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Project Summary

Sewage Sludge Versus Commercial Methods for Reclaiming Strip-Mine Soils

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Two types of methods for revegetating strip-mined soils were compared with regard to cost, feasibility, and environmental impacts: the use of municipal sewage sludge and commercial methods.

The in-depth investigation included visits to strip-mined sites being reclaimed with sewage sludge and a literature review to gather data on strip-mined land reclaimed with commercial methods. The literature review was necessary because adequate data were not available otherwise.

Cost comparisons of the two reclamation methods were made using only those costs associated with renovation after the sludge or commercial materials were delivered to the site. This comparison indicated that reclamation of strip-mined land with sewage sludge costs roughly the same as commercial methods.

The study also used available data to show that both commercial methods and sewage sludge application could be used successfully to reclaim strip-mined soils with no adverse environmental impacts. Selection of the reclamation practice should be based on site-specific evaluations of cost, social, political, and aesthetic factors.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, Ohio, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The process for the surface mining of coal, called strip mining, is accomplished with either area or contour stripping. Both practices involve the removal of overburden materials to expose the coal, the removal of the coal, and the replacement of overburden into the excavated pits. Strip-mining operations typically leave behind steeply sloping spoil or waste mounds depleted of plant nutrients and organic matter. These mounds rarely support vegetation and are easily eroded, causing contamination of nearby water supplies and the destruction of wildlife habitat. These mounds prevent rapid, productive redevelopment of strip-mined lands.

The Surface Mining Control and Reclamation Act of 1977 (PL-95-87) was passed by the Federal government in response to citizen concern and the negative environmental impacts of the waste mounds. Section 508 of the Act sets forth the general requirements for reclamation plans submitted as part of application permits. The main objective of reclamation is to restore the ability of the residual spoils to support a vegetative cover.

Reclamation with commercial methods relies on products readily available on the open market. Inorganic fertilizers are used in combination with lime and topsoil to restore the fertility of strip-mined lands.

Reclamation with municipal sewage sludge uses the residue remaining after the treatment of wastewater. Sewage sludge contains essential plant nutrients, organic matter, and a high alkalinity that can neutralize acid soils. The disposal of sewage sludge has been a problem for many municipalities, and using it for reclamation provides a beneficial alternative to sludge disposal. Sewage sludge also contains various

trace elements (such as metals) that could cause environmental problems, depending on the quality of the sludge. Thus environmental monitoring programs are required by Federal and usually State regulatory agencies to document environmental changes at sludge application sites.

This study was undertaken to compare the costs, feasibility, and environmental impacts of both types of strip-mined reclamation methods (commercial and municipal sewage sludge). The investigation included visits to strip-mined sites being reclaimed with sewage sludge and a literature review to gather data on strip-mined land reclaimed using commercial methods. The review was necessary because adequate data were not available otherwise.

Reclamation Sites

Fulton County, Illinois

At the Fulton County site, sewage sludge is being applied to about 480 ha (1,200 acres). The sludge disposal operation has continued since 1971, with certain fields receiving the maximum annual sludge application of 576 metric tons/ha. Successful reclamation has been achieved, and both soil organic levels and fertility have increased. Growing a corn crop each year and selling it to a local animal feedlot results in a financial return.

Extensive environmental monitoring at the site does not indicate any significant adverse impacts on surface water or groundwater. Although cadmium concentrations have increased in the corn, they are within Federal limits for animal feed.

Costs for the Fulton County operation are primarily influenced by transportation and land costs. The distance from the sludge generation point to the disposal site incurs transportation costs that are nearly half of the total cost. The entire site includes 6,100 ha (15,250 acres) located outside the jurisdiction of the municipal agency producing the sewage sludge. The land costs and real estate taxes would not usually be incurred if a municipality used sludge to reclaim land in its own jurisdiction. The Fulton County operation has permanently solved a sludge disposal problem, reclaimed strip-mined land, and been positively received by the public.

Ottawa, Illinois

The State of Illinois requires that about 0.8 ha (2 acres) of a 60.7-ha (150-acre) strip-mined site be reclaimed to demonstrate the effectiveness of using sewage sludge before the remaining area is subsequently reclaimed. Digested lagoon sludge was applied to the area, and grass was sown in late 1979. The pilot project successfully reclaimed the site by producing a flourishing grass cover.

Environmental monitoring did not indicate any adverse impact on groundwater or surface water. Costs for the project were greatly influenced by the sludge transportation distance, which represented more than 64 percent of the total costs for reclaiming the 0.8-ha (2-acre) site.

The Ottawa operation provides a viable sludge disposal operation. Though no large volume of sludge has been used to date, the project demonstrates the usefulness of sludge in reclaiming strip-mined sites. Overall, the Ottawa operation has had positive public reactions, with no negative reaction of any kind. In fact, it may influence other private concerns to enter into similar ventures.

Sites Using Commercial Methods

A literature review was conducted to gather data on strip-mined land that had been reclaimed using commercial methods. The review indicated that although commercial methods can be successful for reclamation, the vegetation may not survive on very acid soils if the underlying acids migrate upward to the root zone. On very acid spoils, the depth of the topsoil should be increased, and limestone should be applied before the topsoil is added. In all cases, periodic fertilization and liming are needed to maintain a good vegetative ground cover.

The data also indicated that the water quality of acidic mine spoil runoff is rapidly upgraded after the spoil is covered with topsoil. The duration of this improvement depends on the stability of the topsoil and the growth of the plant cover. Groundwater quality has shown a short-term reduction in acidity and sulfate concentration following mine spoil reclamation.

Cost Analysis

The full report presents only cost data for sites where the costs were actually incurred and documented. The data were developed using two scenarios: (1) an acid strip-mined site with relatively steep slopes reclaimed to produce a forage crop similar to the Ottawa operation, and (2) a neutral-pH soil with flatter slopes reclaimed to support row crop agriculture similar to the Fulton County operation. Cost estimates were developed for each scenario with a range for unit and total costs. Earthworking generally incurred the greatest unit cost.

Cost comparisons for reclaiming strip mines using sludge and commercial methods are difficult to make because of the dissimilarities of the two methods and the differences in the cost data bases available.

For purposes of comparison, costs for reclaiming with sludge included only those costs associated with the operation after the sludge was delivered (monitoring, staff, sludge application, site preparation, and farming costs). Therefore, the total unit costs used for comparison with commercial methods for the Fulton County and Ottawa operations were $9,045/ha ($3,660/acre) and $26,804/ha ($10,850/acre), respectively. The unit costs for commercially reclaiming the two sites ranged from $8,382/ha ($3,395/acre) to $15,543/ha ($6,290/acre) and from $7,243/ha ($2,930/acre) to $13,568/ha ($5,495/acre), respectively. These costs do not take into consideration the degree of reclamation achieved at any of the sites studied or described. The rate of sludge application that would be required to be equivalent to commercial methods of reclamation is not clear, so a range of reclamation costs was calculated to achieve the various reclamation objectives described as follows.

The main objective of the Fulton County operation was to build up organic matter since the soil pH was neutral. Costs were estimated for achieving 1, 2, and 3 percent soil organic matter, which corresponds to a sludge application rate of 100, 200 and 300 metric tons/ha, respectively. The costs ranged from $13,546/ha ($5,485/acre) to $40,638/ha ($16,450/acre). The objective of reclamation at the Ottawa site was to neutralize the acid soils and promote grass growth. Costs were estimated for sludge application rates ranging from 1,000 to 2,500 metric tons/ha, and they ranged from $10,860/ha ($4,400/acre) to $27,150/ha ($11,000/acre).

Reclamation costs for commercial methods were estimated for each scenario. Estimates were made for costs of topsoil replacement ranging from 30 to 122 cm deep. The estimates ranged from $8,382/ha ($3,395/acre) to $29,808/ha ($12,070/acre) for site 1, and from $7,243/ha ($2,935/acre) to $27,833/ha ($11,270/

acre) for site 2. Municipal sludge application for strip-mined reclamation was shown to be roughly equal in cost to commercial reclamation methods. A one-time sludge application (Ottawa) appeared to be less costly and more comparable to commercial methods.

Social and Environmental Impacts

Selection of a sludge management strategy cannot be based solely on cost. Land reclamation using sewage sludge offers the municipal agency a productive use for a waste product. The public usually reacts positively to using sludge for reclamation, as this practice tends to be more aesthetically acceptable than a landfill or an incinerator complex.

Residents near the reclamation site may oppose the transportation of sludge outside the jurisdiction of the sludge-generating municipal agency. The public may also be concerned with the potential for environmental degradation posed by the presence of many trace elements in the sludge.

Private companies may chose to reclaim their strip-mined lands using sewage sludge to improve public relations, or they may avoid it because of public concern. Additionally, these companies are not generally familiar with the concept of reclamation using sewage sludge. They may not have the proper equipment for applying sludge and may also be hesitant about becoming involved with the requirements and red tape of municipal agencies.

Conclusions

The results of the environmental monitoring at the Ottawa and Fulton County sludge reclamation sites indicate that municipal sewage sludge does not adversely affect groundwater, surface water, soil, or crops when properly managed. The data from these two sites show that the use of sewage sludge for strip-mined reclamation is a highly satisfactory procedure, since sludge restores the neutral pH of acid soils and increases the nutrient and organic matter content. The Fulton County site is now producing corn, and the Ottawa site supports a vigorous stand of grass.

The literature survey revealed that commercial methods would not negatively affect groundwater, surface water, soil, or crops if properly managed. But commercial methods may have a short-lived effect, since there appears to be a tendency for the underlying acids to migrate upward to the root zone eventually and affect the growing plants.

Sewage sludge may thus have a more permanent effect on keeping a good vegetative cover on renovated, strip-mined land. This tendency may make the sewage sludge renovation of strip-mined land attractive, even if it is more costly.

Recommendations

1. Factors that should be considered when selecting sewage sludge or commercial methods for reclaiming strip-mined lands include the ownership of the site, the availability of sewage sludge, the sludge transportation distance, and the prospects for short- or long-term disposal.
2. The cost comparison procedure will vary depending on who is making the comparison—the strip-mine owner or the sludge generator. An owner should compare the costs of both practices based on site-specific information, whereas a sludge generator should compare the cost of land reclamation with that for other viable sludge management options.
3. Insofar as possible, cost comparisons for sewage sludge and commercial methods should be made for achieving the same end conditions.
4. Many studies have been conducted to demonstrate that sewage sludge can be used to renovate strip-mined land. Thus attention should now be paid to improving operations (such as methods of application, transportation, etc.) and to defining more clearly the level of renovation achieved by various sludge application rates.

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The complete report, entitled "Sewage Sludge Versus Commercial Methods for Reclaiming Strip-Mine Soils," (Order No. PB 85-107 779; Cost: $13.00, subject to change) will be available only from:
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