WASTE DUMP DEVELOPMENT
AT
KAISER RESOURCES LTD.

by

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INTRODUCTION

The development of waste dumps has continued at Kaiser Resources Ltd.'s coal mining operation in southeastern British Columbia since 1967. The design and location of waste dumps are important criteria in the development of efficient mine and reclamation plans. With increased mining activity in the whole region and more complicated and diverse mining ventures being planned, a mining scheme which considers the impact of the mine on all aspects of the environment and also incorporates a reclamation schedule is becoming increasingly important. Such an assessment is underway on a proposed mine in the Greenhills area approximately 22 miles (35 km) north of Sparwood.

The present mine is located on Harmer Ridge approximately 3 miles (5 km) east of Sparwood. The Harmer mine is situated on the northeastern rim of the Crows West Coal Basin, a large topographical feature 30 miles (48 km) long and 12 miles (19 km) wide. In this area there are 12 mineable seams within a 2,500 foot (760 m) stratigraphic sequence. The coal seams vary from 5 feet (1.5 m) to 50 feet (15 m) in thickness and occur at elevations of between 3,500 feet (1070 m) and 7,500 feet (2290 m).

The rock units which comprise the overburden consist mainly of sandstones and siltstones with some mudstones, carbonaceous shales, and conglomerates. The coal proposed for mining is mainly medium-volatile bituminous coal with some high-volatile bituminous seams in the upper stratigraphy. All seams are low in sulphur content.

The mining method used to produce the bulk of the coal is shovel-truck mining, operating 15 and 25 cubic yard shovels and end-dump trucks ranging from 100 ton to 350 ton capacity. The large volumes involved in the operation, therefore, produce large dumps which grow to designed size very quickly. The steep topography and high elevation of the mine site demands a dump design that ensures stability, concomitant with careful construction to ensure safety. It must also show a commitment to land reclamation and the avoidance of environmental damage.

DUMP DESIGN

The first stage of dump design involves selecting a dump site. In the mountainous terrain of the Elk and Fording River Valley areas, this generally necessitates dumping strati graphically below the footwall of the lowest coal seam being mined. Where the coal seams are dipping, a wrap-around dump configuration is used on the slopes below the footwall. In areas where the seams are generally flat or slightly synclinal and where several seams are to be mined, material is hauled downhill to reach the footwall of the lowest seam. Following the general site selection, the dump is designed based on the following parameters: stability, economics, and environmental impact.

STABILITY

The importance of dump stability is obvious. The potential costs involved with a failure become so large that, in all cases, a consultant is retained to study the dump proposals in order to ensure that the probability of a slide is remote. Consultants examine the proposals on the basis of dump material, size of the dump, topographic surface covered by the dump, consistency of the foundation, and relevant hydrological parameters.

The blasting of competent sediments prior to loading and end-dumping by large equipment produces a somewhat coarse dump which undergoes some natural segregation during actual dumping. The toe area of the dump is coarser than the upper slope, thus preventing a build up of pore pressures that could cause dump instability. The foundation of a proposed dump is also tested for possible instability; areas with known potential hydrological problems are avoided.

ECONOMICS

Another consideration in designing a dump is to make its construction as economical as possible. Shortening the haul lengths to reduce haulage and dumping costs are prime objectives. The amount of material to be rehandled during reclamation of a completed dump is also forecast.

ENVIRONMENTAL IMPACT

Environmental considerations are interrelated with the stability and economic parameters of dump design. Stream valleys and heavily wooded areas are avoided because of the possible instability created by wet, weak foundations. In addition, major alterations of stream valleys caused by dumping could result in other potential environmental problems. For example, the siltation of streams by drainage from a dump slope must be avoided due to potential fisheries damage and the detrimental effects on water quality. The aesthetic impact of a large dump in an exposed area is also a governing factor in dump design and dump site selection.

When all the factors have been weighed and recommendations from the geotechnical and environmental studies have been implemented, the final dump design can be incorporated into the mine plan and application can be made for the appopriate Mine permit. The next step is dump construction.

DUMP CONSTRUCTION

Dump construction involves several procedures which are closely monitored to avoid problems during and after construction.

The first step is site preparation, this could involve prelogging or brushing, trenching to avoid siltation, or berming of the toe area to prevent large materials from advancing too far down the slope. On Harmer Ridge, most of the major wrap-around dumps have been prelogged and the merchantable timber removed. The smaller Baldy Ridge mine has been brushed off as only small stands of lodgepole pine covered the dump area. Runoff from these areas is controlled by two large dams which retain the fines washed from the dumps. Since the dumps are constructed above eastward and northward flowing drainages, the runoff from the mine site can be treated quite effectively at the dam locations before leaving the mine property.

When site preparation has been completed and dumping has begun, it is important that common sense should prevail to ensure safe construction of the dump. Very fine materials which tend to slide and become unstable under load or saturation should be dumped along the outside ridge of the developing dump, or preferably in an alternative location where heavy traffic or any other cause for potential failure cannot jeopardize the dump. Whenever possible, dumps should not be constructed on areas covered by deep snow. The dump should also be monitored to detect abnormal movement, for dumps tends to settle, particularly on their outside edge. This deformation should be carefully examined for telltale signs of a possible failure. At Harmer Ridge, dump movement is minimal. The reasons for this are that because of the amount of equipment in operation multiple bench mining is necessary and two or more dumps are being constructed simultaneously. The lower dump tends to load the toe of the upper dump and thus stabilizes any settling tendency. Also, to provide for future mine developments on the ridge and the necessity to maintain eastward flowing drainages, narrow dumps were designed for this area. Narrow dumps tend to advance quickly and settle minimally.

As the dump nears completion, several modifications can be incorporated in the design. The first step, usually, is to free dump the whole area back to the pit limit. This releases dump maintenance equipment for use elsewhere and progressively shortens the haul length. When the pit limit is reached, the dumping is resumed in the initial development direction, but inclined upwards at an angle of 2% to 6%. The usual grade is 4% which, from an economic standpoint, provides the most suitable compromise between gain in dump elevation and the loss of truck performance. This final dump development is watched closely so that as much material as possible can be dumped over as short a distance as possible without jeopardizing the dump design.

When this step is completed the wrap-around dump is ready for resloping. The general dimensions of the dump lifts (without the final ramping) are 100 to 140 feet wide every 50 feet of elevation. Instead of the major dumps being designed in a wrap-around configuration, mining situations sometimes allow for construction of dumps onto the exposed footwall. This can occur where the footwall is less than 25°, but preferably less than 15° in dip. Generally such situations are limited by a lack of dump room, so the dumps are usually constructed with upward grades of 4% and with efficient use of all available room. The dumps are typically narrow (100 feet), except in very low-dip and synclinal situations where a wider profile is possible. The constructed dumps are then ready to be reclaimed.

DUMP RECLAMATION

Dump reclamation usually occurs after a short period but may be up to 5 years after completion. The final dump slope of 34°-36° still continues to settle during this dormant period, even with one or two lifts below it, and produces a profile of smaller benches which further aid the resloping task. There are two general configurations which result from resloping of the dumps. The first condition exists where the end-dumping has produced a long high slope. The angle of repose of the material (34°-36°) is reduced to 30° which is punctuated every 200 feet in elevation by a 20 foot horizontal berm. This results in an overall slope of 28.7°. In the areas where a 100 to 140 foot wide dump occurs every 50 feet, the slope between berms is reduced to 22.5° and berms of approximately 90 feet are left. This produces an overall slope of about 14°.

Depending on the type of material being dumped and on whether a 30° slope or a 22.5° slope is being created, D9 dozers are used to push material perpendicular to the proposed contour of the slope. This works ideally where the slope is being reduced to 22.5°; but where steeper slopes are required, the dozers have difficulty backing directly up slope. In this case, they turn and push parallel to the desired contour, which results in a steeper slope made up of many small benches. The benches retain moisture important to seed germination and plant growth. This growth spreads as the terraces slough off. It is important to provide for surface drainage when resloping. Features such as terraces, catchment ditches, and a rolling topography all prevent rapid runoff and retain water for short periods which promotes the development of good ground cover.

During the summer of 1979, high single-lift dumps constructed in 1969-70 were resloped in preparation for fall seeding. The largest dump, on Six-Mile Creek, required the handling of approximately 4,000,000 yd^3 of material back to a slope of 28°. The material was a combination of blasted rock and clay-rich overburden. The material could only be resloped to approximately 22° by direct downhill dozing, due to the soft nature of the material. Therefore, after the steepest grade had been attained by down-dip pushing, the dozers terraced the dump to a 28° overall slope by dozing parallel to the contour. The program in this creek valley progressed satisfactorily and demonstrated how the coarse material has accumulated at the toe of the dump. It also indicated the need for several major cross-berms in addition to the general terrace effect. These berms aided in seeding and harrowing.

Another dump that was resloped was situated in a steep section of Sawmill Creek, where the slope could not be reduced to less than 34° over most of the area. The dump was initially constructed over sand-stone bluffs that formed a 34° face. As the face could not be cut back to create the proper angle and there was not enough material in the upper regions of the dump, terraces which could accommodate a small D7 dozer were constructed. After a terrace was completed, it was necessary to undercut part of it to provide enough material to construct the next bench. The result was a terraced section of stream valley sloping 34° at the top, down to approximately 28° at the toe. The terracing should prevent rapid runoff on the slope.

CONCLUSIONS

The examples of Six-Mile Creek and Sawmill Creek illustrate the planning of dump development and the potentially high cost of dump reclamation. Site selection and design of construction are two important decisions made in the life of a project, which are modified only slightly during construction. The costs of constructing the initial dump must be weighed against the costs of possible extensive res!oping in order to ensure successful dump reclamation.

These considerations, along with sound design and construction, will simplify the task of reclamation - the final stage of waste dump development.

DISCUSSION RELATED TO R. BERDUSCO[1]S PAPER

The questions and answers are combined with those pertaining to C. Pelletier and D. Lane's papers. They are presented following D. Lane's paper.