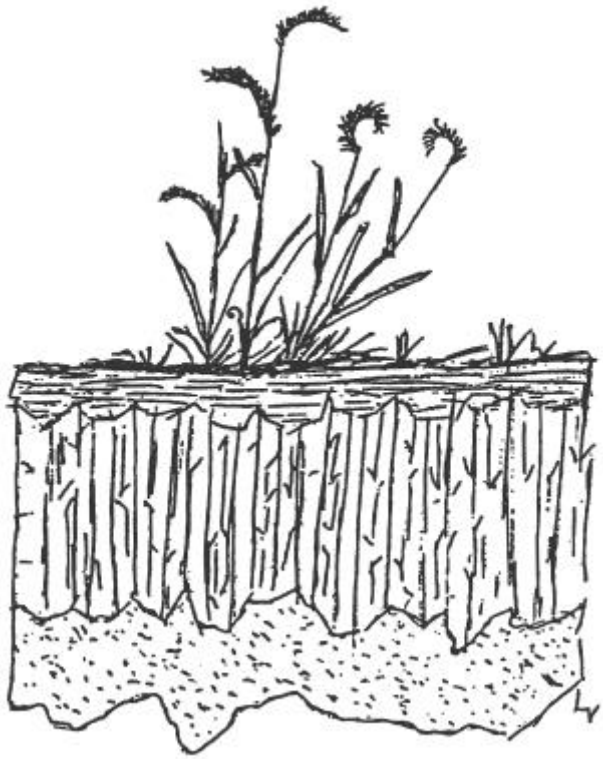
SECTION I

TOPSOIL

Section Editor: Laurel E. Vicklund



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A. Introduction

Section editor: Laurel E. Vicklund

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Topsoil is one of the largest resources to be managed, besides coal, on the mine site. Vegetation establishment and general reclamation success that directly affects postmining land use is enhanced by proper salvage and replacement of topsoil.

Topsoil is a living component, and represents the "skin" of the landscape. In the upper inches are stored microorganisms, seeds, and roots. The sooner salvaged topsoil can be replaced, the better chance these living features in the soil have of enhancing reclamation efforts.

Salvage, stockpiling, and replacement activities require large equipment and a dedicated amount of time. Planning and coordination are necessary to ensure that areas are properly salvaged ahead of the mining operations, and that timely topsoil replacement and seeding takes place after the regrading operations.

Procedures outlined in this section feature salvage and replacement methods. Methods for topsoil removal offer suggestions to manage salvage depth to ensure adequate recovery. Unique ideas are offered to enhance native vegetation establishment in the subsection entitled "Preserving Seedbed Viability Through Direct Haul of Frozen Topsoil".

There is no single best method of handling topsoil salvage and replacement activities. Application of a combination of these techniques will aid in adequate topsoil salvage and replacement.
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B. Salvage
1. Topsoil Identification and Salvage Control

Section editor: Laurel E. Vicklund Subsection author: Frank K. Ferris

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Situation:

Topsoil salvage is required by law to assure productivity of reclaimed lands. Topsoil identification, stripping control, and experienced equipment operators will assure a high quality topsoil resource for reclamation.

Special Considerations:

Topsoil varies in depth atop overburden that is less productive than topsoil for plant growth. Stripping considerable overburden with topsoil may significantly reduce plant productivity.

Description of Technique:

a. Topsoil Identification

Topsoil identification for equipment operators is best if related to location, depth, color, structure, texture, salt depositions, and site ripping. An operator need not have specialized knowledge of topsoil to become expert at stripping.

(1) Location

Deep topsoil is usually located in draws and valley floors; ridge tops have generally very shallow topsoil. Shallow ridge topsoil usually covers unweathered overburden that may not be favorable for final reclamation.
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(2) Color

Brownish earthtone colors consistent with near surface color indicate topsoil. When bright colored earth tones or distinct color change occurs, it usually means topsoil has ended. One needs to be careful not to confuse recent rainfall saturation for a change of color.

(3) Structure

Structure is the best indication to the trained eye, and can be equated to blocky hexagonal shapes. Overburden has an irregular, blocky look; topsoil has a regular shape. Tilled fields, however, will not show this structure.

(4) Texture

Soils that contain too much sand or clay may need to be excluded. Infiltration and water retention are poor for pure clays and sands.

(5) Salt Deposition

A faint white to very white color indicates an area of salt accumulation. Rainfall leaches salt to this level and evapotranspiration removes the water, leaving the salt. This area can be too saline or alkaline if it is near a major drainage, and is a good indication that the stripping should cease within a couple feet. In upland areas, however, topsoil showing some salt accumulation may meet regulatory requirements. Defer to the environmental engineer when the situation is uncertain.

(6) Roots

Roots can be an indicator of topsoil. A dense mass of roots indicates the surface sod. However isolated roots, especially shrub roots, can penetrate well beyond topsoil. Therefore, roots should always be used with caution in determining topsoil depths.

b. Topsoil Salvage Control

Topsoil salvage control is best when several of the following aspects are joined for overall control: Pedestals, ripping, backhoe pits, site supervision, topsoil classes, augers, and quality equipment operators.

(1) Pedestals

Pedestals are the most critical references for quality control (see Figures 1 and 2). They illustrate topsoil horizons and reference the original surface. For example, pedestals eliminate the possibility of draw bottoms being viewed as stripped when in fact no topsoil was stripped (see Figure 3).

(2) Ripping

Ripping the area as it is being stripped is the best way to identify topsoil, or the completion of topsoil salvage. Ripped topsoil shows structure while ripped overburden shows a color change from topsoil and a lack of structure.

(3) Backhoe Pits

This is an excellent method of staking topsoil depth. Backhoe pits work very well, because one can enter the sloped pit and observe and dig at the topsoil horizons to determine the color, texture, structure, and moisture limits as well as salt deposition.

(4) Site Supervision

Checking the equipment operators twice a day is important for quality control. Quality control is maintained by halting stripping operations at the bottom of the topsoil, inspecting, and then removing any topsoil remaining in areas the operator may have stopped stripping too soon. During the inspections you would stake additional cuts, or indicate completion of an area. When a dependable, quality equipment operator is stripping deep topsoil, two visits per day may not be needed.

(5) Instruction

Topsoil identification classes for equipment operators assure the salvage of only topsoil. This document can be used as the class outline.

(6) Quality Contractor

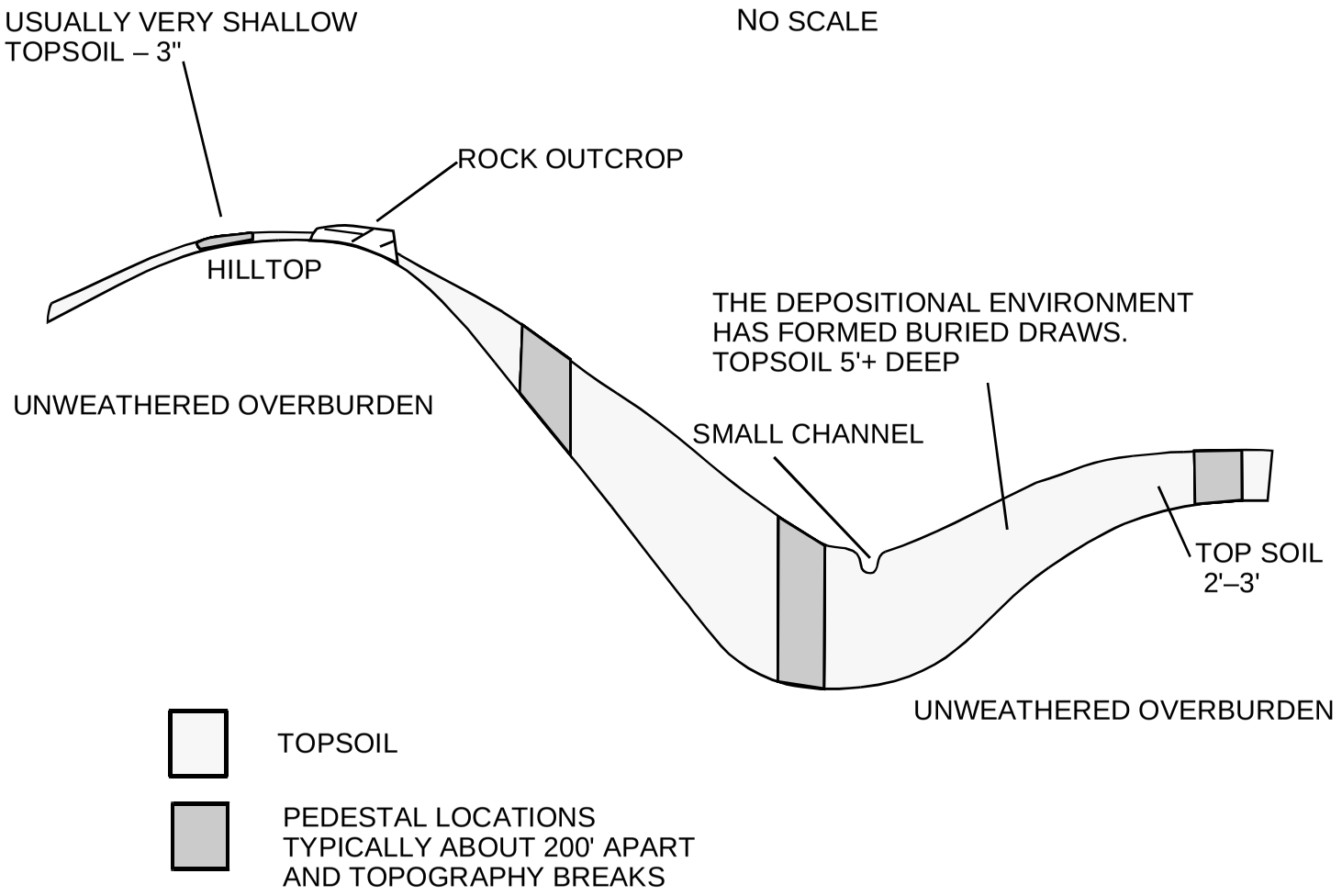
If topsoil handling is contracted, an experienced, reputable contractor is important for a good salvage operation. The foreman and key operators need some previous experience, or at least the topsoil identification classes for a start.

(7) Augers

These can be used by a highly trained individual to stake topsoil depths, but should not be used as a primary tool for identifying stripping depths. The auger cuttings are difficult to interpret, as the act of cutting blends soil horizons, masking individual soil features.

FIGURE 1

NO SCALE



TOPOGRAPHY WITH TYPICAL TOPSOIL DEPTHS

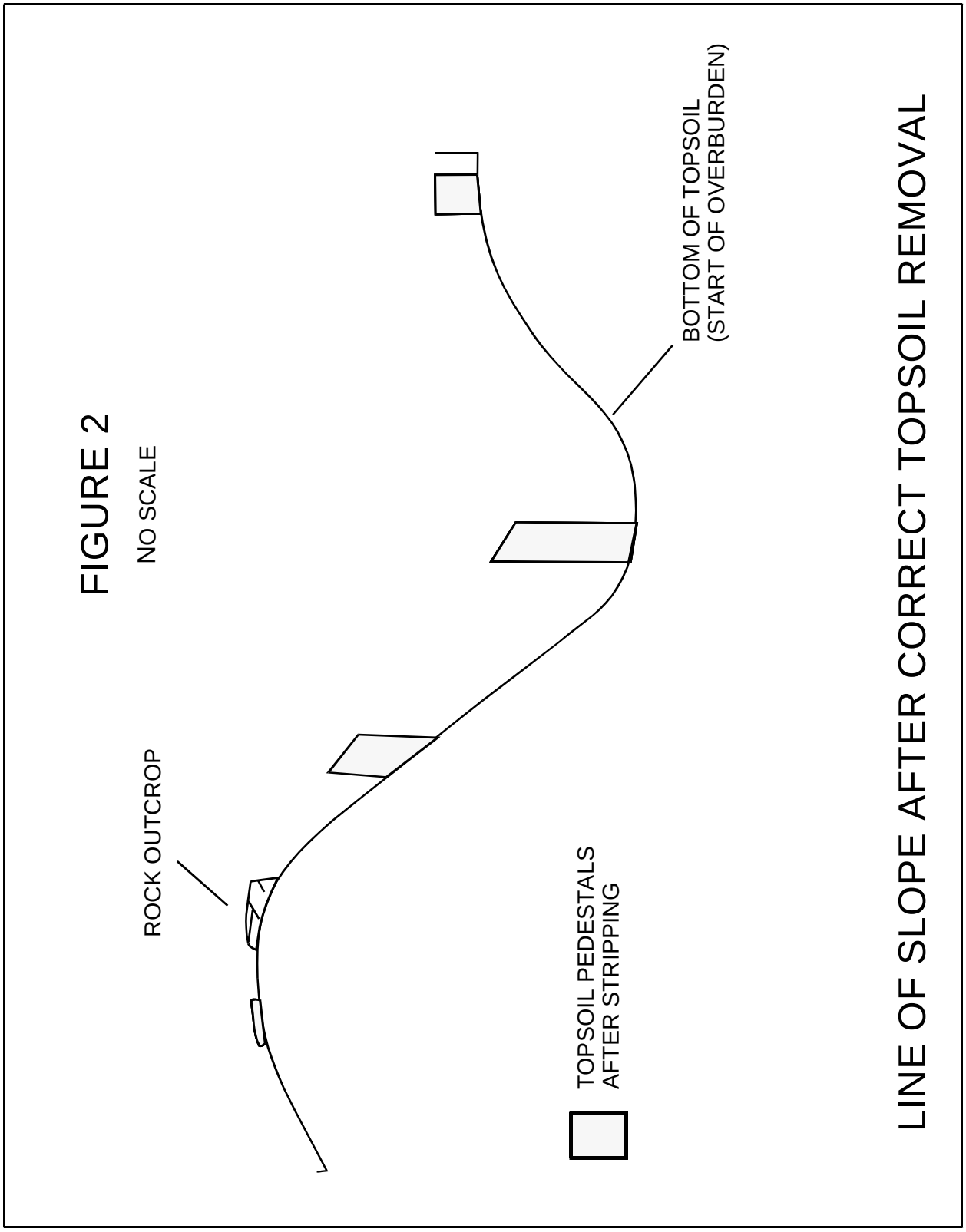
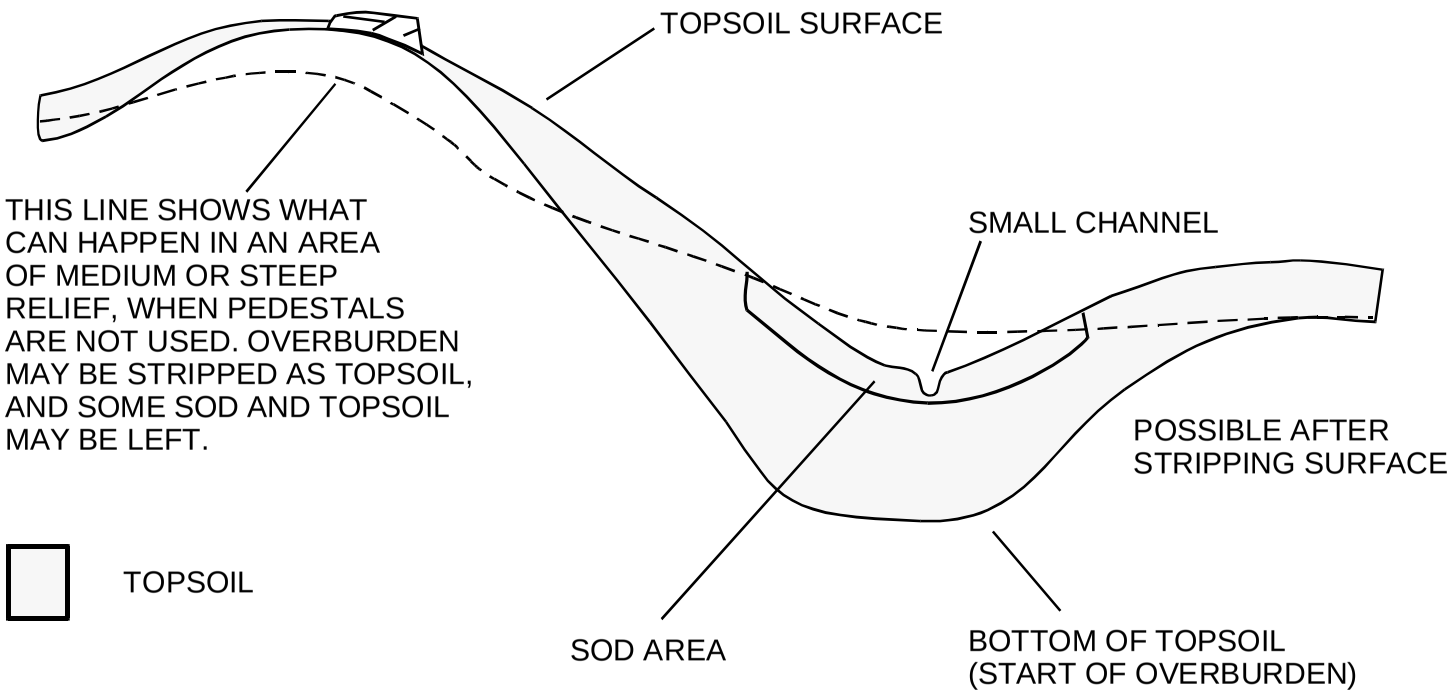


FIGURE 2
NO SCALE
ROCK OUTCROP
BOTTOM OF TOPSOIL
(START OF OVERBURDEN)
TOPSOIL PEDESTALS
AFTER STRIPPING
LINE OF SLOPE AFTER CORRECT TOPSOIL REMOVAL

FIGURE 3

NO SCALE



LINE OF SLOPE AFTER INCORECT TOPSOIL REMOVAL

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2. Topsoil Stripping

Section editor: Laurel E. Vicklund Subsection author: Marilee G. O'Rourke

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Situation:

Regulations require that all topsoil be removed from areas to be affected within the permit area, and replaced for reclamation or stockpiled in the most advantageous manner.

Special Considerations:

As with all mine related activities, dust emissions resulting from topsoil activities need to be kept to a minimum. Inadequate dust control could result in work stoppage. Access and haul roads associated with topsoil activities should be maintained in safe operating condition.

Description of Technique:

a. Topsoil Salvage Control

(1) General

Undisturbed topsoil is off limits to all equipment and vehicles except when such topsoil is being stripped. This will keep disturbances to a minimum and eliminate topsoil contamination.

The area requiring topsoil removal is staked or otherwise identified. A ditch is cut around the area to be worked each day. All topsoil hauling between the active stripping area and the stockpile is on stripped areas only. Where possible, topsoil removal is conducted in a manner that ensures any drainage from disturbed areas will flow directly to sediment control structures. Ideally, topsoil removal is done only during daylight hours.
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A clear boundary delineating the native and stripped area is established and maintained. The edge is sloped back at a 2H:1V slope angle, and a 2H:1V toe ditch of non-topsoil material is bladed along the final topsoil edge. This ditch provides sediment control for the area and reduces disturbance to the remaining topsoil areas.

(2) Pedestals

Topsoil depths, previously surveyed at 200-foot intervals, are indicated on laths. Pedestals of topsoil are left at these stakes to allow verification of the stripping depths. These pedestals and survey control points are left in place until the project supervisor approves removal. Upon clearance for removal, the pedestals are salvaged as topsoil.

(3) Completion

Upon completion, all topsoil removal areas are bladed to collect any additional topsoil not salvaged by scrapers. The entire area should be smooth-bladed for future mining operations.

(4) Sediment Control

Sediment control needs to be addressed daily. At the end of each work day, all disturbed areas are contained and controlled. Stripping of topsoil from the bottom of drainages should be given first priority in order to prevent contamination of topsoil by disturbed runoff. It may be necessary to strip drainage corridors to establish proper drainage prior to additional topsoil removal.

b. Contractor Considerations

(1) Environmental Regulations

All levels of contractor supervisory personnel need to be aware of, and are required to abide by, all state and federal environmental regulations that govern surface coal mining activities. It is the responsibility of the contractor to train each contractor employee with regard to these guidelines.

(2) Security

Access and security policies are site specific, and need to be addressed on an individual basis. It may be advisable to require the contractor to have a supervisor with State Mine Certification on site during all contractor working hours. The supervisor should have the authority and responsibility to exercise the terms of the contract on behalf of the contractor.

c. Quantities

(1) Daily Work Report

The project supervisor should inspect the working area prior to the beginning of each shift. A daily work report, showing all load counts and hours worked for each piece of equipment, should be completed and signed by the project supervisor.

(2) Payment Calculations

Typically, payment for topsoil removal is based on a per-cubic-yard unit rate of material handled. The unit rate should include payment for all other incidental work, such as haul road construction and upkeep, drainage control, ditch and berm construction, and other ancillary activities needed to complete the job. Mobilization and demobilization costs are usually additional to the unit rate(s).

Topsoil quantities and removal areas can also be calculated using aerial photography or standard field survey methods.

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3. Topsoil Stockpiling

Section editor: Laurel E. Vicklund Subsection author: Marilee G. O'Rourke

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Situation:

Topsoil stripped from an area prior to mining is preserved for later use in a topsoil stockpile. Regulations may require that topsoil not promptly redistributed be stockpiled in such a manner so as to minimize wind and water erosion and unnecessary compaction.

Special Considerations:

Procedures must be followed that will prevent the loss of topsoil from the stockpile through erosion. The establishment of a quick growing cover of vegetation on the topsoil stockpiles is advantageous to reduce erosion and loss, and may be required by regulation. Proper construction of slopes as well as a ditch/berm around the stockpile will also aid in erosion control and topsoil conservation.

Description of Technique:

The limits of topsoil stockpiles are field staked prior to placement of topsoil. Roads to and from stockpiles need to be stripped of topsoil prior to use. Stockpiles must be marked with a topsoil sign before stockpiling is begun.

Construction of a perimeter ditch/berm should precede any activities associated with material placement in the stockpile. The topsoil stockpile is completely enclosed with this ditch/berm, which should be approximately 1.5 feet high, or higher as needed for sediment control and topsoil conservation. If a sediment control structure is required, the ditch/berm will need to be constructed to ensure drainage to the structure.

Topsoil stockpile slopes should not exceed 5H:1V, to allow for seeding necessary to prevent erosion. When stockpiling is completed, the stockpile may be scarified parallel to the contour to minimize wind and water erosion. Large rocks uncovered during final grading activities should be removed.
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4. Topsoil Stripping Equipment

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Situation:

There are three general equipment fleet types used to remove and/or move topsoil. These are scrapers; loaders, trucks, and dozers; and shovels and trucks. Each fleet has unique characteristics. Using a fleet of equipment in the wrong application will usually lead to poor quality topsoil recovery, higher costs, and potential compliance problems.

Special Considerations:

Other than removal of topsoil from the upper portion of stockpiles, topsoil should not be stripped at night. Color changes, which are critical in differentiating between topsoil and overburden, are not readily evident after dark.

The stripping of frozen topsoil must be carefully evaluated. Under high moisture conditions and deep frost, shallow topsoil can be cemented to the overburden and it is extremely difficult to strip only the topsoil. Evaluate the site conditions and, if necessary, bypass until later.

Description of Technique:

a. Scrapers

Scrapers are the best stripping method for quality control. Scraper cuts should be no more than 50 percent of the topsoil depth for topsoil six inches or deeper. Trying to single-pass load topsoil that is six inches or deeper will usually include significant amounts of overburden.

Topsoil stripping should proceed from higher to lower topographical areas; generally this is also from shallow to deeper topsoil. In this way the scrapers are always being pushed downhill for their best productivity, and they finish loading in an unstripped area. After the
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hill slope is stripped to the draws and the width of the topsoil remaining in the draw is not sufficient to obtain a full scraper pan, the direction of topsoil stripping in the draw should be changed to parallel the flow line of the draw. When completing an area, the topsoil being dragged out of the cut and onto stripped ground will be significant. Loose topsoil inadvertently dragged onto previously stripped areas is difficult to salvage and likely will be lost or contaminated. By reversing scraper traffic periodically, this can be minimized.

b. Loaders, Trucks, and Dozers

A bulldozer is not designed to cut six inches of compacted topsoil and a loader cannot see its digging face. Because of these equipment characteristics, it is much more difficult to accurately strip topsoil. However, this equipment fleet works well in two feet and thicker topsoils that are on a flat to gently rolling topography with two feet or more of a subsoil that is suitable as a topsoil substitute. Thus, if topsoil with some suitable subsoil is dozed into piles or rows, and the loader cuts into the undisturbed suitable subsoil under the topsoil while loading, the topsoil quality will not be impacted. In irregular topography with shallow topsoil on unweathered overburden, the loader and dozer fleet will significantly cut and load overburden and degrade the topsoil resource.

c. Shovels and Trucks

Shovels and trucks are very cost effective in moving large topsoil stockpiles where the shovel is able to stay near its design productivity. If the shovel and truck operation is trying to take all the topsoil stockpile, the economics of the operation will be decreased by 50 percent for the volume that is represented by the stockpile edges and floor. A shovel will spill topsoil, leave stockpile edges the bucket cannot get, and leave topsoil under its tracks if the site was not flat or level. Additional support equipment is needed to push bypassed topsoil into the shovel face. In some cases it is more efficient to complete stripping with scrapers and not use extra support equipment to keep the pile edges and floor pushed in to the loading pile.

d. General Notes

Using specific equipment from one equipment fleet to compensate for the weak area of another fleet usually works very well. For example, scrapers could be used to strip the shallow topsoil and place it on the deep topsoil in flat areas for the loader, truck, and bulldozer operation.

C. Replacement
1. Topsoil Replacement Depths

Section editor: Laurel E. Vicklund Subsection author: Frank K. Ferris

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Situation:

Uniform topsoil depth replacement is generally required on reclaimed topography, however the erosional processes of water and wind will make topsoil depths uneven. In some areas, different topsoil depths will add to species diversity, but extensive erosion may produce very low productivity and an area that is hard to stabilize. Erosional forces usually move topsoil to areas where it is not needed as the depositional area collects topsoil. Varying topsoil depth in accordance with topography will help offset these processes, and make more effective use of the topsoil resource.

Critical Consideration:

At bond release, sufficient topsoil depth is needed to provide excellent vegetative cover. A reclaimed surface's topsoil depth varies according to how much the area is exposed to erosional processes. Erosion can reduce the topsoil depth below the minimum needed for suitable vegetation density in high erosional areas. If the following procedures deviate significantly from the approved permit, approval from the regulating entity may be needed.

Description of Technique:

By placing deeper topsoil in high erosional areas and less in depositional areas, the site will be more productive at and beyond bond release. See Figure 1. The high erosional areas would not erode through the deep topsoil layer and cause areas of low vegetation productivity.

1. Additional topsoil should be placed at erosional points, draws, slopes, etc. because erosional forces will decrease the depth.
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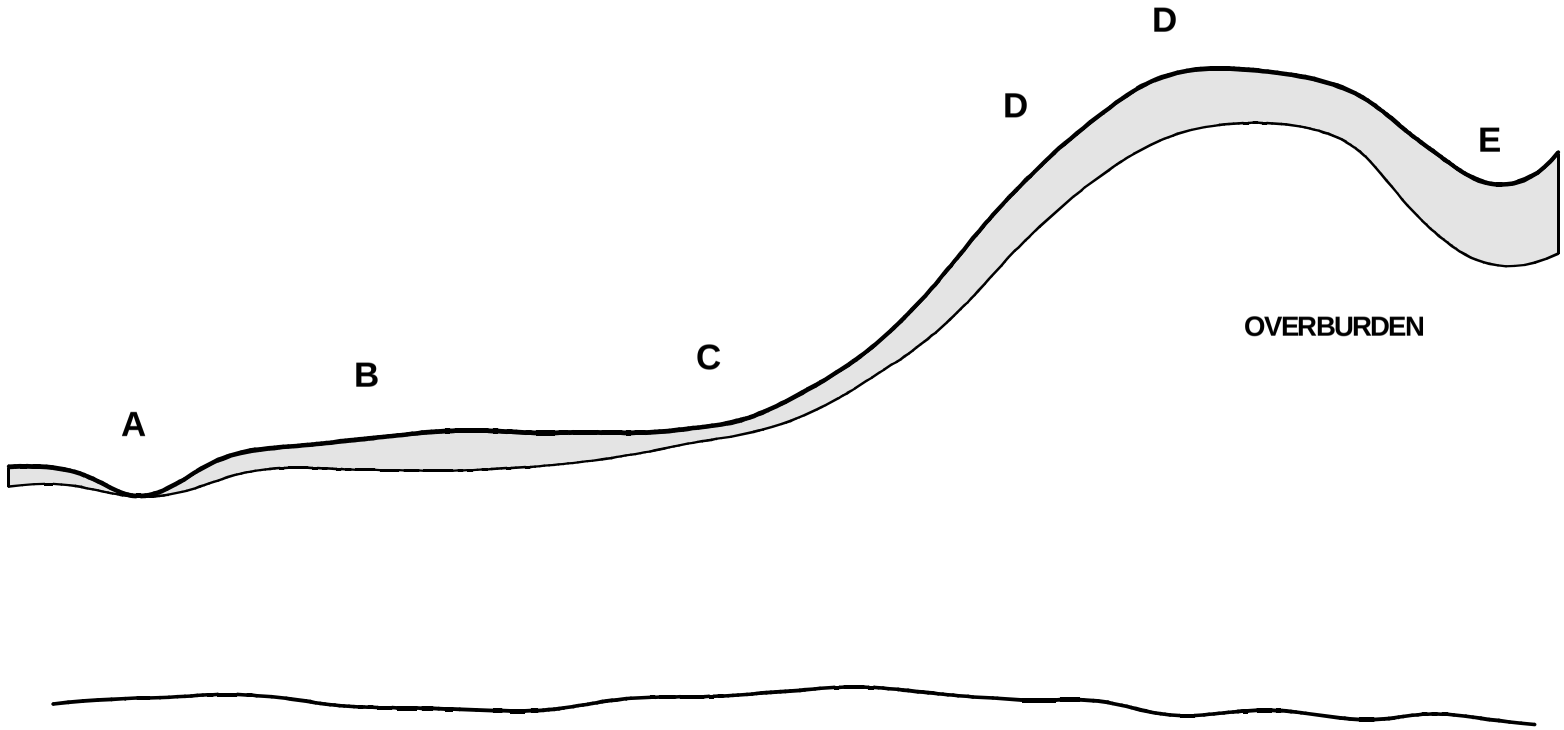
2. Less topsoil should be placed in depositional areas, toes of slopes and ridges, and low gradient channels.

3. The erosional potential is based on the steepness of slopes, and the concentration of water and wind exposure.

FIGURE 1



TOPSOIL SECTION OF RECLAIMED GROUND

AREA (following figure)	DESCRIPTION OF TOPOGRAPHY	SUGGESTED TOPSOIL PLACEMENT RANGE	COMMENTS (see cross section for additional detail)
A	Major channel bottom	Zero	Major channels are usually wet, depositional, have a shallow gradient, and support extensive vegetation.
B	Grain/hay field	85 to 100 percent	Depth may vary according to postmining land use requirements. Deep rooting crops may require deeper soil.
C	Toe of slope	35 to 60 percent	Toe of slope areas need to have a maximum slope of 7H:IV and should be about 300 feet wide. This thinned area may be from 100 to 600 feet wide, depending on the length of transition from slope to field and the size of the slope above the area.
D	Hill slopes and tops	150 percent	Through wind and water erosion, topsoil will be moved from this area, therefore the 150 percent of average topsoil depth. On a more complex hill topography, there could be multiple areas of erosion and deposition.
E	Steep gradient draws	200 percent minimum	Draws and drainage channels coming off of hilly areas usually have a steeper gradient than would be ideal. This steeper gradient will likely cause some erosion in the channel. To be sure the topsoil in the channel is not completely eroded away, additional topsoil is suggested to ensure vegetative establishment. In areas where erosion has broken through the topsoil, it is more difficult to establish adequate vegetation.

2. Topsoil Replacement

Section editor: Laurel E. Vicklund Subsection author: Marilee G. O'Rourke

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Situation:

The replacement of topsoil after mining marks the beginning of reclamation in a given area. The careful planning and supervision of the environmental engineer, as well as the skill of the equipment operators, will ensure this foundation is properly laid.

Special Considerations:

As with all mine related activities, dust emissions resulting from topsoil activities need to be kept to a minimum. Inadequate dust control could result in work stoppage. Access and haul roads associated with topsoil activities should be maintained in safe operating condition.

Description of Technique:

a. General

Prior to topsoil replacement, confirmation of approved final grade and samples for analyses of the top four feet of soil should be obtained. The replacement area is then delineated and scarified parallel to the contour at an approximate depth of one foot on 18-inch intervals. Rock piles are typically constructed within the redistribution areas prior to topsoil placement. Topsoil is tapered into the edges of the rock piles during replacement. Rocks unearthed during scarification are either pushed together to form small piles or added to existing rock piles.

Sediment control needs to be addressed daily. At the end of each work day all replacement areas are contained and controlled.
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(1) Equipment Traffic

Equipment operation on topsoil areas is limited to the extent necessary to perform removal of the stockpiled topsoil and redistribution on regraded areas. Equipment traffic routes are not allowed on topsoiled areas. Ideally, topsoil redistribution should only be done during daylight hours.

(2) Replacement Depths

A uniform depth of topsoil is placed on the loosened regraded surface. The desired thickness is contingent on the specific operating plans. Topsoil thickness can be increased in localized areas to produce micro-contours. Redistributed topsoil is blended in with previously reclaimed areas or native edges where applicable. Guidance stakes on a maximum of 100-foot centers provide verification of the topsoil redistribution depths while maintaining existing contours.

(3) Final Touches

Following topsoil redistribution, the area should be bladed and inspected to ensure adequate drainage. The area should be scarified to a depth of approximately one foot at 18-inch intervals. To minimize erosion problems, scarification is performed parallel to the contour. The topsoil redistribution edges are bladed to form 2H:1V slopes. A perimeter ditch/berm, constructed of overburden material, is built around the outer edge of the area for sediment control and topsoil conservation. Edges of redistribution areas should be straight and have a smooth appearance.

(4) Remaining Stockpile

Partially used stockpiles are recontoured with slopes no steeper than 5H:1V. The exposed area of the stockpile is scarified parallel to the contour to minimize erosion. A ditch/berm approximately 1.5 feet or higher as needed for sediment control and topsoil conservation, is reestablished.

b. Contractor Considerations

(1) Environmental Regulations

All levels of contractor supervisory personnel need to be aware of, and are required to abide by, all state and federal environmental regulations that govern surface coal mining activities. It is the responsibility of the contractor to train each contractor employee with regard to these guidelines.

(2) Security

Access and security policies are site specific and need to be addressed on an individual basis. It may be advisable to require the contractor to have a supervisor with State Mine Certification on site during all contractor working hours. The supervisor should have the authority and responsibility to exercise the terms of the contract on behalf of the contractor.

(3) Daily Work Report

The project supervisor should inspect the working area prior to the beginning of each shift. A daily work report, showing all load counts and hours worked for each piece of equipment, should be completed and signed by the project supervisor.

(4) Payment Calculations

Typically, payment for topsoil redistribution is based on a per-cubic-yard unit rate of material handled. The unit rate should include payment for all other incidental work, such as haul road construction and upkeep, drainage control, regraded area scarification, topsoil scarification, ditch and berm construction, and other ancillary activities needed to complete the job. Mobilization and demobilization costs are usually additional to the unit rate(s). Topsoil quantities and redistribution areas can also be calculated using aerial photography or standard field survey methods. An average depth of topsoil replaced for a specific area is also calculated.

NOTES

3. Elevation Control

Section editor: Laurel E. Vicklund Subsection author: Frank K. Ferris

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Situation:

Depth control is needed to attain the desired topsoil replacement depth for optimum reclamation success.

Special Considerations:

Control of topsoil replacement depth is difficult, because the reference point is continually being covered with topsoil.

Description of Technique:

a. Staking

Staking with four-foot lath seems to be the best method of controlling topsoil replacement depth. Important points for staking are *spacing, location, marking,* and *proofing*.

(1) Spacing

Spacing needs to be frequent enough to prevent shallow areas in between the stakes. The rows should be spaced three to four scraper widths apart. Rows can be approximately 35 to 40 feet apart, with stakes at 40 to 80 foot intervals (see Figure 1). The interval will be determined by the equipment operator experience.

(2) Location

Location of stakes should be in a basic grid pattern, with extra stakes at topography breaks. These stakes at topography breaks are the most important (see Figure 1).
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FIGURE 1

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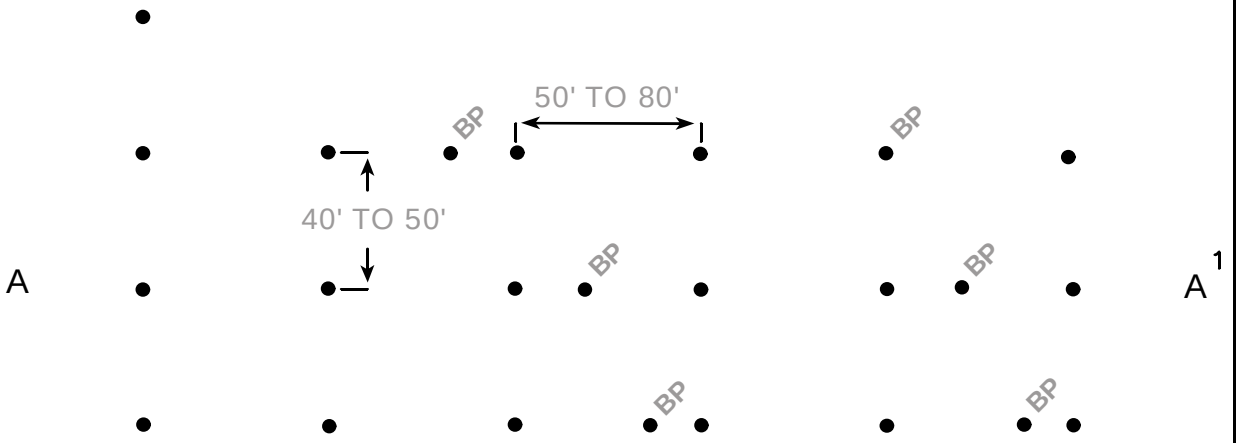
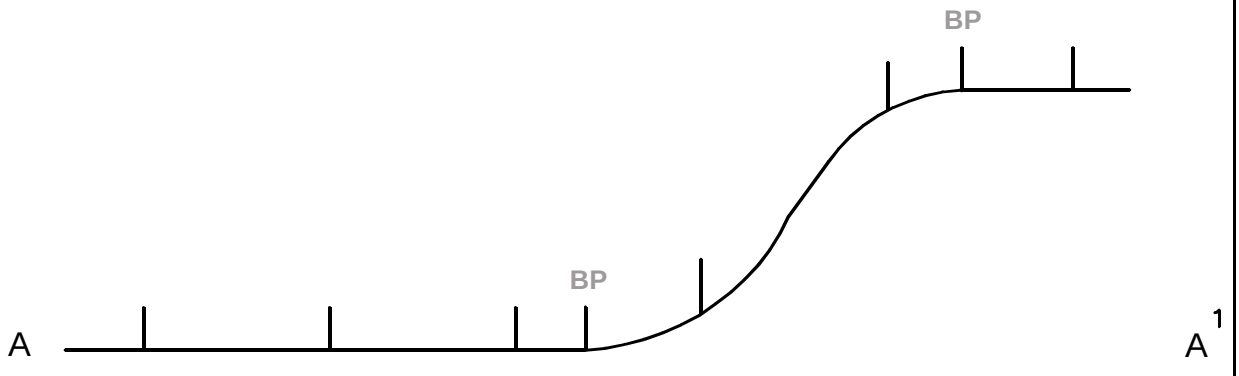


BP= BREAK POINT

PLAN VIEW

NO SCALE



PROFILE

NO SCALE

(3) Marking

Stake marking can be done by painting the length to be covered, the length to be left uncovered, or simply marking the final fill line. Any of these methods seem to work well as long as both sides of the stake are marked. About a two-inch overfill is usually needed to account for compaction and settling.

(4) Proofing

Depth proofing is a good quality control check, and an absolute necessity when payment is based on fill depth. Backhoe pits provide the best verification because they clearly illustrate the topsoil/subsoil interface.

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4. Preserving Seedbed Viability Through Direct Haul of Frozen Topsoil

Section editor: Laurel E. Vicklund Subsection author: Kenneth L. Wrede

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Situation:

In the summer of 1987, reclamation personnel at the Wyodak Mine near Gillette, Wyoming observed that a small parcel of regraded spoil, which had received "live" frozen topsoil during a stripping operation the previous winter, was producing noticeable stands of native grasses and shrubs. "Live" topsoil is material which is hauled directly from the stripping area to the replacement area. It was also noted that the density of undesirable plant species of an opportunistic nature was lower when compared to adjacent areas conventionally seeded.

While a formal study was never conducted, it is visibly evident even today that the parcel of land has better diversity and density of native species than that of adjacent lands. It is also thought, though never weighed against the operational difficulties nor calculated, that hauling "live" frozen topsoil may reduce the cost of final revegetation.

Special Considerations:

While the practice of hauling frozen topsoil is not one which operational personnel would savor, there is reason to believe that several long-term benefits could be achieved using this method. Ideally, the direct haul of frozen topsoil would:

1. Propagate heartier stands of native grasses and shrubs.
2. Reduce plant stress by moving them while they are in a dormant state.
3. Reduce the amount of interseeding needed in some reclamation operations.
4. Speed the succession of native species on reclaimed lands.
5. Lower seed costs.

While making a standard practice of moving topsoil in the dead of winter usually is not thought to be an ideal reclamation practice, these results indicate occasional use of the practice might have
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benefits in special situations. A mosaic of mature native grasses, distributed among areas seeded by conventional means, would provide a seed source for adjoining lands, and mature shrubs would tend to spread to areas outside of the mosaic.

Description of Technique:

During the winter of 1986/1987, an area of approximately 16 acres in and near the floodplain of the restored Donkey Creek channel received "live" frozen topsoil during a direct haul stripping operation. A dozer/scraper fleet was used for this operation. Replacement depth was approximately 1.88 feet. Efforts were made to selectively handle the top six inches of frozen topsoil, and "cap" topsoil previously laid. It was hoped that this "seed bank" approach might encourage quicker reestablishment of native species and cover. (Wyodak Mine Annual Report, 1987)

Spring and fall plantings were not conducted in the area during 1987, but were delayed until the following year. In spite of this, substantial stands of intermediate, western and bluebunch wheatgrass appeared during the spring and summer of 1987, along with two predominant shrub species, rubber rabbitbrush and silver sagebrush. It is also theorized that native plant species in this area benefitted from the infiltration of additional moisture during the spring runoff, as the area was not bladed following topsoil placement.

Operational difficulties were encountered as could be expected with any wintertime stripping operation involving scrapers. Rough conditions, common in the cut and fill areas, reduced cycle times. "Live" topsoil was many times placed beneath "B" and "C" horizon material in the reclaimed area due to logistical difficulties. Although it turned out to have a positive effect as was previously mentioned, final grading could not be done effectively because the massive blocks of frozen topsoil were nearly impossible to fine blade.

Another fear was that seeds of undesirable weed species would be caught in the void spaces left in the ungraded topsoil, germinate, and compete with native plant species. The opposite has in fact proven true, as the area was nearly free of kochia weed during the first growing season and has not experienced the encroachment of undesirable weed species.

D. References

Wyodak Mine. November 30, 1987. Annual Report, submitted to the Wyoming Department of Environmental Quality - Land Quality Division. p. 10.

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