
SOME PRESENT DAY RECLAMATION PROBLEMS:
AN INDUSTRIALIST'S VIEWPOINT

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The strip-mining industry of Ohio has a very definite interest in the strip-mining and reclamation techniques being followed in other countries. I have visited the West German brown-coal stripping operations several times in the last ten years, most recently in July, 1960. Hence, while this paper will be devoted particularly to a discussion of some of the important factors in our Ohio reclamation practice, it seems fitting that references should be made, for purposes of comparison, to the engineering and economic characteristics of West German brown-coal mining and reclamation.

Strip-mine reclamation in Ohio is controlled by our state law, which requires

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that spoil banks be graded to a gently rolling topography, and that the areas of land affected by mining be planted with suitable vegetation as approved for each location by the state reclamation authorities. The Ohio laws does not require the planting of the final-cut area, recognizing that this would be impractical in most instances. The law does require that the last cut be cleared of debris and that, wherever practicable, lakes and ponds be created by the construction of dams.

An inspection of reclaimed areas in Ohio will show that the state is effectively enforcing the reclamation law and that the reclamation efforts are being attended by a very respectable degree of success. In some instances, grading and revegetation have produced land more productive agriculturally than the undisturbed land in the areas. In a few instances, due to soil acidity, unsuitable planting selections, or mismanagement of the revegetated areas, reclamation has been less successful. The Ohio coal industry has recognized the need for sound progress in reclamation techniques, and through its own organization, the Ohio Reclamation Association, it has attempted to conduct reclamation studies of its own, and to collaborate fully with government agencies and other organizations in both research and the application of improved reclamation practices. It was through the Ohio Reclamation Association and the helpful cooperation of Dr. Knabe that experimentation with the black alder on the Ohio spoil banks was begun several years ago. Experimental plantings with this tree give some reason to hope that it may have an important place in more successful forestry plantings in the reclaimed areas.

At this point, may I state my conviction that the most promising area for the application of research in strip-mine reclamation lies in the field of forestry. If we could find trees which would grow as successfully on calcareous spoil banks as our crown vetch plantings are growing in Harrison, Jefferson, and Belmont Counties, we would have achieved a major breakthrough in spoil-bank reclamation. Prior to our discovery of the suitability of crown vetch for spoil-bank planting, about eight years ago, we were planting the more ordinary forage-crop species, and while these species grew with considerable success, it became obvious, as time went on, that the quality of spoil-bank pasture land of this type tended to deteriorate. It now seems that, with the advent of crown vetch, we are able to develop a highly productive forage crop which, if properly managed, will provide permanent and increasingly productive pasture. I believe it is most unfortunate that we have not yet found tree species which respond as favorably to the environment of the reclaimed areas as does the crown vetch, and I once again present a plea for more research in the forestry field. My company reclaims about 1,200 acres of eastern Ohio land a year. About three-fourths of this is now being planted in crown vetch. We would much prefer to plant more trees, and we will do so whenever we find more suitable species. It seems obvious that, at a time when our country has so much land in agricultural production that vigorous efforts are being made to reduce the acreage under cultivation by Federal regulation, and when the need for more forests is clearly indicated, it is a mistake to follow a reclamation pattern which is designed ultimately to produce crops which are already too abundant. The need for more forestry research is acute and it is gratifying to know that both state and federal agencies are displaying a renewed interest in this field. The Ohio Reclamation Association is pursuing its own program designed to produce better reclamation and is eager to collaborate in every way with all agencies operating in the field of research related directly or indirectly to spoil-bank reclamation.

The Ohio stripping industry believes that the Ohio law provides for the application of all of the sound reclamation principles and practices that have been developed to date. We believe that the Ohio law is adequate and that it is the most comprehensive and the most stringent reclamation law in effect in the United States today. Furthermore, the Ohio law is being effectively enforced by the Division of Reclamation. It is not unlikely that, as progress is made in the field

of improved reclamation, amendments to the law may be in order. The Ohio coal-stripping industry will not oppose sound and constructive amendments. On the other hand, from time to time, proposals are made for the revision of the law which are unsound and which would not result in improved reclamation practices. Sometimes these proposals are made by sincere persons who do not understand the subject; sometimes they are made by those who are so prejudiced against coal stripping that they would like to see legislation which would make stripping uneconomic, thereby legislating the industry out of business. I submit that all such efforts actually hinder the cause of good reclamation and tend to retard progress.

There are two proposals which are made from time to time and which have been touched upon in this Symposium. These proposals have been opposed by the industry, and it seems proper that the industry's position should be clearly stated here. I refer to, first, the proposal to require that the affected area be restored to approximately the original contour by filling or partly filling the last cut; and second, the proposal that the original topsoil be removed before stripping is done, stored until it is completed, and then replaced on the surface of the graded banks. Each of these proposals is impractical and uneconomic and, as is known by some of the proponents of legislation of this kind, the enactment of either would so increase coal-production costs as to make it impossible for Ohio strip mines to operate. I shall attempt to show that this is true and why it is true.

With respect to the first item, namely, the filling of the last cut, no one will dispute the fact that the last cut in the ordinary Ohio stripping operation presents for a time an appearance which is objectionable from an aesthetic standpoint. If the filling of the last cut were feasible from the standpoint of economics and engineering, and if the possible benefits were substantial, then it would seem that there is nothing unreasonable about the proposal.

However, the proposal is impractical from both engineering and economic considerations. In demonstration of these contentions, figure 1 is presented. This sketch and the accompanying data have been carefully prepared by the engineering department of the Hanna Coal Company Division of Consolidation Coal Company. The drawing is made to scale and represents a typical actual mining area at the company's mines in Harrison County, Ohio.

Stripping is done by a 65 cubic-yard power shovel. The vertical height of the final high wall is 94 ft, plus the thickness of the coal, which is 4 ft—a total height of 98 ft. The width of the bottom of the final cut is 90 ft. The sketch shows what would be required to fill this last cut completely. Of course modifications of the complete filling of this cut could be considered. I will not attempt to cover them here, but simply state that no modification of the final contour indicated on the sketch would substantially alter the economic or engineering aspects of the project.

With respect to the engineering problems involved, it will be noted that the material to fill this final cut must be obtained from the spoil banks previously deposited. Nothing can be accomplished by attempts to obtain fill material from the high wall side of the cut; the overburden consists almost entirely of stratified rock, which can be dislodged only by expensive blasting operations. Actually, in the operation of this particular mine, and it is typical for Ohio, the cost of drilling and blasting of the overburden is the largest item in the total coal-production cost. This means that it costs more to drill and blast the overburden than it does to move the overburden by the use of a 65 cubic-yard shovel. Furthermore, blasting the final high wall would not accomplish any effective fill as it would create a new cavity to be filled from some other source, and would increase the actual extent of the area disturbed by mining operations.

The fill material must therefore come from the spoil banks. These are characterized by large blocks of dense rock which only the large shovel is able to

50 CY. SHOVEL OR LARGER
 (WHERE COAL RECOVERY IS 6200 TONS PER ACRE)
 WITH RESPECT TO FILLING FINAL STRIP CUT

442 CU. YDS. PER LINEAL FT.
 27,426 CY. PER ACRE OF RECLAIMED AREA
 36,008 CY. PER ACRE OF COAL UNCOVERED
 36,008 CY. AT \$3.450 PER CY. = \$12,423 PER AC. OF COAL RECOVERED
 RESULTING COST PER TON OF COAL IS \$2.00

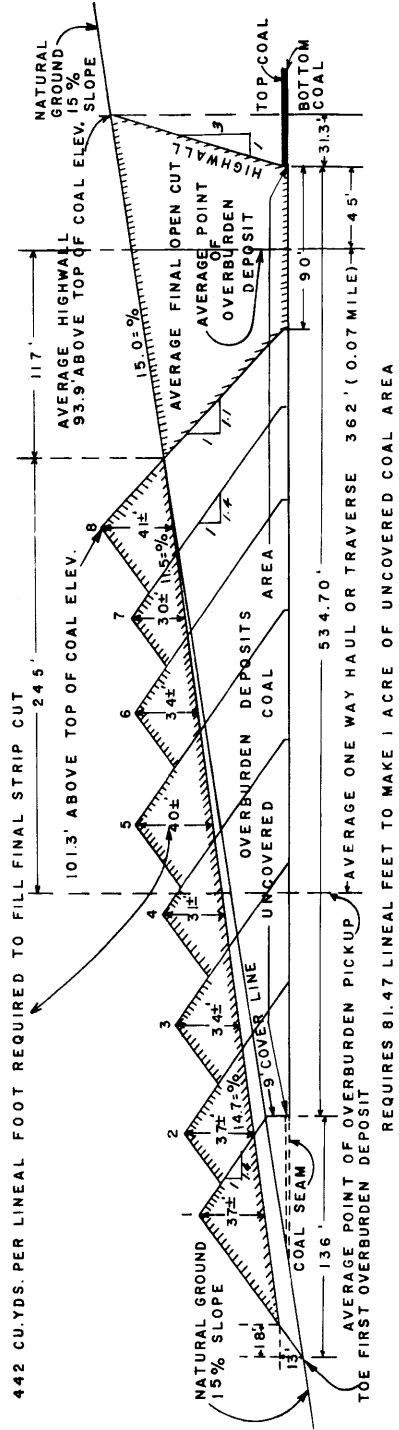


FIGURE 1. Diagram showing, to scale, method of mining by Hanna Coal Company in Harrison County, Ohio.

handle. This material is too big to be moved by an ordinary bulldozer or drag-line, or transported by truck or any other available machine. Furthermore, no bulldozer could safely be operated on the spoil banks which have an angle of repose of 1.4:1. It must therefore be concluded that, as of today, there is no machinery available capable of doing this job with a practical degree of efficiency.

In presenting the economics of this problem, we have ignored the engineering difficulties involved and made the assumption that the material to be moved into the final cut could be handled by machinery at a nominal cost per cubic yard of 34½ cents. Under this very conservative estimate, the cost of doing this job would be \$12,423 per acre of coal recovered from the total area mined and the cost per ton of coal be filling the last cut would be \$2.00. When it is remembered that coal from Ohio strip mines sells for less than \$4.00 a ton, the economic absurdity of the proposal is obvious.

Reference should be made also to the effect of such a reclamation job with respect to conservation. The creation of a long gradual slope means that uncontrollable erosion is going to occur. Dr. Knabe in his remarks stated that he had seen a backfilling job that had been done at Steubenville, Ohio. This highly untypical example has often been referred to in discussions of this kind, and in each case, little or no reference has been made to the fact that this job was done as a specialized, small, isolated project within the city limits of Steubenville. The overburden was relatively soft material and the high wall was less than half the height of that shown on figure 1. Most important of all, and providing the very simple explanation of why this kind of grading was done, is the fact that the land involved was worth more than \$4,000 an acre as building lots in the city of Steubenville. A less representative example of Ohio stripping could not be found anywhere in the state.

The example given in figure 1 is a valid representative example of the problems involved in filling the last cut in Ohio mines. The figures presented can readily be checked by any competent engineer.

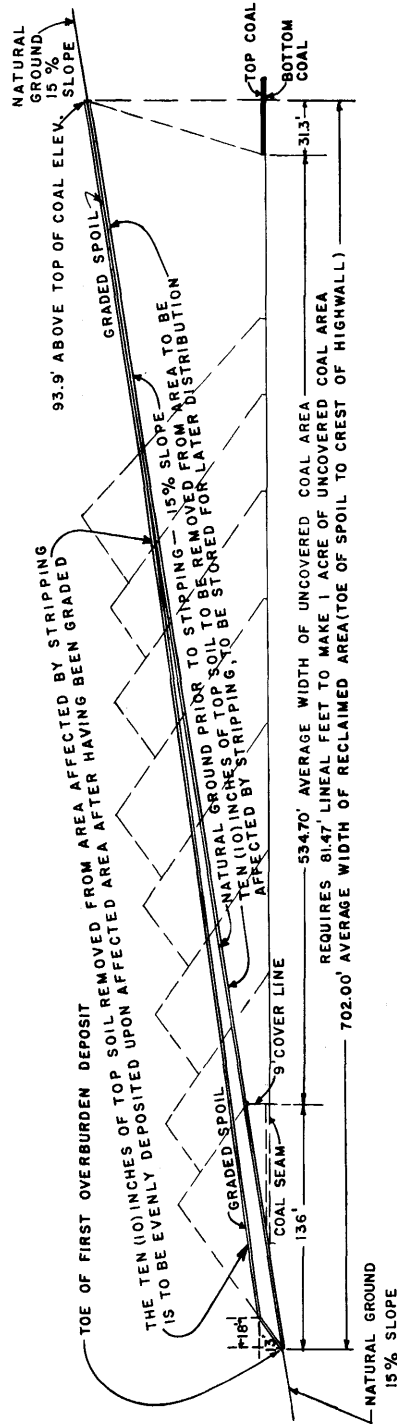
With respect to the second proposal, namely, the replacement of topsoil, the first fact that needs to be stated is that in the areas of Ohio where most of the strip mining is done, there is little or no topsoil present before the land is disturbed. Hence, in most instances, there is no topsoil available for replacement. Ignoring this fact, however, and again thinking only of the engineering and economic considerations that would apply if topsoil were available, reference is made to figure 2. The example is from the same mining operation as figure 1. Again, numerous modifications of contour can be suggested, but no such modifications would change substantially the economic or engineering problems involved.

With respect to the engineering problems, it is difficult to see where the topsoil could be stored during operations. It would not be stored above the high wall area as it would simply slide down the hill and into the pit. Furthermore, in most instances there would not be room for such storage above the high wall of the final cut. The same objections apply to storage below the affected area: if on a hillside, the material would again slide and spread; if in the bottom of a hollow, it would be washed away by the drainage system of the area. It must be remembered that mining operations usually continue in an area such as shown by the sketch for a period of from two to seven years. The physical problems of storing this material in an operation of this kind would seem to be almost insuperable.

Figure 1 ignores the physical problems involved. It assumes that 10 inches of topsoil is present and that means could be found for the efficient storing and handling of this material. The estimated cost per acre of coal uncovered, for this topsoil job, would be \$1770, and the cost per ton of coal produced would be \$.2855. Such an addition to the operating costs of Ohio mines, and I am sure that the average cost would be more than this, would put them out of business. Replacement of topsoil is therefore impracticable; is economically prohibitive and,

50 CY. SHOVEL OR LARGER
(WHERE COAL RECOVERY IS 6200 TONS PER ACRE)
WITH RESPECT TO APPLICATION 10" TOP SOIL

ESTIMATED COSTS							
LENGTH OF HAUL (ONE WAY)							
.75 MI.	1.00 MI.	1.25 MI.	1.50 MI.	1.75 MI.	2.00 MI.	2.25 MI.	2.50 MI.
.7973	1.0031	1.2131	1.4175	1.6242	1.8282	2.0369	2.2336
PER CUBIC YARD	.2855	.3453	.4035	.4624	.5205	.5798	.6358
PER TON OF COAL	CALCULATED AVERAGE HAUL (ONE WAY) IS 1 MILE REPRESENTING COST PER TON OF \$2855						
COST PER ACRE OF COAL UNCOVERED IS \$1770							



THIS REPRESENTS THE AVERAGE WIDTH OF THE AREA FROM WHICH 10" OF TOP SOIL IS PROPOSED TO BE REMOVED
THERE IS REQUIRED 21.67 CU.YDS. TO BE REMOVED PER LINEAL FOOT OR 1765 CU.YDS. FOR EVERY ACRE OF COAL UNCOVERED

FIGURE 2. Diagram demonstrating problems of dealing with 10-inch topsoil in Harrison County, Ohio.

from the standpoint of the fertility of the area, it would in most cases contribute nothing. The original surface material in the mining areas of eastern Ohio is so impoverished and unfertile as to classify the areas as marginal or submarginal lands. This is shown by the fact that the value of such lands as farm land in most of the areas is certainly less than \$100, and in many instances not more than \$25.00 an acre. Under what theory could anyone justify the expenditure of \$1,770 for the replacement of so-called topsoil in this area?

In the preliminary remarks of his first paper, Dr. Knabe stated clearly that any strip mining reclamation program had to be related to the economics of the mining operation, and I am sure he would agree that the costs of filling the final cut, and of topsoil replacement, in Ohio, render these measures entirely impracticable. I am sure that he would also agree that the brown-coal operations in West Germany are characterized by geological, economic, and engineering considerations that present an over-all situation so different from Ohio strip mining as to make it impractical to think of applying German grading, contouring, and topsoil handling practices in Ohio.

In West Germany, underground mining is characterized by thick coal seams lying deeply underground and the production cost of underground coal in West Germany is in the range of \$12.00 a ton. In Ohio, the output of underground coal, in terms of tons per man-shift is about seven times as great as that from underground mining in West Germany. It is at once apparent that strip mining in Germany is conducted under competitive conditions radically different from those prevailing here. The production cost of underground coal in West Germany of \$12.00 per ton is to be compared to less than \$4.00 per ton here, and in this connection it must be remembered that wages in West Germany are from one-fourth to one-third as much as those prevailing in the United States.

The brown-coal deposits mined in West Germany vary in thickness from about 40 ft to 400 ft, as compared to a thickness of from 2 to 5 ft here in Ohio. The overburden in the brown-coal mines consists of gravel and other easily dug materials. It is for this reason that stripping is done with wheel-type excavators. These excavators are not at all suitable for difficult digging and are completely incapable of operating in rock overburden such as that which prevails in Ohio. On the other hand, the fuel value of the brown coal as mined is from one-half to one-third that of bituminous coal. The water content of the brown coal as mined is very high, running above 40 per cent.

The ratio of the overburden thickness to the thickness of the coal is also a very significant factor. The most modern brown-coal operations are designed and equipped to handle overburden up to a maximum thickness of 400 ft where the coal thickness is about 400 ft. Mining is usually commenced with an overburden of less than 100 ft and with a coal seam thickness of about 50 ft. As mining progresses, the thickness of the coal increases as does the thickness of the overburden, but the ratio remains about the same. In Ohio, as shown by figures 1 and 2, a maximum overburden of about 100 ft can be economically handled where the coal thickness is 4 ft. And it should be remembered that the Ohio overburden consists of dense rock that must be blasted rather than the easily dug materials characteristic of brown-coal stripping.

In order to develop a brown-coal mine in West Germany, it is necessary to transport the overburden a great distance, in some instances as much as 10 miles. The overburden is loaded into rail cars, transported to the spoil area, and dumped into a pit alongside the track. It is picked up by huge wheel-type excavators and conveyed hundreds of feet to the point of final deposition. This point must be out of the mining area altogether, and is carefully selected so as to permit piling of the overburden in very deep spoil banks. It will be seen, therefore, that the surface area of the final overburden deposit bears no direct relation to the area of the coal seam mined. Since the thickness of the overburden deposits in these

spoil banks is so great, the area to be reclaimed on the overburden piles is relatively small, in some cases almost insignificant as compared to the area of the spoil banks at an Ohio strip mine. This of course means that top-soil replacement presents a relatively simple problem. However, since the topsoil must be transported the same distance as the spoil material, the cost of handling the topsoil is also very high. Dr. Knabe stated that the cost of topsoil replacement amounted to from two cents to four cents per ton per cubic yard of overburden handled. Against this figure it should be noted that in a typical large Ohio mine, the total cost of overburden handling must be kept below six cents per cubic yard or operations are uneconomic. I do not have exact figures on the total cost of overburden handling in West Germany but, because of the transportation distance involved, the total is obviously many, many times the cost of overburden handling in Ohio. I would estimate that, where the overburden is loaded and transported in cars, the cost of stripping runs between 50 cents and \$1.00 per cubic yard.

Since, in the brown-coal operations, a large part of the overburden must be hauled away from the mining operations, it follows that immense cavities are created in the mining area. As mining progresses it becomes, of course, possible to deposit overburden in the mined-out area. But even under these conditions, the transportation problems are enormous. Since the overburden is free-flowing, the angle of repose of the refuse deposits is very small. Furthermore, the danger from slides in the high wall creates a serious problem. Therefore, the operating pit itself must be immensely wide as compared to ours. The final cut is therefore correspondingly wide. Assuming that the maximum overburden is 400 ft, and I have been told by the management of the brown-coal operations in West Germany that they do not consider it feasible to mine beyond that thickness, and further assuming the coal thickness of 400 ft, one can visualize a final cut 800 ft deep and a half mile or more in width. As Dr. Knabe's sketch indicated, no one contemplates back-filling this final cut. It is allowed to fill up with water and a large lake is formed. In some instances, of course, overburden from a new mine can be deposited in the cavity created by worked-out mining operations, but in any case, a final-cut problem exists in West Germany which certainly presents a problem of at least equal magnitude to that here in Ohio.

I have not attempted to give a thorough analysis of the engineering and economic factors related to open-pit mining in West Germany, but I think I have said enough to make it perfectly clear that comparisons of strip mining in West Germany and Ohio have little meaning until all of the facts are considered, and when this is done, it becomes apparent that the geological, economic, and engineering factors are sufficiently different so as to make valid comparisons extremely difficult. However, once these facts are known, I am sure we can learn a great deal from those phases of reclamation experience in West Germany and elsewhere that are related to soil conditions, climate, agriculture, and forestry, and I strongly recommend that the coal industry and all agencies interested in spoil-bank reclamation include in their research and development activities a thoroughgoing study of reclamation practices in other lands. Dr. Knabe has favored us with a visit and has presented a good deal of valuable information; we should reciprocate by telling him all we know about reclamation. It is to be hoped that his visit will mark the beginning of a period of cordial cooperation and communication between our two countries in the field of reclamation.

In conclusion, I must observe that the problems of the unsightly appearance of the final cut and preservation of topsoil are real ones; they merit careful attention and study; however it is easy to exaggerate their importance and magnitude. Approaches to these problems that are based on unsound idealism, or inadequate information will accomplish nothing constructive, and are doomed to failure from the outset. Coal stripping is too important for our economic, industrial, and social welfare to allow it to become the victim of unsound and unrealistic preju-

dice. However, joint research by government and private organizations, from both this country and abroad, such as reported in the present symposium, provide an excellent opportunity for the presentation of all viewpoints, so that final evaluations can be reached which are based on the solid foundation of fact.
