quantity and quality by mine operations may be temporarily redistributed upon approval by the Division and modification of this M&RP.

Host Site. Soil relocation may occur provided that such action does not permanently adversely affect topsoil of the host site.

Topsoil Suitability. Stockpiled soil relocation may occur provided the material is retained in a condition more suitable for redistribution than if stockpiled.

240 RECLAMATION PLAN

241 General Requirements

Topsoil redistribution, amendments, and stabilization are discussed in Sections 242, 243, and 244, respectively.

242 Soil Redistribution

242.100 Soil Redistribution Practices

Within the disturbed area, any contaminated surface soil will be removed and stored during the final reclamation process. If the contaminated soils can not be rehabilitated, the material will be buried along with ~~excess gravels, crushed stone, or~~ other contaminants. All backfill placed prior to topsoil and substitute topsoil spreading will be ripped or loosened by the methods described in this section and in Section 341.200 of this M&RP.

Soil previously removed from the Dugout Creek channel walls during culvert construction will be returned to the channel area during final reclamation, to the extent possible. If after construction and resoiling of the channel area an excess of "channel" soil exists, it will be appropriately distributed within the disturbed area to increase topsoil thicknesses.

Soil Thickness. The Dugout Canyon topsoil will be distributed to the disturbed areas illustrated on Plate 5-5. Topsoil will not be distributed on the primary road or the floor of the stream channel. During reclamation, the topsoil will be allowed to settle and attain equilibrium with its natural environment. This procedure will be followed for all areas in which facilities such as ancillary road beds, mine pads, and building sites are to be abandoned.

Based on the results of the sampling and analysis of soil test pits TP-1, 4, 5, 6, 7, 8, and 9 and the description of pits 14 and 14A, approximately 27,411 CY of topsoil/growth media will be available to be distributed on reclaimed surfaces within the disturbed area boundary (Appendix 2-6). An estimated 14.7 acres within the disturbed area will receive topsoil. Based on the estimated quantity of available topsoil and the area to be covered, approximately 13.8 inches of topsoil will be placed in the reclaimed areas.

The Pace Canyon topsoil will be distributed to the disturbed areas illustrated on Plate PC5-5. Topsoil will not be distributed on the realigned road segment. The area above the portal and the channel diversion area will have topsoil stripped and stockpiled immediately adjacent to these areas temporarily. This topsoil will be surrounded with a silt fence for protection until the soil can be replaced, mulched, gouged and reseeded. The replacement will immediately follow the completion of construction of the portal and channel diversion. Plate 7-5A in Appendix 7-12, shows the location of soil/vegetation treatments at the fan facility.

Compaction. To prevent compaction of topsoil, soil moving equipment will refrain from unnecessary operation over spread topsoil. Front-end-loaders and other wheel mounted equipment may be used to transport and dump topsoil. However, to minimize compaction, only track-mounted equipment (e.g. bulldozers, trackhoes) will be used to spread the topsoil. The topsoil will be loosened prior to seeding as described in Section 341.200 of this M&RP.

Erosion. Care will be exercised to ensure the stability of topsoil on graded slopes to guard against erosion during and after topsoil application. Erosion control measures may include but not be limited to surface roughing and deep gouging.

242.200 Regrading

Since the Dugout Canyon mine area has been disturbed by previous mining activities, there are no private or public topographic maps which can be used to accurately determine the original

geometric configuration of the canyon. Prior to topsoil redistribution, the disturbed area in Dugout and Pace Canyon will be regraded to agree with final reclamation topography (Chapter 5).

~~Where possible, regraded land will be scarified by a ripper-equipped tractor or other appropriate equipment.~~ The surface will be ripped to between 6 and 24 inches where possible to reduce surface compaction, provide a roughened surface to assure topsoil adherence, and promote root penetration.

On slopes too steep to accommodate contour ripping with a tractor or other appropriate equipment, the surface will be roughened to between 6 and 24 inches with the teeth of a trackhoe bucket.

In the area of Dugout Creek, the soils removed during culvert construction will be returned and placed along the slopes of the reclamation channel. Where dictated by the design of the reclamation channel, the soils will be placed within the interstitial spaces of the riprap to promote the establishment of riparian vegetation. The soils placed outside the riprap portion of the channel area will be reseeded with the appropriate seed mix following soil preparation and roughening.

242.300 Topsoil Redistribution on Impoundments and Roads

The sedimentation pond and embankment will be dismantled and reclaimed with the other surface disturbed areas. Similarly, reclamation of abandoned roads will also follow the same technique as for other disturbed areas, except as noted.

243 Soil Nutrients and Amendments

Soil nutrients and amendments will be applied to the redistributed soil as necessary, to establish the vegetative cover. The type and rate of application will be determined just prior to final reclamation activities based on analyses of samples collected from the stockpiled topsoils and substitute topsoils. The soils will at a minimum, be tested for pH, EC, total carbon, SAR, potassium, nitrate-nitrogen, and water holding capacity.

244 Soil Stabilization

244.100 Protection and Stabilization of Surface Areas

All reclaimed areas will be stabilized to control erosion by application of mulch, surface gouging, ~~contour furrowing,~~ or other appropriate methods. Rills and gullies will be regarded. Reseeding will be accomplished using BTCA methods suitable for steep slope reclamation. Additional and more detailed discussions regarding topsoil protection during and after final reclamation can be found in Chapter 5. Methods of Revegetation to be employed at final reclamation at this site are discussed in more detail in Chapter 3.

244.200 Mulch Application

Mulch will be applied to all areas that have been regraded and covered with soil to stabilize the topsoil. For further discussion of Revegetation practices to be utilized, see Chapter 3 of this M&RP.

244.300 Rills and Gullies

Postmining Land Use and Revegetation. Rills and gullies that disrupt the postmining land use or reestablishment of vegetative cover will be regraded, the topsoil replaced, and reseeded.

Water Quality. Rills and gullies that contribute to the degradation of stream quality will be regraded, receive new topsoil, and be revegetated.

250 PERFORMANCE STANDARDS

251 Topsoil, Subsoil, and Topsoil Supplements Management

All topsoil, subsoil, and topsoil supplements shall be managed as outlined in Sections 230 and 240.

252 Stockpiled Topsoil and Subsoil

All stockpiled topsoil and subsoil will be managed according to plans outlined in Sections 230 and 240.

REFERENCES:

Jensen, E. H., and Borchert, J. W., 1988. Soil Survey of Carbon Area, Utah. Soil Conservation Service, United States Department of Agriculture, Washington D.C.

Johnson, Wm. M., 1975, Soil Taxonomy, A Basic System of Soil Classification For Making and Interpreting Soil Surveys, Supt. of Doc. S.C.S., Washington, D.C.

Leatherwood, J., and Duce, D., 1988. Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining. State of Utah Department of Natural Resources, Division of Oil, Gas and Mining.

APPENDIX 2-9

Pace Canyon Fan Facilities
Topsoil and Storage Pile Calculations

Topsoil Calculations

General

- The outslopes of the topsoil stockpiles and berms are assumed to be 1:1. The angle of repose for soils in this area are in excess of 50°. Thus, the assumption is valid. Topsoil stockpiles for the Degas holes have successfully been built using 1:1 slopes.

- This site has been previously disturbed. Thus, topsoil resources are limited. One foot of topsoil will be stripped and stockpiled from areas impacted by construction with the exception of the current road area and areas only temporarily disturbed. Such as the area impacted by portal construction. (See Plate PC7-5A)

- Berms will be constructed of subsoil not topsoil.

- Topsoil stripped from temporarily disturbed areas will be stockpiled separately. This topsoil will be protected with silt fences until it is replaced, mulched, gouged and reseeded. These areas include the area above the portal and channel diversion area.

- The topsoil stockpiles will be designed to hold more than the projected volume to insure proper storage if additional topsoil is found.

Ave. topsoil depth = 12"

Area to be stripped of topsoil = 57,460 ft^2

Volume of topsoil = (57,460 ft^2)(1 ft) = 57,460 ft^3 = 2128 CY

The Average End Area method will be used to estimate the volume in the topsoil stockpiles. The areas used in the calculation were generated in AutoCad using 1 foot contours

Shaft Area Topsoil Stockpile

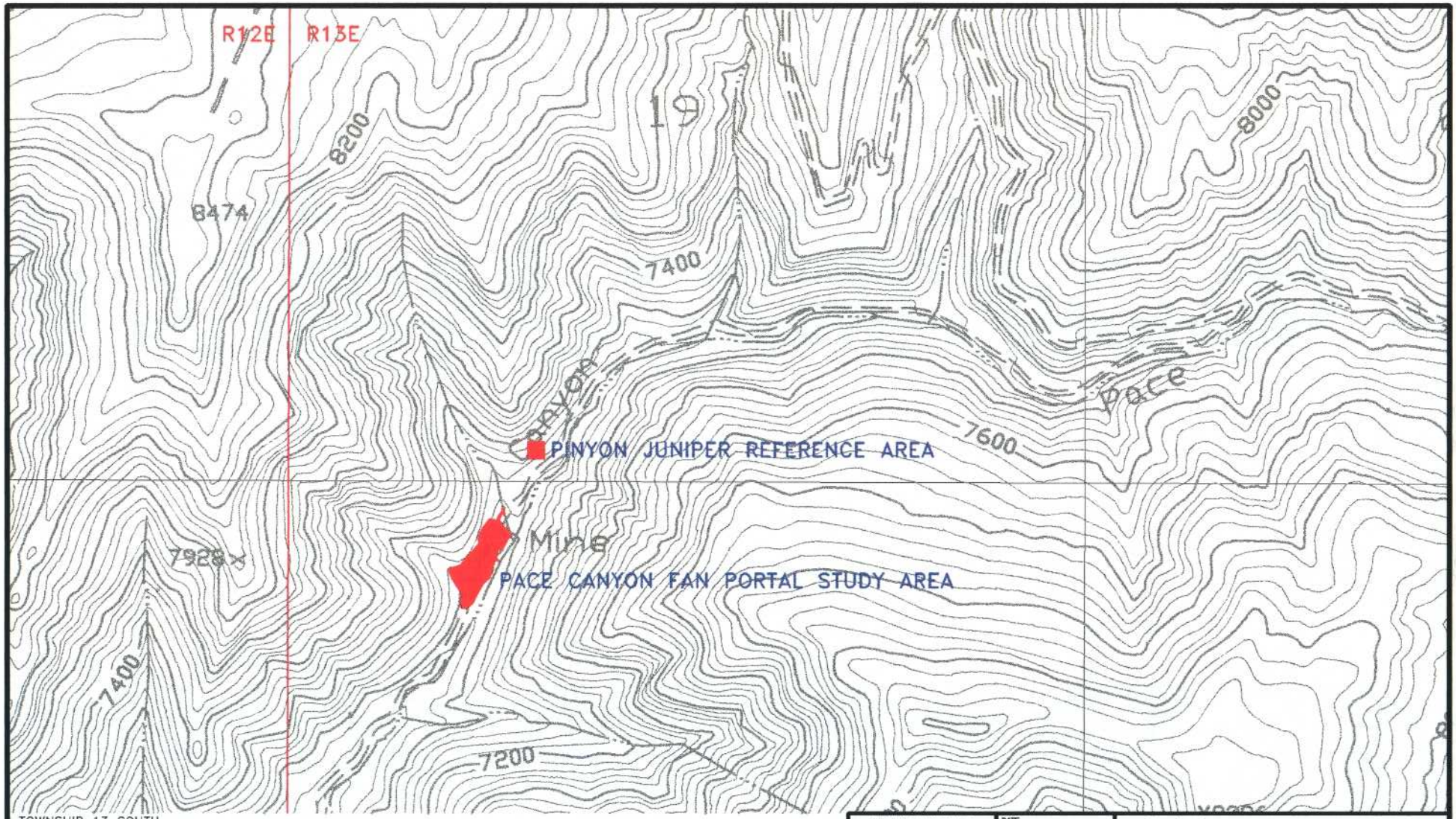
Elevation (ft)	Area (ft^2)	volume (ft^3)
7028	0	
		87
7029	174	
		278
7030	381	
		483
7031	585	
		654
7032	723	
		841
7033	958	
		1035
7034	1111	
		1197
7035	1282	
		1298
7036	1314	
		1313
7037	1312	
		1300
7038	1290	
		1264
7039	1238	
		1210
7040	1182	
		6415
7045	1384	
		6813
7050	1341	
		5923
7055	1028	
		4013
7060	577	
		34,123 ft^3 ⇒ 1264 CY

Portal Area Topsoil Stockpile

Elevation (ft)	Area (ft^2)	Volume (ft^3)
7016	6	
7017	72	36
7018	229	301
7019	357	293
7020	443	400
7021	538	491
7022	653	596
7023	769	706
7024	889	829
7025	1030	959
7026	1273	1152
7027	1384	1328
7028	1488	1436
7029	1658	1573
7030	1886	1772
7031	1855	1870
7032	1804	1829
7033	1744	1774
7034	1672	1708
7035	1591	1632
7036	1494	1543
7037	1381	1437
7038	1256	1318
		24,983 ft^3 ⇒ 925 CY

Total Stockpile capacity = 1,264 CY + 925 CY = 2,189 CY

These topsoil stockpiles will be difficult to build. If there is more topsoil than can be stored in the stockpiles some topsoil may be stored at the Dugout Canyon mine topsoil stockpile.



NOTE:

VEGETATION AT THE DUGOUT CANYON MINE PROPOSED FAN BREAKOUT AREA, 2003, MT. NEBO SCIENTIFIC, INC.

REGISTERED PROFESSIONAL ENGINEER
No. 169707
LAYNE D. JENSEN
7-7-05
STATE OF UTAH

REVISIONS OR UP-DATES		
NO.	DATE	BY
1	1-26-05	LDJ

DATE:	11-17-04
DESIGNED BY:	LDJ
DRAWN BY:	SWF
CHECKED BY:	VSM
SCALE:	1"=1000'

FILENAME: G:\UC801\07\PERMIT DWG\PLATE3-1E.DWG\11-17-04

Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN VEGETATION AND REFERENCE AREA

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE 3-1E

EarthFax Engineering, Inc.

CHAPTER 5

ENGINEERING

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Cross sections of the proposed surface facilities are provided on Plate 5-3 and Figure 7-9-2 (Appendix 7-9). The disturbed area shown on Plate 5-2 is the same as the land area for which a performance bond or other guarantee has been posted.

Under the currently approved construction plan, several areas within the existing disturbed area boundary will not be significantly disturbed during site construction. The first such area consists of 0.08 acres located on the hillside west of the portal pad, north of the substation access road, and east of the storage area adjacent to that road. The second such area consists of 0.13 acres located on the hillside above the mine haulage/manway portal. Each of the above areas is located on a hillside above the area of actual disturbance.

Plate PC5-2 in Appendix 5-10 shows the layout of the Pace Canyon Fan Portal Site. Cross sections of this facility are also shown on this map. Figure PC-2 in Appendix 5-10 depicts the Gilson seam mine planned workings. (February 2005). Facilities at the Pace Canyon Fan Portal Site will include:

- Portals - see Section 529,
  Fan Shaft - 18 foot diameter shaft,
  Fan - metal structure containing a fan,
  Transformers - metal structure sitting within a concrete containment structure,
  Emergency Generators - two trailer mounted generators sitting within a concrete containment structure,
  Fuel Storage Tank - Tank sitting within a concrete containment structure adjacent to the generators,
  Sediment Trap - see Appendix 7-12.

Transportation Facilities. Roads that will be constructed, used, or maintained by SCM in the permit area for the mining and reclamation operations are shown on Plate 5-2. No rail systems or overland conveyor systems (other than the material-handling conveyors in the mine yard) will be associated with the permit area. Drainage structures associated with the roads are discussed in Section 752.200 of this M&RP. Typical cross sections of the primary roads are provided on Figure 5-1. Refer to Sections 527.100 and 527.200 for additional information concerning roads to be used during the mining operation. As shown on Plate PC5-2 the existing road in Pace Canyon will be realigned to allow construction of the facility. However, after construction is complete the realigned

road will be treated the same as the rest of the road. A typical cross-section of the realigned road is provided in Appendix 5-10.

A draft environmental assessment (EA) was prepared by the BLM for the Pace Canyon Fan facilities, however OSM and BLM determined a final EA was not required (e-mail, January 24, 2005). BLM comments associated with the proposed fan facilities will be submitted to UDOGM following their review of the M&RP (Personal communications, January 31, 2005, between Vicky Miller (Canyon Fuel Company), David Spillman (Dugout Canyon Mine) and Stan Perks (BLM).

Three material handling conveyors will be constructed on the surface at the mine site. As noted on Plate 5-2, the mine conveyor will transport coal from the mine to the coal stock pile. The reclaim belt will convey coal from the stock pile (via a reclaim tunnel) to the crushing facility. The loadout belt will convey coal from the crusher to the truck loading bin, from which the coal will be loaded into trucks for off-site transport. Each conveyor will be of sufficient size to handle the production levels coming from the mine and the anticipated truck loading rates. Conveyor widths will range from 42 to 60 inches.

Other Relevant Information. Information regarding the BLM surface lease in NW¼ SW¼ Sec. 23, T. 13 S., R. 12 E. is provided in Appendix 1-3. A legal description of the permit boundaries is provided in Section 114 of this M&RP.

521.200 Signs and Markers

Mine and Permit Identification Signs. A mine and permit identification sign will be displayed at the point where the county road ends and the private road enters the surface-facilities area, and at all other possible entrances to the mine site. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area. The sign will contain the following information:

with the associated contaminated soil and disposed of at a state-approved facility that is permitted to receive such waste. Adequate spill collection materials (including absorbents to stop or contain contaminants that may enter a stream) will be readily available at the site during these activities to contain any such spills.

During construction and other activities at the site, wet concrete will not be allowed to enter or come into contact with stream flows. Any water at the site which is contaminated with wet concrete or other contaminants will not be discharged into stream channels. Concrete trucks and other equipment used in the mixing and placement of concrete will be washed in areas well away from stream channels.

The air shaft constructed at the Pace Canyon Fan site will either be lined with concrete or steel.

526.200 Utility Installation and Support Facilities

Utility Installations. All coal mining and reclamation operations will be conducted to minimize damage, destruction, or disruption of services provided by electric lines, telephone transmission stations, water lines, and sewer lines which pass over, under, or through the permit area. Areas where these utilities will be located are within non-subsidence zones. No other utility installations exist in the permit area. All utility installations associated with the Dugout Canyon Mine will be removed following mining in accordance with the reclamation plan discussed in Section 540 of this M&RP.

At the Pace Canyon Fan facilities, the fan will operate on electricity transported through the mine. A building with a concrete floor and side walls would be constructed to house the fan's backup diesel generators and a 8,000 gallon diesel fuel storage tank. The concrete building is designed to contain the contents of the 8,000 gallon diesel tank and the spillage of other hydrocarbons within the building (refer to Section 526.200 for cleanup and disposal information). The diesel generators would be linked to the fan via conduit capable of housing the electrical supply and relay devices.

Underground Development Waste. Underground development waste which is generated at the Dugout Canyon Mine will be disposed of either:

- Underground within the Dugout Canyon Mine (without bringing this waste to the surface);
- At the approved temporary waste-rock storage site at the Banning Loadout;
- At the approved waste-rock disposal facility at the Dugout Canyon Mine, SUFCo Mine and Skyline Mine.

Descriptions of the waste-rock disposal facilities at the Dugout Canyon Mine (Refuse Pile Amendment, February 2003), SUFCo Mine and the Skyline Mines are provided in their respective M&RPs. A discussion of the disposal of underground development waste in the underground workings of the Dugout Canyon Mine is provided in Section 536.500 of this M&RP.

Material such as subsoil and rock generated during construction of the shaft and portal at the Pace Canyon Fan Site will be used to construct the site. The layout for the shaft and portal has been designed to avoid oxidized or burnt coal, however should it be encountered during construction these materials will either be hauled to a waste rock facility for permanent disposal or stored underground, upon approved by MSHA. Refer to Section 536.500 for additional discussion. ~~This material will be used to backfill the portal and shaft during reclamation.~~

Minimization of Acid, Toxic, and Fire Hazards. Data presented in Chapter 6 indicate that neither acid- nor toxic-forming materials are present in the overburden, underburden, or coal. These conclusions are supported by the data contained in Appendix 5-7 and RA Attachment 5-4 (Refuse Pile Amendment), which provides the results of analyses of waste-rock materials. Should an acid- or toxic-forming problem with the waste rock be identified during future sample collection, those materials so identified will be buried within 30 days after the material is exposed at the mine site.

As noted previously in this section, temporary storage of debris generated at the mine will be in a dumpster. As a result, this debris will be protected from the wind and other elements. Because debris that is generated at the mine site will be only temporarily stored at the mine prior to off-site disposal, there is no significant potential for this debris to spontaneously combust. Fire extinguishers will be kept on mobile equipment in the mine yard to extinguish any fires should combustion of the waste materials occur. No waste materials that constitute a fire hazard will be accumulated in the permit area. No hazardous materials, as defined in 40 CFR, will be disposed of underground. These materials will be disposed of in accordance with all applicable state and federal regulations.

528.400 Dams, Embankments, and Impoundments

No dams, embankments, or impoundments will be used for the handling or disposal of coal, overburden, excess spoil, or coal mine waste in the permit area.

529 Management of Mine Openings

It is currently anticipated that five underground mine openings will be associated with the Rock Canyon and Gilson Seams. A portal and shaft will be constructed into the Gilson seam at the Pace Canyon Fan Portal Site (see Plate PC5-2 in Appendix 5-10). The primary purpose of the shaft and portal will be for ventilation. The portal will also be used as an emergency escape way. A fence will be installed to surround the Pace Canyon Fan facilities to assist in managing the mine openings, refer to Figure PC-3 in Appendix 5-10 for the approximate location of the fence. Should additional protection become necessary at the Pace Canyon Portal opening, a gate across the portal entrance will be installed. Additional openings into the Gilson Seam may be planned in the future but are not part of this M&RP.

Locations of the Rock Canyon portals are shown on Plate 5-2. One of these openings will serve as primary pathway for ingress and egress of personnel and machinery, one will serve as a beltway for removal of coal from the mine, and one will be used for mine ventilation. The

- Removal of the pad upon which surface activities will be constructed at the mine, thereby creating a slope which will adequately drain while minimizing long-term erosion concerns;
- Backfilling to remove highwalls within the objectives noted above (cut and fill balance, site stability, and erosion control),
- Construction of stable channels across regraded areas;
- Placement of topsoil;
- Revegetation and mulching of the topsoiled site; and
- Removal of the sedimentation pond and sediment trap (together with accompanying regrading, topsoiling, revegetation, and mulching of the sedimentation pond area) and implementation of interim sediment-control measures.

The estimated cut quantity for the Dugout Canyon facility is approximately 97,575 cubic yards with an estimated fill of 99,630 cubic yards (see Appendix 5-5). The difference between these two quantities is anticipated to be balanced by compaction and the import of topsoil from the stockpile. Regrading activities will continue until the final surface configuration defined by Plates 5-5 and 5-6 is approximated. Details regarding topsoil placement and revegetation following regrading are provided in Chapters 2 and 3, respectively.

The estimated cut quantity for the Pace Canyon Fan Portal Site is approximately ~~5,069~~ 6,361 cubic yards with an estimated fill of ~~5,262~~ 6,287 cubic yards. These values include ~~1900~~ 2,128 cubic yards of topsoil being placed on the surface and approximately ~~667~~ 972 cubic yards of material being used to backfill the portal and shaft (refer to Section 542.700 for additional sealing information). The difference between these two quantities is anticipated to be balanced by swell of the cut material. Regrading activities will continue until the final surface configuration defined by Plate PC5-5 in Appendix 5-10 is approximated. Details regarding topsoil placement and revegetation following regrading are provided in Chapters 2 and 3, respectively.

Roads within the disturbed area have been designed with a width of 16 to 20 feet (see Section 527.200). The main canyon access road up- and downstream from the proposed disturbed area has a current width which generally ranges from 16 to 25 feet, averaging approximately 20 feet. Hence, post-reclamation retention of a road with a width of 16 to 20 feet will be compatible with adjacent roads, including those roads upstream from the disturbed area which will not be altered by mining activities. Therefore, this road width is considered appropriate for the post-mining land use.

542.700 Final Abandonment of Mine Openings and Disposal Areas

Abandonment of Openings. All mine openings (including Pace Canyon portal) will be sealed at least 25 feet inside the mine opening. Prior to installation of the seal, all loose material will be removed from the roof, floor, and rib of the mine within 3 feet of the seal area. The seal will then be constructed using solid concrete blocks (average minimum compressive strength of 1,800 psi) with nominal dimensions of 6 inches high, 8 inches wide, and 16 inches long. Mortar will consist of one part cement, three parts sand, and no more than 7 gallons of water per sack of cement.

The seal will be recessed at least 16 inches deep into each rib and 12 inches deep into the floor. No recess will be made into the roof. In the bottom course, each block will be laid with its long axis parallel to the rib. The long axis in succeedingly higher courses will be perpendicular to the long axis of the blocks in the preceding course. An interlaced pilaster will be constructed in the center.

The seals will have a thickness of approximately 16 inches. Following seal construction, the entries will be backfilled from the seal to the outside surface with soil that is sloped at the surface to match the final slope at the entry. The soil will then be raked and revegetated with the approved seed mixture (see Chapter 3).

Alternatively, a cast-in-place MSHA approved seal will be installed with a minimum thickness of 3 feet and with a minimum compressive strength of 200 psi.

APPENDIX 5-9

Dugout Canyon Mine Blasting Plan

BLASTING PLAN
PACE CANYON

LOCATION: Pace Canyon, approximately 7 miles east of Wellington, Utah and approximately 11 miles north of State Hwy 6 &50

CFC has determined that it is necessary to enhance the mine ventilation system of the Dugout Canyon Mine. The proposed enhancement is an eighteen to twenty foot diameter air shaft having a developed depth of approximately seventy feet. The shaft will connect the underground mine workings and the surface ventilation fan ducting. The shaft will be developed in native sandstone of the Blackhawk formation.

There are no structures within ½ mile of the blast site which would require protection. There are no dwellings, public buildings, schools, churches, or community or institutional building within 1000 feet of the blast area. Therefore, there is no need to notify residents or owners of dwellings in writing relative as to how to request a pre-blast survey.

Although there are no residents within one-half mile of the blast site, the permittee will notify the adjacent landowners (Trustee of Milton and Ardith Thayn Trust) and the Carbon County Sheriff's Office via a written notification indicating the proposed times for blasting. Following initiation of the blasting process, those listed above will be notified at least 24 hours prior to blasting via telephone communication. A record of that telephone notification will be maintained for inclusion in the blasting record.

Access control measures mandated under R645-301-524.530 will involve placing traffic control personnel one half mile above and below the blast site on the Pace Canyon road, and underground in the Dugout Canyon Mine a minimum of 1,000 feet from the blast site. These individuals will stop livestock, unauthorized personnel, and CFC mine personnel from venturing into the blasting area.. All areas will post "blasting signs" meeting the criteria of R645-301-524, et al. Following the blast, the Utah certified coal mine surface blaster, or the Industrial Commission of Utah certified mine foreman or firebosswill examine the blast site for unusual hazards (R645-301-524.531) such as imminent slides, or charges not detonated, and that access to and travel within the blasting area can be safely resumed (524.532). A record of that underground examination will be made as designated by regulation.

The fan portal blasting activities will be conducted within 500 feet of an active coal mine and if applicable, both UDOGM and MSHA will authorized the blasting. A blast design narrative addressing UDOGM and OSM regulations (R645-301-524.212 and 30 CFR 780.13(c) and 816.61 (d) (1) (ii)) is provided below.

R645-301-524.100 through R645-301-524.700 apply to surface blasting activities incident to underground coal mining, including, but not limited to, initial rounds of slopes and shafts. Thus the requirements of the aforementioned UDOGM regulations are pertinent to the first two six foot development rounds in the shaft. At the depth of 12 feet, the 30 CFR Part 75 regulations become applicable. These regulations include requirements for ventilating the working face.

A blast pattern design has been prepared which will give adequate results for the development of a eighteen to twenty foot diameter air shaft. The design was determined based upon a final circular dimension of twenty feet, including either a concrete or metal lining in the shaft.

Each blast round will break approximately six feet of material; twelve to fourteen rounds will be needed to break through to the underground works. In order to do this, an inverted cone of rock will be outlined using eight holes having a diameter of one and five-eights inch. Each of eight holes will be started approximately 5 feet from center, and will be drilled on a twenty-seven degree angle toward center for a total depth of 6 3/4 feet. The hole bottom will be no closer than eighteen inches to any other hole bottom, meeting the requirement of 30 CFR 75.1315, paragraph (c). The inverted cone can also be referred to as a "pyramid cut". The purpose of the pyramid cut is to eliminate the need for a large diameter borehole in the center of the entry or "burn hole". This in turn reduces equipment requirements.

Approximately 17 inches from the top of the pyramid cut holes, eight "first relievers" will be developed angled slightly towards the cent of the shaft. Seventeen inches from the circle outlined by the first relievers, a circle of sixteen holes will be drilled to a six foot depth, in a vertical fashion. These are the "secondary relievers".

Seventeen inches from the "secondary relievers" are the "trim holes", which will be nine inches from the outside arc of the cut. There will be twenty-eight trim holes, each having a six foot depth. The hole will be angled out at the bottom, at about seven degrees from vertical, such that the bottom of the hole is at the outside radius of the cut, (extended from the vertical side of the developed hole).

The explosive used will meet the following specifications;

1. a MSHA "permissible explosive", approved for the specific type of blasting,
2. cartridge type, approximately 11/4 inches in diameter, eight inch long and with a uniform density of approximately 7.27 ounces per cartridge.

There should be no flyrock generated by the construction blasts being used to develop the Pace Canyon air shaft because all boreholes will be stemmed with noncombustible material.

The amount of explosives which will be used per round to develop the air shaft in Pace Canyon is minuscule compared to the magnitude of blasts which are the intent of the R645-301-524 regulations.

Various forms to be used in association with blasting are presented below.

DUGOUT CANYON MINE
PACE CANYON FAN PORTAL FACILITIES - BLAST DESIGN

TYPE OF MATERIAL: _____
TYPE OF BLASTING CAP: _____
TYPE OF PRIMER: _____
TYPE OF EXPLOSIVE: _____
SIZE OF HOLE: _____
DEPTH OF HOLE: _____
BURDEN: _____
STEMMING: _____
SEQUENCE: _____
BLASTER'S NAME (PRINT): _____
BLASTER'S SIGNATURE: _____

CROSS SECTION OF CRT

USE OF EXPLOSIVES
RECORDS OF BLASTING OPERATIONS

NAME OF OPERATOR CONDUCTING THE BLAST:	DATE AND TIME OF BLAST:
DURATION:	LICENSE NUMBER:
SIGNATURE OF BLASTER IN CHARGE:	
DIRECTION AND DISTANCE FROM NEAREST BLAST HOLE TO THE NERAEST DWELLING, PUBLIC BUILDING, SCHOOL, CHURCH, COMMUNITY OR INSTITUTIONAL BUILDING OUTSIDE PERMIT AREA.	
WEATHER CONDITIONS:	
WIND DIRECTION AND APPROXIMATE VELOCITY:	TEMPERATURE:
NUMBER OF HOLES, BURDEN AND SPACING (Sketch Below)	TYPE OF MATERIAL BLASTED:
DIAMETER AND DEPTH OF HOLES:	TYPES OF EXPLOSIVES USED:
TOTAL WEIGHT OF EXPLOSIVES USED:	MAXIMUM WEIGHT OF EXPLOSIVES DETONATED WITHIN ANY 8-MILLISECOND PERIOD:
INITIATION SYSTEM:	TYPE AND LENGTH OF STEMMING:
MATS OR OTHER PROTECTION USED:	
IF APPLICABLE:	
TYPE OF SEISMOGRAPHIC INSTRUMENT, SENSITIVITY, AND CALIBRATION SIGNAL:	
EXACT LOCATION OF INSTRUMENT:	DATE, TIME AND DISTANCE FROM BLAST:
NAME OF PERSON AND COMPANY TAKING READING:	
NAME OF PERSON AND COMPANY ANALYZING RECORD:	
VIBRATION AND/OR BLAST LEVEL RECORDED:	
REASON FOR SCHEDULED BLAST:	
SKETCH OF BLAST PATTERN:	

DUGOUT CANYON MINE
P.O. BOX 1029
WELLINGTON, UT 84542
TELEPHONE: (435) 637-6360

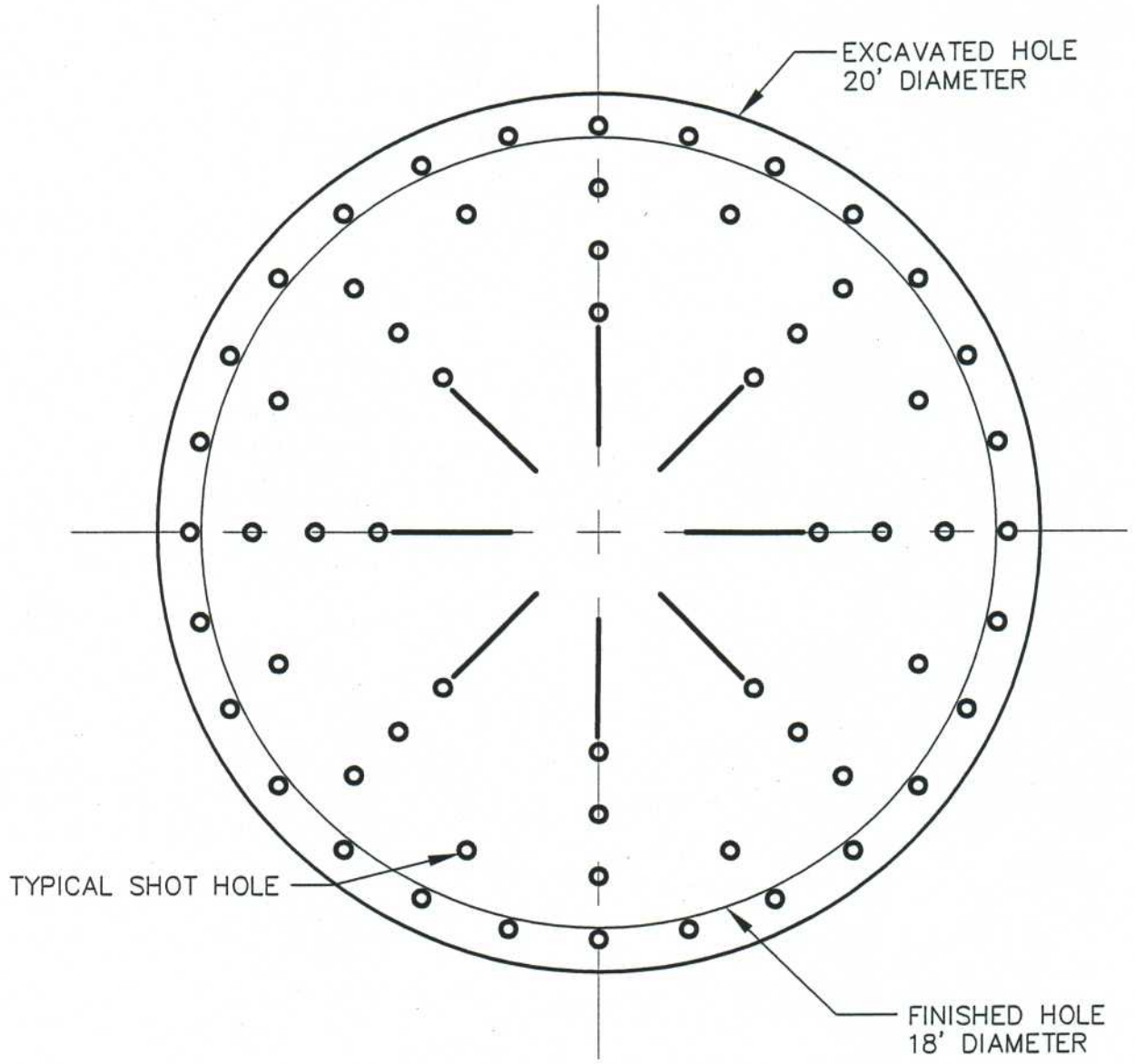
BLASTING SCHEDULE

DATE TIME PERIOD

INFORMATION TO BE COMPLETED ONCE BLASTING SCHEDULE IS DETERMINED.

The blasting site is located in Pace Canyon, approximately 7 miles east of Wellington, Utah and approximately 11 miles north of State Hwy 6 &50. An area will be blasted to establish a shaft to the Dugout Mine's underground workings in the Gilson Coal Seam.

Audible Signals: Warning: Three short horn blasts. All Clear: One long horn blast.



NOTES:

1. PATTERN MAY VARY WHEN EXCAVATION NEARS THE BOTTOM OF THE SHAFT.
2. SHOT HOLES ARE 6' TO 7' DEEP DEPENDING ON DRILLING ANGLE.

NOT TO SCALE

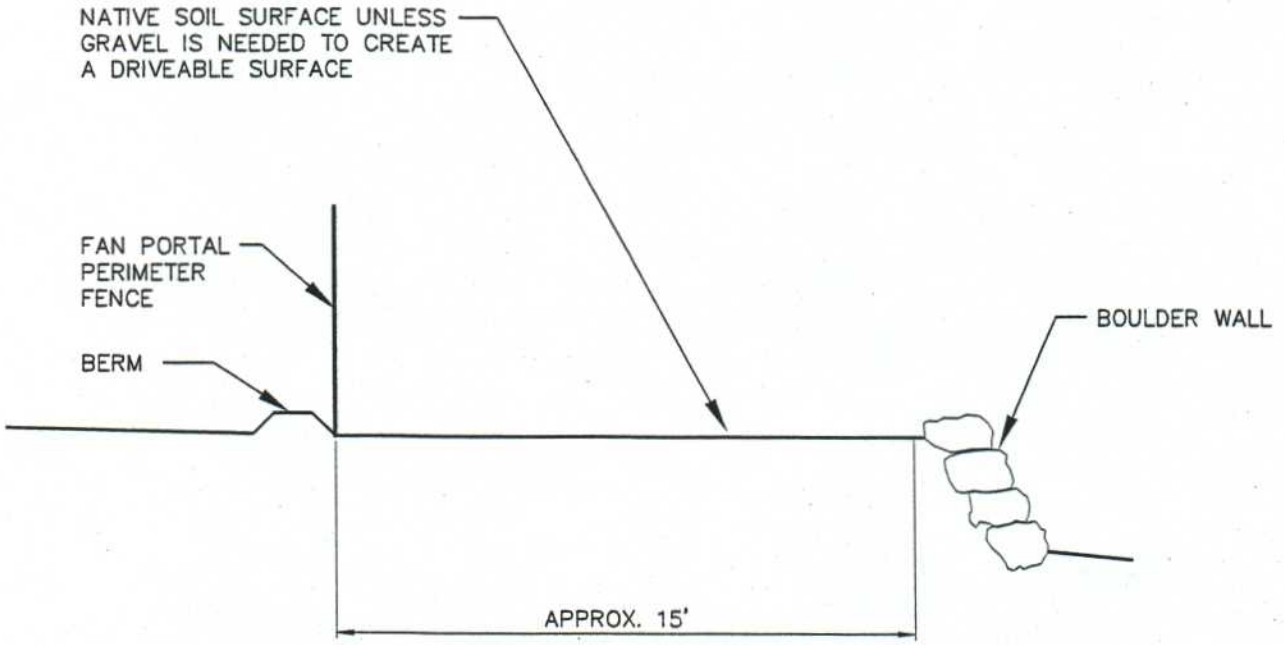
FIGURE 1. TYPICAL SHOT PATTERN FOR VENTILATION SHAFT

EarthFax

APPENDIX 5-10

Pace Canyon Fan Facilities

G:\UCB01\07\PERMIT DWG\APP5-10 FIG PC1.DWG 01/31/05

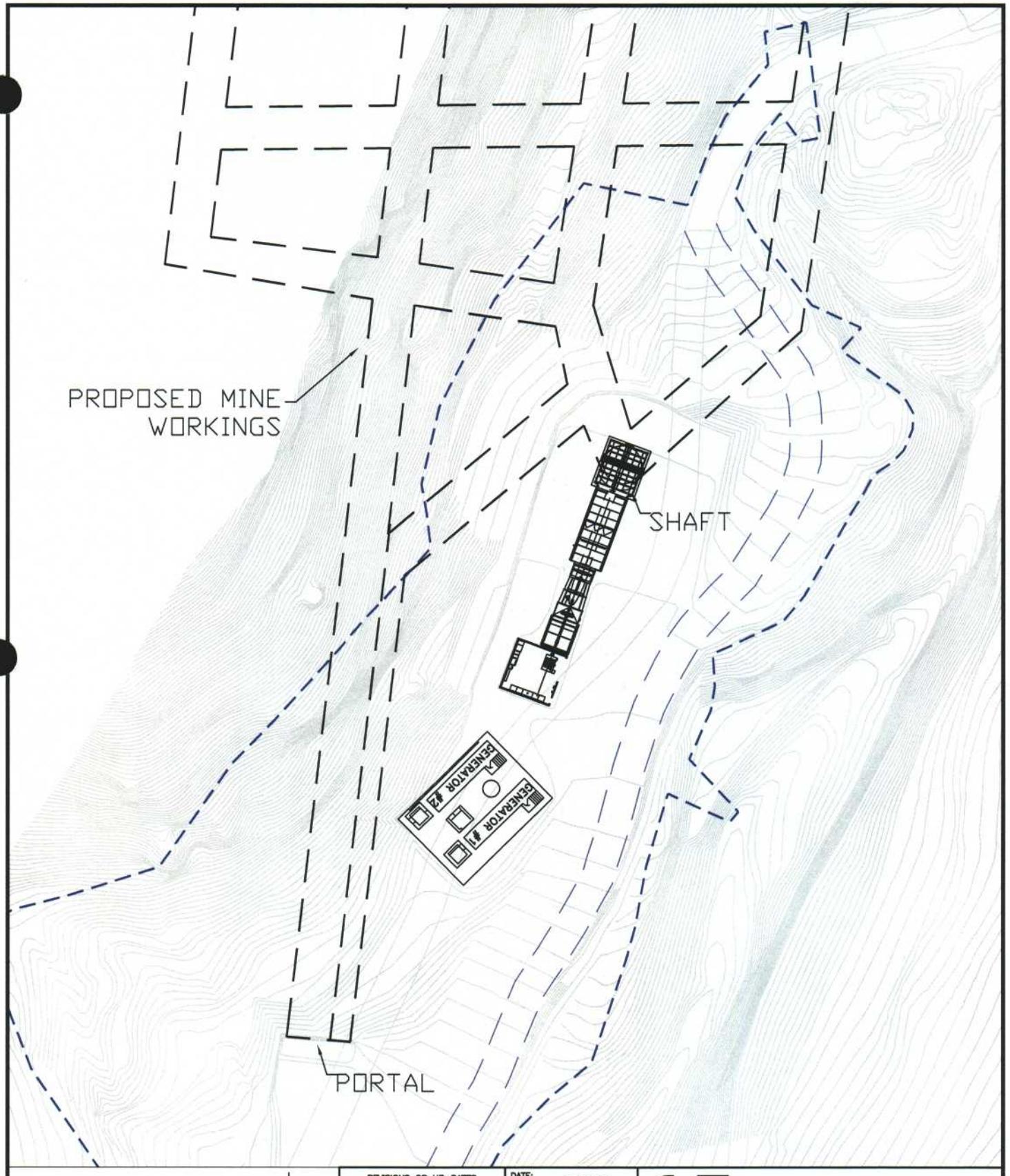


REGISTERED PROFESSIONAL ENGINEER
2-7-05
No. 189797
LAYNE D. JENSEN
STATE OF UTAH

0' 5'

APPENDIX 5-10, FIGURE PC-1. TYPICAL CROSS-SECTION OF THE REALIGNED ROAD, PACE CANYON FAN FACILITIES

EarthFax



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NO.	DATE	BY	DESIGNED BY:	
			DRAWN BY:	CAH
			CHECKED BY:	
			SCALE: NTS	

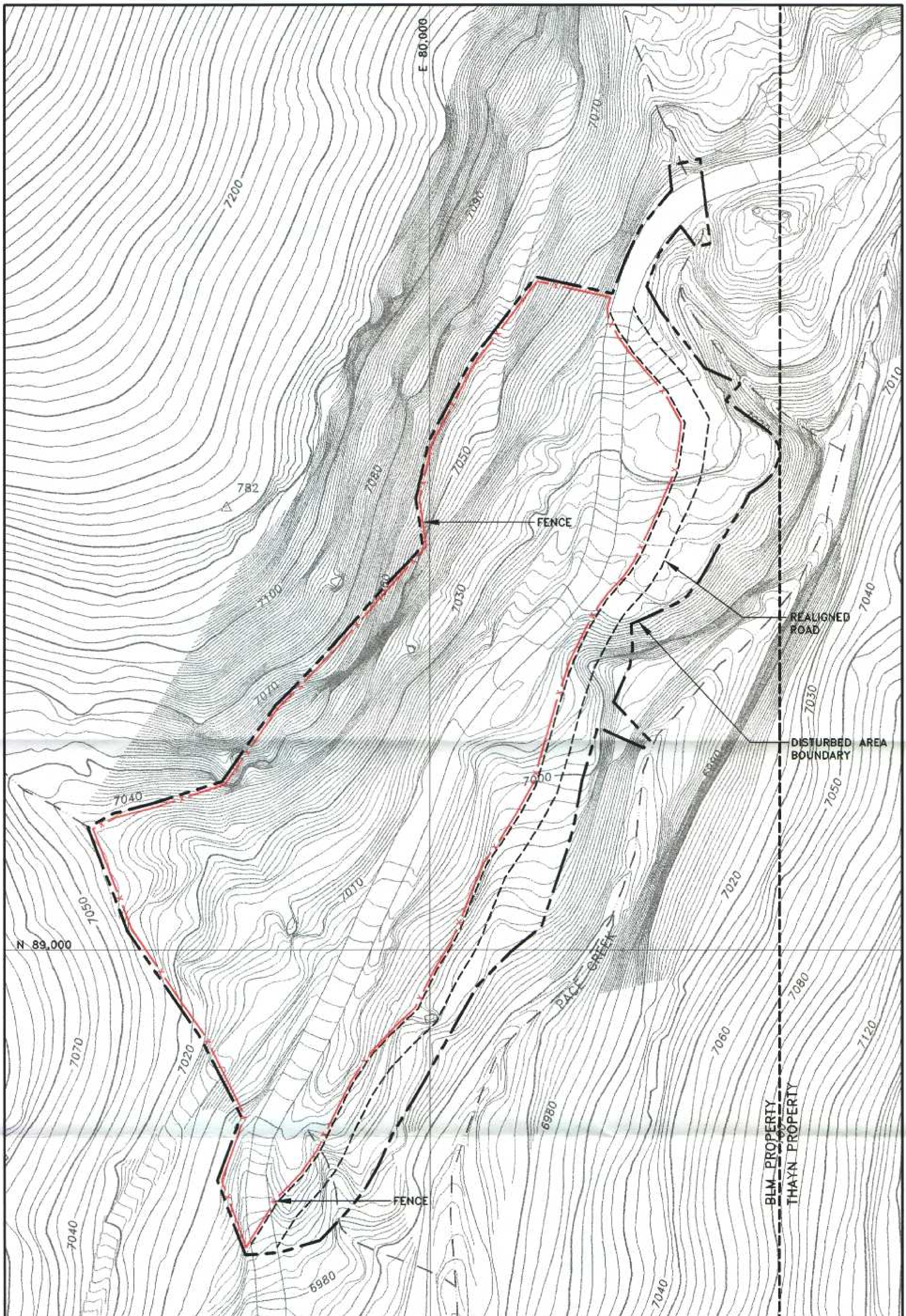
FILENAME: Blasting Plan.dwg

Canyon Fuel Company, LLC
Dugout Canyon Mine

GILSON SEAM MINE WORKINGS

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER Figure PC-2
Appendix 5-10



TOWNSHIP 13 SOUTH, RANGE 13 EAST, SECTION 30

TOPOGRAPHY FROM OLYMPUS AERIAL SURVEYS INC.
FLOWN 08-12-04

REGISTERED PROFESSIONAL ENGINEER
No. 189737
LAYNE D. JENSEN
STATE OF UTAH

REVISIONS OR UP-DATES			DATE:	02-01-05
NO.	DATE	BY	DESIGNED BY:	LDJ
			DRAWN BY:	SWF
			CHECKED BY:	VSM
			SCALE:	1"=60'

FILENAME: G:\UOB01\07\PERMIT DWG\APP5-10 FIG PC3.DWG\02-0?-05

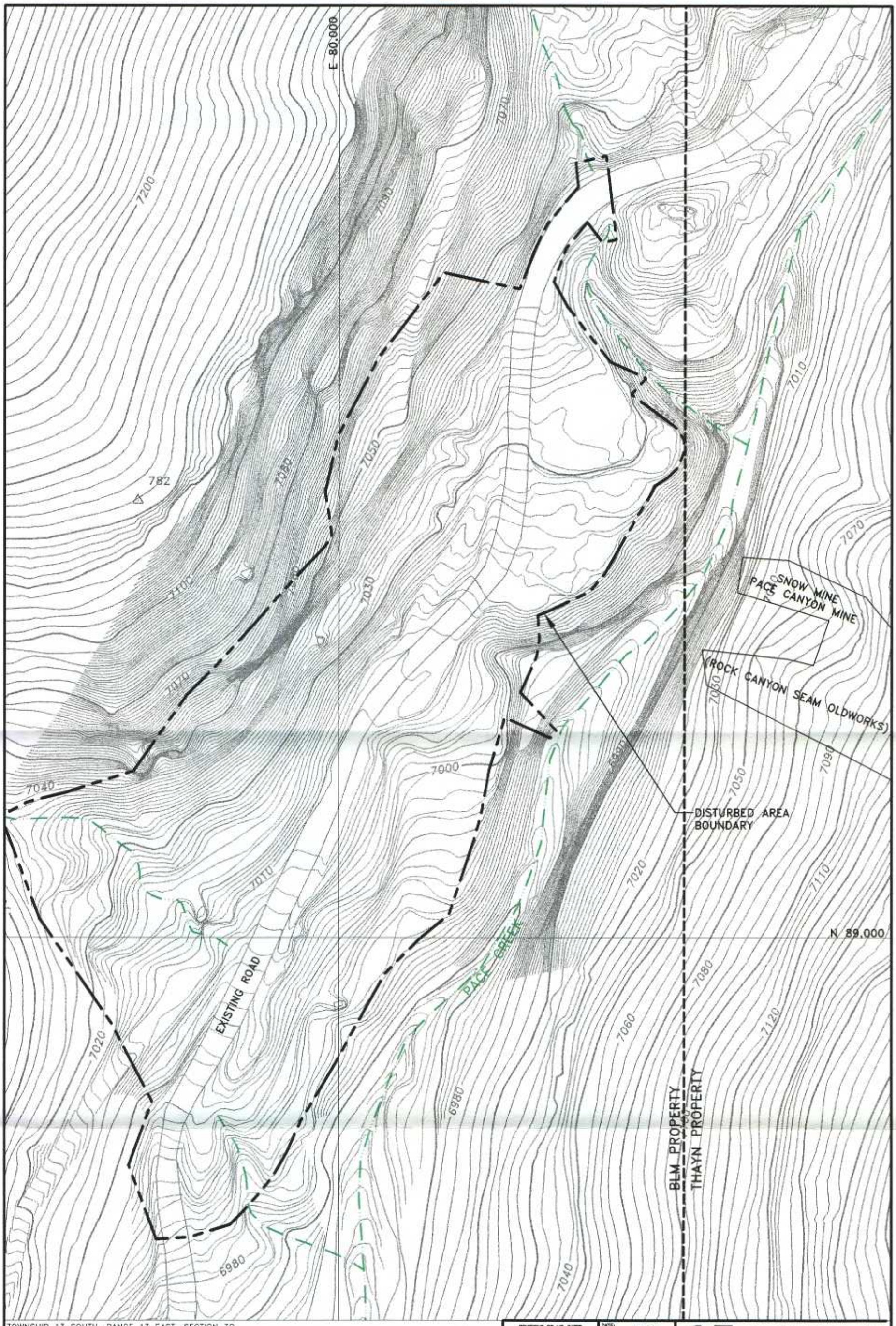
Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN
FENCE LOCATION MAP

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
APP. 5-10 FIG. PC-3

EarthFax Engineering, Inc.



TOWNSHIP 13 SOUTH, RANGE 13 EAST, SECTION 30

TOPOGRAPHY FROM OLYMPUS AERIAL SURVEYS INC.
FLOWN 08-12-04

REGISTERED PROFESSIONAL ENGINEER
No. 169797
LAYNE D. JENSEN
STATE OF UTAH

REVISIONS OR UP-DATES			DATE: 11-16-04	
NO.	DATE	BY	DESIGNED BY:	LDJ
1	1-26-05	LDJ	DRAWN BY:	SWF
			CHECKED BY:	VSM
			SCALE: 1"=60'	

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Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN EXISTING SURFACE TOPOGRAPHY

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE PC5-4

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CHAPTER 7
HYDROLOGY

LIST OF PLATES (Continued)

Plate

The following plates are located in Appendix 7-12

LIST OF APPENDICES

Appendix

CHAPTER 7
HYDROLOGY

710 INTRODUCTION

711 General Requirements

This chapter presents a description of:

- Existing hydrologic resources within the permit and adjacent areas;
- Proposed operations and the potential impacts to the hydrologic balance;
- Methods of compliance with design criteria and the calculations utilized to show compliance;
- Applicable hydrologic performance standards; and
- Hydrologic reclamation plans for the Dugout Canyon Mine.

Additional information can be found in the following amendments: Methane Degassification Amendment (August 2003), Refuse Pile Amendment (February 2003), and the Leachfield Addendum A-1 (March 2001). The remainder of the State Lease ML-48435-OBA (SITLA Lease) was incorporated into the Dugout Canyon Mine permit area in 2005.

712 Certification

All maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

713 Inspection

Impoundments associated with the mining and reclamation operations will be inspected as described in Section 514.300 of this M&RP.

to be dry and plugged at a depth of approximately 470 feet. All subsequent attempts to monitor this well have found the plugged/dry condition unchanged.

Monitoring well GW-32-1 is perforated in the Blackhawk Formation immediately above the Sunnyside seam (see Table 7-1) in a location which is down dip of Soldier Canyon Mine workings. Water level monitoring information shows a fairly consistent rise in water elevation.

From November 1994 through August 1995, the water level appears to have stabilized at a depth of approximately 291 feet (Figure 7-7). There is no information at this time that would suggest that underground mining activities in the nearby Soldier Canyon Mine are effecting the water levels observed to date.

Monitoring well G-58.5 was completed by Mountain Fuel Supply Company into the Blackhawk Formation in 1979. Waddell et al. (1986) reported a depth-to-water in March 1980 in this well of 502.8 feet. Waddell et al. (1982) reported depths to water of 501.7 to 502.4 feet in April and September 1880. No additional water-level data are available for this well.

Attempts for this M&RP to construct a potentiometric surface for the Blackhawk Formation in the Soldier Canyon area based on data collected from GW-5-1, GW-6-1, and GW-32-1 proved fruitless. The difficulty in preparing this potentiometric surface may have been due to the influence of outcropping in the adjacent Soldier Canyon, the influence of mining in the nearby Soldier Canyon Mine, and/or varying lengths and stratigraphic locations of the perforated sections of the monitoring wells within the discontinuous strata which comprise most of the Blackhawk Formation. However, based on water-level data collected from one of the existing Dugout Canyon portals and from monitoring wells GW-5-1 and G-58.5, Waddell et al. (1986) concluded that the flow of groundwater in the Blackhawk Formation within the permit and adjacent areas is to the north away from the face of the cliffs (i.e., down dip as generally seen in the Castlegate Sandstone~~ on Plate 7-3~~). They estimated the hydraulic gradient in the Blackhawk Formation to be 42 feet per mile (0.008 ft/ft). Waddell et al. (1986) indicate that the coal bearing zone to be mined in the Dugout Canyon operations will probably be saturated in most areas and will require dewatering during mining. However, since mining was initiated at the Dugout Mine, saturated coal zones have not been encountered. The majority of the water encountered during mining both the Rock Canyon and Gilson seams has entered the mine through the roof and discharges from isolated sandstone channels within the Blackhawk Formation.

The data presented in Figure 7-10 indicate that discharge from the Flagstaff Formation dominates the flow of Dugout Creek throughout the year. Seepage from the underlying formations may slightly influence the flow of Dugout Creek during the autumn months, but this influence appears to be minimal. The lack of seepage from the Blackhawk and immediately-overlying formations to Dugout Creek supports the conclusion presented in Section 724.100 that the flow of groundwater within the permit and adjacent areas is to the north-northwest (i.e., away from Dugout Canyon).

Limited flow data is available from monitoring points within Pace Canyon and Rock Canyon Creeks. However, the data included in Appendix 7-7 suggests that flow within Pace Canyon Creek varies seasonally. Data collected at points PC-1A and PC-2 since June 1999, which are included in the Division's water database and in the updated spreadsheets found in Appendix 7-7, supports this determination. Flows in spring/early summer are typically several times greater than in late summer/fall. Also, it is interesting to note that in 2002 and 2003 there have been periods when there is no flow at station PC-2 and flows measured in late summer/fall at PC-1A have been significantly less than in previous years. The drop in flow is undoubtedly related to the prolonged drought the area has been suffering through since 1999. Base flow within this drainage appears to originate from springs discharging from the Castlegate Sandstone, Price River, Flagstaff/North Horn, and Colton Formations. The majority of the flow appears to originate from springs within the North Horn and Flagstaff Formations. A surface water monitoring point (Fan) has been added on Pace Creek at a location approximately 600 feet upstream from the top of the Pace Canyon Fan facilities disturbed area boundary. Surface flows measured at monitoring point Fan indicate that the stream is intermittant and likely fluctuates in flow volume seasonally. Rock Canyon Creek base flow in its upper reaches appears to originate from springs discharging from the Northhorn Formation. Flow data from monitoring site RC-1 indicates the lower sections of Rock Creek generally flow in response to spring runoff and after summer precipitation events.

Surface flows measured at monitoring point RC-1 near the mouth of Rock Canyon indicate that the stream is intermittant and also fluctuates in flow volume seasonally. In 2002 and 2003, flow was measured at RC-1 only flowed after a significant precipitation event. Again, the lack of flow in this creek is most likely related to the drought conditions that appear to have begun in the area in 1999.

No streamflow data are available for ephemeral drainages in the permit and adjacent areas. When it does occur, ephemeral runoff in the area is expected to occur predominantly in the months of

Sediment yields may increase locally due to subsidence. Subsidence cracks which intersect stream channels with steep gradients could, for a short period of time, cause an increase in the sediment yield of the stream. However, this sediment increase would cause the crack to quickly fill, recreating pre-subsidence stream channel conditions. Thus, the potential impact to sediment yield from subsidence in the permit area would be minor and of short duration.

Various sediment-control measures will be implemented during reclamation as the vegetation becomes established. As discussed in Section 542.200 of this M&RP, these measures will include installation of silt fences and straw-bale dikes in appropriate locations to minimize potential contributions of sediment to Dugout Creek and Pace Creek. These measures will reduce the amount of erosion from the reclaimed areas, thereby precluding adverse impacts to the environment.

Acidity, Total Suspended Solids, and Total Dissolved Solids. Probable impacts of mining and reclamation operations on the acidity and total suspended solids concentrations of surface and groundwater in the permit and adjacent areas were addressed previously in this section.

Data presented in Appendix 7-2 and summarized in Section 724.100 of this M&RP indicate that the average TDS concentration of water in the Blackhawk Formation (as measured in inflow to the nearby Soldier Canyon Mine) is approximately 750 mg/l and is of the sodium-bicarbonate type. As noted in Section 724.200, the TDS concentration of water in Dugout Creek ranges from 350 to 500 mg/l. The TDS concentration in Pace Creek ranges between 525 and 840 mg/l with an average TDS of about 620 mg/l. The dominant ions in these~~is~~ waters are calcium, magnesium and bicarbonate during high-flow periods, whereas the dominant ions during low-flow periods are sodium, magnesium, sulfate, and bicarbonate.

These data suggest that the TDS concentration of water in Dugout Creek and Pace Creek can be expected to increase if water is discharged from the mine to the Creek. During periods of low streamflow, the dominant ions in the Blackhawk Formation water, Pace Creek and Dugout Creek should be similar. However, during periods of high streamflow, the dominant cation will be sodium in the Blackhawk water, magnesium in the Pace Creek water, and calcium in Dugout Creek. It should be noted that it is anticipated that the Dugout Canyon Mine will use powdered limestone or dolomite (i.e., calcium-magnesium-carbonate) for rock dust. It is not anticipated that gypsum rock dust (calcium-sulfate) will be used in the mine. Hence, dissolution of rock dust by water in the mine

should not influence the chemical type of water in Dugout Creek or Pace Creek if mine water is discharged to the creek.

Typical iron and manganese concentrations in the Blackhawk Formation, Pace Creek and Dugout Creek (as summarized in previous sections) are:

	Blackhawk Formation	Dugout Creek	Pace Creek
Dissolved iron	<0.1 mg/l	<0.01 mg/l	<0.1 mg/l
Total iron	<0.5 mg/l	<1.0 mg/l	<1.0 mg/l
Dissolved manganese	--	<0.01 mg/l	–
Total manganese	<0.1 mg/l	<0.1 mg/l	<0.01 mg/l

These data indicate that the concentration of iron and manganese in Dugout Creek and Pace Creek should not be significantly affected by discharges from the mine.

Dugout Creek and Pace Creek, as part of the lower Price River basin, is classified according to Section R317-2-13 of the Utah Administrative Code (Standards of Quality for Waters of the State) as a class 2B (secondary contact recreation use), 3C (nongame fish and other aquatic life use), and 4 (agricultural use) water. No TDS standards exist for class 2B and 3C water. The TDS standard for class 4 water is 1,200 mg/l.

It should also be noted that the dissolved iron standard for class 3C water is 1.0 mg/l. No dissolved iron standard exists for class 2B or 4 waters. The data presented above indicate that potential discharge water from the mine will not exceed the dissolved iron standard of Dugout Creek or Pace Creek. No standards exist in the R317 regulations for total iron, dissolved manganese, or total manganese. However, the data presented above indicate that potential discharges from the mine to Dugout Creek and Pace Creek will meet the effluent limitations of 40 CFR 434.

Mining in the Gilson seam on the east side of the Right Fork of Dugout Creek resulted in the operator draining the flooded old Knight Ideal Mine working in August 2002 and again in May 2003 to prevent catastrophic flooding of the current Dugout Canyon Mine operations. The old workings contained water with total iron in excess of 1 mg/l and this water was discharged to Dugout Creek at a rate that at times reached 1117 gpm. As a result of draining the old workings, the water discharged to Dugout Creek did have a total iron concentration in excess of the UPDES permit limit of 1mg/l for a short period of time. It appears that water will be continuously drained from the

Knight Ideal Mine for the foreseeable future to maintain safe underground working conditions but at a discharge rate expected to be much less than 100 gpm.

No hydrologic impacts have been noted at the adjacent Soldier Canyon Mine nor at the Dugout Canyon Mine due to subsidence. Although tension cracks may locally divert water into deeper formations, resulting in increased leaching of the formation and increased TDS concentrations, the potential of this occurring is considered minimal. This conclusion is based on experience at the Soldier Canyon Mine and on the fact that the shale content of the North Horn Formation, the Price River Formation, and the Blackhawk Formation should cause these subsidence cracks to heal quickly where they are saturated by groundwater flow. Thus, potential impacts on TDS concentrations would be minor and not of significant concern. To date (January 2004), mining and subsidence within the Dugout permit area has not resulted in the loss of surface flows in the Dugout Creek drainage or impacts to ground water discharge rates at the monitored seeps and springs.

Flooding or Streamflow Alteration. Runoff from all disturbed areas will flow through a sedimentation pond or other sediment-control device prior to discharge to Dugout Creek or Pace Creek. Three factors indicate that these sediment-control devices will minimize or preclude flooding impacts to downstream areas as a result of mining operations:

1. The sedimentation pond and sediment traps have~~s~~ been designed and will be constructed to be geotechnically stable. Thus, the potential is minimized for breaches of the sedimentation pond to occur that could cause downstream flooding.
2. The flow routing that occurs through the sedimentation pond and other sediment-control devices reduces peak flows from the disturbed areas. This precludes flooding impacts to downstream areas.
3. By retaining sediment on site in the sediment-control devices, the bottom elevations of Dugout Creek and Pace Creek downstream from the disturbed area will not be artificially raised. Thus, the hydraulic capacity of the stream channel will not be altered.

The volume of streamflow will increase in Dugout Creek and Pace Creek if water is discharged from the mine to the creek. Potential impacts to the creek channel could include the displacement of fines on the channel bottom, and minor widening of the channel. However, the degree of widening will likely be minimized by the increased vigor and quantity of vegetation which will be sustained along the stream channel by the increased availability of water. In particular, it is anticipated that the deciduous streambank vegetative community (see Section 321.100) will increase in density and vigor as a result of mine-water discharges. This effect will occur for the

distance downstream that surface flows can be sustained above channel transmission losses. Care will be taken during discharge of this water to avoid flooding of downstream areas. Once mining ceases, the mine will be sealed and no discharges will occur. The streamflow in Dugout Creek and Pace Creek will then return to pre-mining discharge levels.

Following reclamation, stream channels which have been altered by mining operations will be returned to a stable state (see Section 762.100). The reclamation channels have been designed to safely pass the peak flow resulting from the 10-year, 6-hour or the 100-year, 6-hour precipitation event as appropriate for the channel and in accordance with the R645 regulations (Appendix 7-11). Thus, flooding in the reclaimed areas will be minimized. Interim sediment-control measures and maintenance of the reclaimed areas during the post-mining period will preclude deposition of significant amounts of sediment in downstream channels following reclamation, thus maintaining the hydraulic capacity of the channels and precluding adverse, off-site flooding impacts.

Subsidence tension cracks that appear on the surface will increase the secondary porosity of the formations overlying the Dugout Canyon Mine. During the period prior to healing of these cracks, this increased percolation will decrease runoff during the high-flow season (when the water would have rapidly entered the stream channel rather than flowing into the groundwater system). During low-flow periods, the result of this increased percolation will be an increase in the base flow of the stream. Hence, the net result will be a decrease in the flooding potential of the affected stream.

Subsidence under the main fork of Dugout Creek will occur in areas where overburden ranges from 600 to 1200 feet thick. The area of the least amount of overburden, approximately 600 feet, occurs in the southern half of Section 14, Township 13 South Range 12 East. Additionally, subsidence on the right hand fork of Dugout Creek will occur where overburden ranges from 500 feet to 2000 feet. The least amount of overburden on this fork of the creek occurs in the northeast quarter of Section 23, Township 13 South, Range 12 East. In both areas where the least amount of overburden occurs, the stream channels are lined with several feet of soils and fine grained sediments. Also, the upper Blackhawk Formation, which consists of interbedded shale, mudstone, siltstone, and sandstone, is exposed at the surface in a portion of these low overburden areas. The Castlegate Sandstone is present in the two low overburden areas but is rarely exposed in the channel floors.

Figure 7-11

layers in the Blackhawk Formation but does not appear to draw additional recharge from overlying or underlying groundwater systems (see Appendix 7-3).

The strong vertical gradients in Blackhawk Formation rock layers underlying actively mined coal seams in the Soldier Canyon Mine and the absence of significant discharge into the mine from these layers indicates that mining does not draw groundwater from the underling Mancos Shale. Additionally, the distinctive solute composition of Mancos Shale groundwater has not been observed inside the Soldier Canyon Mine (see Appendix 7-3).

From the above discussion, it appears that the Soldier Canyon Mine has not decreased groundwater discharge in overlying or underlying groundwater systems. Hence, it is unlikely that coal mining will effect the discharges of any spring as a result of mining in the Dugout Canyon permit and adjacent areas.

Potential for Increased Stream Flows

If sufficient water is encountered in the Dugout Canyon Mine workings to require discharge of that water to the surface, the flow of Dugout Creek and Pace Creek will be increased. To estimate the potential quantity of inflow to the Dugout Canyon Mine, the investigation of Lines (1985) was reviewed. In this investigation, Lines (1985) evaluated groundwater conditions in the Trail Mountain Area, located in the hydrogeologically-similar Wasatch Plateau approximately 23 miles southwest of the proposed Dugout Canyon Mine permit area. Using a finite-difference model, Lines (1985) evaluated potential inflows into a hypothetical coal mine in the Blackhawk Formation assuming hydraulic conductivities of 0.01 ft/day for the Blackhawk Formation and 0.02 ft/day for the Star Point Sandstone. He further assumed hydraulic gradients which varied from 0.041 ft/ft to 0.098 ft/ft. Results of these evaluations are presented in Figure 7-11.

As noted in Section 724.100, the median hydraulic conductivity of the Blackhawk Formation in the vicinity of the permit area is 5.1×10^{-4} ft/day, a factor of 20 lower than the values assumed by Lines (1985). As also noted in Section 724.100, the average hydraulic gradient of the Blackhawk Formation is 0.008 ft/ft, a factor of 5 lower than the lowest values assumed by Lines (1985). Since an increase in the hydraulic conductivity and the hydraulic gradient would tend to increase the inflow to the mine, using the evaluation of Lines (1985) should result in an overestimate of potential inflows to the Dugout Canyon Mine.

729 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas is to be prepared by the Division.

730 OPERATION PLAN

731 General Requirements

This permit application includes an operation plan which addresses the following:

- Groundwater and Surface Water Protection and Monitoring Plan;
- Design Criteria and Plans;
- Performance Standards; and
- Reclamation Plan.

731.100 Hydrologic-Balance Protection

Groundwater Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic, toxic, or other harmful infiltration to the groundwater system. Additionally, the permittee will manage excavations and disturbances to prevent or control discharges of pollutants to the groundwater.

As indicated in Section 728.300, it is anticipated that an average of approximately 190 gallons per minute of groundwater encountered in the mine will eventually be discharged to Dugout Creek or Pace Creek. This water will be discharged in a controlled manner, in accordance with an approved UPDES permit, via a pipeline from the mine to the creek. The Dugout Creek discharge point is anticipated to be located at the upstream inlet to the Dugout Canyon culvert, UC-5. If the discharge occurs to a point outside of the culvert, riprap will be placed at the outlet of the pipe to prevent erosion. The Pace Creek discharge point will be located southeast of the fan shaft. The pipe will discharge directly to the creek. The pipe outlet will be riprapped to prevent erosion. Any erosion that occurs at the points of discharge will be repaired as soon as practical.

Surface Water Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic or toxic drainage, prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevents water pollution. Additionally, SCM will maintain adequate runoff- and sediment-control facilities to protect local surface waters.

During initial construction to develop the surface facilities, and prior to installation of all runoff- and sediment-control facilities as outlined in Section 732 of this M&RP, silt fences will be installed along the top bank of Dugout Creek and its eastern tributary in areas prior to disturbance. These silt fences will be installed in accordance with Figure 5-4. If required for control of local erosion, straw-bale dikes may also be installed at the site during initial construction. These dikes will also be installed in accordance with Figure 5-4. The silt fences and straw-bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. Once the sedimentation pond, ditches, and culverts are installed, the silt fences and straw-bale dikes may be removed.

During initial construction to develop the surface facilities in Pace Canyon, and prior to installation of all runoff- and sediment-control facilities as outlined in Appendix 7-12 of this M&RP, silt fences will be installed along the disturbed area boundary and along the tributary drainages upstream and downstream of the surface facilities. These silt fences will be installed in accordance with Figure 5-4. If required for control of local erosion, straw-bale dikes may also be installed at the site during initial construction. These dikes will also be installed in accordance with Figure 5-4. The silt fences and straw-bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. Once the sedimentation trap, ditches, and culverts are installed, the interim silt fences and straw-bale dikes will be removed.

Once the runoff- and sediment-control facilities outlined in Section 732 have been installed, these structures will prevent additional contributions of suspended solids to streamflow outside the permit area. A description of sediment control following reclamation is presented in Sections 540 and 760 of this M&RP.

731.200 Water Monitoring

Groundwater Monitoring. Groundwater monitoring to be conducted in the permit and adjacent areas will consist of data collection from monitoring wells, springs, and mine-water discharges. Locations of wells and springs to be monitored are noted on Plate 7-1. The groundwater monitoring plans presented herein were developed based on information presented in the PHC

TABLE 7-5

Surface Water Monitoring Program

Field and Laboratory Measurement Protocol

Streams	Protocol	Comments
DC-1	1	Located on Dugout Creek downstream of mine
DC-2	2	Located on Dugout Creek immediately upstream of mine on left-hand fork
DC-3	2	Located on Dugout Creek immediately upstream of mine on right-hand fork
DC-4	3	Located on Dugout Creek upstream of mine on west fork of left-hand fork
DC-5	3	Located on Dugout Creek upstream of mine on east fork of left-hand fork
PC-1a	2	Located on Pace Creek on the eastern edge of State Coal Lease ML 48435-OBA
PC-2	2	Located on Pace Creek on the western edge of State Coal Lease ML 48435-OBA
RC-1	2	Located on Rock Creek on the southern edge of State Coal Lease ML 48435-OBA
FAN	1	Located on Pace Creek above fan facilities

Protocols

1 Stream: quarterly operational surface water quality measurements analyzed as per parameters listed below.

2 Stream: quarterly operational surface water quality measurements analyzed as per parameters listed below except during first wet or dry years when weekly flow will be obtained from April 1 through August 31, as conditions permit, in addition to quarterly samples.

3 Stream: weekly flow measurements during first wet or dry year will be obtained from April 1 through August 31 as conditions permit. Also during the first wet or dry year, one operational laboratory sample and one tritium sample will be obtained at these sites during high and low flow season.

Surface Water Quality Parameters

FIELD MEASUREMENTS	REPORTED AS
Flow	gpm or cfs
pH	pH units
Specific Conductivity	μs/cm @ 25°C
Dissolved Oxygen	mg/l
Temperature	°C

Laboratory Parameters	Reported As	Operational Monitoring	Baseline Monitoring
Acidity	mg/l		X
Aluminum (Dissolved)	mg/l		X
Ammonia	mg/l		X
Arsenic (Dissolved)	mg/l		X

2. Water samples will be obtained during high- and low-flow season in conjunction with the quarterly sampling, if applicable. The samples will be analyzed in accordance with Table 7-4 with the addition of tritium analysis.

In addition to the above regular monitoring, one water sample will be collected at each spring sampling point during low flow period every fifth year, during the year preceding re-permitting, to be analyzed for baseline parameters (Table 7-4).

Groundwater was discovered discharging from old Gilson coal seam workings located on the east side of Dugout Canyon during construction of the Dugout Canyon Mine in September 1998. Prior to construction, this water seeped unnoticed through unconsolidated fill and into Dugout Creek. The water discharging from these old workings will be monitored on a quarterly basis for the parameters listed in Table 7-4 beginning in the fourth quarter of 1998. The monitoring point is labeled MD-1 on Plate 7-1.

Data will be collected from the Dugout Canyon Mine and Pace Canyon Fan Portal mine-water discharge point in accordance with the UPDES permits. No water will be discharged prior to obtaining the necessary UPDES permits. The monitoring requirements proposed herein, including the analytical parameters and the sampling frequency, may be modified in the future in consultation with the Division if the data demonstrate that such a modification is justified.

Data will be collected under the groundwater monitoring program every year following the completion of surface reclamation activities. During the post-mining period, water levels will be collected from the monitoring wells and data/samples will be collected from the identified springs once each year during September or October (i.e., the low-flow season while the sites are still accessible). Groundwater monitoring during the post-mining period will continue until bond release.

All groundwater monitoring data will be submitted to the Division by the end of the quarter following sampling. If analyses of any groundwater sample indicates noncompliance with the permit conditions, the permittee will promptly notify the Division and take immediate appropriate actions. UPDES reporting requirements will be met for the mine-water discharge points. The Snotel data used to determine "wet" or "dry" years, as described previously in this section, will be submitted with the first quarter water monitoring data beginning in the year 2001.

Equipment, structures and other devices used in conjunction with monitoring the quality and quantity of groundwater in the permit and adjacent areas have been or will be installed, maintained,

and operated in accordance with accepted procedures. Where feasible, this equipment will be removed or properly abandoned by the permittee when no longer needed.

Surface Water Monitoring. Surface water monitoring to be conducted in the permit and adjacent areas will consist of data collection from streams and sedimentation pond discharges. Locations of streams to be monitored are noted on Plate 7-1. The surface water monitoring plans presented herein were developed based on information presented in the PHC determination, the baseline hydrologic data, and the geologic data presented in Chapter 6 of this M&RP.

Station DC-1 will be monitored to evaluate surface-water conditions downstream from the proposed surface facilities. Stations DC-2 and DC-3 will provide data concerning background surface-water conditions immediately upstream from the proposed surface facilities. Stations DC-4 and DC-5 will be located at the Castlegate Sandstone-Blackhawk Formation contact and will provide data that will be used to determine the relationship between the Blackhawk Formation and the base flow of Dugout Creek.

PC-1a and PC-2 are located on Pace Creek and will be monitored to evaluate surface-water conditions up gradient and down gradient, respectively, of the permit area. Monitoring point (Fan) has been added on Pace Creek at a location approximately 600 feet upstream from the top of the Pace Canyon Fan facilities disturbed area boundary. Monitoring locations Fan and PC-2 will be monitored to evaluate surface water conditions up gradient and down gradient , respectively, of the Pace Canyon Fan facilities. RC-1 has also been established as monitoring point to obtain baseline data for future mine expansion. Baseline data will be obtained from the aforementioned three sites for three years prior to initiating operational sampling.

Protocols for surface-water monitoring within the permit and adjacent areas are:

- DC-1, FAN - Quarterly data collection in accordance with Table 7-5 (operational parameters). This table is the same as that presented in Coal Regulatory Program Directive Tech-004, with the exception that total hardness and total alkalinity are not included. As explained above, total hardness, which is primarily of concern in water supplies being developed for domestic use, was not added to the list because summer-home development of the permit area is not an identified post-mining land use. Total alkalinity was not added to the list because the baseline data indicate that acid-generating materials, which may affect the alkalinity of the water, are not present within the permit and adjacent areas.

- DC-2, DC-3, PC-1a, PC-2, and RC-1 - Quarterly data collection in accordance with Table 7-5. Collection of gain-loss hydrograph data during the first wet year and the first dry year

731.300 Acid- and Toxic-Forming Materials

Analyses presented in Chapter 6 of this M&RP indicate that acid- and toxic-forming materials are not present within the permit area. Parameters defining acid- and toxic-forming materials will periodically be monitored as described in Chapter 6 of this M&RP. In the event that acid- or toxic-forming materials are identified, they will be disposed of in appropriate waste-rock disposal facilities as described in Chapter 5 of this M&RP.

731.400 Transfer of Wells

Before final release of bond, exploration or monitoring wells will be sealed in a safe and environmentally sound manner in accordance with R645-301-631, R645-301-738, and R645-301-765. Ownership of wells will be transferred only with prior approval of the Division. The conditions of such a transfer will comply with State and local laws. The permittee will remain responsible for the management of the wells until bond release in accordance with R645-301-529, R645-301-551, R645-301-631, R645-301-738, and R645-301-765.

731.500 Discharges

Discharges into an Underground Mine. No discharges of surface water will be made to an underground mine in the permit and adjacent areas.

Gravity Discharges from an Underground Mine. No gravity discharges will be made from an underground mine in the permit and adjacent areas.

731.600 Stream Buffer Zones

The surface facilities for the Dugout Canyon Mine will be constructed within 100 feet of Dugout Creek (a perennial stream, intermittent adjacent to mine facilities) and Pace Creek (an intermittent stream adjacent to fan facilities). However, surface runoff- and sediment-control facilities designed for the site (as discussed in subsequent sections of this chapter) will ensure that coal mining and reclamation operations will not cause or contribute to the violation of applicable Utah or federal water standards and will not adversely affect the water quantity and quality or other environmental resources of the stream.

Stream Channel Diversions. Temporary or permanent stream channel diversions will comply with R645-301-742.300.

Buffer Zone Designation. The area surrounding the streams that is not to be disturbed will be designated as a buffer zone, and SCM will mark those zones as specified in Section 521.200 of this M&RP.

731.700 Cross Sections and Maps

The locations of water rights for current users of surface water flowing into, out of, and within the permit and adjacent areas is provided on Plate 7-2. The locations of each water diversion, collection, conveyance, treatment, storage, and discharge facility to be used in the Dugout Canyon area is presented on Plate 7-5 or in Addendum A to Appendix 7-9.

Locations and elevations of each station to be used for water monitoring during coal mining and reclamation operations are presented on Plate 7-1. The design details and cross sections for the sedimentation pond are provided on Plate 7-4. Other relevant cross sections or maps are presented and discussed in Chapter 5 of this M&RP.

731.800 Water Rights and Replacement

No surface mining will occur in the Dugout Canyon Mine permit area.

732 Sediment Control Measures

The sediment control measures within the permit area have been designed to prevent additional contributions of sediment to streamflow or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent limitations, and minimize erosion to the extent possible.

The structures to be used for the runoff-control plan for the permit area include disturbed and undisturbed area diversion channels, a sedimentation pond, containment berms, silt fences, and road diversions and culverts.

Sediment control measures for the Pace Canyon Fan Portal Area are discussed in Appendix 7-12.

733 Impoundments

733.100 General Plans

There will be a single sedimentation pond operating at the mine facility as described in Section 732.200. The sedimentation pond will be located in the southwest corner of the disturbed area. The sedimentation pond topography and cross sections are presented on Plate 7-4 of this M&RP. Detailed design information is presented in Appendix 7-8. Details regarding the impoundments at the Pace Canyon Fan Portal Site can be found in Appendix 7-12.

Certification. All maps and cross sections of the sedimentation pond have been prepared by or under the direction of, and certified by a qualified, registered, professional engineer.

Maps and Cross Sections. The topography and cross sections for the sedimentation pond are provided on Plate 7-4 of this M&RP.

Narrative. A description of the sedimentation pond is presented in Sections 732.200 and 742 of this M&RP.

Subsidence Survey Results. No underground coal mining will occur beneath the proposed sedimentation pond. Therefore, there will be no effects on the pond or pond embankment from subsidence.

Hydrologic Impact. The hydrologic and geologic information required to assess the hydrologic impacts of the proposed sedimentation pond are presented in Section 724 and Chapter 6 of this M&RP, respectively.

Design Plans and Construction Schedule. There are no additional structures proposed for the mining operation at this time. Any structures proposed in the future will not be constructed until the Division has approved the detailed design plan for the structure.

733.200 Permanent and Temporary Impoundments

Requirements. The sedimentation pond has been designed using current, prudent engineering practices. Specific foundation design and construction criteria are presented in Chapter 5 of this M&RP. Specific hydrologic design criteria for the pond are presented in Section 743. The pond will be inspected regularly based on the schedule contained in Section 514.300.

Permanent Impoundments. There are no permanent impoundment structures proposed for use in mining and reclamation operations within the permit and adjacent areas.

Temporary Impoundments. The Division's authorization is being sought for the construction of the sedimentation pond as a temporary impoundment at the mine as part of coal mining and reclamation operations.

Hazard Notifications. The sedimentation pond will be examined for structural weakness and erosion in accordance with the schedule presented in Section 514.300. A report of these findings will be submitted to the Division as outlined in Section 514.300.

734 Discharge Structures

Discharge structures within the Dugout Canyon Mine facilities area will consist of the primary and emergency spillway on the sedimentation pond and a discharge line from the underground workings. Discharge structures at the Pace Canyon Fan Portal Site will consist of a spillway from the sediment trap and discharge line (UPDES) from the underground workings. All discharge structures will be constructed and maintained to comply with R645-301-744.

735 Disposal of Excess Spoil

There will be no excess spoil generated at the mine.

736 Coal Mine Waste

Coal mine waste will be stored and disposed of as described in Chapter 5.

740 DESIGN CRITERIA AND PLANS

741 General Requirements

This M&RP includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed and undisturbed areas. The design criteria and plans for the Pace Canyon Fan Portal Site can be found in Appendix 7-12.

742 Sediment Control Measures

742.100 General Requirements

Design. Sediment-control measures have been designed to provide the following:

- Prevent additional contributions of sediment to stream flow or to runoff outside the permit area;
- Meet the effluent limitations defined in Section 751; and
- Minimize erosion to the extent possible.

Measures and Methods. The sediment control measures at the mine will include practices carried out within and adjacent to the disturbed area. Sediment control methods will include:

- Retention of sediment within the disturbed area;
- Diversion of runoff away from the disturbed area;
- Diversion of runoff using channels or culverts through disturbed areas to prevent additional erosion;
- Provision of silt fences, riprap, contemporaneous revegetation, vegetative sediment filters, a sedimentation pond, and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment; and
- Treatment of mine drainage in underground sumps.

A sediment trap was constructed in the ditch on the southeast side of the disturbed area as shown on Figure 1 in Addendum A to Appendix 7-9. The trap was installed to collect sediment prior to it reaching the pond, therefore requiring less frequent sediment pond cleaning. The sediment trap has been fully designed to pass design flows, regardless of the quantity of sediment and/or ice collected in the trap. Sediment accumulations within the trap would not be considered a compliance concern. If the trap is unable to direct the water to the pond through culvert DC-11 (24" CMP), the water will flow through the trap and proceed down the existing ditch into the sediment pond.

A sediment basin was constructed above the inlet to culvert DC-10. The function of the sediment basin and sediment trap will be the same, both will pass the design flow regardless of the quantity of sediment in the trap/basin and sediment accumulation will not be a compliance concern. The trap/basin designs are located in Addendum A to Appendix 7-9.

A sediment trap will be constructed in association with the Pace Canyon Fan Portal site. Contemporaneous reclamation and gravel should adequately control sediment at the site, with the sediment trap providing an extra measure of protection. Details regarding this sediment trap can be found in Appendix 7-12.

752.100 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763 of this M&RP.

752.200 Road Drainage

All roads will be located, designed, constructed, reconstructed, used, maintained and reclaimed according to plans and designs presented in Sections 732.400, 742.400, and 762 of this M&RP. All roads have been designed to:

- Control or prevent erosion, siltation and the air pollution attendant to erosion by vegetating or otherwise stabilizing all exposed surfaces in accordance with current, prudent engineering practices;
- Control or prevent additional contributions of suspended solids to stream flow or runoff outside the permit area;

A road not to be retained for use under an approved post-mining land use will be reclaimed immediately after it is no longer needed for coal mining and reclamation operations.

762.100 Restoring the Natural Drainage Patterns

All natural drainage patterns will be restored during reclamation. Details regarding the reclamation of stream channels are provided in Appendix 7-11. As noted in that appendix and on Plate 5-5, the following channels will be restored during reclamation:

Channel	Location
RD-1	Upstream ephemeral tributary on the west side of Dugout Creek
RD-2	Middle ephemeral tributary on the west side of Dugout Creek
RD-3	Eastern perennial tributary of Dugout Creek
RD-4	Upper Dugout Creek
RD-5	Dugout Creek below confluence of RD-3 and RD-4
RD-6	Ephemeral channel across the reclaimed survey monument access road
RD-7	Upstream ephemeral tributary on the east side of Dugout Creek
RD-8	Middle ephemeral tributary on the east side of Dugout Creek
RD-9	Downstream ephemeral tributary on the west side of Dugout Creek
RD-10	Downstream ephemeral tributary on the east side of Dugout Creek

In accordance with R645-301-742.333, channels RD-1, RD-2, and RD-6 through RD-10 were designed to safely convey the peak flow resulting from the 10-year, 6-hour precipitation event. With the exception of RD-10, each channel was designed with a bottom width of 1 foot, a channel depth of 1 foot, 2H:1V side slopes, and a median riprap diameter of 3 inches. The riprap will be installed in these ephemeral drainages as an extra erosion-protection measure, even though design velocities are not expected to be erosive. RD-10 was designed with a similar cross section, but with a median riprap diameter of 6 inches.

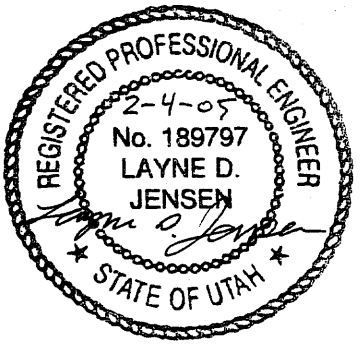
During reclamation of the Pace Canyon Fan Portal Site two drainages will be affected. Both drainages had been disturbed by the road building activities prior to the construction of the Dugout Canyon Mine and Pace Canyon Fan Portal Facilities. In both drainages a section of the channel had been destroyed by the road construction. During reclamation these drainages will be reestablished. Reclamation channel PCRD-1 will be constructed in the drainage south of the portal with the exception of where the channel crosses the road. At the road crossing a swale will be constructed. Reclamation channel PCRD-1 will be constructed with a bottom width of 2.5 feet, side

APPENDIX 7-12

Pace Canyon Fan Portal Site

APPENDIX 7-12
ATTACHMENT 1

Hydrology Calculations



— Pace Canyon Portal Site —

Rainfall Depths

10-yr	6-hr	1.35 in.
10-yr	24-hr	1.95 in
25-yr	6-hr	1.65 in
25-yr	24-hr	2.35 in
100-yr	6-hr	2.05 in

Curve Numbers

The curve number will be determined by combining vegetation, Hydrologic soil group, Vegetation density, Vegetation condition, and Field observation

The vegetation type is identified as mixed conifer on Plate 3-1 This vegetation type is very similar to pinyon-juniper. In fact Mt. Nebo who did a veg. study on the portal site identified the site as being a Pinyon-juniper vegetation type. (see Plate 3-1E)

Plate 2-1 identifies two soil types in the associated watersheds Map unit 96 Rock outcrop Rubbleland Travesilla complex and map unit 84 Podo-Rock outcrop complex 50-70 percent slope. The Soil Survey of Carbon Area, Utah (1988) identifies the Hydrologic Soil Group as D for these soils.

Field observation indicates that the drainages on either side of the portal area do not flow for smaller storm events.

A general description of the vegetation type indicates a cover density between 60-70% which indicates a fair hydrologic condition.

According to Table 2-2d (pg 3) The curve number for the Pinyon-juniper vegetation type is 80

During the operational period there will also be reclaimed areas and graveled pads and roads.

The curve number for reclaimed area will be assumed to be 80 although with the use of the deep gouging method the reclaimed areas will not generate any runoff for a few years.

The curve number for the pad and road areas will be assumed to be 89 see Table 9.1 (pg 4 of this attachment)

Four watersheds have been identified. Three of the four watersheds are upgradient of the disturbed area and do not contain disturbed areas related to the portal construction.

Thus these three watersheds have a curve number of 80

The Forth watershed contains the disturbed area. This watershed contains, undisturbed areas, road and pad areas, and reclaimed areas. The curve number will be determined by using an area weighted average.

Reclaimed	= 0.45 Acre	CN = 80
road/pad	= 0.69 Acre	CN = 89
undisturbed	= 1.00 Acres	CN = 80
	2.14 Acres	

$$CN = \frac{(0.45)(80) + (0.69)(89) + (1.00)(80)}{2.14} = 82.9 \Rightarrow 83$$

Table 2-2d.—Runoff curve numbers for arid and semiarid rangelands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and I_a = 0.2S. For range in humid regions, use table 2-2c.

[2]Poor <30% ground cover (litter, grass, and brush overstory).
Fair 30 to 70% ground cover.
Good >70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

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To Lane Jenson	From Sharon Falvey	
Co./Dept. Earth Fax	Co. DOGM	
Phone #	Phone # 801 538-5260	
Fax # 561-[illegible]-1861	Fax #	

9.2

Table 9.1.--Runoff curve numbers for hydrologic soil-cover complexes

(Antecedent moisture condition II, and I_a = 0.2 S)

Land use	Cover: Treatment or practice	Cover: Hydrologic condition	Hydrologic soil group: A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	"and terraced	Poor	66	74	80	82
	" " "	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
	"and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight row	Poor	66	77	85	89
	" "	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	"	Good	55	69	78	83
	"and terraced	Poor	63	73	80	83
	"and 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
	"	Fair	25	59	75	83
	"	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		---	74	84	90	92

1/ Close-drilled or broadcast.
2/ Including right-of-way.

Watershed Area a	Drainage Area (ac)	Curve Number	S (in)	Y (%)	I (ft)	L (hr)	Time of Conc. (hr)	Peak Flow (cfs)
PCWS-1	2.14	83	2.048	46.9	560	0.026	0.044	0.61
PCWS-2	2.55	80	2.500	70.9	535	0.023	0.038	0.49
PCWS-3	39.78	80	2.500	70.4	2377	0.076	0.126	6.33
PCWS-4	149.3	80	2.500	57.7	4563	0.141	0.235	19.05

Notes

Watershed locations can be found on Plates PC7-5 and PC7-6
S = 1000/CN - 10
Y = average watershed slope = (length of contour lines)(contour interval)/(watershed area)
I = hydraulic length
L = watershed lag =(I^0.8(S+1)^0.7) / (1900(Y)^0.5)
Time of Concentration + 1.67L
Peak Flow is based on a 10-yr 6-hr storm event (calculations can be found on pages 6 to 9)

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Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-1

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 2.14 acres
Depth = 1.35 inches	CN = 83.00
Duration = 6.0 hrs	Time conc.= 0.04 hrs

OUTPUT SUMMARY

Runoff depth: 0.296 inches
Initial abstr: 0.410 inches
Peak flow: 0.61 cfs (0.281 iph)
at time: 2.505 hrs

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Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-2

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 2.55 acres
Depth = 1.35 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.04 hrs

OUTPUT SUMMARY

Runoff depth: 0.216 inches
Initial abstr: 0.500 inches
Peak flow: 0.49 cfs (0.191 iph)
at time: 2.508 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-3

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 39.78 acres
Depth = 1.35 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.13 hrs

OUTPUT SUMMARY

Runoff depth: 0.216 inches
Initial abstr: 0.500 inches
Peak flow: 6.33 cfs (0.158 iph)
at time: 2.537 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-4

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 149.30 acres
Depth = 1.35 inches	CN = 80.00
Duration = 6.0 hrs	Time conc.= 0.24 hrs

OUTPUT SUMMARY

Runoff depth: 0.216 inches
Initial abstr: 0.500 inches
Peak flow: 19.05 cfs (0.127 iph)
at time: 2.632 hrs

- Drainage Ditch Design -

Assumptions

1) All ditches designed for the 10-yr 6-hr storm event

2) When riprap is required the method presented by Searcy, (1967) will be used (see pg 22)

3) Riprap thickness is two times the D_{50}.

4) A Mannings n of 0.03 will be assumed for bare earth.

5) A Mannings n of 0.035 will be assumed for rocky earth.

6) A Mannings n for riprap channels will be determined using the following equation:

$$n = 0.0456 (D_{50} \times \text{Slope})^{0.159}$$

(Abt. S.R. et.al. 1987)

D_{50} = median riprap size (in)
Slope = (ft/ft)

7) Filter blankets under riprap channels will be 1/2 the riprap thickness.

PCUD-1

Contributing watershed is 50% of PCWC-2

Q_{10-6} = 0.25 cfs

minimum slope = 1.7 %

maximum slope = 5 %

Triangular ditch

Side slopes = 2:1
Depth = 1'

Max velocity = 2.41 fps No riprap
Max depth = 0.56 ft
freeboard = 0.44 ft

See pages 13+14 for calculation sheets
See page 19 for the figure

PCUD-2

Contributing watershed is PCWS-3

Q_{10-6} = 6.33 cfs

minimum slope = 10.4 %

maximum slope = 32.3 %

Trapizoidal ditch

Side slopes = 2:1
Depth = 1'
Bottom width = 2.5'
Riprap D_{50} = 6"

Max. Velocity = 6.58 fps < 7.5 fps ∴ ok
Max depth = 0.38 ft < 1 ft ok
freeboard = 0.62 ft

See pages 15+16 for the calculation sheet.
See page 20 for the figure

PCO-1

Contributing watershed: Depending on final grading upto 100% of the watershed will drain to this ditch Assume 100% of PCWS-1

$Q_{10\text{-}6} = 0.61$ cfs

minimum slope = 14.3 %

max slope = 36.4 %

Trapizoidal ditch

Bottom Width = 1.25'
Side slope 2:1
Flow is against the berm on one side
Depth = 1 ft

max velocity = 4. fps ∴ no riprap
max depth = 0.13 ft
freeboard = 0.87 ft

See pages 17+18 for the calculation sheets
See page 21 for the figure.

PCUD-1 MIN SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon Pc
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth
Slope	017000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	0.00	ft
Discharge	0.25	cfs

Results		
Depth	0.56	ft
Flow Area	0.2	ft²
Wetted Perim	1.25	ft
Top Width	0.56	ft
Critical Depth	0.43	ft
Critical Slope	0.063775	ft/ft
Velocity	1.61	ft/s
Velocity Head	0.04	ft
Specific Energ	0.60	ft
Froude Numb	0.54	
Flow Type	Subcritical	

< 1.0 ft $\therefore$ OK freeboard $= 0.44'$

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PCUD-1 MAX SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon Pc
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	bare earth
Slope	050000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	0.00	ft
Discharge	0.25	cfs

Results		
Depth	0.46	ft
Flow Area	0.1	ft²
Wetted Perim	1.02	ft
Top Width	0.46	ft
Critical Depth	0.43	ft
Critical Slope	0.063775	ft/ft
Velocity	2.41	ft/s < 5fps
Velocity Head	0.09	ft
Specific Energ	0.55	ft
Froude Numb	0.89	
Flow Type	Subcritical	

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PCUD-2 MIN SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	$D_{50} = 6''$
Slope	0.104000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.50	ft
Discharge	6.33	cfs

Results		
Depth	0.38	ft
Flow Area	1.3	ft²
Wetted Perimeter	4.21	ft
Top Width	4.03	ft
Critical Depth	0.51	ft
Critical Slope	0.037939	ft/ft
Velocity	5.06	ft/s
Velocity Head	0.40	ft
Specific Energy	0.78	ft
Froude Number	1.60	
Flow Type	Supercritical	

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PCUD-2 MAX SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon Portal
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.051	$D_{50} = 6''$
Slope	0.323000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.50	ft
Discharge	6.33	cfs

$n = 0.0456 (D_{50} \times Slope)^{0.159}$

(Abt et al, 1987)

$n = 0.0456 (6 \times 0.323)^{0.159} = 0.051$

Results		
Depth	0.31	ft
Flow Area	1.0	ft²
Wetted Perimeter	3.88	ft
Top Width	3.73	ft
Critical Depth	0.51	ft
Critical Slope	0.054546	ft/ft
Velocity	6.58	ft/s
Velocity Head	0.67	ft
Specific Energy	0.98	ft
Froude Number	2.29	
Flow Type	Supercritical	

< 7.5 fps $\therefore$ ok

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PCD-1 MIN SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon Pc
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data			
Mannings Coeffic	0.035		rocky earth
Slope	0.143000	ft/ft	
Left Side Slope	2.00	V : H	
Right Side Slope	2.00	V : H	
Bottom Width	1.25	ft	
Discharge	0.61	cfs	

Results			
Depth	0.13	ft	<1.0' ∴ ok freeboard = 0.87'
Flow Area	0.2	ft²	
Wetted Perim	1.53	ft	
Top Width	1.38	ft	
Critical Depth	0.19	ft	
Critical Slope	0.038858	ft/ft	
Velocity	3.66	ft/s	
Velocity Head	0.21	ft	
Specific Energ	0.33	ft	
Froude Numb	1.85		
Flow Type	Supercritical		

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PCD-1 MAX SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Pace Canyon Pc
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	rocky earth
Slope	0.364000	ft/ft
Left Side Slope	2.00	V : H
Right Side Slope	2.00	V : H
Bottom Width	1.25	ft
Discharge	0.61	cfs

Results		
Depth	0.10	ft
Flow Area	0.1	ft²
Wetted Perim	1.46	ft
Top Width	1.35	ft
Critical Depth	0.19	ft
Critical Slope	0.038858	ft/ft
Velocity	4.93	ft/s < 5.0 fps ∴ no riprap
Velocity Head	0.38	ft
Specific Energ	0.47	ft
Froude Numb	2.87	
Flow Type	Supercritical	

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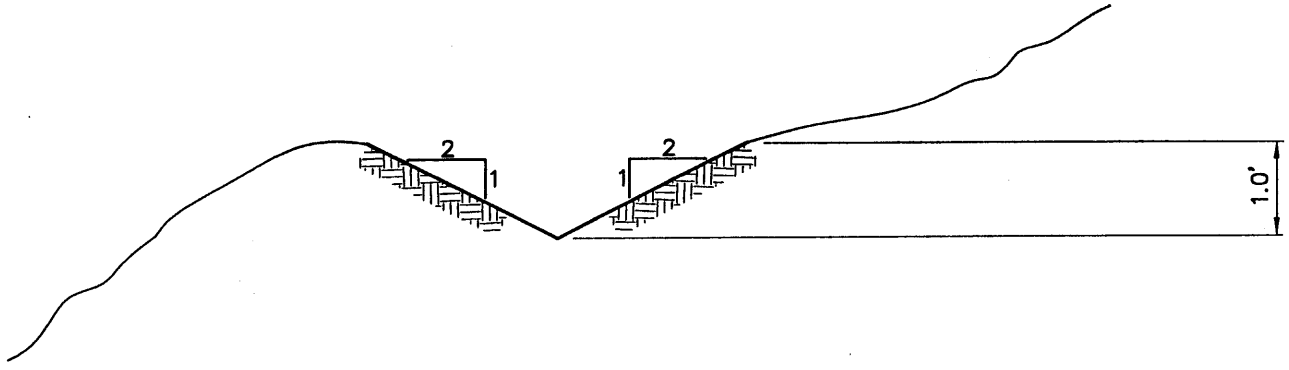

NO SCALE

PCUD–1

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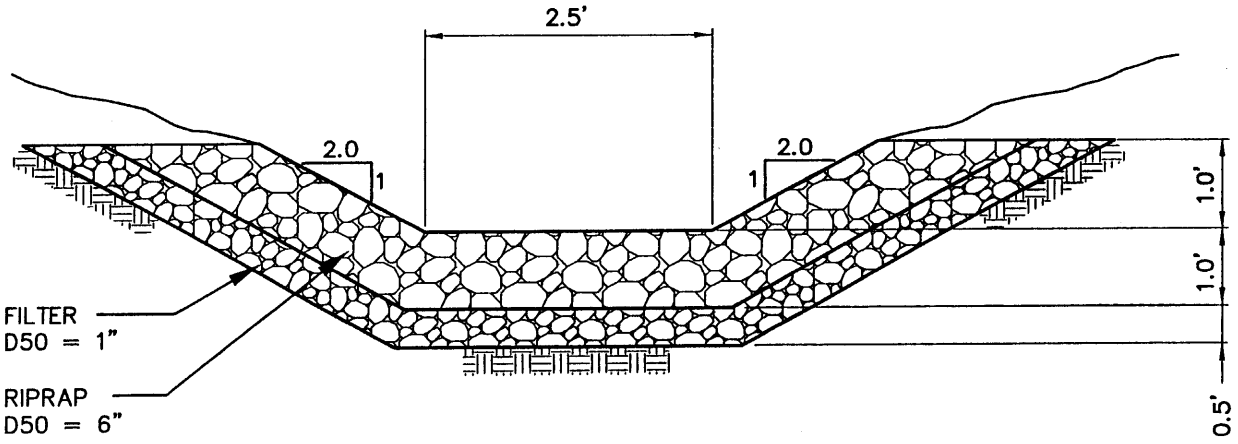

NO SCALE

PCUD–2

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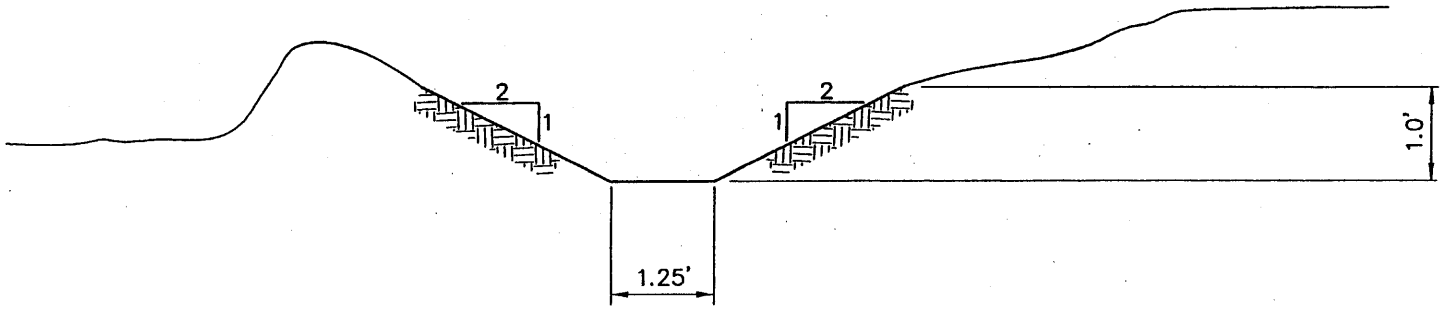

NO SCALE

PCD–1

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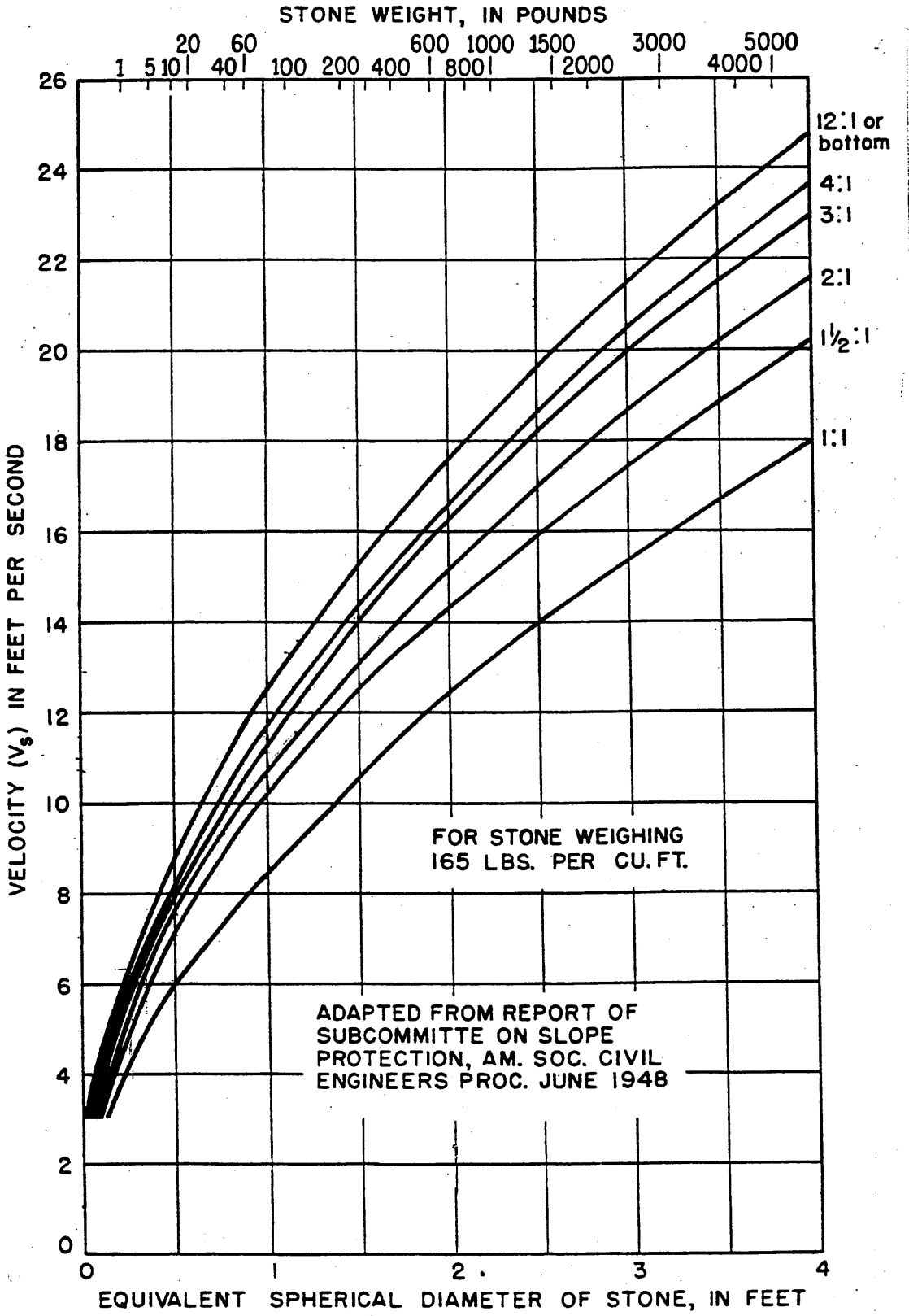

FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

Searcy, J.K. 1967. Use of Riprap for Bank Protection. U.S. Dept. of Transportation, Bureau of Public Roads, U.S Government Printing Office, Washington D.C.

- Culvert Design -

PCUC-1

All of PCWS-2 will flow into this culvert

$$Q_{10-6} = 0.49 \text{ cfs}$$

The inlet capacity using the nomograph on page 30 indicates a minimum culvert size less than 12"

To minimize the chance of clogging an 18" culvert should be used. minimum inlet capacity of 5.5 cfs.

Check culvert capacity.

18" CMP
Slope = 7.9 %

See pg 26 for calculation sheet.

Max. depth = 0.18'
Discharge velocity = 4.07 fps
No Riprap required at culvert outlet.

PCUC-2

Contributing Watershed: PCWS-3

$$Q_{10-6} = 6.33 \text{ cfs}$$

The inlet capacity nomograph on page 30 indicates a 21" culvert could handle the design flow.

To add a factor of safety a 24" CMP should be used. minimum inlet capacity 11 cfs

Check culvert capacity

24" CMP
Slope = 10.7 %

See page 27 for calculation sheet

max depth = 0.54 ft
Discharge velocity = 9.31
outlet riprap required.

Assuming 2:1 side slopes in the channel where the culvert outlets a $D_{50} = 12"$ riprap will resist displacement and dissipate energy. $D_{50} = 12"$ riprap should extend 15' below the culvert.

see pg 22 for riprap figure.

PCUC-3

All of PCWS-4 will flow into this culvert

$Q_{10-6} = 19.05$ cfs

The inlet capacity using the nomograph on page 30 indicates a minimum culvert size of 27"

To minimize the chance of clogging and to provide some extra capacity use a 36" culvert which has an inlet capacity of over 30 cfs

Check culvert capacity

36" CMP
Slope = 2.5 %

See page 28 for calculation sheet.

max. depth = 1.2' < 3' ok
Discharge velocity = 7.27 fps
Riprap required
Use D_{50} = 6" Riprap at the outlet

Mine Water Discharge Culvert

Flow up to 300 gpm = 0.7 cfs

Water will be pumped out of the mine. Therefore, inlet capacity is not an issue.

Check Culvert Capacity 6" HDPE Culvert.

Slope = $35'/134' = 28.2\%$

max depth = $0.17' < 0.5'$ ∴ ok
Discharge velocity = 11.75 fps Outlet protection required

Place $D_{50} = 15"$ at the culvert outlet

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PCUC-1
Worksheet for Circular Channel

Project Description	
Worksheet	Pace Canyon P
Flow Element	Circular Channe
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	cmp
Slope	0.079000	ft/ft
Diameter	18	in
Discharge	0.49	cfs

Results		
Depth	0.18	ft
Flow Area	0.1	ft²
Wetted Perime	1.06	ft
Top Width	0.98	ft
Critical Depth	0.26	ft
Percent Full	12.0	%
Critical Slope	0.017527	ft/ft
Velocity	4.07	ft/s
Velocity Head	0.26	ft
Specific Energ	0.44	ft
Froude Numbe	2.05	
Maximum Disc	17.20	cfs
Discharge Full	15.99	cfs
Slope Full	0.000074	ft/ft
Flow Type	Supercritical	

< 5.0 fps ∴ no riprap

PCUC-2
Worksheet for Circular Channel

Project Description	
Worksheet	PACE CANYON PORTAL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Slope	0.107000	ft/ft
Diameter	24	in
Discharge	6.33	cfs

Results		
Depth	0.54	ft
Flow Area	0.7	ft²
Wetted Perimeter	2.18	ft
Top Width	1.77	ft
Critical Depth	0.89	ft
Percent Full	26.9	%
Critical Slope	0.015967	ft/ft
Velocity	9.31	ft/s
Velocity Head	1.35	ft
Specific Energy	1.89	ft
Froude Number	2.65	
Maximum Discharge	43.12	cfs
Discharge Full	40.08	cfs
Slope Full	0.002669	ft/ft
Flow Type	Supercritical	

riprap required
Place $D_{50} = 12''$ at the culvert outlet

PCUC-3
Worksheet for Circular Channel

Project Description	
Worksheet	PACE CAYON PORTAL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Slope	0.025000	ft/ft
Diameter	36	in
Discharge	19.05	cfs

Results		
Depth	1.19	ft
Flow Area	2.6	ft²
Wetted Perimeter	4.09	ft
Top Width	2.94	ft
Critical Depth	1.40	ft
Percent Full	39.8	%
Critical Slope	0.014132	ft/ft
Velocity	7.27	ft/s
Velocity Head	0.82	ft
Specific Energy	2.01	ft
Froude Number	1.36	
Maximum Discharge	61.45	cfs
Discharge Full	57.12	cfs
Slope Full	0.002781	ft/ft
Flow Type	Supercritical	

1.19 ft < 3' ok

7.27 ft/s > 5 ∴ need riprap at outlet
use $D_{50} = 6''$

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Project Engineer: Tom Suchoski

Mine Water Discharge Culvert
Worksheet for Circular Channel

Project Description	
Worksheet	Portal Canyon
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.014	HDPE Pipe
Slope	0.282000	ft/ft
Diameter	6	in
Discharge	0.70	cfs

Results		
Depth	0.17	ft
Flow Area	0.1	ft²
Wetted Perimeter	0.63	ft
Top Width	0.47	ft
Critical Depth	0.42	ft
Percent Full	34.3	%
Critical Slope	0.017186	ft/ft
Velocity	11.75	ft/s
Velocity Head	2.15	ft
Specific Energy	2.32	ft
Froude Number	5.85	
Maximum Discharge	2.98	cfs
Discharge Full	2.77	cfs
Slope Full	0.018052	ft/ft
Flow Type	Supercritical	

outlet riprap required
Place D_{50} = 15 to 18" riprap at outlet
> 0.7 cfs ∴ OK

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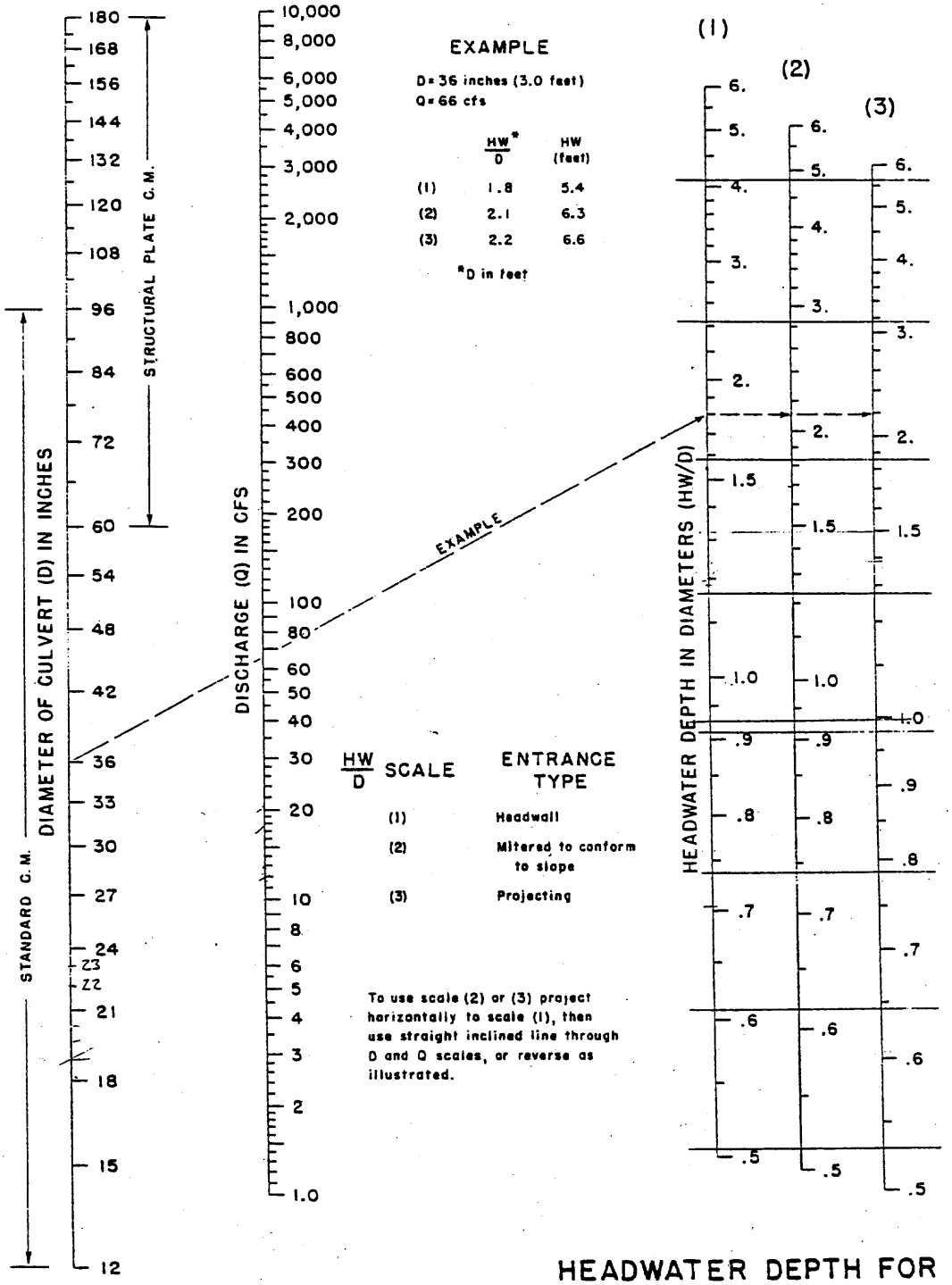
CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Ref (U.S. Dept. of Transportation, 1977)

- Sediment Trap Design -

Sediment control at this site is being acheived using Alternate Sediment Control Measures (ASCM). These ASCMs include contemporaneous reclamation, clean gravel placed on pads and roads, silt fences (during construction) and a sediment trap.

The sediment trap is a part of the ASCM and is not intended to be a sediment pond. Thus, the sediment trap will not be designed as a sediment pond and will not have the capacity of a sediment pond.

The contemporaneous reclamation and gravel should adequately control sediment. The sediment trap will provide an extra measure of protection

Sediment Trap Capacity

elev.	Area (ft^2)	Volume (ft^3)	
6986	55.5		
6987	158.3	106.9	
6988	291.8	225.1	
6989	452.7	372.3	
6990	641.5	547.1	
6991	857	749.3	
6992	1098.8	977.9	spillway elevation
6993	1459.7	1279.3	
6993.5	1500	739.9	
		4997.8 ft^3	= 0.115 Ac-ft

The runoff depth for the 10-yr 24-hr storm event is 0.66 inches. (see page 33)

Total runoff volume = $(0.66 in/12 in/ft)(2.14 Ac)(43560 ft^2/ac) = 5127.0 ft^3$

The sediment trap can hold nearly all of the 10-yr 24-hr storm event if the spillway is plugged.

Although not required as it is for a sediment pond the sediment trap's spillway will be designed to pass the 25-yr 6-hr storm event.

$Q_{25-6} = 0.99$ cfs (see page 32)

revised 1-05

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-1 25-YEAR 6-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 2.14 acres
Depth = 1.65 inches	CN = 83.00
Duration = 6.0 hrs	Time conc.= 0.04 hrs

OUTPUT SUMMARY

Runoff depth: 0.468 inches
Initial abstr: 0.410 inches
Peak flow: 0.99 cfs (0.457 iph)
at time: 2.505 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
PCWS-1 10-YEAR 24-HOUR

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type II	Area = 1.93 acres
Depth = 1.95 inches	CN = 83.00
Duration = 24.0 hrs	Time conc.= 0.05 hrs

OUTPUT SUMMARY

Runoff depth: 0.661 inches
Initial abstr: 0.410 inches
Peak flow: 1.42 cfs (0.729 iph)
at time: 12.006 hrs

Spillway Design, (PCDC-1)

$Q_{25-6} = 0.99$ cfs
Use an 18" CMP.

Inlet capacity = 5.5 cfs (pg 30)

Slope = 8/33 = 24.2 %

Outlet Velocity = 7.44 fps

Requires Riprap Use $D_{50} = 6"$ for outlet protection

revised 1/05

SEDIMENT TRAP SPILLWAY DESIGN
Worksheet for Circular Channel

Project Description	
Worksheet	Pace Canyon P
Flow Element	Circular Channe
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	CMP
Slope	242000	ft/ft
Diameter	18	in
Discharge	0.99	cfs

Results		
Depth	0.19	ft
Flow Area	0.1	ft²
Wetted Perime	1.10	ft
Top Width	1.00	ft
Critical Depth	0.37	ft
Percent Full	12.9	%
Critical Slope	0.016790	ft/ft
Velocity	7.44	ft/s
Velocity Head	0.86	ft
Specific Energ:	1.05	ft
Froude Numbe	3.61	
Maximum Disc	30.11	cfs
Discharge Full	27.99	cfs
Slope Full	0.000303	ft/ft
Flow Type	Supercritical	

> 5fps ∴ riprap is required

use $D_{50} = 6''$

EarthFax Engineering Inc
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666
Project Engineer: Richard White

- Topsoil Stockpiles Sediment Control -

A berm will be constructed around the topsoil stockpiles to contain all runoff from the topsoil stockpiles. The berm will be designed to completely contain the runoff from the 10-yr 24-hr storm event.

Rainfall depth = 1.95" (10-yr 24-hr)

Although the topsoil stockpiles will be revegetated a bare earth condition will be assumed for runoff calculations. A Hydrologic soil group of D will be assumed.

CN = 89 (Dirt Road)

$$\text{Runoff depth} = \frac{(P-0.2S)^2}{P+0.8(S)}$$

$$S = {}^{1000}/_{CN} - 10 = \frac{1000}{89} - 10 = 1.236$$

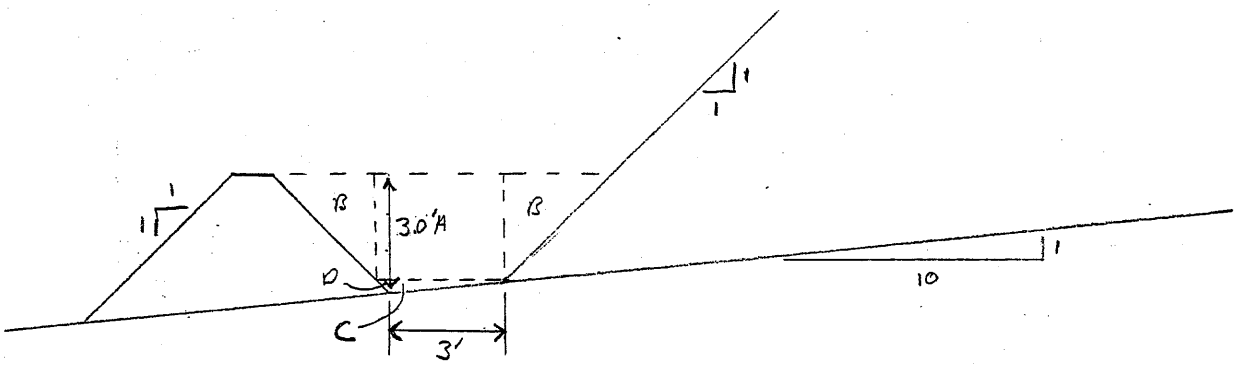
$$\text{Runoff depth} = \frac{(1.95-0.2(1.236))^2}{1.95+0.8(1.236)} = \frac{2.8995}{2.9388} = 0.99"$$

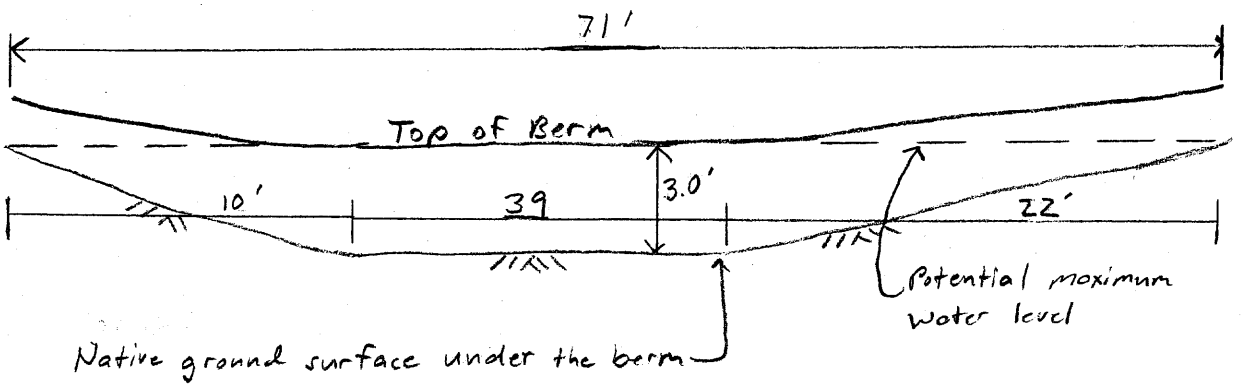
Shaft Topsoil stockpile

Topsoil stockpile area above shaft = 5193 ft²

Runoff Volume = $(5193\ ft^2)({}^{0.99}/_{12}) = 428.4\ ft^3$

$$\text{Area} = \overset{A}{(2.7)(33)} + \overset{B}{2(\tfrac{1}{2}(2.7\times 2.7))} + \overset{C}{\tfrac{1}{2}(3\times 0.3)} + \overset{D}{\tfrac{1}{2}(0.3\times 0.3)} = 16.7\ ft^2$$





Berm length retaining runoff = 71'

Containment Volume = $(16.7\ ft^2 X 39) + \frac{1}{2}(10' X 16.7\ ft^2) + \frac{1}{2}(22 X 16.7\ ft^2)$

$= 651 + 83.5 + 183.7 = 918.2\ ft^3$

Required containment = $428.4\ ft^3 < 918.2\ ft^3$ ∴ OK

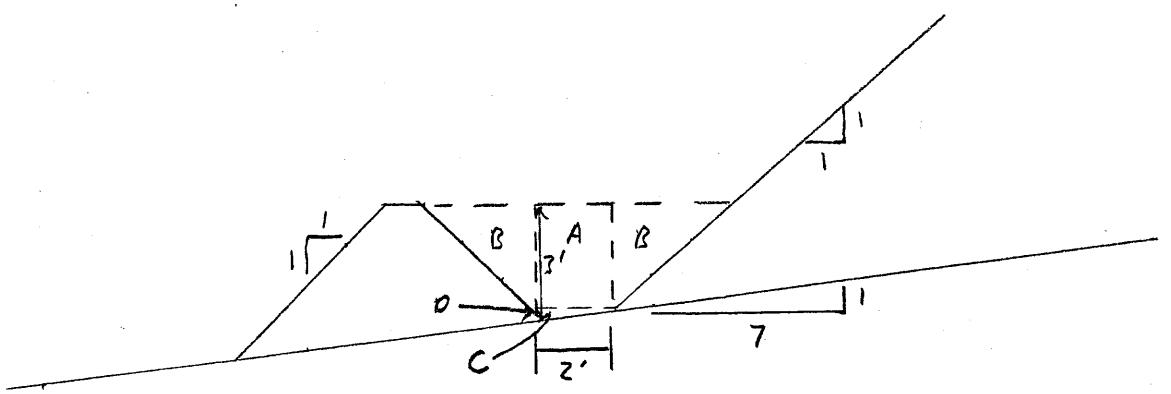
A 3.0' tall berm should be constructed on the lower part of topsoil stockpile. The berm along the road and in the higher areas only needs to be about 1' tall.

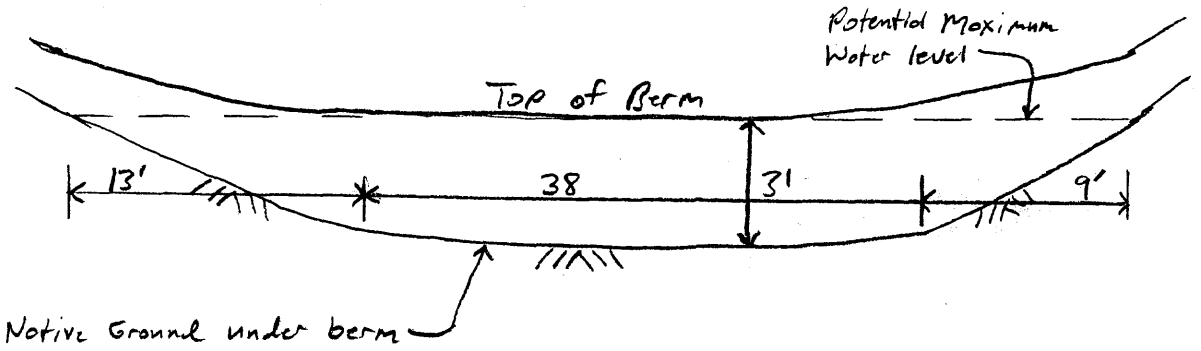
Portal Topsoil Stockpile

Stockpile Area = $3928\ ft^2$

Runoff volume = $(3928\ ft^2 X 0.99/12) = 324.1\ ft^3$

Area = $(2.7)(2) + 2(\frac{1}{2}(2.7 \times 2.7)) + \frac{1}{2}(0.3 \times 2) + \frac{1}{2}(0.3 \times 0.3) = 13.0\ ft^2$



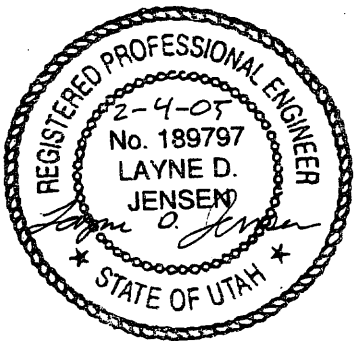


Containment Vol. = (13.0)(38) + ½(13)(13.0) + ½(9)(13) = 637 ft³

Required containment vol = 324.1 ft³ < 637 ft³ ∴ ok

APPENDIX 7-12
ATTACHMENT 2

Alternate Sediment Control Calculations



Comparison of Pre-Mining, Operational and Post-Reclamation Sediment Yields for the Pace Canyon Fan Site

Sediment control during the operational phase and after reclamation will be by Alternate Sediment Control Measures ("ASCM"). Sediment control during the operational phase will be a blend of contemporaneous reclamation, covering pad areas with gravel, reseeding areas and a sediment trap. The ASCM used successfully for the reclamation of many sites will be used for the reclamation of this site. The reclamation sediment control methods to be applied at this site are as follows:

1. Deep gouging;
2. Mixing hay into the soil;
3. Mulching the gouged surface;
4. Securing the mulch with a tackifier; and
5. Revegetation.

The purpose of this calculation is to evaluate the sediment yield characteristics of the disturbed area under pre-mining, operational and post-mining conditions. The four conditions to be evaluated will be as follows:

1. Pre-mining, This site was disturbed by previous logging, mining and grazing access activities. The site has been disturbed for nearly 100 years. Hence pre-disturbance information is not available and the pre-mining condition is a disturbed condition. Although the pre-mining condition is a disturbed condition where possible an undisturbed condition will be assumed for these calculations.

2. Operational, after the site is constructed and ASCM have been installed. The sediment trap will not be accounted for in this calculation.

3. Immediate Post-Reclamation, after deep gouging, mulching and seeding but before vegetation establishment.

4. Long Term Post-Reclamation, after vegetation is well established and depressions from deep gouging are mostly gone.

During the operational phase 2 inches of washed gravel (2" minus) will be placed on the flatter portions of the pad area. The steeper areas around the portal will be covered with riprap. Areas disturbed by construction with slopes at 2:1 or less and that will not be impacted by operational activities will reclaimed using the same methods as for final reclamation. Areas with a slope greater than 2:1 or which may be disturbed during operations will be mulched and hydroseeded. The topsoil stockpile will be gouged and hydroseeded but will not generate any sediment since the stockpile will be surrounded by a berm that will completely contain all runoff and sediment. See Plate 7-5A to see where the various ASCM are being used.

Contemporaneous and final reclamation consists of mixing 2 tons/acre hay into the soil during deep gouging. Another 1 to 1.5 tons/acre of straw mulch will be broadcast on the surface. The straw mulch will be secured with a tackifier when the site is hydroseeded. A small amount of wood fiber mulch will also be applied with the tackifier during hydroseeding.

Since all three time periods contain a road none of the calculations will include sediment yield from the road.

Methodology

Sediment yield calculations will be made using the Modified Universal Soil Loss Equation ("MUSLE") as presented by Israelsen et. al. (1984) and Barfield et. al. (1994)

$$A = R*K*LS*VM$$

where:

A = Sediment Yield (tons/acre/year)
R = Rainfall Factor
K = Soil Erodibility Factor
LS = Length and Steepness of slope factor
VM = Erosion Control Factor

Each of the above factors will be evaluated for each of the three conditions.

Rainfall Factor (R)

R=15 From Map R7 Israelsen et. al. (1984)

The same factor will apply for all four conditions.

Soil Erodibility Factor (K)

As mentioned above the site has been disturbed for a long time and pre-disturbance data are not available. The Soil Survey of Carbon Area, Utah catagorizes soils in the vicinity of the site that were not disturbed at the time of the survey. The bottom of the canyon with relatively flat slopes are identified as map unit 96 Rock outcrop-Rubbleland-Travesilla Complex. The erodibility factor identified in Table 12 on page 279 is 0.10 for the surface sample and 0.37 for soils at a depth greater than 3 inches. Since the surface and subsoils have been mixed at the site I will assume a soil erodibility factor of 0.3 for all conditions since the same soil will be used during contemporaneous and final reclamation.

The soil erodibility factor for graveled surface will be assumed to be 0.05 for the operational period.

Length-Steepness Factor (LS)

$$LS = \left[\frac{65.41\,s^2}{s^2+10{,}000} + \frac{4.56\,s}{\sqrt{s^2+10{,}000}} + 0.065\right]\left(\frac{l}{72.6}\right)^m$$

Where:

LS = Length Steepness Factor
S = Slope Gradient (%)
l = Slope Length (ft)
m = empirical exponent (function of slope)

Pre-mining

Based on the undisturbed topography in the vicinity of the site the natural slopes range between 40% and nearly vertical on the rock outcrops. Since this is the baseline for comparison of the sediment yield during each condition I will assume a slope of 40% to be conservative. In an undisturbed condition the slopes extend unbroken from the ridge lines down to the channels in the canyons. These distances may be thousands of feet. However, this site is between two drainages and the maximum slope length is about 800' with an average slope length of 400' to 500'. For the undisturbed condition I will assume a slope of 40% and a slope length of 400'.

LS = 25.3 (Table 2 Israelsen et. al. (1984))

Operational Period

A different LS factor will be used for the different conditions at the site. The undisturbed areas will use the same LS factor as above (LS=25.3). The graveled and riprapped areas of the site have a conservative slope length of 400' and an average slope of about 12.5%

LS = 3.84 (Table 2 Israelsen et. al. (1984))

For the areas to be reseeded but not gouged I will assume the worst case which is the 1:1 slope above the fan with a slope length of 40 feet.

LS = 26.72 (Table 2 Israelsen et. al. (1984))

The LS factor for the reclaimed areas will be the same as determined for the reclaimed condition below.

Immediate Post Reclamation

The reclaimed areas will be deep gouged prior to seeding. Deep gouging creates 1 to 3' deep holes that prevent runoff from concentrating and achieving an erosive velocity. In the early

stages of reclamation the gouges prevent any water from running off the reclaimed areas. The gouges also stop any runoff from upgradient undisturbed areas. Therefore, the slope length is very short. I will assume a slope length of 10' although the distance is actually less. The maximum slope of reclamation is a 2:1 slope or 50%. I will assume the maximum slope of 50% and a slope length of 10'.

LS = 5.64 (Table 2 Israelsen et. al. (1984))

Long-term Post Reclamation

In the long term the depressions from gouging will disappear leaving an unbroken slope with a maximum slope of 50%. However, most of the reclaimed site will have slope much lower than 50%. I will assume a 35% slope and the same slope length as for the pre-mining condition (400').

LS = 20.44 (Table 2 Israelsen et. al. (1984))

Erosion Control Factor (VM)

Pre-Mining

A vegetation study was performed for this site. The following are the results of the vegetation study. I will use the these values to estimate the Erosion Control Factor.

Total vegetation cover = 52.5%
Litter/rock cover = 33.84%
Bare soil = 21.5%

Grass density = 4.4%
Forbs = 18.0%
Shrubs = 22.3%
Overstory (trees) = 7.8%
Canopy of tall weeds (shrubs plus trees) = 30.1%

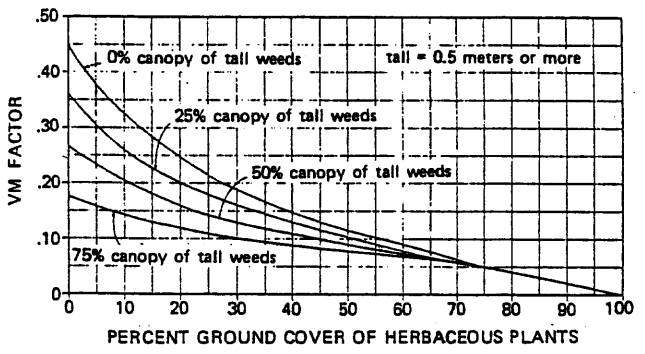


Figure 8. Relationship between forb density and VM factor.

Israelsen et. al. (1984)

VM = 0.2

Operational

The undisturbed areas will use the same value as for the pre-mining condition.

The gravel placed on the site will be like a stone mulch. Figure 6 from Israelsen et. al. (1984) estimates the VM based on R*K*LS and the tons/acre of stone mulch. The gravel is to be placed 2 inches thick. I will assume a density to 115 lbs/ cubic foot.

(2"/12 in/ft)(43560 ft^2/acre)(115 lbs/cubic foot)/(2000 lbs/cubic foot) = 417.5 tons/acre

R * K * LS = 15*0.3*3.84 = 17.3

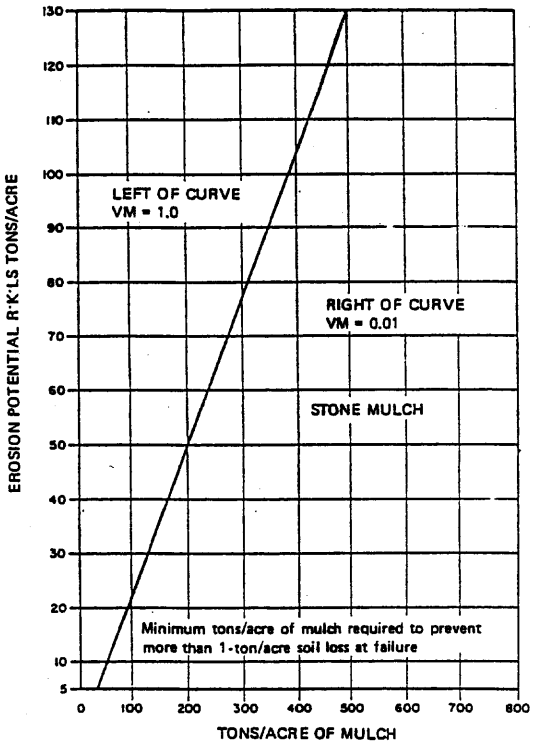


Figure 6. Stone mulch vs. R·K·LS.

VM = 0.01

The reseeded areas will likely not have very good vegetation. However, the native soil is very rocky. This rocky surface will reduce the erosion. Table 3 in Israelsen et. al. (1984) gives a range of values for scraped soil between 0.66 and 1.30. Due to the rock content in the soil and some limited vegetation I will assume a VM = 0.9

Immediate Post Reclamation

$$R * K * LS = 15*0.3*5.64 = 25.38$$

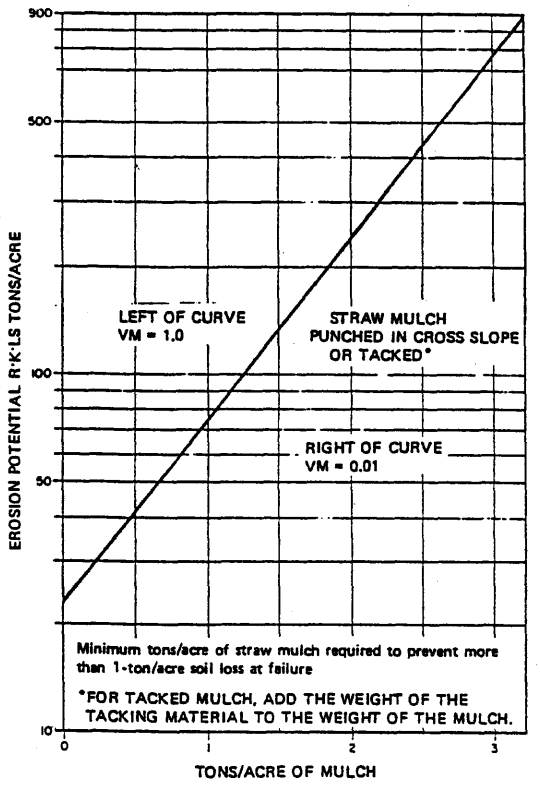


Figure 4. Straw mulch anchored vs. R·K·LS.

At least 1 ton/acre of mulch will be added with a tackifier to the reclaimed surface. Therefore, the point plots on the right side of the line.

$$VM = 0.01$$

Long-term Post Reclamation

I will assume the same vegetation as for the pre-mining condition.

$$VM = 0.2 \text{ (see figure 8 on page 5)}$$

Calculation Summary

Time Period	R	K	LS	VM	A (tons/acre/yr)	Area (acre)	tons/yr
Pre-Mining	15	0.30	25.3	0.20	22.77	2.70	61.48
Operational							
undisturbed	15	0.30	25.3	0.20	22.77	1.34	30.51
gravel/riprap	15	0.05	3.84	0.01	0.03	0.69	0.02
revegetated	15	0.30	26.72	0.90	108.22	0.16	17.32
reclaimed	15	0.30	5.64	0.01	0.12	0.30	0.04
					Operational Total	2.49	47.89
Immediate Post Reclamation	15	0.30	5.64	0.01	0.12	2.70	0.32
Long-term Post Reclamation	15	0.30	20.44	0.20	18.40	2.70	49.68

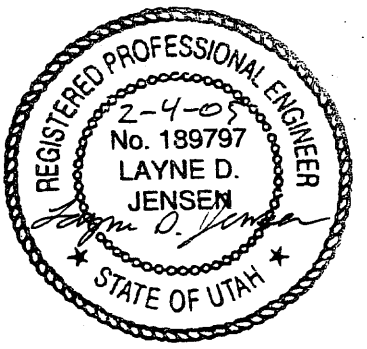
The area in the above table for the pre-mining and reclamation conditions is the area inside the disturbed area boundary. The operational areas do not add up to the total area inside the disturbed area boundary because the area within the topsoil stockpile berm has been removed. The topsoil stockpile is surrounded by a total containment berm and no runoff and sediment will leave this area.

As can be seen above the operational and reclaimed surfaces will generate less sediment than the pre-mining condition. The sediment trap will further reduce the sediment load reaching the creek during the operational period.

revised 1-05

APPENDIX 7-12
ATTACHMENT 3

Reclamation Hydrology Calculations



Reclamation Channels

The curve numbers identified on pages 1+2 of Attachment 1 for undisturbed and reclaimed areas will be used for estimating peak flows for each reclamation channel.

A summary of the watershed characteristics can be seen on the following page.

The channel design methodology can be found on pg 10 of the operational hydrology calculations in Attachment 1.

PCRD-1

Contributing watershed is PCRWS-2

$Q_{10\text{-}6} = 6.36$ cfs (pg 5)

minimum slope = $1/8.9 = 11.2\%$

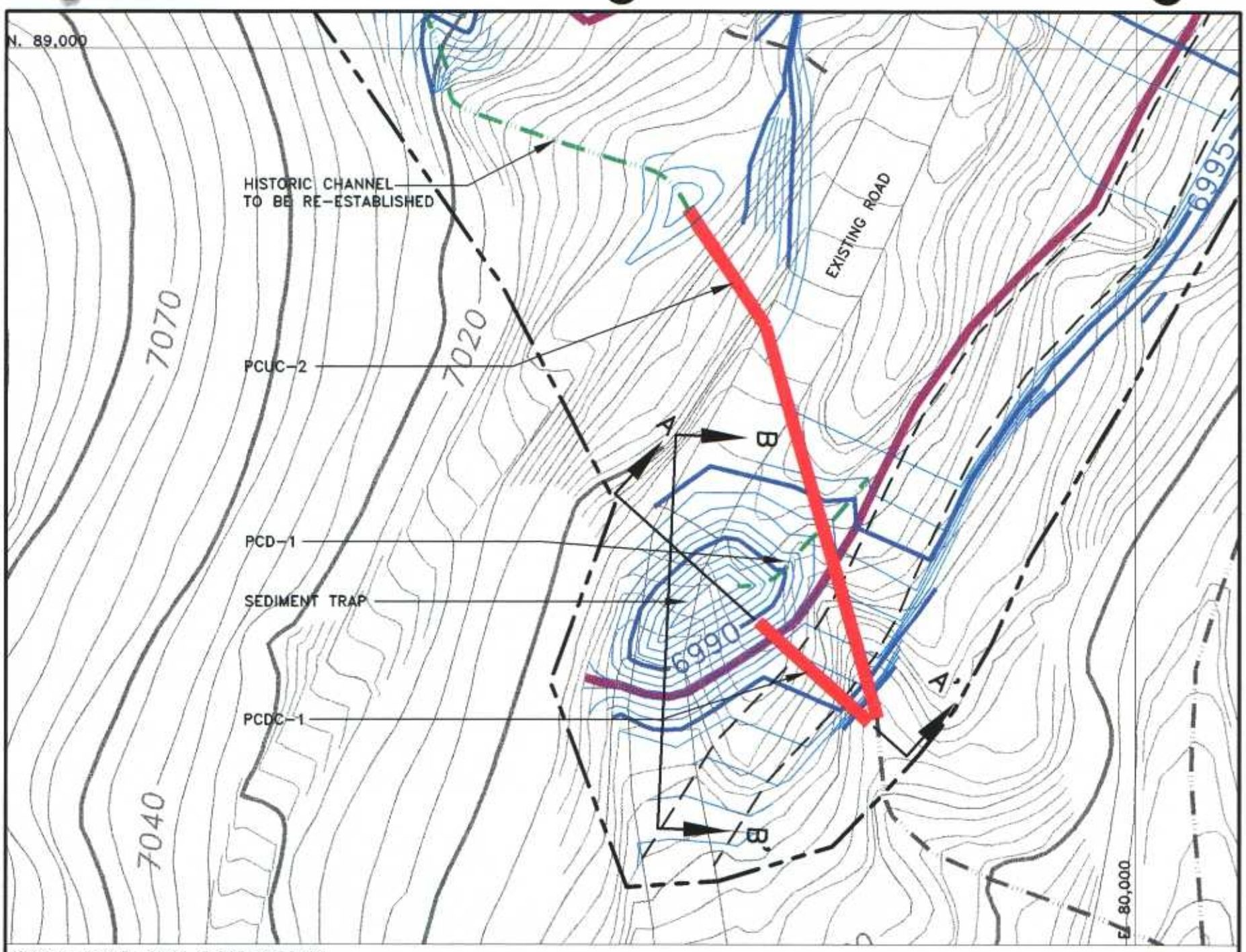
maximum slope = $1/2.95 = 33.9\%$

Trapizoidal ditch

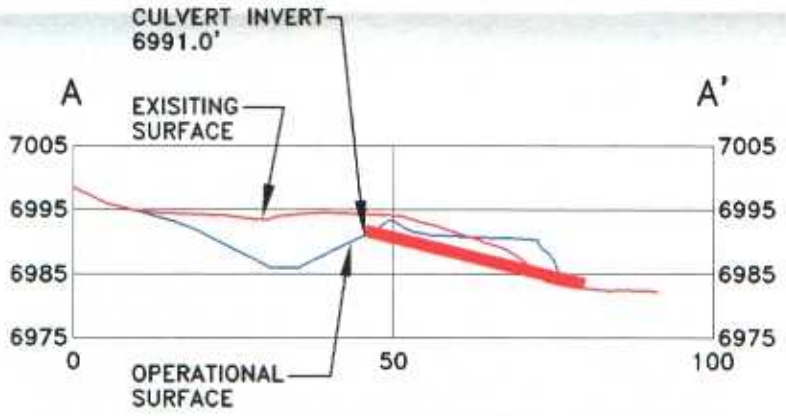
Side Slope = 2:1
Depth = 1'
Bottom Width = 2.5'
Riprap D_{50} = 6"

Max. Velocity = 6.7 fps
Max. Depth = 0.38'
freeboard = 0.62'

See pages 6+7 for calculation sheets
See page 10 for the figure.

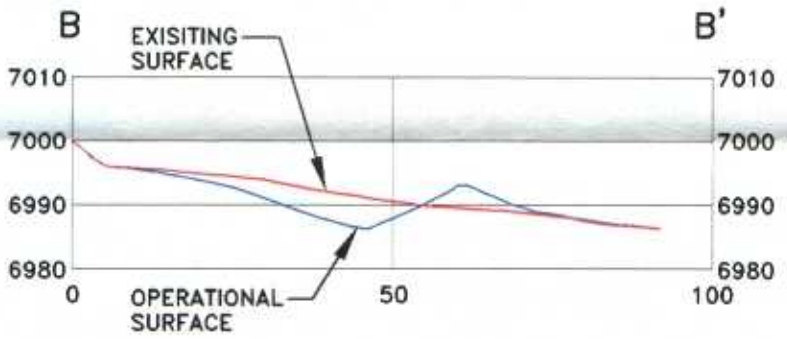


TOWNSHIP 13 SOUTH, RANGE 13 EAST, SECTION 30



SECTION A–A'

HORZ: 1"=30'
VERT: 1"=30



SECTION B–B'

HORZ: 1"=30'
VERT: 1"=30

LEGEND

CULVERT

TOPOGRAPHY FROM OLYMPUS AERIAL SURVEYS INC.
FLOWN 08–12–04

REGISTERED PROFESSIONAL ENGINEER
No. 159707
LAYNE D. JENSEN
1-7-21
STATE OF UTAH

REVISIONS OR UP-DATES			DATE: 12-13-04	
NO.	DATE	BY	DESIGNED BY:	LDJ
1	1-26-05	LDJ	DRAWN BY:	SWF
			CHECKED BY:	VSM
			SCALE:	1"=30'

FILENAME: D:\UGBS\VCF\PERMIT DWG\PLATE7-4.DWG 12-13-04

Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN SEDIMENT TRAP DETAIL AND CROSS SECTIONS

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE PC7-4

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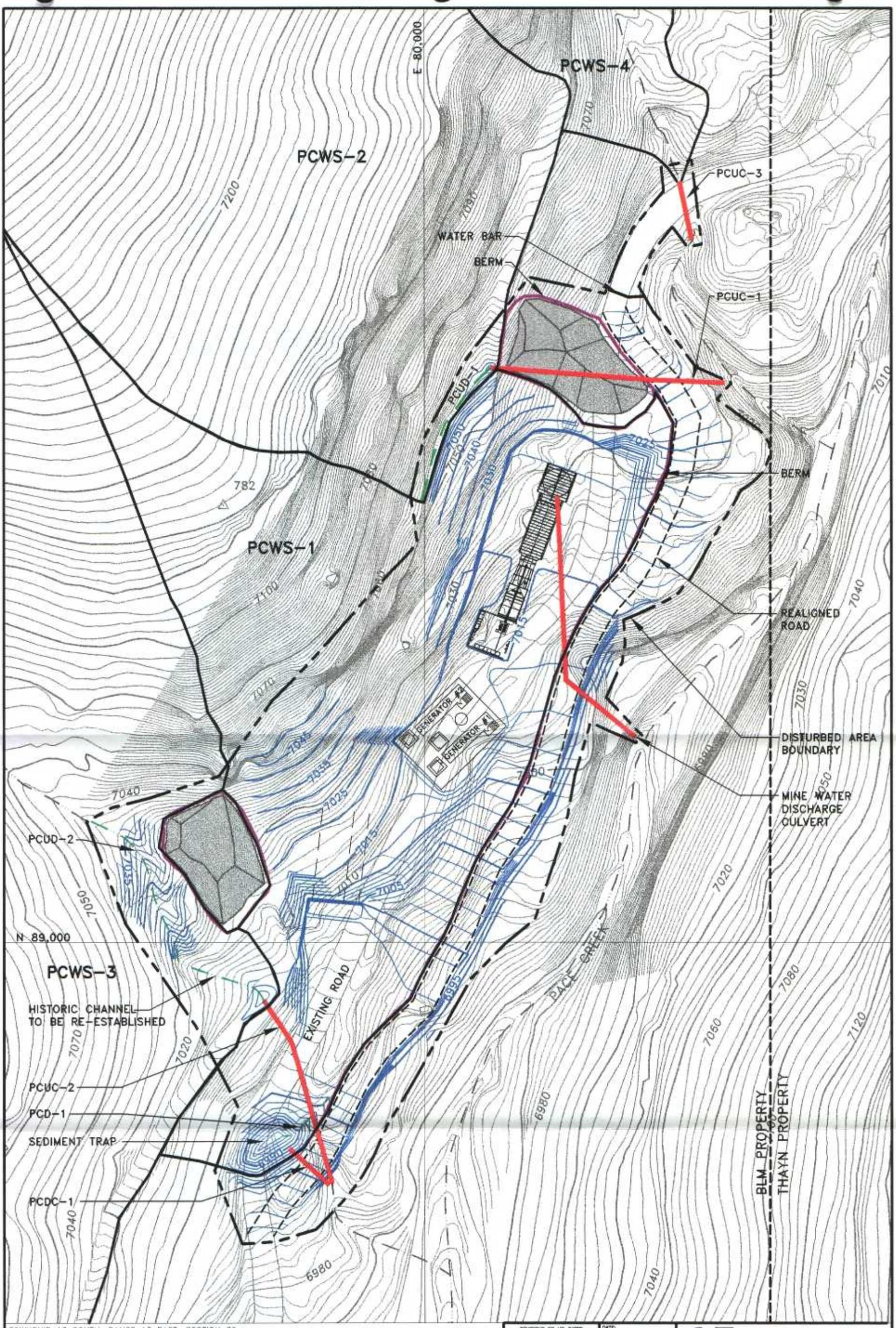

TOWNSHIP 13 SOUTH, RANGE 13 EAST, SECTION 30

LEGEND

WATERSHED BOUNDARY

CULVERT

TOPOGRAPHY FROM OLYMPUS AERIAL SURVEYS INC.
FLOWN 08-12-04

REGISTERED PROFESSIONAL ENGINEER No. 136707 LAYNE D. JENSEN 4-7-05 STATE OF UTAH

REVISIONS OR UP-DATES		
NO.	DATE	BY
1	1-26-05	LDJ

DATE: 11-16-04
DESIGNED BY: LDJ
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CHECKED BY: VSM
SCALE: 1"=60'
FILENAME: G:\UCS01\07\PERMIT.DWG\PLATE7-5.DWG\11-16-04

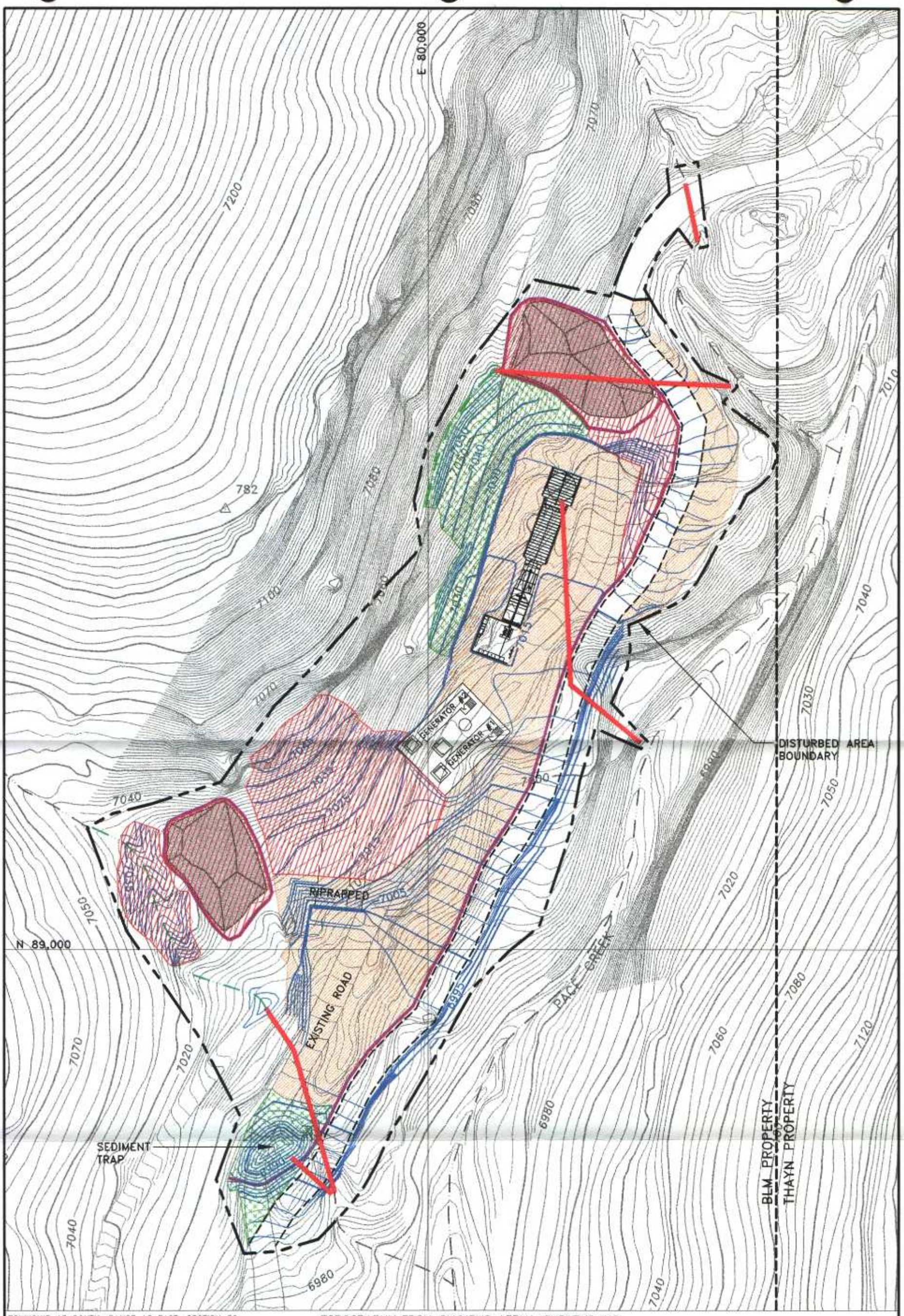
Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN DISTURBED AREA DIVERSIONS

P.O. BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE PC7-5

EarthFax Engineering, Inc.



TOWNSHIP 13 SOUTH, RANGE 13 EAST, SECTION 30

TOPOGRAPHY FROM OLYMPUS AERIAL SURVEYS INC.
FLOWN 08-12-04

LEGEND

- AREAS TO BE DEEP GOUGED, MULCHED AND HYDROSEEDED
- AREAS TO BE MULCHED AND HYDROSEEDED
- GRAVEL OR RIPRAP
- CULVERT

REGISTERED PROFESSIONAL ENGINEER
No. 165707
LAYNE D. JENSEN
STATE OF UTAH

REVISIONS OR UP-DATES			DATE: 11-16-04	
NO.	DATE	BY	DESIGNED BY:	LDJ
1	1-26-05	LDJ	DRAWN BY:	SWF
			CHECKED BY:	VSN
			SCALE:	1"=60'

FILENAME: G:\UCDG\07\PERMIT DWG\PLATE7-5A.DWG\11-16-04

Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN SEDIMENT CONTROL MAP

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE PC7-5A

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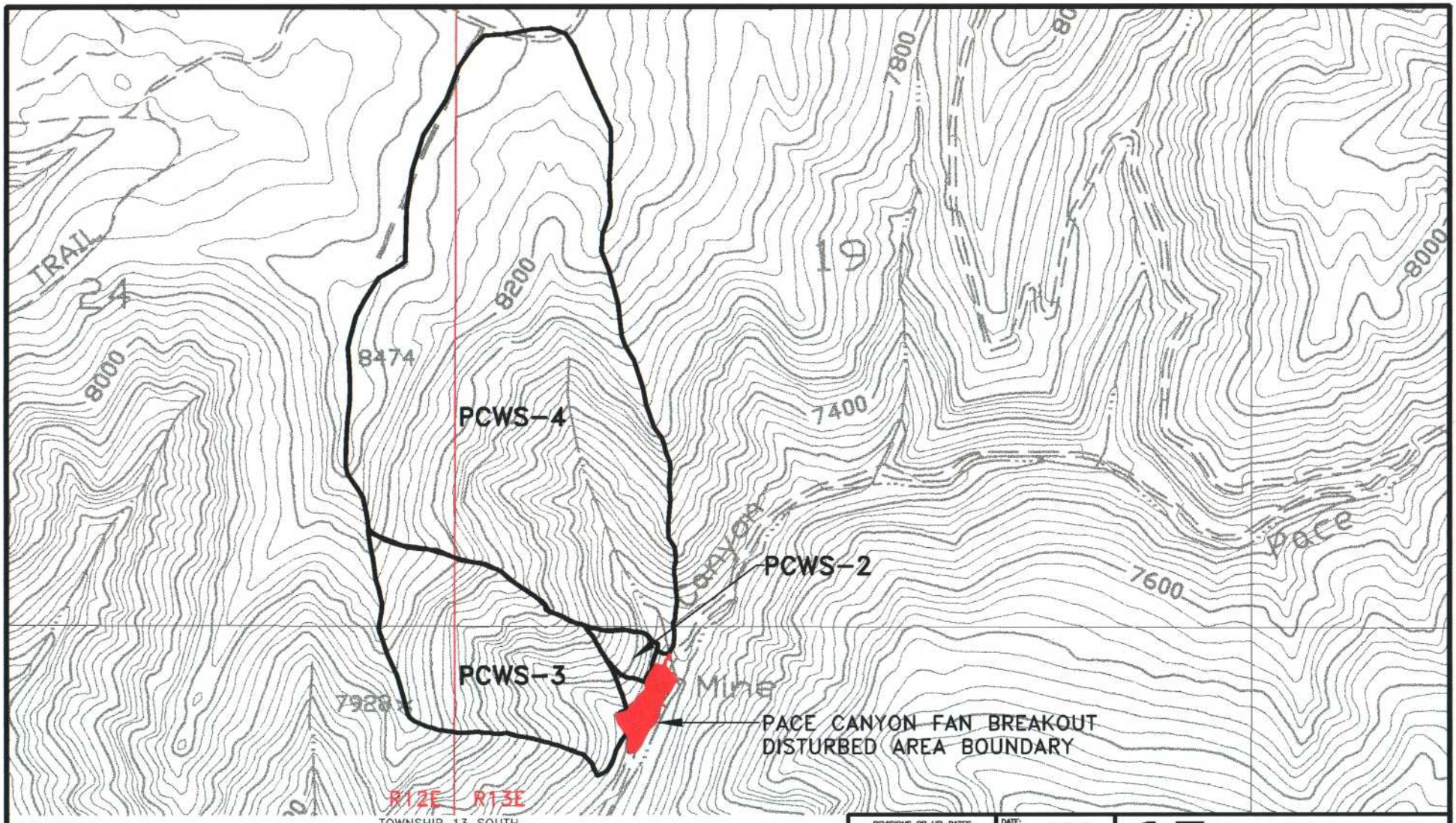


LEGEND

PACE CANYON UNDISTURBED WATERSHED BOUNDARY

REGISTERED PROFESSIONAL ENGINEER
No. 180797
LAYNE D. JENSEN
STATE OF UTAH

REVISIONS OR UP-DATES			DATE: 11-17-04	
NO.	DATE	BY	DESIGNED BY:	LDJ
1	1-26-05	LDJ	DRAWN BY:	SWF
			CHECKED BY:	VSM
			SCALE:	1"=1000'

FILENAME: G:\UC801\07\PERMIT DWG\PLATE7-6.DWG\11-21-04

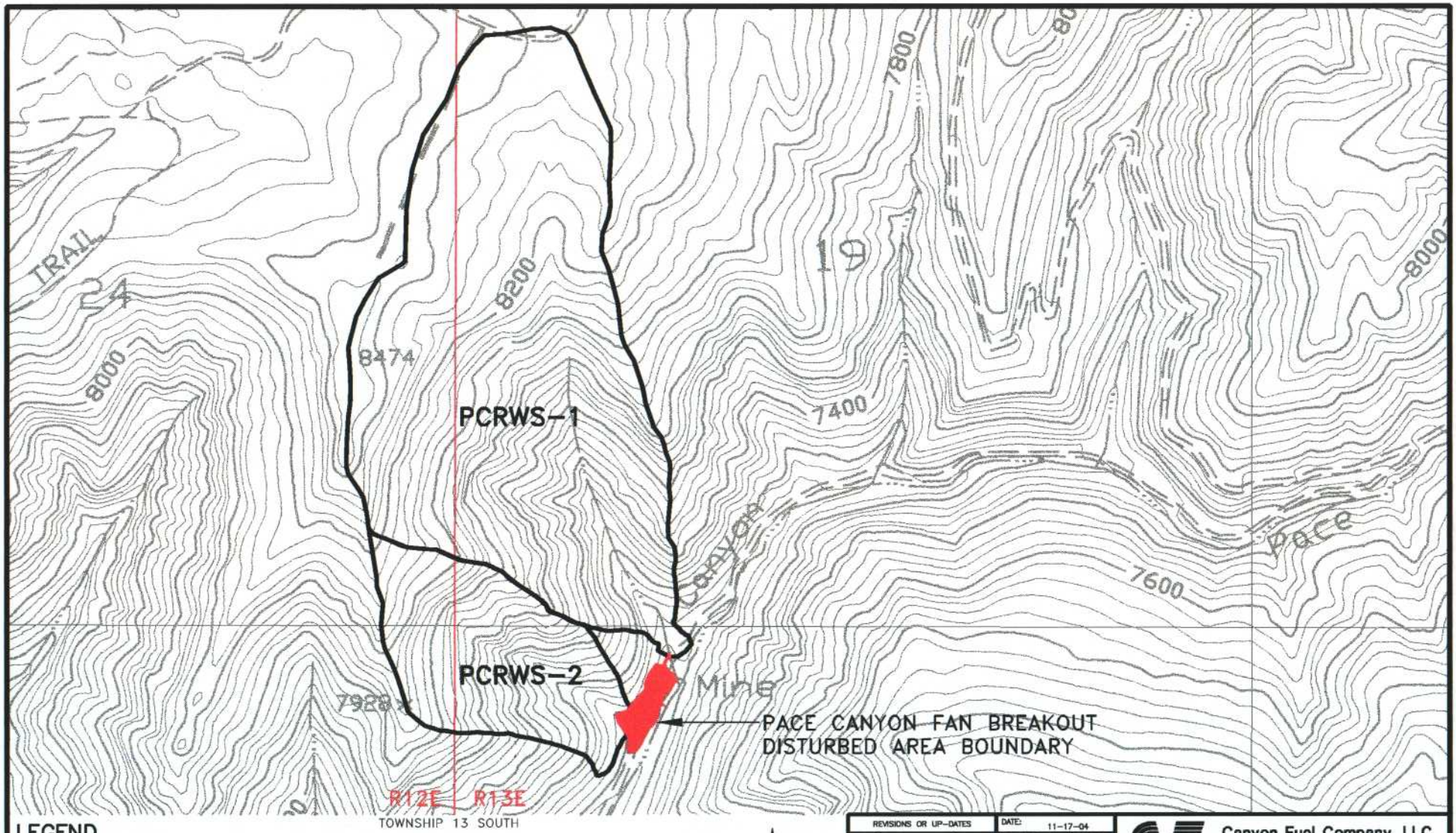
Canyon Fuel Company, LLC
Dugout Canyon Mine

PACE CANYON FAN UNDISTURBED WATERSHED BOUNDARIES

P.O BOX 1029
WELLINGTON, UTAH 84542

DRAWING OR MAP NUMBER
PLATE PC7-6

EarthFax Engineering, Inc.



LEGEND

PACE CANYON RECLAMATION WATERSHED BOUNDARY

REGISTERED PROFESSIONAL ENGINEER
No. 189797
LAYNE D. JENSEN
11-7-05
STATE OF UTAH

REVISIONS OR UP-DATES		
NO.	DATE	BY
1	1-26-05	LDJ

DATE:	11-17-04
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