0021

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

Michael O. Leavitt
Governor
Ted Stewart
Executive Director
James W. Carter
Division Director

355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203
801-538-5340
801-359-3940 (Fax)
801-538-5319 (TDD)

July 19, 1994

TO: Daron Haddock, Permit Supervisor

FROM: Wayne H. Western, Reclamation Engineer WHW

RE: Tank Seam Road, Co-Op Mining Company, Bear Canyon Mine, ACT/015/025, Folder #2, Emery County, Utah

SYNOPSIS

Cut Slopes: At your request the Division evaluated the cut slopes, in the Dames and Moore report, on the Tank Seam access road. The Dames and Moore report examined two cut slopes for reclaimabilty and one for stability. Dames and Moore reported that all the cut slopes would meet the minimum static safety factor of 1.3.

The Division evaluated the cut slopes using SB-STABLE. In the Division's initial study the soil, rock properties, and slope profiles were the same as those used by Dames and Moore. The Division's analysis also showed that the cut slopes would have a minimum static safety factor exceeding 1.3 during construction and reclamation.

Fill Slope: The Dames and Moore report examined fill slope profile for stability. The fill slope profile is shown in Plate 3. The natural slope in Plate 3 has an angle of 35 degrees while the fill is 45 degrees. The natural slope is shown to consist of soil.

An assumption used in the Dames and Moore report was that the critical failure surface would be at the contact between the fill and the natural soil. No other failure surfaces, for the fill slope, were examined in the Dames and Moore report. Dames and Moore found the safety factor to be 1.44.

The Division determined the safety factor, along the contact between the fill and natural slope, to be 1.4. The Division then examined other failure surfaces that were not explored by Dames and Moore. Several failure surfaces were found that did not meet the minimum safety factor. Some of them had a safety factor lower than 1.1. Those slip surfaces would begin at the outer edge of the road, go through the fill into the natural soil, and exit below the fill's toe.

The text describes the slopes as consisting of bedrock covered with soil. The plate used to describe the cut slope showed the bed rock covered with 6 feet of soil. The Division modified the slope stability model, so the natural slope consisted of bedrock covered with 6 feet of soil. The rock properties used in the cut slope analysis were used in the model.

SB-STABLE found some failure surfaces that went from the fill into the natural soil, into the bedrock, and the back into the natural soil and fill. That type of failure seemed unlikely to the Division. To prevent such failure from occurring in the model the Division increased the rock's strength parameters in the model. Failure surfaces with safety factor of 1.1 were found using the modified profile.

The Division informed Co-Op Mining of the results and they passed the analysis on to Dames and Moore. In a draft letter to Co-Op, Dames and Moore stated the slope's profile in the initial study had been overly simplified. Instead of a smooth slope with a uniform soil cover the natural slope consisted of bedrock "steps". The bedrock is exposed in some areas of the slope and covered with 2 to 3 feet of soil in others. Dames and Moore felt that if bedrock steps were added to the model, then the natural slope would not fail.

The Division then modified its model by assigning rock properties to all areas of the natural slope. Safety factors of 1.31 were discovered for some failure surfaces.

Until then all models had been run using dry soil parameters. It was assumed that since the bedrock was close to the surface any pore pressure would be minor. When saturated conditions were used (still no pore pressure) the lowest static safety factor was 1.29.

The Division then ran the model, assuming dry conditions and 2 feet of soil covering the bedrock. The lowest safety factor was 1.2. The contact between the fill and natural slope is 90 feet. The critical failure surface extended 40 feet into the natural soil. **Dames and Moore did not state what the maximum spacing of the steps was. If a 40-foot width between steps does occur near the toe then the slope will have not met the minimum safety requirements.** When saturated conditions were assumed with 2 feet of soil cover, the safety factor dropped to 1.15.

The Division contacted UDOT for their opinion on placing fill, that will have a 45 degree slope, on a 35-degree slope. They said that they would not recommend placing any fill on a 35-degree slope.

Analysis:

Cut Slopes and Reclamation: Using the information supplied by Dames and Moore the Division performed a slope stability analysis. The Division's results agreed with the

Dames and Moore study that showed the cut-slopes to be stable and reclaimable.

Fill Slope: The Division did not agree with the initial Dames and Moore study regarding the fill-slope. Even after the Division added a strong bedrock layer 6 feet under the natural soil the safety factor continued to be 1.1.

When Dames and Moore learned of the low safety factor they revised their assumptions about the slope's profile. They claimed that if the slope was modeled with bedrock steps then the safety factors would be satisfactory. Dames and Moore did not supply the Division with any information on the steps spacing or demonstrate that the steps would prevent failure.

When the Division analyzed the slope using Dames and Moore revised assumptions the safety factor was 1.31. When saturated soil conditions were assumed the safety factor dropped to 1.29. The regulations require road embankments to have safety factors no less than 1.3.

The bedrock step spacing is important. The Division has demonstrated that if a 40 gap in the bedrock can result in a safety factor of 1.2. While Dames and Moore's assumption about steps may appear reasonable they have supplied the Division with no information that such conditions will occur on all fill surfaces.

In the model the fill did not fail because it has high strength parameters. The strength parameters were based on one soil sample. If the parameters are decrease slightly then the fill failures to have the required safety factor.

The model is very sensitive to small changes in slope profile and material properties. If the Operator is allowed to construct fill slope then he must supply the Division with detailed as-built designs demonstrating the slope's stability.

RECOMMENDATION

1. Require the Operator to expose bedrock when needed to ensure that the slope is stepped.

2. Require the Operator to test fill material prior to placement.

3. Require the Operator to submit detailed slope profiles and stability analysis for each fill-slope.