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WASTE DUMPS - DESIGN, CONTOURING, AND VEGETATION

KAISER RESOURCES LTD. OPERATIONS

Paper Prepared

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INTRODUCTION

The coal bearing property owned by Kaiser Resources Ltd. is situated in the southeastern corner of British Columbia. This property consists of two separate areas: the Crows Nest Coal Basin and the Elk River Basin. The Crows Nest Coal Basin is some 30 miles in length and approximately 12 miles in width near the centre of the basin. This coal field contains about 12 mineable seams that outcrop within a 2,500 foot stratigraphic sequence, primarily along the western slopes of the Rocky Mountains. The second field is a portion of the Elk River Basin and is approximately 8 miles in length and 2-3 miles in width and contains between 7 and 14 mineable seams that outcrop within a 2,000 foot sequence of coal bearing measures. The coal seams in both fields range in thickness from 5 to 50 feet and vary in elevation from 3,500 feet to 7,000 feet in the Crows Nest Basin and from 4,500 feet to 7,500 feet in the Elk River Basin.

On both coal fields the overburden is composed mainly of sandstone, siltstone, mudstone, and carbonaceous mudstone with some conglomerate. In pH this material ranges from 4.2 to 7.8. The coal ranges from low to high volatile bituminous type with a sulphur content of 0.3 to 0.4%.

At present 80% of the total raw coal mined by the company is mined by surface methods. The remainder is extracted from underground using mainly hydraulic techniques. Total raw coal production in 1977 was 75 million tons.

The main area of mining at present is centred on Karmer Ridge where there are recoverable reserves of 64 million short tons of metallurgical coal. To mine this coal approximately 300 million bank cubic yards of overburden will have to be moved. That means that annually 40 million bank cubic yards must be moved to release 6 million short tons of coal to meet the company's contractual commitments.

The Mine Planning Department is responsible for providing a practical mine plan for the recovery of coal for the company's spoil to facilitate the final reclamation of the area. This waste dump site selection has to include such factors as economics and safety.

MINING METHODS

The first stage in implementing the mine plan is the drilling and blasting of the overlying rock. This overburden is removed in 50-foot high benches parallel to the strike of the coal seam. Rock is loaded by 25 and 15-yard shovels into 200, 170, and 100-ton trucks.

The waste rock is hauled to disposal areas clear of the pit limits and clear of future mining operations.

WASTE DISPOSAL

Development of each waste dump is commenced by placing waste rock to form a bench extending outwards from the topographic contour that corresponds with the design elevation of the working surface of the waste dump. The overburden is hauled from the pit and end dumped at the crest of the waste pile. Some rock spills over the crest and the remainder is pushed over with dozers. For safety reasons trucks do not back to the very edge. The result of this method of placement is that the face of the waste pile remains the angle of repose and advances outwards from the natural slope by the gradual accumulation of material on the face of the dump.

Materials deposited at the crest are distributed down the length of the face and are segregated by gravitational sorting, accumulating at the toe of the dump. As the face of the dump advances outwards from the slope, this coarse layer becomes covered. This situation creates an effective underdrain which prevents build up of high pore water pressures within the dump and the subsequent loss of dump stability.

With the continuing development of the open-pit mine the mining operations are carried out at progressively lower levels and new dumps are established at elevations corresponding to the level of mining. These levels at Harmer occur at 50 or 100-foot vertical intervals. Dumping at these new levels is continued along the contour below the dumps previously established. This method of spoiling is referred to as wrap-around.

The terrace width along the top of each wrap-around dump is at least 100 feet. This is to allow the spoil trucks to proceed safely in and out to the dumping site.

For wrap-around benches having vertical separation of 100 feet this construction has the effect of reducing the average overall slope at the top of the pile from 37° to 23°. For 50-foot vertical separation between benches and minimum bench widths of 100 feet, the average slope angle is further reduced to 17°. This reduction in s slope angle within the upper region increases the total stability of the spoil pile.

As the existing open-pits are mined to lower elevations this continuing wrap-around technique will further contribute to the dump stability. The spoil dumps are composed of siltstone, mudstone, sandstone, and conglomerate. Siltstones and mudstones comprise 60% of the waste material and are the fine fraction, while sandstones form the coarse fraction with blocks ranging in size up to 10 feet.

Dumping of waste material is deliberate and is handled as it occurs during the mining operations. In the past no attempt was made to segregate the unconsolidated and weathered surface rock during dump construction which lead to potential dump instability, basically because this material did not allow percolation of water and therefore became saturated. At present this unconsolidated material is spread as uniformly and as thinly as possible throughout the dump, thus preventing the development of localized areas of instability.

RECONTOURING

EARLY ATTEMPTS

With the inception of full-scale surface mining on Harmer Ridge in 1968, field-scale resloping activities have primarily been concentrated on smaller worked out surface mines up to 50 acres in size.

Resloping operations involved the use of D-8 or D-9 dozers fitted with U-blades which were used primarily to restructure relatively short overburden dump slopes from their 37° angle to a maximum of 26°. Dump slopes were typically not longer than 200 feet so pushing of overburden down these slopes was practical on a small scale.

Other important design criteria included drainage control and aesthetics. Both of these were satisfied by attempting to reslope the dumps in such a way as to blend them into the natural surroundings. Also, by using a maximum angle of 26° successful vegetation using grasses, legumes, and shrubs was possible.

At this time in the development of reclamation techniques, other facts came to light as the result of experimentation. It appeared that direct seeding and planting on slopes exceeding 26° had markedly reduced survival. Also, attempts to use the same resloping procedures used on small dumps on long dump slopes proved impractical. Long reversing distances for dozers and the large volumes of material to be moved necessitated a change in resloping concepts.

PRESENTLY USED TECHNIQUES

Born from a need to reduce reversing distances and provide breaks in otherwise long monotonous slopes, the bench or terrace configuration arose.

Simple in both design and construction this concept involves a dump surface stability design incorporating benches with 50 feet of vertical separation with a connecting slope of 26°. Bench widths vary depending upon local conditions but are typically 20 feet resulting in an overall dump angle of 22°.

To accomplish large-scale benching programs, larger dozers including Fiat-Allis HD41B's and D-9G Cats were used.

Field-scale experiments have also shown that slope angles of 30° can be successfully vegetated, depending upon the materials, inherent dump stability, and other related local factors.

Another technique, the terrace configuration, is used where either the original ground or limited space does not allow for benching.

This concept involves construction of successive terraces without an initial slope between them. The resulting "stair-step" to 4 feet high and up to 8 feet wide, depending upon local conditions and the nature of materials."

The governing principle behind the use of this technique is the assumption that at least 30 - 40% of the terrace will slough onto the terrace below, thus forming very short, steep slopes between relatively narrow terraces.

Vegetation is then possible on both the terraces and the short slopes and because movement of materials is reduced on the short slope surfaces, vegetation can spread onto them as they stabilize.

In all cases, the overall angle of the terrace configuration cannot exceed the natural angle of repose of the materials in question. However, reducing the angle of a gravel pit from 37° using terraces to an overall angle of 30° has allowed for vegetation. A continuous slope of 30° on gravel, however, has continually frustrated vegetation attempts.

MINE PLANNING AND RECLAMATION

Only in recent years has the full potential of reclamation been appreciated with the incorporation of concrete requirements for reclamation in mine plans.

Having these requirements, based on experience both locally and around the world in recent years, has enabled mine planners to more effectively deal with reclamation needs while still maintaining an economically viable mine plan.

One major contribution to the art of dump stability is the concept of wrap-around dumping. Not only is overall stability improved, but in many cases greater efficiency of waste disposal is realized. From a recontouring point of view, the effort required to achieve a satisfactory slope angle is much reduced because material is never pushed more than from one bench level to the next. Depending upon wrap-around dump design, resloping effort can be reduced by as much as 807_0 over conventional benching on a free dump.

Other criteria to be considered in planning overburden dumps from stability and vegetation standpoints are a) dump location with respect to underground water sources, b) spoil materials with respect to slip plane effects, and c) drainage control.

Subsurface drainage control can be addressed for example by consolidating coarser drainage materials in the lower layers of the dump. Slip planes can be avoided by pre-stripping and avoiding localized dumping of unstable material. Surface drainage can be controlled by judicious alignment of benches. For example, in a basin dump, benches are usually sloped towards the centre where rip rap reinforces the watercourse. If water is to be prevented from running across dump material, benches can be sloped away from the centre to both or one side such as is the case on an even slope or ridge. Insloping or outsloping benches or terraces is another drainage control technique used depending upon whether the priority is to shed water off the surface of the slope or drain it through the slope.

CONCLUSIONS

Site preparation must be the single most important factor for the successful reclamation of a spoil dump. Initially the main areas of concern have to be dump stability and erosion control. But allied to these factors must be an awareness of the spoil characteristics so that surficial stability may be achieved. For although a dump may be basically stable, surface creep may inhibit the establishment of vegetation and may not be successful even with the use of costly binders or mulches.

The final slope angles may also vary with the type of spoil, vertical distances between benches, and specific local conditions.

The state-of-the-art of waste dump design with regard to reclamation at Kaiser has greatly improved since the commencement of mining in 1967.

It is now possible to accurately determine and plan for the reclamation requirements that were previously not fully understood. In developing this approach, the economic benefits of planning dump slopes for reclamation over the conventional "after thought" approach can be fully realized especially in the light of spiralling costs of manpower, equipment, and supplies.

Indeed the old adage that "Reclamation be an Integral Part of Mining" must still apply.

DISCUSSIONS RELATED TO A.W. MILLIGAN'S PAPER

Ken Crane - Luscar Stereo Ltd. Are you still fertilizing areas which you have revegetated and, if so, are the fertilizer applications decreasing in quantity?

ANS. There are some areas that were revegetated a few years ago, which we are leaving now. We haven't decided on a definite time when to stop maintenance. However, in some sites we believe it could be as long as ten years.

Neil Duncan - Energy Resources Conservation Board. We noticed that Kaiser has tree nurseries in the valley. What success have you had with planting some of the trees, and have you given any thought to planting them on the terraces?

ANS. Yes, this is something that we will be doing. We used to plant using the old forestry standard square planting method. Now, we have changed the whole approach to the business of planting trees and shrubs. Where we are developing a site for wildlife habitat we plant selected sites with groups of cover trees. The overall success up to this point is about 85-90% survival of all trees planted.

Now, instead of planting the 1+1's, we are transplanting them into the nursery and holding them for up to four years. We feel that by doing this they will have a better chance of survival. If we put them out into the field too early they do not grow because they need to develop better root systems. If we hold them in the nurseries and root prune them, we will be able to put a tree in the field that will grow readily.

Dave Headdon - University of Calgary. I noticed that you terraced slopes. To me it looks like your slumping problems are caused by too much internal moisture. If you increase the area and hence the amount of infiltration, you may continue to have internal slumping problems. Have you ever thought of burying pipes in the toe of slopes to channel the water thereby act as hydraulic dissipators?

ANS. I'm not sure that we are still having slumping problems since we recently changed to wrap around dumps. In the old days when the spoil was just dumped over the edge we had more than slumping problems. At present these dumps are fairly stable.