RECLAMATION ENGINEERING AND DESIGN IN SOUTHWESTERN WYOMING[1]

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Bridger Coal Company operates a large (4.4 to 7.2 MTPY) surface coal mine in Sweetwater County, Wyoming. Primary stripping is accomplished with four draglines and explosives casting. Supplemental stripping is done with a truck/shovel fleet and scraper fleet. Reclamation is done primarily with a scraper/dozer fleet, with draglines used as available and needed. Various characteristics affect the resultant post mining contour, and can be flexibly incorporated into mine and reclamation engineering and design. These include special handling abilities, spoil profiles resulting from casting and mining, and equipment capabilities. It is critical that reclamation requirements be incorporated into mine engineering, to insure cost effective reclamation. Three examples illustrate this process: a boxcut pit at Ramp 17, Fault Wash reconstruction, and closure of several ramps with a dragline.

INTRODUCTION

The following discussion describes three site specific reclamation projects where engineering support was utilized to provide cost effective recontouring of the post-mining landscape. These projects are: 1) the selective placement of out of pit spoil to enhance and create topographic diversity in the reclamation of dragline spoils, 2) the use of draglines for the purpose of reclamation of haulage entries, and 3) the reconstruction of the Fault Wash drainage.

ENVIRONMENTAL SETTING

The Jim Bridger Mine is located on the western rim of the Continental Divide, at elevations ranging from 6,800 to over 7,100 feet. The area receives less than 9 inches of precipitation annually. Approximately 20,000 acres are under permit, with disturbance of 10,000 acres projected over the life of the mine. Soils are typically Entisols and Aridisols, coarse textured, moderately alkaline (ph 7.5 to 8.0) and moderately saline (EC 4.0 to 6.0 mmho/cm). The native plant community is typically big sagebrush/thickspike wheatgrass or Gardner's saltbush/Bottlebrush squirreltail.

SELECTIVE PLACEMENT OF OUT OF PIT SPOIL

The reasoning associated with design of an out of pit spoil dump primarily revolved around two parameters. The first concern was to develop an initial boxcut in an undeveloped area of the mine and establish concurrent reclamation by placing the excavation material to final grade. (See Figure 1.)

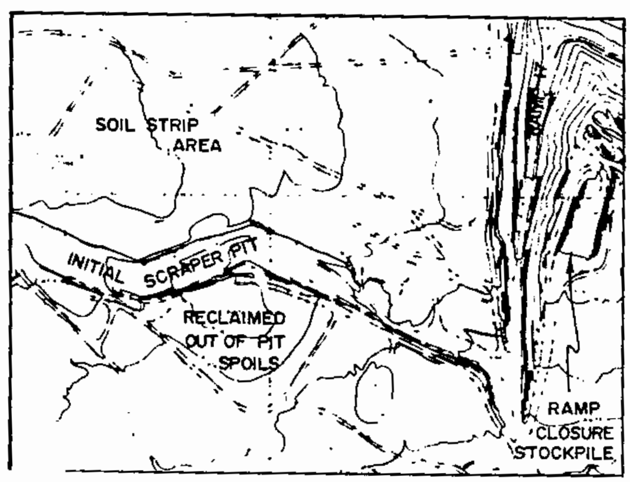

Figure 1.--Map showing placement of initial boxcut material for ramp closure and as out of pit spoil.

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Secondly, an effort was made to facilitate future excavation requirements by using the out of pit spoil as a preconstructed truck dump location. Consequently, the material was placed in such a manner that the front of the dump tied to ground elevation approximately 400 feet from the coal outcrop and the rear of the dump was elevated by approximately fifty feet.

The initial boxcut was opened with a scraper fleet (5 CAT 631's and 2 CAT D9L's), while the second cut was removed by a fleet of three trucks and a Bucyrus Erie shovel. Essentially, the scraper fleet was used to complete the following process:

1) Strip soil and establish low wall stockpiles.

2) Move 300,000 yards to ramp closure position.

3) Continue boxcut excavation by placing spoils out of pit at final grade.

4) Place remaining material to set up truck dump for next pit.

5) Direct haul soil from second cut to reclaim boxcut spoils.

Additional benefits were derived from elevating the rear embankment of the scraper dump. By elevating the backside of the pit, the reclamation dirt work requirement for grading future dragline spoil peaks was minimized. Also, an area was established where soil from the highwall could be directly applied (eliminating doubling handling of these materials). Finally, the gradient of the reclaimed area was reduced which alleviated erosion in the area.

To implement the preceding plan, Bridger completed an approximate original contour analysis to show that the planning objectives were consistent with those contained within the permit document. The essential question that needed to be resolved was whether the spoils were temporary or permanent. In order to be considered permanently placed, very specific regulatory requirements (Ch. II, Sec. 3.b.16 and 3.c.1, WDEQ-LQD Rules and Regulations) had to be met. These regulations address gradients, geology, hydrology, stability, thick or thin overburden determination, and surface runoff. Bridger Coal was able to demonstrate that these concerns were addressed in the original permit or subsequent design. Consequently, a non-substantial deviation to the permit was then approved. Considerable assistance was received from WDEQ-LQD personnel in expediting the approval process with the OSM.

A significant reclamation benefit resulted. Less than a year after mining was started, the area was reclaimed and vegetation successfully initiated. Concurrent reclamation of additional disturbance in the area was also established.

USE OF DRAGLINES TO RECLAIM HAULAGE ENTRIES

Several ramp haulage entries have been reclaimed at Bridger Coal Company by utilizing large draglines as the primary dirt moving equipment. (See Figures 2 and 3.)

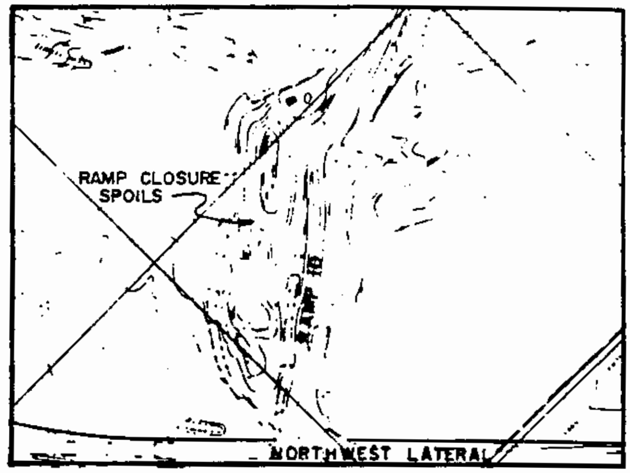

Figure 2.--Map showing Ramp 10 entry and associated spoils.

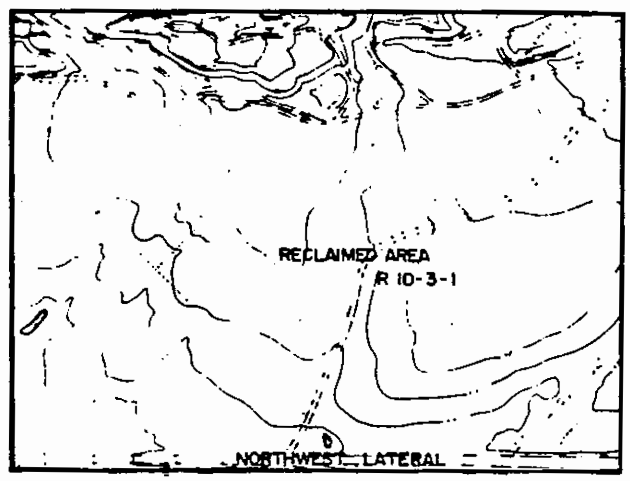

Figure 3.--Map showing Ramp 10 following reclamation with a Marion 8200 dragline.

The use of draglines proves to be the Company's most cost effective alternative as yard for yard dragline dirt is approximately fifty percent less expensive than any other method that could be utilized.

In 1984, Bridger Coal's engineering department completed a study of costs to maintain ramps and concluded that the number of ramps should be reduced. A side benefit that resulted was the ability to create larger reclaimed areas, and use a dragline to do the dirtwork. Additional costs were also saved by reducing final mine closure accrual costs.

The profile of all reclaimed haulage entries is similar. They tend to be shallow at the upper end or outcrop and deepen down dip. A profile across the entry typically shows a sixty foot bottom with the sides sloping back at the angle of repose. Total vertical depth of the entry from the top of the spoil can exceed two hundred and fifty feet at the highwall face. The width from one spoil peak to another might exceed 600 feet horizontally.

Reclamation of the haulage entry proceeds by spoiling across the lower end with dragline spoil during excavation of a normal dragline cut sequence. This spoil is then leveled with dozers providing a pad where the dragline can sit and start chopping into one edge of the entry. Reclamation is initiated from the downdip end of the entry and proceeds towards the mouth of the entry. Spoil removed from the edge of the entry is placed in the existing open entry, which elevates the entry bottom to the desired drainage elevation. The sides sloping into the drainage bottom are constructed at the proper gradient during this step. Consequently, a typical five percent ramp is reconstructed to approximate the original topographic drainage gradient. The dragline digs on this grade until the mouth of the entry is reached. The dragline will then cross at the mouth of the entry and reverse the digging procedure. After completing the cut back through the opposite side of the entry, the machine will cross on the pad at the end of the pit.

Some additional support equipment may be required as the dragline tends to only roughly grade the dirt work. Scrapers and dozers generally complete the final grade work and place soil. General seeding practices then follow.

Draglines are especially well suited to final closure of ramps because the entry is generally less than 600 feet wide. The Marion 8200's in use at Bridger Coal have 300 feet of horizontal reach, making closure of the ramp in two passes (one from each side) efficient.

FAULT WASH

Fault Wash is an ephemeral drainage across the northern portion of the mine that was reconstructed in 1984. Reconstruction of the drainage shows the effective utilization of engineering concepts.

Development of the initial boxcut along the crop line in the area was done with the scraper fleet. The toe of the boxcut material was kept out of the drainage for the first 2,000' by using the scrapers in a haulback operation into an existing active area of the pit. Thus, the native channel remained undisturbed (since there were no underlying coal reserves to extract) and costs for drainage reclamation were avoided.

Once the crop line crossed the drainage, disturbance became necessary in order to recover coal reserves. Prior to disturbing the natural drainage, detailed surveys were conducted to determine the stream gradient and typical cross section of the stream embankment. Sediment samples were also taken at each of the surveyed cross section locations. The stream data was then modeled with a computer program (HEC-6 Army Corp of Engineers' computer program) to determine natural stream conditions (sediment transport, water velocity, etc.).

The area was initially reclaimed and regrade approval secured in late 1983. The channel was located to take advantage of existing spoil topography. The channel as it existed then could be described as relatively straight and narrow, with approximately a 3% grade. Excessive erosion that accompanied normal runoff the following spring caused the Wyoming Department of Environmental Quality, Land Quality Division to issue a violation.

Subsequently, the channel was again designed and modeled to demonstrate hydrologic stability. The stream was reclaimed to provide a similar stream gradient (.8%) and a meander pattern was created through use of alternate point bars. The curvature of embankment tended to create similar current patterns as were found in the native reach.

Sinkholes that appeared in this area were repaired in the spring of 1986, and measures taken to prevent future subsidence. These measures included lining portions of the channel with bentonite and increasing the gradient to 1%. The result to date is an initially stable channel with an appropriate meander that will contain surface runoff and move the water/sediment load generated from the upstream native reach through the reclamation.

SUMMARY

The reclamation process must take into account a variety of constraints, including post mining topography, drainage gradients, equipment characteristics and availability, planned post reclamation topography, and mine plan sequencing. Concomittantly, the mine planning and engineering process must accommodate reclamation constraints such as the approved post reclamation contour. Only by interfacing these processes can cost effective reclamation be achieved.