NORTH DAKOTA STATE UNIVERSITY

APPLICATION TRANSMITTAL

SPONSOR ORGANIZATION: Lignite Energy Council

Address

PROJECT TITLE: The Success of Current Soil Depth Requirements on Mineland in North Dakota: An Assessment

Principal Investigator/
Project Director: Gary A. Halvorson

Department Land Reclamation Research Center

PROJECT BUDGET: $ 33,960

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THE SUCCESS OF CURRENT SOIL DEPTH REQUIREMENTS ON MINELAND IN NORTH DAKOTA: AN ASSESSMENT

A Research Proposal Submitted to the Lignite Research Council of the North Dakota Industrial Commission

Principal Investigator
Gary A. Halvorson

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Industrial Commission Funding Requested

$33,960

Lignite Industry Match Requested

$33,960

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ABSTRACT

The depth of soil replacement required on stripmined land in North Dakota was reduced by the Public Service Commission following public hearings in 1986. The amount the soil depth was reduced depending on the quality of the underlying spoil material. These decreases in soil depth requirements do not go beyond 1996. The purpose of this research will be to determine if the current requirements are sufficient to reclaim the land to productivity equal to or better than undisturbed land. This will be done by selecting sites in fields reclaimed to cropland and measuring wheat yields in these fields. These yields will be compared to nearby undisturbed land. Regression equations of yield versus soil depth should tell whether current requirements are sufficient. Assuming they are sufficient, the continuation of the current requirements should keep reclamation costs low compared to the cost of increased soil depths. Total cost of the project over two years is $67,920.

PROJECT SUMMARY

In 1986 regulations were adopted by the Reclamation Division of the Public Service Commission to reduce the depth of soil required for reclamation of cropland. The new requirements were based on properties of the spoil material. A sunset clause was added to these new regulations which requires their reevaluation after ten years.

The purpose of this study is to evaluate the yields from land which was reclaimed under the current regulations and compare them to yields from undisturbed sites and sites reclaimed under the previous regulations. Evaluation of these yield data should allow us to determine if these soil depths are sufficient for maximum potential yields to occur. Sites will be selected from at least four of the mines now operating in central North Dakota. Fields will be selected which are representative of the different spoil characteristics which require different depths of soil replacement. At least four sites in each field will be selected. Each of these sites will be sampled for wheat yield, soil depth and soil chemical and physical properties. Yields will be regressed against soil depth. These regressions will be used to determine if the current soil depth requirements have successfully produced yields equal to or better than undisturbed land. Yields will be measured over a two year period.

Assuming that this research provides the information necessary to continue the current regulations, the lignite industry will save close to a million dollars a year in reclamation costs.

PROJECT DESCRIPTION

Introduction

Data from years of previous research on the depth of topsoil and subsoil required to reclaim land following stripmining were compiled and published by Doll et al. in 1984. They drew conclusions on the amount of topsoil and subsoil needed and made recommendations for reducing the depth of soil required based on the properties of the spoil material. These recommendations contained a range for the depth of soil to be replaced. Following public hearings the Public Service Commission adopted these recommendations using the lesser depth of the range given. In addition, more soil is required if the saturation percentage is greater than 95% for spoil with an SAR of 12-20.

The amount of suitable plant growth material required is given in section 69-05.2-04 of the North Dakota Rules Governing Reclamation of Surface-Mined Land as follows:

Table 1. Suitable Plant Growth Material Redistribution Thickness

Spoil Properties			Total Redistribution Thickness	
Texture	Sodium Adsorption Ratio (SAR)	Saturation Percentage (SP)	(Topsoil Plus Subsoil) Average in Inches	(Centimeters)
Medium*	< 12	***	24	(61)
Coarse**	< 12	***	36	(91)
***	12-20	< 95	36	(91)
***	12-20	> 95	42	(107)
***	> 10	***	48	(122)

*Loam or finer.
** Sandy loam or coarser.
***Not applicable.

Further, it is stated that these requirements are effective only for those areas disturbed prior to the year 1997. In other words, starting in 1997 requirements will revert to the deeper depths of suitable plant growth material. If it can be proven that the current soil depth requirements are adequate, then extending the current rules will be justified.

Objectives

1. Measure wheat yields from cropland on reclaimed and undisturbed land.
2. Develop regression equations comparing yields with depth of topsoil.
3. Determine whether current rules require sufficient soil replacement to achieve productivity equal to or better than before mining.

Methodology

Fields which have been reclaimed to cropland will be selected from at least four mines in western North Dakota. Fields will be selected which have been reclaimed under different soil depth requirements.

Fields will be chosen to represent each of the categories given in Table 1. Additional fields reclaimed under the older regulations with deeper soil depth requirements will also be selected. Within each field four or more sites will be located for sampling. The soils at each site will be characterized for topsoil depth and subsoil depth. Soil samples, in foot increments, will be taken to a depth of five feet and will be

characterized for chemical and physical properties. Particle size will be measured using the hydrometer method (Day, 1965). A glass electrode will be used to measure pH (Peech, 1965). Soluble salts will be determined on saturation extracts (Bauer and Wilcox, 1965). Soluble Ca, Mg and Na will be determined quantitatively using atomic absorption spectrophotometry.

Undisturbed cropland fields will be selected as close as possible to the reclaimed fields. Soil depth will be determined from an assessment of the lift depths that would be taken from these fields if they were to be mined.

Regression equations will be developed which compare wheat yields to depth of soil replacement. These equations will be developed for each of the categories in Table 1. Undisturbed soils will be compared to reclaimed soils. Soils reclaimed under the previous regulations will be compared to those under the current regulations. Evaluation and recommendations will be made on whether the current soil replacement requirements are adequate.

Anticipated Results

Previous and ongoing research of the LRRC and other organizations indicate that the current soil replacement requirements are adequate to produce yields equal to or better than before mining. It is anticipated that there will be no relationship between soil depth and wheat yields for soil depths greater than those now required. This would show that current requirements are adequate.

Facilities, Resources and Technologies

The research will be conducted by the staff of the LRRC. We have adequate vehicles and equipment for the research. This includes a hydraulic probe for soil cores which is mounted on a pickup. We have vehicles for transportation and hand tools for harvesting small plots. At our office site in Mandan we have several PC computers and a main frame VAX on which all necessary statistical analyses can be performed. Laboratories are well equipped for the kind of analyses described in this proposal.

Environmental and Economic Impacts

During the course of the study the environmental and economic impacts will be very minor. The wheat harvest from each site will total $1m^2$ or less and will be accomplished by walking into each field and hand harvesting each site. Soil sampling will be conducted when no growing crop is in the field.

Ultimately, the impact of this project on the environment will be to reassure the companies, the PSC and farmers and ranchers that the land is being reclaimed to a productive potential equal to or better than it was before mining. The economic benefit will be that the current reduced depths of soil replacement can be allowed to remain in effect past 1996. Assuming current regulations reduce topsoil respread depths by one foot, about 2.1 million yards of soil will not have to be handled by scrapers each year. This amounts to an annual savings of almost a million dollars for the lignite industry in the state.

STANDARDS OF SUCCESS

The project will be considered successful if the data allow us to determine if the soil replacement requirements are sufficient to ensure that the productivity of reclaimed land is equal to or better than the productivity of undisturbed land (and land reclaimed under the previous regulations).

BACKGROUND

The first experiments in North Dakota on vegetative reestablishment compared the replacement of 2 inches of topsoil with chemical amendments (Sandoval et al., 1973; Power et al., 1974; and Power et al., 1975). These experiments showed that 2 inches of topsoil on sodic spoil produced much higher yields than the application of gypsum. Different depths of topsoil were studied in an experiment initiated in 1972 (Ries et al., 1978). Yields increased with increasing depth of topsoil up to the deepest depth of 12 inches. Yield trends indicated that maximum yields had not yet been reached.

When a nonsodic sandy loam topsoil was replaced on moderately sodic clay loam spoil, yields on 0.15, 0.30 or 0.60 m of topsoil were higher than on only 0.05 m (Halvorson, et al., 1987). Yields on 0.60 m of topsoil were generally no better than on 0.30 m. In this case, deeper depths of topsoil did not increase yields because the clay loam spoil was not as drought prone as the sandy loam topsoil and therefore, as the depth of topsoil increased, the ability of the profile to continuously supply water to the growing crop decreased.

In a subsoil wedge experiment in which the combined topsoil-subsoil thickness was increased from 0 to 2.10 m over highly sodic spoil with a sodium adsorption ratio

(SAR) of 25, highest yields of all crops occurred when about 0.20 m of topsoil (a mixture of A and B horizons) was placed over 0.55 to 1.10 m of subsoil (C horizon) (Power et al., 1981). Data from 15 wedge plots in Montana, Wyoming, and North Dakota showed that the depth of soil required for maximum production was dependent on spoil characteristics (Barth and Martin, 1984). Maximum production was achieved on these plots when replaced soil depths were 0.71 m on sodic spoil, 0 m on soil-like spoil, and 0.50 m on generic spoil (i.e., spoil lacking distinguishing traits such as sodicity).

As a result of these and other studies, regulations were instituted in North Dakota which required the replacement of 5 feet of topsoil and subsoil. If less than 5 feet of suitable plant growth material (SPGM) was available then proportionally less was required to be replaced. Research continued in the study of SPGM depth requirements, but now focused on whether 5 feet was more than necessary.

In particular, a study of SPGM requirements on nonsaline, nonsodic spoil compared the productivity of 0.23, 0.46 and 0.69 m of topsoil replaced over loamy sand spoil with and without subsoil, over clay loam spoil, or over silty clay loam spoil (Halvorson et al., 1986). At least 0.69 m of topsoil plus subsoil was required to achieve highest yields on nonsodic, nonsaline, loamy sand spoil, but 0.46 to 0.69 m of topsoil was sufficient for highest yields on clay loam and silty clay loam nonsaline, nonsodic spoil.

The research studies given above and others conducted in North Dakota on SPGM replacement depths were summarized by Doll et al (1984). In addition, they came to the conclusion that the amount of subsoil needed to restore productivity on reclaimed land is dependent on the chemical and physical characteristics of the underlying spoil. They

developed suggested guidelines for soil replacement based on spoil properties. The parameters they determined to be of importance were sodium adsorption ratio (SAR), texture and electrical conductivity (EC). These recommendations contained a range for the depth of soil to be replaced. Following public hearings the Public Service Commission adopted these recommendations using the lesser depth of the range given and eliminated the EC requirement. In addition, more soil is required if the saturation percentage is greater than 95% for spoil with an SAR of 12-20. These requirements are given in Table 1. A sunset clause was added to these regulations so that starting in 1997 the regulations will revert to the deeper depths of suitable plant growth material.

QUALIFICATIONS

The LRRC has been conducting research on the reclamation of mined lands since 1981. The staff is well acquainted with this subject and have published widely in this area. The principal investigator, Gary Halvorson, has conducted research in mined-land reclamation for 14 years. Dr. Halvorson has been involved in numerous projects studying the depth of soil replacement necessary for reclamation of stripmined land in North Dakota. A more detailed listing of his qualifications and pertinent references is given as an appendix to this proposal.

VALUE TO NORTH DAKOTA

Successful completion of this study will show whether the current soil replacement depths are adequate for successful reclamation in North Dakota. This should reassure companies, government officials, and farmers and ranchers that the land is being reclaimed to equal to or better productivity. If the results show that current

standards are inadequate, then the data should provide enough information to change the standards in order to get adequate reclamation.

Assuming that this study does show that current soil replacement depths are adequate, recommendations will be made to make the current requirements permanent. As compared to the earlier requirements for a deeper depth of soil, cost savings for the lignite industry will be continued. Cost savings are estimated to be about a million dollars a year.

MANAGEMENT AND TIMETABLE

This project will be managed to ensure the timely completion of the various aspects of the project. This includes selecting the sites, harvesting the wheat, taking soil samples and analyzing them for chemical and physical properties, statistically analyzing the data and presenting the data in reports to the industrial commission and industry. The various aspects of the study will be completed as given in the following timetable.

	1994											
Tasks	J	F	M	A	M	J	J	A	S	O	N	D
Select Sites	x	x	x	x	x	x						
Harvest							x	x				
Soil Samples									x	x	x	
Data Analyses											x	x
Reports					x			x				x

	1995											
Tasks	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Select Sites												
Harvest							x	x				
Soil Samples				x	x							
Data Analyses	x	x	x	x					x	x	x	x
Reports					x			x				x

2-Year Budget		
Item	**Industrial Commission**	**Lignite Energy Council**
Salary		
Scientist	$15,000	$15,000
Temporary Help	1,500	1,500
Fringe Benefits		
Scientist (.27)	4,050	4,050
Temporary (.01)	15	15
Total Salaries	**$20,565**	**$20,565**
Operating		
Supplies	1,000	1,000
Soil Analyses	6,000	6,000
Total Direct Costs	**$27,565**	**$27,565**
Indirect Costs (.232)	**$ 6,395**	**$ 6,395**
Total Cost	**$33,960**	**$33,960**
Total Project Cost $67,920		

TAX LIABILITY

As part of NDSU, the LRRC does not pay taxes.

Appendix A.

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