Differential Settling on Surface Mined Sites

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Differential settling created changes in elevation and surface shape on the upper slope of a reclaimed surface mined site. These changes altered the original surface drainage pattern. Maximum surface alterations occurred on the upper slope while changes in elevation on the downhill study area were not significant. The cause of differential settling and methods for its alleviation are presently not fully understood.

Reclamation of surface mined lands involves establishment of an environment suitable for sustained vegetative growth. Essential considerations include (1) stable land surfaces of suitable shape which are free of excessive erosion and (2) a plant growth medium free of toxic substances which is deep enough for adequate plant rooting and which has the capability to store sufficient water. The interrelation of these factors will dictate the level of productivity following mining.

Surface mining of coal reserves in the northern Great Plains involves removal of coal deposits at distances far below the zone considered important for agricultural productivity. Following mining operations the important components of the original system remain, with the exception of the extracted coal. Reclamation research is directed at determining the most beneficial method of rearrangement of these basic components. The goal of establishing an environment as productive as existed prior to mining is not unreasonable. The greatest challenge facing researchers is in developing guidelines which are both practical and economically feasible.

One of the problems investigators must resolve involves the stability of surface mined sites which includes minimization of differential settling (1,2). Mass land subsidence has been reported on some reclaimed areas. Diffficulties relating to subsidence are of concern to sustained agricultural productivity on surface mined lands.

The cause of differential settling and methods for its alleviation are presently not fully understood although contributing factors could be related to backfilling and spreading methods currently in use. The purpose of this investigation was to characterize the degree of mass land movement at a particular study location.

PROCEDURE

The study area was located at the North American Coal Corporation Indian Head Mine near Zap, North Dakota. The site was mined in 1971 and reshaped in 1973. Study site characteristics were as follows: bulk density of 1.5 g/cm^3, sodium absorption ration of 33, and silty clay loam texture. The study area before and after the occurance of differential settling is shown in Figures 1 and 2, respectively.

Figure 1. Study area prior to settling.

Figure 2. Study area following occurrence of differential settling.

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Appreciation is expressed to North American Coal Corporation personnel for their assistance during this study.

A runoff monitoring plot 26.6 feet across the slope by 145 feet long was originally located at the study site. The area was smoothed and the plot borders installed in November, 1974. No significant change in surface elevation was visually apparent in the spring of 1975 when monitoring of runoff and erosion events began. On November 4, 1975 surface elevations on the runoff plot were determined. Elevation was again measured on May 3, 1976, June 29, 1977 and July 28, 1978. Readings were taken in a grid pattern at 5 foot intervals across the slope and 10 foot increments down the slope for a total of 90 points in the 0.09 acre area. Topographic maps of the uphill, 26.6 by 70 foot, area were constructed from the elevation grids of the study site (Figs. 3-6).

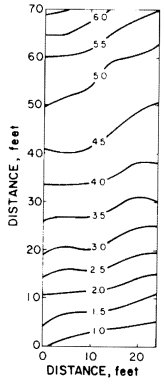

FIG. 3 SURFACE CONTOUR ELEVATIONS AND SHAPES NOVEMBER 4, 1975

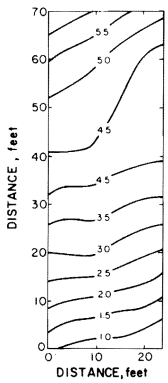

FIG. 4 SURFACE CONTOUR ELEVATIONS AND SHAPES MAY 3, 1976

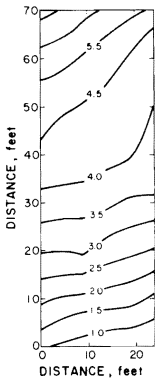

FIG. 5 SURFACE CONTOUR ELEVATIONS AND SHAPES JUNE 29, 1977

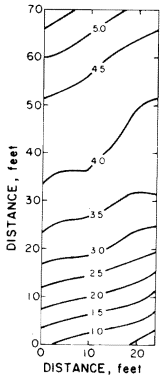

FIG. 6 SURFACE CONTOUR ELEVATIONS AND SHAPES JULY 27, 1978

Because of the possibility of differential settling at a bench mark location, establishment of reliable bench marks or reference elevations proved difficult. Suitable bench marks would be points whose elevation differences remained uniform during the study period. If this criterion were met, it would indicate either uniform settling at the bench mark locations or no settling. The probability of uniform settling at several different locations would appear slim. The point selected as a bench mark was chosen because of its apparent stability.

RESULTS AND DISCUSSION

Topographic maps showing surface elevation on November 4, 1975, May 3, 1976, June 29, 1977 and July 27, 1978 are presented in Figures 3, 4, 5, and 6, respectively. The bench mark elevation was chosen arbitrarily with the same elevation used in constructing each of the topographic maps. The numbers on the contour lines represent surface elevations in relation to the established bench mark elevation. The contour lines delineate uniform ground elevation occurring across the slope. Changes in the location of a particular contour line between survey dates indicate variations in elevation at the location. To more clearly illustrate surface alteration over time, a slope profile (Figure 7) was constructed in the maximum alteration

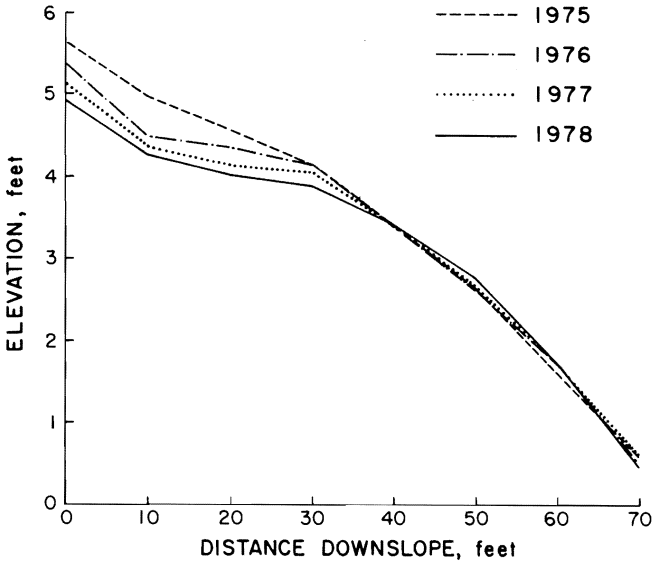

FIG.7 SLOPE PROFILE SURVEY OF THE 19 FOOT HORIZONTAL STATION

portion of the study area. The slope profile was drawn through the horizontal 19 foot station shown on the topographic maps.

In general, surface runoff moves in a direction perpendicular to the contour lines. The original surface drainage as shown by the location of the contour lines changed substantially during the study period which resulted in variations in the direction of surface runoff at some locations. The most significant variation in elevation appeared in the uphill portion of the area. The maximum elevation changes occurred in only a portion of the influenced area. Little change in elevation was measured in the downhill study area. Differential settling continued to appear on the reclaimed site 5 years after the area was leveled.

The causes of subsidence must first be determined before methods for its alleviation can be introduced. A stable, productive post-mining environment would be aided if differential settling could be minimized.

SUMMARY

Changes in the shape and surface elevation of a reclaimed surface mined site were measured over a 33 month period. A maximum settling amount of 0.7 foot occurred on the upper slope of the study area while little elevation change appeared in the downhill region. Changes in elevation and surface shape continued through the fifth year following leveling. If subsidence could be minimized, a more stable, productive post-mining environment would result.

REFERENCES

1. Agricultural Research Service and North Dakota Agricultural Experiment Station Staffs. 1977. **Progress report on research on reclamation of strip-mined lands in the Northern Great Plains.** Northern Great Plains Res. Ctr. and North Dakota Agr. Exp. Sta. Prog. Rpt. 26 p.

2. Omodt, H. W., Schroer, F. W. and Patterson, D. D. 1975. **The properties of important agricultural soils as criteria for mined land reclamation.** North Dakota Ag. Exp. Sta. Bul. 492. January. 52 p.