ACT/015/009 #2

United States Department of the Interior

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BUREAU OF LAND MANAGEMENT
Moab District
P.O. Box 970
Moab, Utah 84532

MAR 24 1988

D. Wayne Hedberg
Data Management Coordinator
State of Utah
Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Dear Mr. Hedberg:

We have received from your office a copy of Beaver Creek Coal Company's PAP Amendment, Second Mining East of Escarpment, Trail Mountain #9 Mine, ACT/-015/009-88A. We were to review and provide any comments or recommendations to your office concerning this proposal. Our response is to confirm telephone conversations between Stephen Falk in our Price office with Pamela Grubaugh-Littig of your staff.

Beaver Creek's proposal to proceed with limited second mining (partial pillar split) is to occur only between crosscut 63 and crosscut 38 of the South Mains. This area is entirely on State Section 36; the State of Utah controls the mineral and surface rights. This proposal occurs on non-Federal coal and surface and out of our jurisdiction to administer the Mineral Leasing Act. The BLM has been approached by Beaver Creek to evaluate the proposal and give opinion to the feasibility as an outside interest. We agreed to Beaver Creek's request. Please refer to our comments below.

Beaver Creek hired Leonard Witkowski, P.E., from Englewood, Colorado to calculate the minimum-size pillar that would not fail, thereby protecting the escarpment. Mr. Witkowski used a method based on the work of Wilson and Ashwin published in Mining Engineering, Vol. 141, in 1972. We (the BLM) have evaluated this rock mechanic procedure and found it corresponded well to classical methods found in SME, Mining Engineering Handbook, by Cummins, Underground Mining Methods Handbook, by Hustrulid, and Rock Mechanics and the Design of Structures in Rock, by Obert and Duvall.

The Wilson and Ashwin method takes into account that the center of the pillar has the yield strength and the surrounding edges of the pillar constitute a yield zone. The maximum stress on the pillar is zero at the ribs and increases linearly inward to the middle of the pillar where the stress is the maximum and equals the yield limit. A formula was derived to calculate yield

limits of a pillar taking into account yielding areas of a pillar. Using this formula, Mr. Witkowski concluded a 40x60-foot pillar would not fail with a safety factor of 1.5 under 700-foot overburden and a 47x60-foot pillar would hold up 1,330 feet of overburden.

We have used another method from Obert and Duvall to substantiate Beaver Creek's conclusions. We looked at the exact partial pillar extraction sequence that Beaver Creek proposed to use in the South Mains. South Mains has 5 entries, with 4 pillars of 55x80-foot size. Beaver Creek plans to turn 30-foot cuts on angle into each pillar. With a standard 20-foot-wide mining cut, we figure that 4,550 $ft.^3$ of coal would be removed from each pillar based on an average 7-foot seam and mining height. The 55x80-foot pillar would have 26,250 $ft.^3$ left remaining after the 30-foot angled cut (see enclosed pillar extraction map). This scenario would give a 60 percent recovery in the mains with no accounting for panel barrier pillars. A design equation from Obert and Duvall is:

$$Sp = \frac{Sv}{1-Ra}$$

Sp = average pillar stress ($lb./in.^2$)
Sv = average vertical stress ($lb./in.^2$)
Ra = recovery rate (%)

Some assumptions basic to rock mechanics need to be made. The vertical stress is approximately equal to the amount of rock above the opening with the standard force of gravity. Hence:

$$Sv = h - 144\ in.^2/ft.^2$$
$$= \text{density of overburden}\ lbs./ft.^3$$
$$h = \text{height of overburden (ft.)}$$

This assumption is accepted by industry and experts, though exact vertical stresses are very complex due to changes in geologic structures. For simplicity, the density of the overburden is 144 $lbs./ft.^3$, which is a reasonable average of the various rock formations above. Hence, the vertical stress used in calculation is a direct relationship to the amount of overburden. The overburden in the area of proposed partial pillar extraction ranges from 1,300 feet to 1,000 feet. With the 60 percent recovery rate, the stress on the pillar will range from 3,250 psi to 2,500 psi.

The strength of the pillar to resist the vertical stress can be estimated by compressive tests on core samples or borehole gages. Compressive strengths of 11 core samples of the Hiawatha coal seam from the adjacent East Mountain area gave a mean average of 3,575 psi, with a standard deviation of 760 psi. If the vertical stress is greater than the strength of the pillar, failure will occur. Hence:

$$F = \frac{Cp}{Sp}$$

F = factor of safety
Cp = compressive strength of pillar (lb./in.^{2})
Sp = pillar stress (lb./in.^{2})

Using the mean compressive strength and the range or overburden stresses, we calculate a factor of safety between 1.1 and 1.5.

This rock mechanics evaluation determines only failure of the pillar. It is assumed that if pillars fail, subsidence effects will manifest themselves to the surface in the form of cracks or ground lowering. This may or may not happen. However, we feel with the calculated stress scenario and the fact that large barrier pillars will remain in place on both sides of South Mains that the strata will hold and no subsidence will occur. One must also realize that a large pillar area in the 1st West panel was completely pulled before the permit stipulation for areas of no second mining was issued. This area was under the escarpment and no detectable subsidence failure has been observed. We therefore give our opinion that Beaver Creek's proposal will not cause failure of the escarpment.

Please contact Brent Northrup of my staff or Stephen Falk in our Price office should you have any questions.

Sincerely yours,

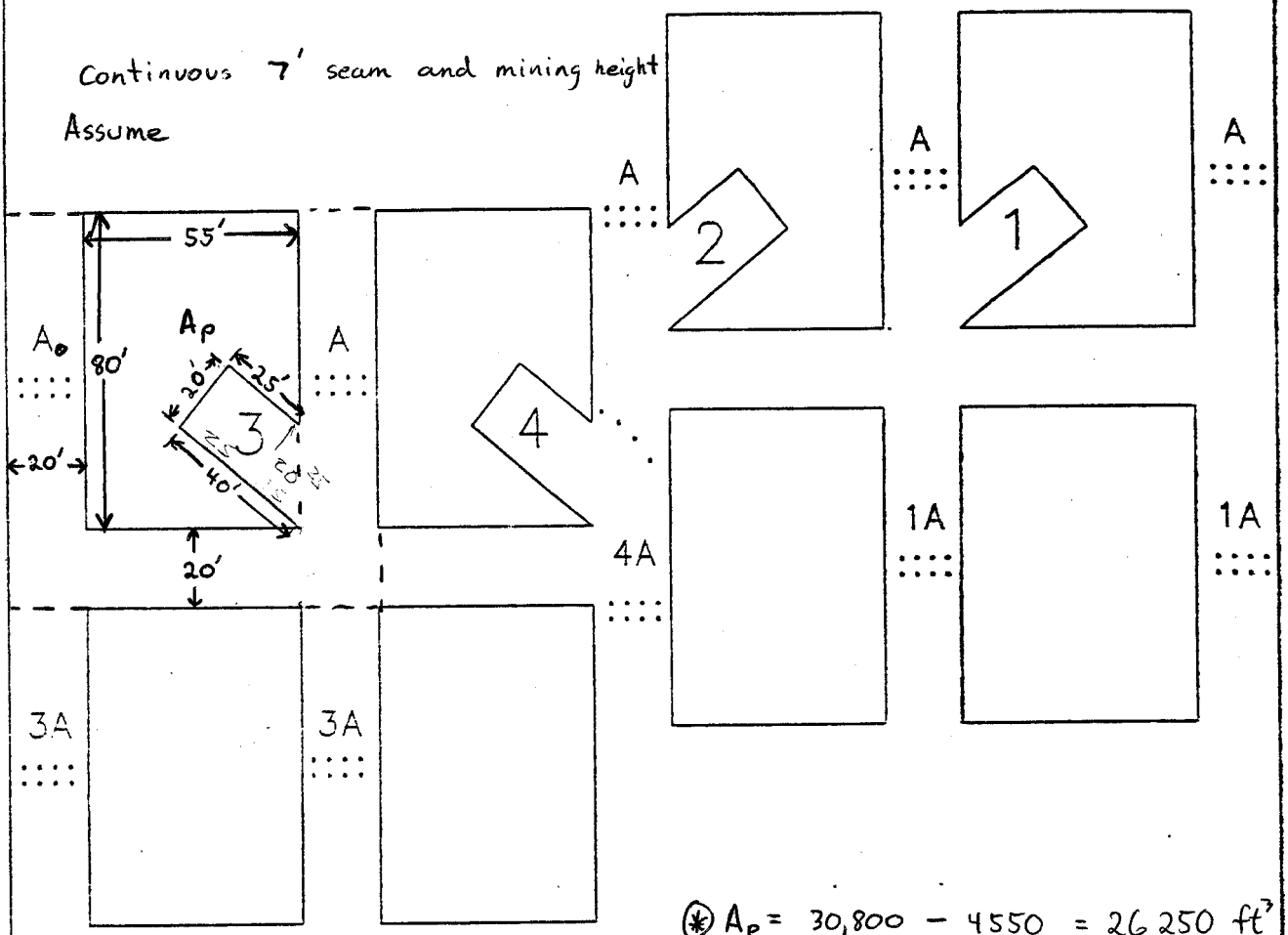
District Manager

Enclosure:
Pillar Map

cc: SD (U-921), w/encl.
Manti-LaSal Forest Supervisor, Price, w/encl.
Beaver Creek Coal Company, w/encl.

Continuous 7' seam and mining height

Assume



* A_p = 30,800 − 4550 = 26 250 ft³

A_o = Area of opening

A_p = Area of pillar

A_t = Area total = $A_o + A_p$

A_t = 100' x 95' = 9500 ft² x 7 ft = 66,500 ft³

A_p = 55' x 80' = 4400 ft² x 7 ft = 30,800 ft³ *

Area of cut 3 = (25' x 20') + (½ 15' 20') = 650 ft² x 7 ft = 4550 ft³

Recovery = $1 - \frac{A_p}{A_t}$ = 60 % PROPOSED

TRAIL MOUNTAIN

SOUTH MAIN PILLAR EXTRACTION SEQUENCE

(RIGHT TO LEFT)

WITH REMOTE CONTROL

NOTE: See Page 50 For Outline

BEAVER CREEK CO			
Main West Pillar Plan			
DWN	R.J.M.	Date	15/Feb.
SCALE: 1" = 50'		REV. Date	
ACAD DRAWING #	Roof A: Page49		

2/17/88