DRAGLINE RECLAMATION[1]

Gregg R. Bierei
Environmental Services Manager, Arch of Wyoming, Inc.
Hanna, Wyoming

Abstract: The use of draglines in rough backfilling phase of mine land reclamation is a cost effective, efficient, and timely means of reclamation. For greatest efficiency the same size machine that mines a pit should reclaim the pit. Dragline productivities experienced in reclamation increase by 30 to 35% over stripping productivities. Typically, lands reclaimed by draglines exhibit greater topographic diversity than those reclaimed by dozer, compaction through the profile seems adequate to prevent major subsidence and unsuitable materials can be diluted in the reclaimed profile when occuring in a core hole 20% by volume. Flexibility in reclamation sequencing is needed so that draglines can be used to improve mine land reclamation and benefit the mining industry.

INTRODUCTION

A cost effective means of moving large volumes of spoil material relatively long distances during reclamation in a timely manner was sought by Arch of Wyoming, Inc. (Arch). Mining conditions in southern Wyoming create rather large high walls present in the final pit area because of dipping coal seams. To meet approximate original contour requirements large volumes of spoil must be moved great distances, sometimes exceeding 1500 feet. Alternate methods of moving this material were studied such as dozer grading, scraper and truck/shovel hauling, beltline installation and dragline reclamation. Under the reclamation conditions present, the dragline method of reclamation rough-backfilling proved most economical and timely.

DRAGLINE USE

Three classes of electric draglines have been used by Arch in the reclamation process. Those classes are: 1) Small - 12 to 18 CY capacity, 164' to 215' dumping radius, and stripping productivity of 500 to 800 bank cubic yards (BCY) per operating hour; 2) Medium - 32 CY capacity, 276' dumping radius, and stripping productivity of 900 to 1150 BCY/op. hr.; and 3) Large - 62 to 78 CY capacity, 254' to 296' dumping radius, and stripping productivity of 2300 to 2900 BCY/op. hr.

Costs for moving a bank cubic yard of material were documented from historical data and related to the dumping diameter of the machines in use. This data was then compared to dozer, scraper, and truck/shovel costs at specified distances material would have to be moved. The first "rule of thumb" ascertained from balancing cut and fill material on engineered cross-sections and later from field experience, was the size of the dragline used in reclaiming a pit area must be as large or larger than the machine that stripped the pit. An attempt to use a smaller dragline in reclamation drastically increases rehandle.

One particular study indicated a pit mined with a large dragline is best reclaimed with a large dragline. The same pit reclaimed with a small dragline experiences a 23% increase in rehandle, a 3% increase in costs, and 3 times total time to complete the reclamation. Although the costs may not be prohibitive when using a smaller dragline, the timeliness of reclamation greatly suffers. A dozer reclamation method in the same pit moves 54% less material (moves dirt only one time), increases costs by 242%, and takes twice as long to complete the reclamation assuming ten 410 h.p. class dozers, three shifts per day, five days per week. One can see by this comparison that dragline reclamation using large class draglines is cost effective and timely.

The timeliness of dragline reclamation can be expressed in the capability of moving loose cubic yards (LCY) per year. A large machine (78 cu. yd.) working five days per week, three shifts per day, can move 15 million LCY annually in reclamation. A 30 CY machine can move 6.6 million LCY annually. To move the same volume of material as a large

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dragline a distance of 500' in the same period of time, it would require 22 large 700 h.p. class dozers. One can see, then, that when in use a dragline can reclaim vast volumes of material in a relatively short period of time.

DRAGLINE APPLICATION

Because of sequencing conflicts between mining and reclamation it is necessary to determine what mined lands would best benefit from dragline reclamation over other backfilling techniques. Using a medium class dragline with a 250' reach, the effective distance material can be moved is in excess of 500' assuming a 180° swing angle and material roll once it is deposited in a final cut. Relating this to a large class track mounted dozer (700 h.p.), the question is asked at what push distance does the cost of a dozer yard exceed that of a dragline? Although one must remember that working conditions vary from mine to mine and mine geology differs, it was determined that a medium size dragline could move one yard 500' at the same cost a large dozer could move the same yard 285'. Likewise, a large class dragline can move a yard of dirt over 525' for the same cost as it takes a large dozer to move the same yard 230'. Therefore, the use of draglines becomes very attractive if dozer push distances exceed the range of 250 to 300 feet. The same kinds of comparisons can be made between scraper or truck/shovel methods and draglines. Based on mining conditions in south central Wyoming, a large class dragline can compete with either scraper or truck/shovel reclamation methods if the draglines do not exceed a 300% rehandle factor or move dirt more than 1500' horizontal distance.

DRAGLINE PRODUCTIVITIES

Most historical dragline operating data has been acquired during the overburden stripping mode of operation. Productivities of draglines have been expressed in bank (in place or unshot) cubic yards (BCY) per operating hour. Draglines in the reclamation mode move loose cubic yards (LCY) or material that has been blasted and moved, and, therefore, swelled. Stripping productivities, then, reflect a productivity somewhat less than what a machine physically moves in terms of volume because it is moving semi-loose or shot material, not bank yards. Because of this one would expect a dragline to move more loose cubic yards in reclamation than bank cubic yards in stripping. If the assumption is made that loose material swells approximately 20%, one can assume that a dragline's productivity in reclamation would increase by some percentage less than 20%.

Historical information shows that dragline productivities on an entire pit basis increase as much as 30 to 35% over stripping productivities--indicating easier digging conditions in the reclamation phase. Well broken, loose material ensures easier digging and good bucket

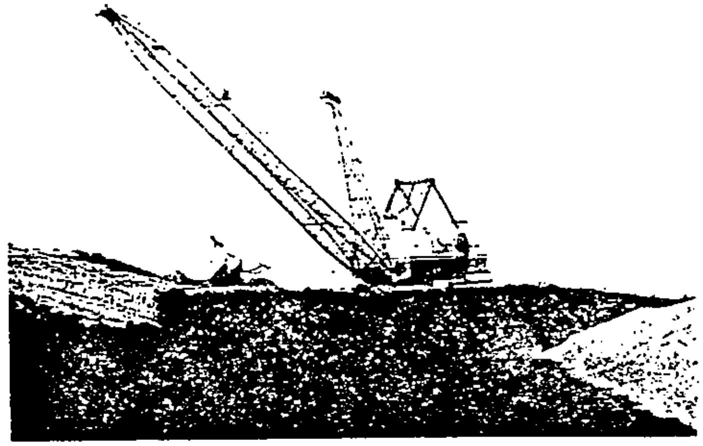

Figure 1.--Dragline positioned on top of high wall spoil casting material into final pit area.

fill. In reclamation, the bucket does not have to be hoisted to the point sheaves. A dragline can experience a productivity increase of 70% over average stripping rates when reclaiming a high wall spoil (fig. 1) after a dragline pad is built.

On the other hand, productivities equalling stripping rates are seen when the dragline chops or digs above the tub. The dragline was not designed to dig in this mode. Down time is encountered in the chopping mode when roll builds up in front of the machine, thus requiring a dozer to knock this material down. Bucket fill problems are also a result of digging above the tub. However, this mode of operation coupled with a 180° swing and proper positioning of machine may be more efficient in some applications because material is thrown far enough that it will not have to be moved a second time.

DRAGLINE POSITIONING

The positioning of a dragline through the reclamation process usually starts with the movement of the high wall spoil into the final cut. Pad building with dozers is preferable over benching up onto the spoil with the dragline. The dragline is then positioned on top of the high wall spoil and digs the spoil below the tub and deposits it into the pit as close to the top of the high wall as possible. Digging from the high wall spoil would be considered Position A. Position B on the second pass of the machine varies depending on pit characteristics.

Ideally, the second pass is positioned on the low wall side of the pit in such a manner that the machine sits where its point sheaves just clear the last low wall spoil pile. In this manner the machine can dump material that will free-fall into the final pit area but take advantage of reach of the machine. A hole is then dug on the low wall side of the machine. Engineered cross-sections determine the depth of the hole to be excavated.

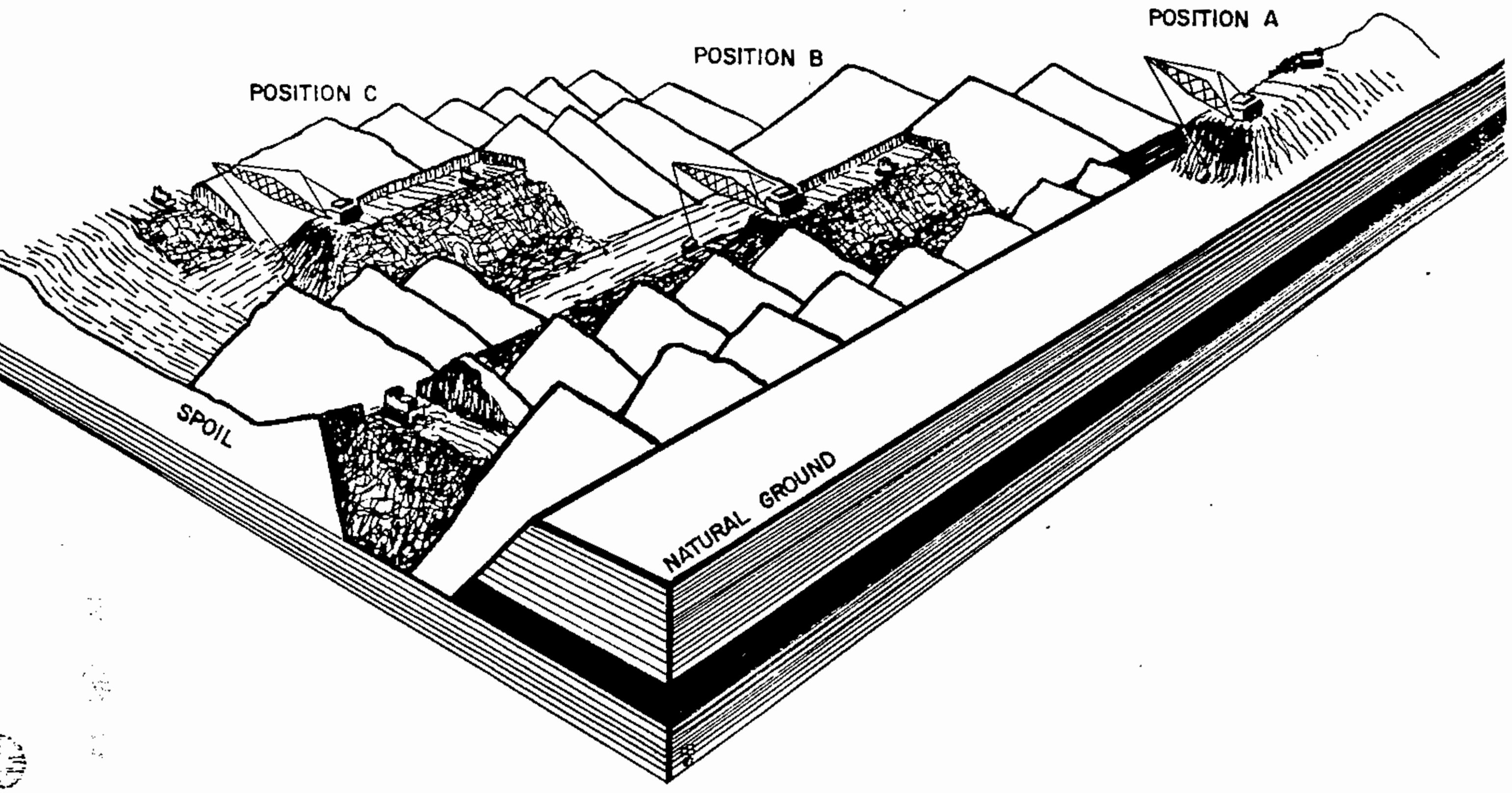

Figure 2.--Typical dragline reclamation positioning.

If a third pass is needed, Position C is located again on the low wall side of the hole excavated during the second pass and the process is repeated; i.e., dirt is cast into the hole dug during Position B. Dozers are always used when possible to build pad or top out spoil peaks to accommodate the dragline. The dragline in each successive pass digs a lesser amount of spoil. No more than three low wall passes are scheduled with the dragline. If more passes are required, a truck/shovel mode of reclamation is entertained. Dozers complete finish grading after each pass. This positioning is the most common used in reclamation, however, different configurations are used for different circumstances. For example, many times on the last pass in a pit the machine is able to dig to grade or approximate the post-mining final contour to eliminate excess dozer finish grading. Lateral movements can also be made with the machine to eliminate the need for an additional pass. Extended benches can also be used on the second pass (first low wall pass) to reduce additional passes. In other alternatives smaller machines can be scheduled to sit upon the spoil cast into the final pit by a larger machine and further cast the spoil toward the high wall. In all cases, positioning of the dragline is designed to reduce the total rehandle as much as possible. Figure 2 illustrates the positioning of a dragline under the most routine pit reclamation circumstances.

CHARACTERISTICS OF DRAGLINE RECLAIMED LANDS

Inherent in a dragline operation is the ability to place spoil in such a manner that the topography of reclaimed land has variability. In other words, the surface configuration of reclaimed lands can be made to exhibit diversity of land forms. Dozer grading of spoil piles often exhibit a homogeneous land form of parallel ridges and valleys or long uninterrupted slopes. Because a dragline can dump material at various angles from the point of digging, a more varied land form results.

Another characteristic of dragline reclamation, which is different from either dozer or truck/shovel reclamation, is the amount of compaction given to the reclaimed pit profile from pit floor to the surface. Although quantitative measurements are not available, observations have been made on the amount of surface subsidence experienced on lands totally reclaimed with a dozer versus those lands reclaimed with primarily a dragline. Fewer incidences of surface subsidence and piping are observed on dragline reclaimed lands as opposed to dozer reclaimed lands. It is thought that the inherent compaction of dragline reclaimed land lies between that of a dozer and truck/shovel operation.

Dozers typically reclaim land by pushing dirt over an established face, steadily lowering the working elevation and extending the location of the face in front of them. In this fashion, dirt is continually pushed over the face and rolls to the floor of the pit experiencing very little compaction. That surface on which the dozer sits experiences some compaction by the track mounted equipment. Large class dozers exert approximately 20 psi ground pressure, although more than dragline, this type of compaction does not impede vegetative growth.

A dragline in the typical reclamation phase digs spoil behind itself when sitting on a pad usually some 20' to 40' below the peak of a spoil pile and deposits material into a final pit area dropping this material many times a vertical distance of 50' to 200'. In the opinion of the author, this material compacts itself during the dumping process producing a semi-compacted profile suitable to eliminate any major subsidence. Surface pressures of dragline, however, are less than those of track mounted or rubber tired equipment. Generally, the pressure of a 30 CY machine is 11.0 psi. Pressure of large class draglines is 15.4 psi, even though a dragline of this class may weigh 7,582,700 lbs or 3,791 tons.

In comparison, rubber tired equipment which usually deposits material in lifts, compaction of materials is great. Ground pressures of rubber tired trucks in the 85 ton class approach 85 psi; scrapers, on the other hand, average around 50 psi. Although the scraper or truck/shovel profile through the spoil would be the most stable from the standpoint of subsidence, surface compaction would have to be eliminated by ripping or discing.

The third point, relative to dragline reclamation, other than varied land forms and adequate profile compaction surrounds the mixing of acid-forming and "toxic" material. Arch has over 80 million yards of dragline reclamation experience using all classes of draglines. During mining, rehandle sometimes reaches 50% on dipping seams. After the reclamation processes, the rehandle of material can reach 300%, or one yard is moved three times during the mining and reclamation processes. This dragline mixing process produces a relatively homogeneous material throughout the soil profile.

Premining data, although sampled at much greater intervals, lead investigators to believe that as much as 1600 acres out of 6400 acres or 25% could have been unsuitable. Approximately 2142 reclaimed acres were sampled at 600' intervals to a depth of four feet for parameters found to be unsuitable during the premining overburden assessment. If an unsuitable hole was found in an area, additional samples were taken on 208' centers. Only 66 acres or 3% were found to be unsuitable after initial reclamation grading had been completed. These areas were then covered with suitable material using mobile equipment. All holes both, premining and postmining, were considered suitable when the hole contained less than 20% by volume of unsuitable material. Although this information is inconclusive, one is led to believe that dragline mixing can greatly reduce the incidence of unsuitable material through mixing even when holes contain greater than 20% by volume of unsuitable material.

DRAGLINE SEQUENCING

The dragline's main purpose is to remove overburden above the coal in the most efficient manner possible and to uncover coal at the proper rate to meet contractual demands. In many coal operations the dragline is the principal stripping machine, therefore, its first priority is to the production of coal. Sequencing machines in reclamation may pose scheduling conflicts depending on mining conditions and site geology. Ideal sequencing situations exist when rather short pits are required by mine site geology or faulting and when a machine can be sequenced in and out of production when coal bound. The dragline is most beneficial in final pit reclamation and in most cases cannot begin this work until all the coal is removed from the last cut.

Because the dragline promotes a more diverse postmining reclaimed topography than usually produced by the use of dozers and because the dragline method of reclamation is beneficial to the mining industry in terms of efficiency, it is mandatory that regulatory entities remain flexible when evaluation contemporaneous reclamation. The advantages of dragline reclamation to the art of land rehabilition far outweigh the relatively short delays in sequencing that may be necessary to promote their use.

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