**INTEGRATED MINED-AREA RECLAMATION
AND LAND USE PLANNING**

Volume 3F

**A Case Study of Surface Mining and Reclamation Planning:
Cannelton Mine No. 9-S,
Cannelton, West Virginia**

Prepared for the

Resource and Land Investigations (RALI) Program
U. S. Department of the Interior
U. S. Geological Survey

ENERGY AND MINERAL RESOURCES

ARGONNE NATIONAL LABORATORY

Energy and Environmental Systems Division

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AND LAND USE PLANNING

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by

Jean E. Bogner and Allen O. Perry

Energy and Environmental Systems Division

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FOREWORD

This report is one in a ten-volume series prepared by the Energy and Environmental Systems Division of Argonne National Laboratory and the Resource and Land Investigations (RALI) Program of the U.S. Department of the Interior under the sponsorship of the U.S. Geological Survey. Because of the close interrelationship of the ten documents in the series, each volume will be most useful only when its relationship to the other products of the program is considered.

The reports in this series are designed primarily to familiarize professional land use and resource planners with the range of possibilities and effective procedures for achieving integrated mining, reclamation, and land use planning. These reports are based on a research program which included an extensive literature review, the compilation and analysis of case study data, and close coordination and interaction with related government programs.

The first volume in the series, *A Guide to Integrated Mined Area Reclamation and Land Use Planning*, summarizes the information in the other volumes and presents conclusions and observations drawn from analyses of that information. Volume 2, *Methods and Criteria for Land Use and Resource Planning in Surface Mined Areas*, examines planning procedures used in several mineral industries and mining regions and discusses problems facing professional planners who must consider surface mine areas in their planning programs.

In Volume 3, *A Guide to Mined Area Reclamation Technology for Reclamation and Land Use Planners*, the methods used to reclaim land in each of several mineral industries are discussed in relation to the physical and cultural constraints that must be considered in planning a reclamation program. Much of the information for this document was obtained from case studies conducted in several mining districts. The case study sites were chosen after consideration of the following: (a) coverage by commodity of those surface mining activities that disturb the greatest acreages, (b) coverage of a variety of cultural and land use settings, (c) evidence of integration of mining, reclamation, and land use planning, (d) cooperation on the part of operating companies and appropriate planning entities, (e) coverage of a variety of surface mining and reclamation methods, and (f) coverage of a variety of physical settings (geology, physiography, climate, hydrology). After the preliminary case study selection, some sites were changed and others dropped because of a lack of company cooperation. The remaining six case studies all meet the criteria listed above. They are not intended to be perfect examples of reclamation and planning procedures. Rather, they illustrate a variety of procedures utilized in different physical and cultural settings to achieve planning goals under a variety of technological, legal, and economic constraints.

Since the case studies are intended to be used as appendices to Volume 3, they are numbered accordingly. The case study reports include:

Volume 3A: *A Case Study of Surface Mining and Reclamation Planning: South Boulder Creek Park Project, Sand and Gravel Operations, Boulder, Colorado.*

Volume 3B: *A Case Study of Surface Mining and Reclamation Planning: International Minerals and Chemical Corporation, Phosphate Operations, Polk County, Florida.*

Volume 3C: *A Case Study of Surface Mining and Reclamation Planning: Georgia Kaolin Company, Clay Mines, Washington County, Georgia.*

Volume 3D: *A Case Study of Surface Mining and Reclamation Planning: Area Strip Coal Mining, Peabody Universal Mine, Universal, Indiana.*

Volume 3E: *A Case Study of Surface Mining and Reclamation Planning: ASARCO Open Pit Copper Mine, Casa Grande, Arizona.*

Volume 3F: *A Case Study of Surface Mining and Reclamation Planning: Cannelton Mountain-Top Removal Coal Mine No. 9-S, Cannelton, West Virginia.*

Volume 4, *A Bibliography of Integrated Mined Area Reclamation and Land Use Planning, With Annotations*, includes primarily references pertinent to reclamation planning and plan implementation.

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ABSTRACT

A mountain-top removal coal mining operation in south-central West Virginia is examined in this case study. A 2010 acre tract that is partly owned and partly leased by Cannelton Industries, Inc., has been about half stripped of the 5 Block and 6 Block Coals. The surrounding land area is characterized by steep-sided hills and generally lacks extensive tracts of level land suitable for agricultural or residential/commercial development. The Cannelton operation, which has already leveled several ridges, is creating areas which may be considered to have a higher land use potential than before mining. Although this site is generally isolated from urbanized areas and thus from structured regional planning efforts, it merits study as an excellent example of an innovative mining technique and integrated site-specific mining and reclamation planning.

1 INTRODUCTION

Surface coal mining in Appalachia has often been linked to adverse environmental impacts such as acid mine drainage, disruption of aquatic and terrestrial habitats, increased sediment load in streams, and engineering problems resulting from abandoned unstable spoil piles and slurry ponds. In the past, however, a coal-based economy in many areas of Appalachia led local residents to be highly tolerant of such effects. Today, the implementation of statewide reclamation standards* and greater environmental awareness by citizens and mining companies have encouraged adoption of mining and reclamation procedures that do not degrade the land-use potential of a particular area after surface coal mining. In some instances -- as in the case of the mining operation examined in this study -- the land may have a higher land-use potential after mining than it did before mining was initiated.

Reclamation planning in Appalachia is somewhat fragmented. In many states, including West Virginia, a reclamation plan must be submitted with the application for a mine permit. Where surface mining activities impinge upon urban areas, local planning commissions often review proposed reclamation plans. In predominantly rural areas, however, reclamation plans for individual surface mines are approved directly by the state permitting agency, which determines legal compliance, without any input from a planning agency per se.

*Imhoff et al. (1976) detail some of these state regulations regarding surface mining.

Two organizations that are concerned with land-use problems and potential in strip mined areas in Appalachia are the Appalachian Regional Commission (ARC) and the Interstate Mining Compact Commission (IMC); these organizations conduct and sponsor a number of research and development projects relating to surface mined land. Although the ARC and IMC are not planning agencies, the type of information they provide may be useful to planning studies in areas affected by surface coal mining. In addition, the Council for Surface Mining and Reclamation Research in Appalachia, the West Virginia Surface Mining and Reclamation Assn., and the Steering Committee for surface mine research in West Virginia may also be able to provide helpful technical information on surface mining and reclamation.

The West Virginia surface coal mine selected for this study is somewhat atypical of Appalachian surface mines. First, the mining technique itself (mountain-top removal) is rather innovative: as the name implies, the mountain or ridge top is essentially leveled during the mining process (Fig. 1.1); this technique is feasible where a minable, relatively horizontal coal seam lies near the mountain or ridge top. Most strippable coals in Appalachia are contour-mined around the steep hills; sometimes auger operations glean additional coal from behind the highwall of the same workings. A major advantage of the mountain-top removal technique over contour mining is that large tracts of level upland remain after mining is completed. Such large flat tracts, which can be adapted to a variety of land uses, are highly prized in Appalachia for both development and agriculture. Ideally, land-use planning should be an integral part of reclamation planning for such sites. Second, the case study site has no acid mine drainage problem, which is a distinct advantage to reclamation activities. Surface water bodies in Appalachia that receive acid mine drainage may have a pH below 4, which is lethal to almost all aquatic life (Appalachian Regional Commission, 1969).

Obviously, one case study cannot address the wide range of technical, operational, legal, and institutional considerations associated with surface coal mining in the United States. This study is intended to introduce planners to these considerations in the context of a specific mine in West Virginia and then to indicate, in a broader sense, what some of the environmental and socioeconomic impacts of surface coal mining might be at any site. It is important to stress that while certain general principles and criteria drawn from this study may be applicable to many regions, some technical details are unique to the mining operation considered and should not be rigidly applied elsewhere.

This case study concludes with guidelines that may be helpful to planners in assessing both positive and negative impacts of surface coal mining in a particular area. Even though these planning guidelines will indicate the types of impacts generated by surface coal mining in a given region, specific information for each area thus affected must be gathered by individual planning bodies.

FIRST CUT (BOX CUT)

SECOND CUT

FOURTH CUT

MOUNTAIN TOP AFTER
FINAL GRADING AND
TOPSOILING

Fig. 1.1. Diagrammatic Sketch of a Typical Mountain-Top Removal Operation
(from Grim and Hill, 1974)

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2 REGIONAL SETTING AND DESCRIPTION OF CASE STUDY SITE

The Cannelton No. 9-S mine, a mountain-top removal operation about 25 miles southeast of Charleston, West Virginia, is the subject of this case study. It lies on the border of Fayette and Kanawha counties, about one mile north of Cannelton, West Virginia (Fig. 2.1), and is operated by Cannelton Industries, Inc. (formerly Cannelton Coal Co.), based in Cannelton, West Virginia. Esmer and Associates, Inc., Consulting Engineers of Boomer, West Virginia, provided consultant services for this case study. The information contained in their consultant report (Esmer, 1976), as well as information obtained from other sources, is used for this study.

2.1 REGIONAL GEOLOGY AND CLIMATE

The Cannelton 9-S mine is located in the Appalachian Plateaus Physiographic Province, a region of relatively flat-lying sedimentary rocks interrupted by gentle northeast-southwest trending folds. The landscape is characterized by a well-integrated dendritic drainage system; major valleys commonly contain alluvial deposits. The hills are steep-sided; local relief from valley bottoms to ridge tops may exceed 1000 ft. The local area generally drains to the southwest toward the northwest-flowing Kanawha River. The site proper drains into Smithers Creek, a tributary of the Kanawha River. The topographic setting of the Cannelton mine is indicated in Fig. 2.1.

The sedimentary rocks exposed at the surface in this part of the Appalachian Plateaus consist entirely of Pennsylvanian age sandstones, siltstones, shales, and coal. (General references for the geology of Kanawha and Fayette counties are Krebs and Teets, 1914, and Hennen and Teets, 1919, respectively.) The oldest exposed Pennsylvania strata occur in the valley bottoms and consist of the Kanawha Formation of the Pottsville Group. Many ridges are capped by the next younger unit, the Allegheny Formation, which includes the coal seam mined at this site. The highest ridges may be topped by the Conemaugh Group, which overlies the Allegheny Formation. Table 2.1 indicates in detail the characteristics of the various rock units, while Fig. 2.2 shows the major coal seams contained in the Pennsylvanian units in this area. The No. 5 Block, or Lower Kittanning, Coal of the Allegheny Formation is the major coal extracted at the 9-S mine.

South-central West Virginia has a relatively humid temperate climate. Annual precipitation averages about 41 in. and is rather evenly distributed throughout the year. The average annual temperature in south-central West Virginia is approximately 55°F, and the area is relatively free of temperature extremes. Figure 2.3 displays both the average monthly temperatures for 1975 and the monthly precipitation for that year.

According to the Soil Conservation Service (SCS), the area around the 9-S mine receives enough rainfall during the growing season to make irrigation unnecessary (Gorman and Espy, 1975). While adequate soil moisture for plant growth is generally available throughout the year, the growing season is limited to the warmer months and averages 140 days (Gorman and Espy, 1975). Agriculture is generally confined to the valleys since the hills are steep and heavily wooded. In Fayette County and the adjoining Raleigh County,

CANNELTON 9-S MINE

CONTOUR INTERVAL 100 FEET
TRANSVERSE MERCATOR PROJECTION
SCALE 1:250,000

Fig. 2.1. Location and Topographic Setting of Case Study Site
(Source: U.S. Geological Survey, Reston, Va.)

Table 2.1. Detailed Description of Pennsylvanian Age Stratigraphic Units in South-Central West Virginia (in descending stratigraphic order)

Conemaugh Group

Cyclic sequences of red and gray shale, siltstone, and sandstone, with thin limestones and coals. May be divided into Casselman and Glenshaw Formations. Extends from the base of the Pittsburgh coal to the top of the Upper Freeport coal. Includes the Elk Lick, Bakerstown and Mahoning coals, and the Ames and Brush Creek Limestones.

Allegheny Formation

Cyclic sequences of sandstone, siltstone, shale, limestone, and coal. Includes the Freeport, Kittaning, and Clarion coals, also the Princess coals of Kentucky. Extends from the top of the Upper Freeport coal to the top of the Homewood Sandstone.

Kanawha Formation

Sandstone (approximately 50%), shale, siltstone, and coal. Becomes more shaly westward in the subsurface. Extends from the top of the Homewood Sandstone to the top of the Upper Nuttall Sandstone. Includes the Stockton (Mercer), Coalburg, Winifrede, Chilton, Williamson, Cedar Grove, Alma, Peerless, Campbell Creek, Powellton, Eagle, Gilbert, and Douglas coals. Upper formation of Pottsville Group.

Source: Cardwell, et al., 1968.

only about 13.5% of the land is farmed; corn, oats, and hay are grown, primarily to feed livestock (Gorman and Espy, 1975). Due to heavy summer thunderstorms, areas seeded in July may be subjected to erosion from excessive run-off. Esmer (1976) indicates that areas being reclaimed from surface mining should be seeded in the spring or fall. However, experience at the 9-S mine site (Rosenthal, personal communication) indicates that seeding can also be done during the summer.

2.2 REGIONAL AND LOCAL SOILS

Most of the soils in Fayette and Kanawha counties are residual and have formed in weathered Pennsylvanian shale, sandstone, and siltstone. The soils in the two counties have generally formed on steep to very steep slopes (frequently greater than 20%). Due to the steep slopes and moderately high rainfall, the erosion potential of most soils is extreme. However, small areas of alluvial and colluvial soils are also found in the two county area; these soils formed on stream terraces and bottom lands and are characterized by slopes that are generally less than 20%. The alluvial and colluvial materials are medium textured ("moderately fine" to "moderately coarse textured") and thin (less than 10 ft), except along major river valleys. Small areas of acid, medium to coarse-textured "gravelly alluvial land" may occur along fast-flowing

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- BASE OF PENNSYLVANIAN SYSTEM

Fig. 2.2. Major Bituminous Coal Seams in West Virginia (Source: Lotz, 1970)

Fig. 2.3. Distribution of Mean Monthly Temperatures and Monthly Precipitation for 1975 (Source of data: Kanawha Airport)

streams that drain sandstone and shale uplands. Figures 2.4 and 2.5 give generalized soil maps of eastern Kanawha and Fayette counties, respectively. The apparent discrepancy in major soil types present in these two counties is probably attributable to the fact that U.S. Dept. of Agriculture Soil Conservation Service (SCS) soils mapping for Kanawha County is in progress, and border problems have not been totally resolved.

Specific soil series originally present in the Fayette County portion of the Cannelton mine site are indicated in Fig. 2.6. The most common soil series in the immediate area of the mine are the Muskingum silt loam and very stony silt loam, which occurs on well-dissected uplands. The Muskingum soils are generally acid and have formed on weathered siltstone, shale, and sandstone; slopes are generally greater than 40%. The SCS rates the Muskingum soils as high in available moisture capacity, moderate in permeability, and moderate to moderately high in natural fertility.

Valley soils present in the immediate vicinity of the mine site include the Ernest and Shelocta silt loams and very stony silt loams. These soils generally formed in acid colluvial deposits derived from shale, sandstone, and siltstone uplands; slopes on the Ernest and Shelocta soils range from 10-40%. These soil series have moderate natural fertility, moderate to high available moisture capacity, and moderate permeability. The lower part of the B horizon of the Ernest series is typically a silty clay loam fragipan, which retards infiltration. Other valley soils in the vicinity of the Cannelton mine include the "gravelly alluvial land," mapped mainly along Smithers Creek, and man-made deposits, including mine dumps, strip mined areas, and made land of other types. The "gravelly alluvial land" consists of coarse-textured mixed gravelly and sandy materials on flood plains; these materials are well-drained, have low moisture holding capacity and 3-8% slopes, and were derived from acid sandstone, siltstone, and shale. (Gorman and Espy, 1975).

2.3 ECONOMIC SETTING OF MINE AND DESCRIPTION OF OPERATING COMPANY

Because of the rugged topography that characterizes this part of West Virginia, most residential, commercial, and industrial development has been limited to flat areas along valley bottomlands. Agriculture, likewise, has been confined to the more level valleys and is not a major industry in the area; according to the SCS, less than 15% of the land is farmed (Gorman and

Fig. 2.4.. Generalized Soils Map of Eastern Kanawha County
(Source: USDA Soil Conservation Service)

SOIL ASSOCIATIONS *

- 1** Calvin-Gilpin association: Moderately deep, well-drained, medium-textured, mostly sloping to very steep soils on dissected uplands and mountains
- 2** Dekalb-Gilpin-Ernest association: Moderately deep, well-drained, moderately coarse textured and medium-textured, mostly sloping to very steep soils on dissected uplands and deep, moderately well drained, mostly sloping or steep soils on foot slopes
- 3** Muskingum-Shelock association: Moderately deep, well-drained, medium-textured, mostly very steep soils on strongly dissected uplands and deep, well-drained, sloping to steep soils on foot slopes
- 4** Steep rock land-Dekalb-Gilpin association: Rough broken sandstone cliffs and rock outcrop areas on uplands and moderately deep, well-drained, moderately coarse textured and medium-textured, very steep soils on uplands

* Texture terms refer to texture of the surface layer.

Scale 1:316,800
1 0 1 2 3 4 5 Miles

Fig. 2.5. Generalized Soils Map of Fayette County, West Virginia

SOIL LEGEND

THE FIRST CAPITAL LETTER IS THE INITIAL ONE OF THE SOIL NAME. A SECOND CAPITAL LETTER, A, B, C, D, E, OR F, INDICATES THE CLASS OF SLOPE. MOST SYMBOLS WITHOUT A SLOPE LETTER ARE THOSE OF NEARLY LEVEL SOILS BUT SOME ARE FOR LAND TYPES THAT HAVE A CONSIDERABLE RANGE OF SLOPE. A FINAL NUMBER, 3, IN A SYMBOL SHOWS THAT THE SOIL IS NAMED AS SEVERELY ERODED.

SYMBOL	NAME
GR	GRAVELLY ALLUVIAL LAND
Ma	MADE LAND
Me	MINE DUMP
MgA	MONONGAHELA SILT LOAM, 0 TO 3 PERCENT SLOPES
MgB	MONONGAHELA SILT LOAM, 3 TO 10 PERCENT SLOPES
MkC	MUSKINGUM SILT LOAM, 10 TO 20 PERCENT SLOPES
MkC3	MUSKINGUM SILT LOAM, 10 TO 20 PERCENT SLOPES, SEVERELY ERODED
MkD	MUSKINGUM SILT LOAM, 20 TO 30 PERCENT SLOPES
MkD3	MUSKINGUM SILT LOAM, 20 TO 30 PERCENT SLOPES, SEVERELY ERODED
MkE	MUSKINGUM SILT LOAM, 30 TO 40 PERCENT SLOPES
MkE3	MUSKINGUM SILT LOAM, 30 TO 40 PERCENT SLOPES, SEVERELY ERODED
MkF	MUSKINGUM SILT LOAM, 40 TO 75 PERCENT SLOPES
MnE	MUSKINGUM VERY STONY SILT LOAM, 20 TO 40 PERCENT SLOPES
MnF	MUSKINGUM VERY STONY SILT LOAM, 40 TO 75 PERCENT SLOPES
ShC	SHELOCTA SILT LOAM, 10 TO 20 PERCENT SLOPES
ShD	SHELOCTA SILT LOAM, 20 TO 30 PERCENT SLOPES
ShE	SHELOCTA SILT LOAM, 30 TO 40 PERCENT SLOPES
Sr	STEEP ROCK LAND
St	STRIP MINE SPOIL

Fig. 2.6. Detailed Soils Map of Fayette County Portion of Cannelton 9-S Mine (Source: Gorman and Espy, 1975)

Espy, 1975). The regional economy has little diversity and is strongly dominated by the coal industry. Other employers in the area include timber and oil/gas development interests. Most transportation routes (roads, railroads) also parallel valley bottomlands; the Kanawha River, which is about two miles from the site, is a major barge route. Land values (surface only) in the area are typically less than \$300/acre (Ward, personal communication). However, much of the land is tied up with leases for mineral rights, which, in addition to the confining effect of the rugged topography, greatly restrict the amount of land available for housing and other types of development.

The Cannelton 9-S mine is generally isolated from residential development. This site is not close enough to Charleston to be included in the metropolitan area. In addition, Cannelton has historically been reluctant to relinquish surface rights of land that it owns in the immediate area. If surface rights of unmined lands were sold for residential development, the company would be forced to relocate residents as mining activities expanded.

Cannelton Industries, Inc., is a major employer in this part of West Virginia, with approximately 635 persons in its Kanawha Division, which includes the 9-S mine, several underground workings, and the Lady Dunn Preparation Plant (Keystone, 1976). Cannelton, which has been actively mining in the area for many years, was incorporated in 1871 when it initiated mining operations on its fee property. In 1910, Cannelton Coal Co. became a subsidiary of the Algoma Steel Corp., Ltd., of Sault St. Marie, Ontario, Canada. As a result, Cannelton provides the steel mill with an assured supply of coking coal. In addition to the Kanawha Division mines in Fayette County, Cannelton also has active mining operations in McDowell and Boone counties of West Virginia, which are included in its Pocahontas and Indian Creek Divisions, respectively (Keystone, 1976). A subsidiary of Cannelton, the Maple Meadow Mining Co., is actively mining in Raleigh County, West Virginia (Ward, personal communication).

Cannelton has no plans at present to enlarge its Kanawha Division operation. Instead, the company plans to develop and increase capacity at its two other mining divisions. With present known reserves, Cannelton can maintain current levels of coal production at its Kanawha Division for at least 30 years (Esmer, 1976). Since Cannelton is a "captive" company (i.e., owned by a steel company), it has a guaranteed market on established transportation routes for its metallurgical coal. Cannelton is thus expected to be a major employer in the area for some time in the future.

2.4 DESCRIPTION OF COAL DEPOSIT

The 9-S mine lies in the southern West Virginia coal field, which is often termed the "low sulfur field." The coal seams in Fayette and Kanawha counties tend to be irregular and difficult to correlate since the area lies close to a "hinge line" that separates the northern West Virginia coal fields from the southern West Virginia coal fields. The major coal removed by Cannelton at this mountain-top removal operation consists of the Lower Kittanning, or No. 5 Block, Coal, which is the lowest coal of the Allegheny Formation. The No. 5 Block Coal includes two benches or seams, the lower 5 Block and the upper 5 Block. Occasionally, what is locally called the No. 6 Block Coal is

also mined at this site; the No. 6 Block is regionally correlated to the Middle Kittanning Coal. At this site, the interval between the upper and lower benches of the 5 Block Coal consists mainly of shale and is 4-13 ft thick. The thickness of the local "6 Block" and its distance above the 5 Block are variable; the 6 Block attains a maximum thickness of about 20 in. and is located about 40-60 ft above the upper 5 Block seam. The interval between the upper bench of the 5 Block and the 6 Block consists of a variety of material, including shale, sandstone, and siltstone.

Figure 2.7 indicates the probable original minable extent of the 5 and 6 Block Coals; note that the 9-S mine lies near the margin of the 5 Block. Reserve information for the 5 Block Coal at this site is not available, but according to Cannelton (Ward, personal communication), coal mining in the tract covered under the present mining permit for the 9-S mine can continue for at least another four to five years. The No. 5 Block coal at this locality is a high quality, high volatile type bituminous coal; the following analysis is typical for coal (as received) from the 9-S mine (Ward, personal communication): moisture, 1.61%; ash, 4.99%; volatiles, 37.28%; fixed carbon, 56.12%; and sulfur, 0.89%. The heating value range of high volatile bituminous coal is about 13,000-14,500 Btu/ton.

Where it is sufficiently thick, the uppermost coal (the local 6 Block) is mined first and is generally marketed without processing for steam coal. The two 5 Block seams (upper and lower benches) are processed through Cannelton's Lady Dunn Preparation Plant at Montgomery, West Virginia, and marketed either as metallurgical coal or as washed steam coal (see Fig. 2.1 for location). To be marketed as metallurgical coal, the coal from the 9-S mine must be blended with higher quality coking coals from Cannelton's underground mines. Most of the coal produced by the 9-S mine is blended and transported directly to the Algoma Steel Corp.

Fig. 2.7. Probable Original Minable Extent of Lower Kittanning (5 Block) and Middle Kittanning (6 Block) Coals in West Virginia (Source: Lotz, 1970)

2.5 DESCRIPTION OF PERMIT AREA AND MINE OPERATIONS

In 1967, Cannelton Industries initiated auger mining operations on the present site of the 9-S mine. The initial permit allowed mining on only 25 acres; mining commenced at the end of a 1948 access road built from Buffalo Lick to the top of the mountain. Gradually, additional permits to mine small tracts in the vicinity of this operation were acquired by Cannelton, and by 1970, the company decided to combine 11 strip mine permits and one prospecting permit into an application for one large permit. This consolidated permit (No. 615-70) was granted by the West Virginia Department of Natural Resources in 1970. According to the permit, the intended total disturbed area was to be 2,010 acres, which at that time was the largest surface mine project initiated in the state (Esmer, 1976). A site plan for the mine is given in Fig. 2.8.

By the beginning of 1977, about 1,100 acres had been disturbed by mining operations (Ward, personal communication). In 1975, approximately 655,113 tons of coal were mined at the 9-S mine (Keystone, 1976). The land stripped to date is located almost entirely in Fayette County and has been owned in fee by Cannelton since 1871 (see Fig. 2.8). An additional leased tract, located mainly across the county line in Kanawha County, is included in the mining permit held by Cannelton, and is owned by the Mariner's Museum of Newport News, Virginia. Cannelton acquired the mineral rights to this tract in 1948 and has only recently been allowed to begin surface mining there. The tract was the site of underground mining of the 5 Block Coal from about 1930 to 1948 (not by Cannelton). In 1977, Cannelton acquired the mineral rights and a new mining permit for an additional 590 acres of the Mariner's Museum's land. Operations are expected to begin on both these leased tracts in the near future (Ward, personal communication).

The disturbed areas for the Cannelton 9-S mine appear as conspicuous high plateaus. The ridge tops that have been mined are characterized by a thick mantle of reworked overburden materials, which were placed on them as mining progressed. The mined areas contrast sharply with unmined ridges where the steep hill tops capped by thin residual soils are still apparent. Overburden removed from the initial cut on a particular ridge is placed in a valley fill (or "head of hollow" fill) to form the outslope of the area to be mined. After the coal is removed from the first cut, overburden materials from the second cut are placed in the first cut. As mining continues across a ridge, the reworked overburden materials are successively placed in the previous cut.

A series of photos will best illustrate mining operations at the Cannelton mine. Figure 2.9 shows an area where the vegetation has been stripped by track-mounted bulldozers in preparation for overburden blasting. Note that the blast-hole drill is located on the bench in the right background of the photo; blasting is done using a mixture of ammonium nitrate and fuel oil (ANFO). The area where the haul road is located has already been mined.

Depending on the size and shape of the overburden materials after blasting, they are removed with either pan scrapers or front end loaders and then loaded into off-highway rear dump trucks. Although the pan scrapers are equipped with twin engines for self-loading most types of loose materials, they often require a tractor dozer as a pusher. Shown in Fig. 2.10 is a case where

Fig. 2.8. Site Plan for Cannelton 9-S Mine

Fig. 2.9. Area Stripped of Vegetation in Preparation for Blasting Overburden (note blasthole drill in right background)

two pushers (tractor dozers) were necessary to accomplish loading. When the overburden consists of large blocky material, pan scrapers cannot be used, and front end loaders are needed to remove the overburden.

Once the coal is exposed (Fig. 2.11), it is excavated (without additional blasting) by rubber-tired front end loaders equipped with a ripper. Like the overburden, the coal is loaded into off-highway rear dump trucks and then transported to the processing plant (Fig. 2.12).

Illustrated in Fig. 2.13 is the proper design of outslope fill areas in order to minimize erosion and promote revegetation after mining. The cut is sloped toward the highwall in order to confine the water to the pit or highwall area, which reduces runoff from the mine. This particular area was mined three years before the picture was taken; a good vegetative cover was established the first year. Figures 2.14 and 2.15 show some of the larger outslope fill areas of the Cannelton site in the foreground and flat cut areas in the background. Note in Fig. 2.15 that pine trees have been planted on the slope to assist in stabilizing the soil and that mining is continuing in the background, as indicated by the presence of the highwall.

2.6 PROCESSING OF COAL PRODUCED AT 9-S MINE

Coal produced by Cannelton's Kanawha Division is processed through the Lady Dunn Preparation Facility, located on U.S. Highway 60 near Montgomery. Most of the coal produced at this facility can be utilized for metallurgical

Fig. 2.10. Tractor Dozers Being Used as Pushers for Pan Scrapers

Fig. 2.11. Tractor Dozers on Coal Seam after Overburden is Removed

Fig. 2.12. Loading Coal into Off-Highway Rear Dump Trucks

Fig. 2.13. Proper Outslope Design to Minimize Run-Off

Fig. 2.14. Typical Flat Mined Area and Outslope Fill Area

Fig. 2.15. Large Outslope Fill Area (foreground) and Flat Cut Area (background)

coal. The proportion of coal supplied to the preparation plant by the surface mine has grown relative to the amount of coal supplied by the underground mines, and the 9-S mine now provides 40-45% of the raw coal.

A closed circuit plant that can produce 1,500,000 tons of clean coal annually, the facility includes a heavy media primary washer using magnetite to remove fines as well as Deister tables for sizing (Esmer, 1976). The plant also has a rewash circuit that produces steam coal which generally contains about 16% ash and is sized greater than 0.25 in. in diameter (Esmer, 1976). Water used by the preparation plant is continuously recycled. A 60 ft. diameter thickener, vacuum filter, and centrifuge are used for water clarification. Both fine and coarse refuse are transported by overland conveyor to Dunn Hollow, where they are deposited in engineered disposal sites (Esmer, 1976).

2.7 WATER REQUIREMENTS AND HYDROLOGIC CONDITIONS AFFECTED BY THE OPERATION

Water requirements at the mine site itself are minimal. A water line transports potable water for drinking and for the workers' bathhouse from a public utility on the Buffalo Lick Fork of Smither's Creek (Fig. 2.8). Most of the surface water runoff from the mine operation, which is collected in settling ponds at the site, is recycled for hydroseeding during reclamation.

For comparison of surface water quality before and during mining operations, Cannelton has supplied typical water analyses. Data are summarized in Table 2.2; sample locations are indicated in Fig. 2.8 (the site plan). Note that higher levels of suspended and dissolved solids and total sulfates are present in the stream that receives mine drainage; pH, however, is essentially unchanged.

Residential water supplies in the area are obtained both from private wells and from public utilities that use groundwater or surface water; residential development is generally limited to the valleys. Although a few isolated farms with private wells are situated on the uplands, there are few such farms near the Cannelton mine site. To date, only one complaint has been filed with Cannelton regarding a private water well (Ward, personal communication), and details of that grievance are not available.

2.8 TRANSPORTATION AND STORAGE OF COAL PRODUCED AT THE 9-S MINE

All of the metallurgical coal processed at the Lady Dunn Facility is shipped by Penn Central Railroad to Toledo, Ohio, and from there, it is transported via ships on the Great Lakes to Algoma's mill at Sault St. Marie, Ontario. During the winter, the metallurgical coal is stockpiled until the spring shipping season begins; there is adequate space available to stockpile only about three to four months production. The steam coal produced as a secondary product at the Lady Dunn Facility is trucked approximately eight miles to the Appalachian Power Co. plant located at Glasgow, West Virginia (Fig. 2.1). Approximately five percent of coal produced at the 9-S mine is not processed but used directly as steam coal by the Union Carbide Alloy Plant (Ward, personal communication). Almost all steam coal produced by the Kanawha Division is transported by truck; rarely, some of the steam coal may be barged on the Kanawha River (Ward, personal communication).

Table 2.2. Comparison of Surface Water Quality before and during Mining Operations at Cannelton Mine. Typical Analyses.

Location ^a	Total Susp. Solids (mg/l)	Total Dis. Solids (mg/l)	pH	Total Sulfates (mg/l)	Alum- inum (mg/l)	Mang- anese (mg/l)	Iron (mg/l)
Lick Fork (drainage re- ceiving stream)							
Site 1	12	85	7.25	15.8	0.3	0.026	0.34
Site 2	9.6	268	7.79	114	0.1	0.059	0.22
Head of Hughes Fork (virgin stream)							
Site 3	1.4	33	7.44	2.9	0.1	0.013	0.05
Site 4	3.0	37	7.53	4.7	0.1	0.029	0.16

Source: Cannelton Industries, Inc.

^aLocations are shown in Fig. 2.8.

3 RECLAMATION PRACTICES AND LEGAL RESTRAINTS ON LAND USE

In West Virginia, land-use controls on mining in rural areas are effected only by the Reclamation Division and the Water Resources Division of the West Virginia Department of Natural Resources. Local land use planning and plan implementation devices exist, but, outside of urban areas they are constrained by statutory exemptions of mining activities. Fayette County regulates land use generally through zoning regulations, subdivision controls, and public health ordinances (Imhoff, personal communication).

Appendix A, which gives a short history of reclamation laws in West Virginia, and Appendix B, which indicates current requirements, should be consulted for background information regarding procedures at the Cannelton 9-S mine. A critical discussion of enforcement of West Virginia strip mining laws is contained in Fritsch et al. (1975).

3.1 RECLAMATION PRACTICES AND COSTS AT THE 9-S MINE

Because a mountain-top removal operation drastically alters the landscape, adequate planning is essential to successful mining and reclamation procedures. As indicated earlier, the large tracts of flat land that are left after mountain-top removal operations are prime areas for development. A major advantage of surface mined areas for development in comparison to underground mined areas is the absence of ground subsidence problems due to roof collapse. The mining and reclamation permit for the 9-S mine (No. 915-70) indicates that "land development" is the proposed land use.

Since 1968, four mountain tops have been leveled by Cannelton, creating more than 1,000 acres of level land (Ward, personal communication). Esmer (1976) indicates that reclamation practices have been concurrent with mining since the beginning of operations and that reclamation procedures have not been altered during the course of work at the 9-S mine. Reclamation work at the site is directed by Perry and Hylton, Inc., a private reclamation consulting firm. However, since the mining and reclamation permit is held by Cannelton, the mining company is ultimately responsible for the work (Ward, personal communication).

Regrading is accomplished mainly by D-9 track-mounted bulldozers and 988 front end loaders. Some pan scrapers are used where considerable earth moving and regrading are required. The reclamation and mining plan for the site (contained in permit No. 615-70) indicates that grading is to be completed within 30 days of stripping. Final grading is to "develop a gently sloping plateau" (Greene, personal communication). Figure 3.1 illustrates an area which has been graded after mining but not yet been seeded; mining activity will continue in the right background area of this photo.

According to Esmer (1976), topsoil has been routinely separated during stripping operations and then replaced, fertilized, and seeded as stripping operations were completed for a particular section of the mine. Before replacement, the topsoil is stored on old strip bench sites. The remaining overburden is deposited at the outer limits of the permit area and will eventually be used to backfill pit areas and where valley fill is needed. A typical backfill plan for a valley fill is shown in Fig. 3.2.

Fig. 3.1. Mined Area after Grading but before Seeding

Fig. 3.2. Typical Backfill (Source: Permit Application No. 615-70 West Virginia Dept. Natural Resources)

The entire 9-S site has been subdivided into 45 component drainage areas which range in size from 11.1 to 641 acres. Different reclamation designs and structures are employed for each area, depending on local topography, geology, and other site conditions (Greene, personal communication). Typically, gabion structures (see Fig. 3.3) are used for sediment control in the various drainage areas.

Fig. 3.3. Gabions Used as a Sediment Control Structure (This structure is made up of large, multi-celled, rectangular, wire-mesh baskets that are rock-filled. They are used as building blocks in the construction of sediment control structures. Gabions are used mainly in building small check dams across drainways; however, they are very versatile, and under favorable conditions, they can be used as primary structures. During construction, foundations must be properly prepared and the gabions securely keyed into the foundation and abutment surfaces. Rock used in filling the baskets must be durable and adequately sized.) (From Grim and Hill, 1974; photograph *not* taken at Cannelton 9-S mine)

Reclaimed areas are seeded year-round with a truck-mounted hydroseeder. The standard application rates of mulch, fertilizer, and seeds are specified on the permit as follows:

<u>Application of</u>	<u>Pounds/Acre</u>
Wood Fiber Mulch	700
Grasses and Legumes:	
Rye	10
Lovegrass	3
Kentucky-31 Fescue	20
Fertilizer:	
18-46-0	
331/2-0-0	400

In reality, the revegetation plan is flexible. The legume grasses used also include alfalfa, birdsfoot trefoil, and sericea lespedeza. Fertilization must generally include a minimum of 150 lbs of ammonium nitrate and 100 lbs of triple super phosphate per acre. According to Rosenthal (personal communication), fertilizer requirements are varied as necessary to be compatible with localized soil conditions.

After they are seeded and vegetation is established, formerly mined areas at the Cannelton mine have the appearance of Fig. 3.4. Because of the reduced slopes of mined areas in comparison to slopes on the undisturbed mountain tops, surface runoff is reduced to provide more available moisture for plant growth.

Fig. 3.4. Mined Area after Seeding and Establishment of Vegetation

Trees are also planted on the outslopes as part of the revegetation procedures; all trees are planted by hand by personnel of the U.S. Forest Service (USFS). Species include autumn olive (four rows on 8 ft centers at edge of outslope) and black locust (three per acre on outslopes). Preliminary results of USFS experiments at this site indicate that hybrid poplar is especially successful on strip benches (Rosenthal, personal communication).

Figure 3.5 gives an aerial view of mined and reclaimed areas at the Cannelton mine. A recent inspection of the 9-S site (October 1976) revealed some interesting aspects of reclamation procedures. At this mine, the materials between the coal seams consist mainly of shale, which easily breaks down during handling and undergoes rapid physical and chemical weathering thereafter. As a result, a mantle of shaley "soil" is formed within a few months after the completion of mining operations. Since this shaley "soil" is characterized by a pH that is considerably higher than that of the natural acidic soils (Muskingum, Ernest, Shelocta Series), it is apparently easier to establish vegetation on the weathered shale materials than on the replaced topsoil.

Fig. 3.5. Panorama of Mined and Unmined Areas (note trees planted in rows down outslope)

Test plots on the site confirm this conclusion. This evidence raises doubts as to the advisability of continuing to spread topsoil at this site and at sites with similar materials. As also shown in Fig. 3.5, a second observation is that trees planted by the U.S. Forest Service have been placed in rows down the outslope rather than being staggered, which may result in gully erosion between the rows.

Detailed reclamation costs for this site are not available. Esmer (personal communication) indicates that \$0.30 to \$0.40 per ton of coal extracted is probably a representative figure. Using 1975 production figures of 655,133 tons from the 9-S mine (Keystone, 1976), reclamation costs for that year would be a minimum of about \$196,500 (based on \$0.30 per ton). In Blakely (1974), Esmer indicates that basic reclamation costs at this site (not including land development) will average only about \$0.107 per ton of coal or about \$700 per acre. However, Argonne personnel familiar with surface mining in West Virginia have suggested that basic reclamation costs may be considerably higher if extensive earthmoving is required and selected spoils are segregated to facilitate revegetation, as is done at this site (Streib and Sobek, personal communication).

3.2 RECLAMATION PLANNING AT THE 9-S MINE

Preliminary reclamation planning for the Cannelton 9-S site was done jointly by Perry and Hylton, Esmer and Associates, and students at West Virginia Institute of Technology (Montgomery, West Virginia). They have compiled preliminary architectural drawings for an intensive residential development, which includes a city of 10,000-20,000 population, an airport, and a reservoir for water supply. Their proposed plan for a portion of this site, which is shown in Fig. 3.6 (Blakely, 1974), probably presents the most intensive type of development plan that is possible for this site. Referring to the figure, Esmer discusses the proposed development at length (Blakely, 1974, pp. 51 and 54):

The design whose map is presented here, has about 625 acres for single family developments. Thus, single family housing could accommodate about 9,000 people. 140 acres of two-family type of residences could accommodate about 4,500 people. Another 4,500 people is planned to be accommodated by 100 acres of multi-family type of developments. Of the 1,846 acres to be developed, 865 acres are used for residential purposes. This is about 46 percent of the land for residential purposes. Compared to national averages, this compares very well with the "Average City - U.S.A." in terms of land use for residential development. The rest of the land use is as follows:

<u>Land Use</u>	<u>Acreage</u>	<u>% of Total Land Use</u>
Commercial	76	3.6
Public Service	112	5.35
Schools	82	3.9
Light Industry	59	2.8
Streets	540	25.7
Recreation	112	5.35

Fig. 3.6. Development Plan for Portion ($\approx$ 655 acres) of Cannelton 9-S Mine Site (Source: Blakely, 1974)

<u>Land Use</u> <u>(Cont'd)</u>	<u>Acreage</u> <u>(Cont'd)</u>	<u>% of Total</u> <u>Land Use</u> <u>(Cont'd)</u>
Residential	865	41.3
Vacant	<u>254</u>	<u>12.0</u>
Total	2100	100.0

The city would have an airport that will be operational 95 percent of the time with a 3,500 ft paved runway for pleasure aircraft and shuttle service to Kanawha Airport. A recreation and water supply dam is planned. The alternate water supply is the *treated water from abandoned deep mines*. It has a 9-hole golf course, along with a hospital, a civic center, amphitheater, central business district, neighborhood shopping centers, many small malls, a large regional recreational park, a ball park, light manufacturing industry, a trailer park, adequate elementary schools, and a junior and senior high school. In this particular design, accompanying this article, a neighborhood concept was used in locating the elementary schools and small shopping areas. In other words, each neighborhood would be self-sufficient for daily needs of the families. The city will be serviced by three highways which provide access to the city at design speeds of 45 to 55 miles per hour.

The economics of this type of development reveal a very interesting picture. First of all, let us stress the fact that reclaimed surface mining operations can improve the land tremendously. The steep hills that were useless before the mining operations, can now provide flat lands for developments. Therefore, the argument that surface mining destroys the environment does not hold water, especially at these times of energy crisis. Since coal is one source of energy which we have an adequate supply of, we should mine it using the most efficient techniques, and not leave 40-50 percent of it underground.

Secondly, coal operators can make more money by reclaiming and developing the land and selling it, than they can by selling coal! Of course, this second point is something that has not been brought to the surface before. In this particular mining operation, cost of reclamation of the land, construction of 20 degree slopes, and filling of hollows was about \$700 per acre. This amounts to \$1,500,000 for the entire project. Since 14 million tons of coal will be mined in this project, the cost of reclamation per ton of coal is about 10.7¢ per ton of coal. The capital improvements for building access roads, streets, utilities, parks, engineering, etc., would cost about \$2,000 per acre. Thus the total cost for reclaiming the land and improving it for the development of a city would be about \$6,000,000. If the average acre was sold for \$15,000, which is a very reasonable price for a city of this type, assuming 1,300 acres of land for sale after streets and other public lands are taken off, the sale price would amount to about \$20,000,000. Thus the profit would be about \$14,000,000.

If the average acre was sold for \$20,000, then the amount of profit would be about \$20,000,000. This, of course, will be a great incentive for a company to reclaim the land properly and develop it to its full potential.

Therefore, reclaimed surface mining, besides providing an adequate economically extracted supply of coal, for the country, can provide land to the public for future growth, as well as handsome returns to the coal companies.

Although Esmer is very optimistic regarding the potential of this development, some of the statements and conclusions presented above are subject to debate. The next section will explore some alternatives to his proposed development.

3.3 PROBLEMS AND ALTERNATIVES REGARDING PROPOSED RECLAMATION PLANS AT THE 9-S MINE

The benefits from reclamation indicated by Esmer have yet to be realized for the site. Currently, most of the reclaimed areas are being used as grazing land for cattle. Although Esmer (Blakely, 1975) indicates that the city would enjoy scenic views "above the pollution level of the valley," he does not address himself to the fact that, in this particular area of West Virginia, there may not be enough industry in the valley to provide an economic base and potential employment for a city of 10,000-20,000. The population of West Virginia decreased by six percent between 1960 and 1970 (Office of the Governor, no date given), mainly because of the lack of employment possibilities. This was the largest population decline of any state during this same period.

The state recognizes the need "to plan comprehensively for future development" (Office of the Governor, no date given) and has delegated this responsibility to the Office of the Governor, the Department of Commerce, land-use planning commissions, the Industrial Development Authority, and local municipalities. There is a distinct need for such governmental bodies and agencies to cooperate with the coal industry, which may be providing potential sites for various types of industrial, residential, commercial, agricultural, and recreational development.

New industry is badly needed in West Virginia to diversify the economy. Problems for industrial development on sites where coal has been stripped by mountain-top removal include water and energy supply, waste disposal, and transportation facilities. These problems are mainly due to the fact that mountain-top removal sites are often isolated both by location and by elevation. Many of these problems could be alleviated by cooperation among the coal extraction companies, reclamation planners, and local/regional governmental bodies to facilitate the adaptation of coal company facilities on a particular site to the needs of a potential industrial developer. Existing mine facilities such as haul roads, railroad spurs, power lines, and water supply may provide the needed impetus to attract new industry to such sites in West Virginia.

Mountain-top removal sites may also be adapted to other uses besides residential or industrial development. In some areas, a commercial shopping center may be needed, and in other areas, space for public buildings may be

required. A 53-acre site in McDowell County in extreme southern West Virginia was donated to the county board of education by the Pocahontas Land Co., and a consolidated high school will be built there (Blakely, 1974). It is important to note that, although mountain-top removal sites provide scenic views that recommend them for residential development, the state's commitment to future industrial and commercial development and the need for sites for schools and other public buildings provide other viable land-use alternatives.

Additional land-use alternatives are agriculture and recreation. Mountain-top removal sites can provide extensive tracts of level land for row crops or grazing. Reclaimed areas at the Cannelton 9-S mine are currently being grazed by cattle. In many reclaimed areas where industrial or commercial development is not feasible, agriculture may be the ultimate, rather than an interim, land-use.

Finally, because mountain-top removal sites provide scenic views, they are also desirable areas for recreational land. Maintaining and improving haul roads, landscaping, and installing public facilities would be the minimum requirements for converting such sites into outdoor recreation areas. More permanent facilities could convert such sites into resorts with golf courses and swimming pools. At the 9-S mine, groundwater-fed ponds have formed in small depressions on the surface of the mined area; these ponds now provide a habitat for ducks and other aquatic wildlife. The development of mountain-top removal sites for recreational areas would encourage the growth of tourism in West Virginia, the profits from which could supplement the economy of the state.

The continued development of mountain-top removal sites in West Virginia is anticipated. Possibly because of the success of the Cannelton operation, other companies in the immediate vicinity are either considering or have already initiated mountain-top removal operations. In Fayette County, Semet Solvay (Division of Allied Chemical Corp.) is also mining the 5 Block Coal and will probably proceed with a mountain-top removal operation (Ward, personal communication). The Semet Solvay mine, however, will not be as large as the Cannelton 9-S mine. In Kanawha County, the Valley Camp Coal Co. is also apparently initiating a mountain-top removal operation (Ward, personal communication).

At the present time, coal mining is responsible for about 25% of West Virginia's total income (Office of Governor, no date given). Where economically feasible, mountain-top removal is an efficient means of extracting the coal and providing flat tracts of land that are highly desirable for development and other uses.

4 PUBLIC PLANNING ASPECTS OF LAND-USE ASSOCIATED WITH SURFACE COAL MINING

As indicated in the introduction, one case study site obviously cannot be used to indicate the wide range of planning considerations associated with surface coal mining across the country as a whole. This chapter will suggest some of the technical, operational, legal, and institutional aspects of planning in areas where coal is presently being mined by surface methods or where it may be mined by surface methods in the future. Finally, the Cannelton 9-S mine will be considered in relation to some of these regional planning guidelines.

One of the major problems of natural resource planning as a whole is the question of defining the basic planning unit. Technical considerations such as resource availability or impacts of mining upon surface water quality imply, respectively, geologic and geographic (drainage basin) boundaries for units to be considered. Operational considerations, on the other hand, imply surveyed limits of the operations of particular companies and the lands they control. Legal considerations, moreover, imply the jurisdictional boundaries of appropriate legislation, which is most often at the state level. Finally, institutional considerations imply the grouping of various areas according to socioeconomic factors.

The planning guidelines discussed in this chapter will thus present a multiple classification and stress the necessity to interface the various planning efforts under each type of planning unit. The overall effort could then be fitted into regional plans which are the logical extension of localized efforts on a number of basic units. Many of the guidelines presented here are adopted from Schmidt and Stoneman, 1972.

4.1 INVENTORY OF TECHNICAL, OPERATIONAL, LEGAL AND INSTITUTIONAL CONSIDERATIONS RELATING TO SURFACE COAL MINING

Table 4.1 indicates technical, operational, legal, and institutional considerations relating to surface coal mining and suggests planning units. These units must, of course, be fitted to local conditions.

The first task for planners in areas affected or potentially affected by surface coal mining is to inventory the considerations associated with surface mining in their specific area in the framework of this idealized inventory. The results of such an inventory will yield a master list of considerations which are subdivided into basic planning units. The major planning effort should then be directed toward integrating the localized considerations under each planning unit into an area plan. In many regions, area plans may have already been formulated by local planning bodies; such plans may need to be modified to deal with considerations related to surface mining.

4.2 ASSESSMENT OF POTENTIAL IMPACTS OF SURFACE MINING

The process of integrating local considerations into a regional plan involves the assessment of potential impacts of surface mining. Table 4.2 is

Table 4.1. Inventory of Considerations Relating to
Surface Coal Mining

Technical Considerations

- Physical and chemical properties of coal seam(s).
- Physical and chemical properties of overburden.
- Physiography, geologic structure, and stratigraphy of area.
- Hydrology of area.
- Soils of area.
- Ecology of area: aquatic and terrestrial flora and fauna.

Planning Units: drainage basins, physiographic provinces,
ecologic communities or habitats.

Operational Considerations

- Land area controlled by mining operation.
- Reserves data.
- Mining method.
- Mining equipment.
- Coal prices, quality, markets & transportation facilities.

Planning Units: individual mines, land areas controlled by
mines with similar conditions and equipment.

Legal Considerations

- State requirements and enforcement policies.
- Local restraints -- zoning regulations, land-use planning guidelines (if any).

Planning Units: states, counties, municipalities.

Institutional (Socioeconomic) Considerations

- Employment opportunities.
- Educational level/opportunities of population.
- Land values/tax base.
- Population distribution.
- Health and safety of population.
- Stress upon community services and facilities.

Planning Units: areas grouped according to demographic criteria such as Standard Metropolitan Statistical Areas (SMSAs), areas within reasonable commuting distance of potential employment.

intended to provide a list of potential surface coal mining impacts that may or may not be important in specific areas. These potential impacts pertain mainly to Appalachia, although many also will be applicable to other areas of the United States. Note that the potential impacts are logically divided into a number of categories that are similar to the categories contained in an environmental matrix. In effect, the assessment of potential surface mining

Table 4.2. Partial List of Potential Impacts of Surface Coal Mining

Water

- Alteration of surface water chemistry (including acid mine drainage).
- Alteration of sediment types and quantities.
- Alteration of surface discharge.
- Alteration of groundwater flow systems.
- Alteration of groundwater chemistry.

Air

- Dust.
- Exhaust emissions -- gases and particulates.
- Weather modifications.

Noise and Vibration

- Noise from operating and transportation equipment.
- Noise and vibration from drilling and blasting.

Landscape Alteration

- Removal of natural vegetative cover.
- Soil inversion.
- Alteration of natural slopes.
- Construction of haul roads, stock piles, settling ponds, processing and transportation facilities.

Ecologic

- Disruption of habitats and migration routes.
- Species changes.

Economic and Demographic

- Increased employment opportunities.
- Altered land values and land use patterns.
- Increased activity in construction and other support industries.
- Increased requirements for energy.
- Increased requirements for community services.
- Impacts upon population distribution and population characteristics.

Human and Social

- Impacts upon health and safety of population.
 - Aesthetic considerations.
 - Cultural changes.
-

^a For a more detailed discussion of potential impacts, consult Bissele et al., 1975.

impacts constitutes an environmental impact statement for surface coal mining in a particular area. Such a statement gives a firm basis for making informed planning decisions.

Finally, the incorporation of planning decisions regarding surface coal mining into regional land-use plans involves an objective assessment of the relative importance of the various impacts described in Table 4.2. In most cases where local or regional planning bodies are assessing the impacts of surface coal mining upon a particular area, a potential land-use conflict exists. Thus, planning agencies must be well informed of mining company goals regarding reclamation and must often attempt to reconcile reclamation activities with developmental, environmental, and recreational land-use interests.

4.3 ASSESSMENTS OF IMPACT OF CANNELTON 9-S MINE

The Cannelton 9-S mine, although it is not situated in an area where many types of development can be expected to occur in the immediate future, represents a substantial contribution to land-use potential in Appalachia. By providing a range of land use alternatives for this site that did not exist prior to mining, the mountain-top removal operation has the net effect of increasing land values for the mined area.

To put this prospect of increased land values in perspective, Table 4.3 indicates the extent to which land in the two counties which include this site has been disturbed by surface mining (contour type). Note that (in 1971) more than 23,000 acres in the two counties were considered to be "not reclaimed." Figure 4.1 indicates that Fayette and Kanawha counties lead the state both in terms of linear miles disturbed and in tons of coal produced by contour mining (1971 figures). Thus, to these two counties, which contain significant land areas disturbed by surface mining and as yet unreclaimed, the prospect of increasing land values as a result of surface coal mining is indeed appealing.

The use of the Cannelton mountain-top removal site for grazing, row crops, recreation, or industrial or public buildings are all viable alternatives, some of which could provide jobs and contribute to the income of the residents of Kanawha and Fayette counties. The use of the site for recreational land could improve the quality of life for area residents; the use of the site for public buildings could provide needed facilities for the two-county area. Thus, several land-use alternatives exist for this and other mountain-top removal sites; individual sites will undoubtedly be developed in various ways.

During the decade 1960-1970, West Virginia lost approximately 14% of its total population, mainly in the 21-44 age group (Schmidt and Stoneman, 1972). New employment opportunities from accelerated coal mine development would tend to stem this emigration of the work force. Since West Virginia has traditionally derived a substantial portion of its income from mining (more than 12% during 1960-1970) (Schmidt and Stoneman, 1972), it is thus significant that the mining sector can make a positive contribution to the state's economic well-being.

To assess the impact of the Cannelton 9-S mine upon the economy and environment of Kanawha and Fayette counties, an environmental matrix could be

Table 4.3. Amount of Land Disturbed and Reclaimed by Surface Coal Mining in Fayette and Kanawha Counties, West Virginia, 1971

Land Condition	Fayette County		Kanawha County	
	Acres	Miles ^a	Acres	Miles ^a
Not Reclaimed ^b	6,723	240	16,333	327
Natural Vegetation ^c	11,076	396	6,451	129
Revegetation ^c	561	20	4,145	83
Total ^d	18,360	665	29,929	540
	<u>%</u>		<u>%</u>	
Land Disturbed as % of Disturbed				
Land in State		7.4		10.9
Land Disturbed as % of County Area		4.3		4.6

Adapted from Schmidt and Stoneman, p.51 (1972).

^aLinear miles.

^b<50% cover by vegetation.

^c>50% cover by vegetation.

^dTotals as reported by Schmidt and Stoneman.

developed for this mine using the factors indicated in Table 4.2. This matrix should probably be drawn three times: before mining begins, when 50% of the total area has been mined and reclaimed according to state regulations (approximately the present situation at the 9-S mine), and after mining is complete. The basic premise of such matrices is that, although surface mining of any type creates some objectionable environmental conditions, such as sedimentation and noise from blasting, many of these conditions are temporary and limited to the duration of mining activities at a particular site. In addition, the amelioration of objectionable environmental conditions according to state mining and reclamation regulations may create jobs and thus contribute positively to the economy.

Although the assignment of numbers under each category in a matrix could be subject to debate, the implication of such a procedure is clear. That is, the mining operation tends to create both a net positive effect upon the economy and a net negative effect upon the environment; many of the negative environmental impacts and positive economic effects persist during the life of an individual mining operation.

Fig. 4.1. Total Linear Miles Disturbed by Contour Strip Mining in West Virginia Compared with Production as of October 1971

5 SUMMARY OF OBSERVATIONS FOR PLANNERS AND CONCLUSIONS

Certain general implications regarding surface coal mining and the incorporation of mining and reclamation planning into structured regional planning efforts can be drawn from the West Virginia case study. This study suggests that:

- The jurisdictional boundaries for public planning need to be set so as to more nearly envelop entire problem areas. For example, the case study site is a mine lying in two counties, owned by a company with interests in other parts of the state, and contributing to steel making in Canada. There are also significant impacts along transportation routes which involve the commodity itself, power, equipment, and workers.
- The cultural and physical settings of a mining activity can be very complex in terms of interdependencies among: (a) jobs, resource commodities, and political behavior; (b) land tenure and land and mineral ownership; and (c) private financial planning and regional economic development. Public planners must perform rigorous analyses to reveal facts and issues before alternative actions can be suggested.
- The results of nonrigorous planning with too narrow a focus are evident. A planning team suggested a new town site as the end land-use of the mining site, disregarding regional economic data that suggest that the new town's residents would have difficulty finding employment. Planners need to scale academic theories against real-world situations and bring social and economic considerations as well as innovative design concepts into their problem solutions.
- In Appalachia, where flat, flood-free land is at a premium, mining can be the initial step in a conversion process for creating sites that benefit both the public, by providing sites for schools, houses, etc., and the mining company, by providing capital return on its investment.
- In the West Virginia case, there was little public planning input to reclamation plans for the conversion of mined land to a beneficial end use. Consequently, certain community and regional issues, such as employment and public infrastructure, were not taken into account in analyses. In addition, there was no record of public approval of the end land use (other than in state regulatory programs).
- Surface mining and reclamation of coal is a highly complex technical activity that requires large capital expenditures and the application of a broad range of technical skills over many years before profits can be realized. Accordingly, before committing capital, the potential developer of coal resources must possess a certain measure of secure knowledge about public intent and probable rules and regulations that might limit operations. This means that public planning input to mining should be orderly, explicit, efficient, scientifically sound, and reliable for private action.

- The concept of reclamation staged in time according to immediacy of function, rather than the actual designation of end land use, is valid and may be especially applicable to rural areas of low level use demand. According to this concept, first stage reclamation consists of storage of valuable soils and minerals and maximum elimination of off-site effects, second step reclamation focuses on building a stable (predictable) soil-water environment, and the third (and final) reclamation stage involves modifying the site in minor but essential ways to accomodate more intenstive land uses that could not have been designated specifically at the initiation of mine planning.

In the future, as more mountain-top coal removal operations like the Cannelton 9-S mine are conducted, there will be a need for local and regional planning bodies to cooperate with both government and industry to develop such sites for uses that are consistent with local and regional needs. Planned development for residences, public buildings, industry, agriculture, and recreation is the key to balancing state goals for economic development with demands for maintaining the quality of life and the environment. When properly planned, mountain-top removal operations such as the Cannelton 9-S mine thus provide viable land use alternatives that did not exist before mining.

GLOSSARY

A horizon of soil-

in a soil profile, the uppermost zone from which soluble salts and colloids have been leached and in which organic matter has accumulated; also called the zone of leaching.

alluvial-

pertaining to or composed of alluvium, which are sediments deposited by a stream or running water.

ANFO-

ammonium nitrate-fuel oil blasting agent; commonly used to fracture consolidated overburden in surface coal mines and other types of surface mines because it is effective and relatively safe to handle.

B horizon of soil-

the horizon of a soil below the A horizon in which minerals leached from the A horizon have accumulated; also called the zone of accumulation.

colluvial-

pertaining to or composed of colluvium, which is a general term applied to (1) any loose, heterogeneous, and incoherent mass of soil material or rock fragments deposited chiefly by mass-wasting at the base of a slope, and (2) alluvium deposited by unconcentrated surface runoff, or sheet erosion, at the base of a slope.

dendritic drainage pattern-

a pattern of regional stream channels which is characterized by irregular branching in all directions with the tributaries joining the main stream at all angles.

fragipan (from the Latin, "brittle" pan)-

a dense natural subsurface layer of soil which often underlies the B horizon; characterized by hardness and relatively slow permeability to water; fragipans are seemingly cemented to a hard consistency when dry, are low in organic matter, and retard infiltration and root penetration in soils where they occur.

metallurgical coal, or coking coal-

a bituminous coal containing a minimum of about 90% carbon and suitable for the production of coke; typically, an agglomerating coal with high carbon content, low sulfur content, and low ash content.

pH-

the negative logarithm of the hydrogen ion concentration of a given solution; a measure of relative acidity and alkalinity on a scale of 1 to 14: a pH of 7 is neutral, pH values below 7 indicate acid conditions, and pH values above 7 indicate alkaline conditions.

steam coal-

coal suitable for use under steam boilers.

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APPENDIX A: BRIEF HISTORY OF RECLAMATION REQUIREMENTS IN
WEST VIRGINIA (Source: Raney, 1975)

- 1939 First surface mining control legislation in the nation
Department of Mines sole regulatory authority
Bond -- \$150 per acre of coal to be mined -- not acreage disturbed
- 1945 Established registration fee of \$50
Increased bonding to \$500 with a minimum of \$1,000
Provided authority for the revocation of permits and forfeiture of bonds
Set forth information necessary to be shown in application (minimal)
Initiated the method of approving the regrading of a mining site
- 1947 Created special fund for deposit of registration fees and forfeited bonds to be used for administration and certain reclamation work
- 1959 Defined surface mining, but excluded augering as a method
Registration fee increased to \$100 -- deposited in General Revenue not Special Revenue account
Provided for annual renewal of permits at a rate of \$50 per year, also to be deposited in General Revenue account
Established Bond Forfeiture Fund to be used only for reclaiming affected areas
Provided for release of bonds upon execution of contract with appropriate Soil Conservation District
Created five surface mining divisions within the State to be staffed by one inspector each and monitored by one supervisor over entire State -- each one was appointed and required to serve probation period of one year
- 1961 Transferred reclamation responsibilities to the newly created Department of Natural Resources
Created Division of Reclamation
Required that bond be deposited with Director, Department of Natural Resources
- 1963 Expanded Division of Reclamation's responsibility for reclamation aspects of surface mining operations
Created Special Reclamation Fund and Program -- industry financed at a rate of \$30 per proposed disturbed acre
Created Reclamation Board of Review
Expanded definition of surface mining to include augering
Required that proof of bond deposit (\$150/acre minimum of \$1,000) be submitted to Director, Department of Natural Resources
Bond posted on entire disturbed area (including access, haulageways, etc.) rather than acres of coal to be removed
- 1965 Excluded the mining of sandstone, sand, and limestone from provisions of the law
Excluded Federal/State Highway projects from the provisions of the law

- 1967 Transferred complete regulatory authority for all surface mining from Department of Mines to the Division of Reclamation
 Established thirty-day frequency for inspections of each operation throughout the State
 Created Reclamation Commission -- required the promulgation of Rules and Regulations
 Created the prospecting permit, its application procedure, and set bonding rate at \$150 per acre
 Established minimum requirement for insurance coverage of any company making application
 Increased bonding rate to margin of between \$100-\$500, with specific amount determined at Director's discretion. It was set at \$300
 Inspector given authority to cease operation in violation
 Triple damages protection to person whose property might be damaged by surface mining operations
- 1971 Increased bonding margin to \$600-\$1,000; originally set at \$750 per acre but recently increased to \$1,000
 Increased Special Reclamation Tax from \$30 per acre to \$60
 Required that all drainage be controlled in approved structures -- installed prior to commencement of activity
 Provided for control of all blasting activity
 Required that all highwalls be eliminated if original slopes were less than 30%. If greater than 30% they must be reduced to a maximum of 30 feet
 Provided for public notification, adjacent landowner notification and the filing of protests for any application
 Increased inspection frequency to every 15 days
 Required that grasses must accompany the planting of trees on completed areas
 Removed provision that a bond was to be released if contract was executed with Soil Conservation District
 Registration fee increased to \$500, annual renewal increased to \$100
 Prohibited expansion of surface mining to 22 counties of the State, designated as "Moratorium Counties"
- 1972 Established West Virginia's participation in the Interstate Mining Compact
- 1974 Responsibility for the reclamation of abandoned coal mine refuse piles throughout the state.
 Established a minimum bond and provided for the reclamation of underground opening areas which exceeded 400 lineal feet along crop line
- 1976 Set forth a minimum salary level for Surface Mining Reclamation Inspectors and Supervisors
 Provided for Division of Reclamation approval of all underground mine opening permits as concerning surface aspects

APPENDIX B: DISCUSSION OF RECLAMATION REQUIREMENTS IN WEST
VIRGINIA (Adapted from Raney, 1975)

The 1971 West Virginia Surface Mining and Reclamation Act serves as the legal foundation for the current program of control. The Division of Reclamation, under the Department of Natural Resources, has the enforcement authority for this act as well as statutory authority which was flexible in so far as meeting changing needs since 1971, practical in that it was capable of being strictly enforced without creating a massive bureaucracy, and comprehensive in that it provided for the control of all aspects of surface mining from original preplanning to final revegetation. The 1971 law was more stringent than previous legislation, particularly because of the increased emphasis on implementation.

Important components of the 1971 legislation are as follows:

Permit Requirement

The major provision in the 1971 act in so far as controlling and monitoring industrial expansion is the requirement that a nontransferable permit be obtained from the Reclamation Division prior to the commencement of any mining activity. In order to obtain a permit, the applicant must furnish technical information that explicitly details all methods of mining, and controls to be used during the operation to ensure that it will not detrimentally affect the surrounding area or its residents and that the finished product is aesthetically acceptable and physically stable.

These considerations must depict methods of: removing, storing, and stabilizing overburden materials; drainage control; haulageway construction; revegetation; and blasting. Such a requirement necessitates that comprehensive preplanning precede any mining activity. This greatly enhances the final product of reclamation as well as the overall environmental stability of an operation. Since every operational aspect must be detailed, all personnel concerned with the specific operation are aware of what is planned and expected. Ideally, each intermittent function is performed with necessary care to ensure that the final goal is achieved as planned.

Once completed and submitted, the theoretical validity of drainage plans is evaluated by engineers and water-resource experts in a multiple agency review. The theoretical aspects of the mining and reclamation plans are evaluated by Reclamation Division personnel to ensure that they are consistent with requirements of the statute and the rules and regulations. The entire application is also reviewed in a series of "on site" field inspections to ensure that each detail is applicable to the particular conditions of area to be mined. These field inspections are most important to the overall control program because each proposed site possesses individual characteristics or peculiarities.

In addition to this, these onsite evaluations assist in the determination of critical areas and what special provisions or limitations must be set forth to ensure that the operation can be conducted in compliance with the law and local environmental standards. These inspections are conducted

by divisional field personnel who recommend the issuance or denial of a permit application. A critical area determination might dictate the need for special planning considerations and subsequently, modified operating procedures, the deletion of selected portions of proposed mining sites, or the total denial of an entire application.

On numerous occasions, agencies other than those normally involved in the review are called upon for expert evaluation. These often include fish and wildlife specialists, geologists, and agronomists, among others. Their recommendations usually dictate modifications to ordinary mining procedures which enhance the protection and maintenance of the quality of a critical area.

In essence, the required technical detail and extent of a completed application and these thorough multiagency reviews collectively serve as a micro-environmental impact statement. It is most important that the operating procedures planned for a particular area be consistent with specific conditions of the site to be mined.

Public Notification

Another very important dimension of the application procedure is the opportunity for public input. The applicant is required to publish an advertisement in a newspaper in the county in which the proposed operation is located, setting forth basic descriptive information. Anyone wishing to protest the proposal is statutorily provided 30 days from the first publication date to reply to the Director of the Department of Natural Resources. In addition to this general notification, the applicant is required to notify by registered mail all property owners within 500 ft of any part of the proposed disturbed area. These persons are provided ten days in which to voluntarily respond to the director.

In the last few years, this procedure has proven to be valuable in contributing to the rationality, as well as the objectivity, of the evaluative processes. Many of the responses raised valid points of local concern which might have otherwise been overlooked. These have, in numerous cases, precipitated the designation of special limitations and occasionally contribute to the denial of entire applications. It is the policy of the Division of Reclamation to answer each protest with an original, not a "form," letter because this assures it maximum consideration in the final reviews.

This policy review procedure also serves a useful purpose in that the location of a proposed mining operation becomes public information; more than likely, there will be a certain percentage of local residents that will monitor the operator's efforts to protect the environment and comply with the law. Since applicants realize this, they take more care in their actions to ensure that no pollution or off-site damage occurs. Such public awareness provides helpful support to enforcement efforts.

The public notification requirement has also significantly reduced the incidence of persons attempting to mine without obtaining a permit. If a person notices a mining operation (which is required to be marked with company name and permit number) without recalling a public advertisement, it is likely

that the Division of Reclamation will be notified. Such participation facilitates regulatory efforts because it is impossible for field personnel of the Division of Reclamation to monitor each area on a daily basis.

Director Authority

The state law provides that the ultimate authority to issue or deny a surface mining permit is that of the Director of the Department of Natural Resources. Once the completed application is submitted, all recommendations from the various reviews are received, and all protests have been considered, the decision is made in a final review session. The alternatives available are: (1) issuance of the permit as submitted, (2) issuance with certain limitations, or (3) denial of the entire application. During the period 1973-75, approximately 1700 acres of proposed surface mining have been denied for myriad reasons, usually related to environmental protection. The normal permit period, from original application to final review, encompasses approximately two months.

Enforcement

First, the law provides for the promulgation of rules and regulations developed by the division. These rules provide necessary supplements to the formal statute. Relative to meeting changing demands and program needs, this provision provides flexibility to the division, because the regulations can be amended without legislative acknowledgment.

The law also provides for an inspection frequency of at least once every 15 days for every active operation. This means that every detail of an operation is thoroughly checked twice monthly, and thus control is more easily maintained than it would be with the monthly or bimonthly frequencies.

Specific time and lineal feet limits governing backfilling, regrading, and revegetation are established and must be met on each operation. The base of these time limits is determined by the removal of coal, i.e., backfilling must follow the removal of coal on contour operations by no more than 60 days or 3000 ft. The established frequency of inspections facilitates compliance with this criteria and consequently reduces the amount of exposed disturbed land at any one time.

Perhaps the most important provision of the law relative to practical enforcement is the cease and desist authority granted to all field enforcement personnel as duly authorized representatives of the director. If, at any time, a violation of the law or the rules and regulations is noted, the inspector is authorized to stop all production at the particular operation. When exercised, this provision is extremely influential in assuring that an operation is continuing as planned and in compliance with the law. The mere possession of such authority contributes greatly to the control of surface mining even when the inspector is not present.

Unlike many other enforcement agencies in West Virginia, as well as neighboring states, each inspector maintains autonomy relative to the exercise of this authority. If personnel in the field were required to check with a

superior prior to exercising a "closure" a majority of its impact would be sacrificed. The only request from the administration is that the inspector be confident that he can statutorily substantiate such action.

Moratorium

In 1971, the legislature added a new article to the surface mining control chapter of the state code. It prohibited the expansion of mining into any county of the state which had not experienced the lawful surface mining of coal during 1970. This involved 22 of the state's 25 counties.

Its intent was to prohibit industrial expansion into these relatively untouched counties until the methodologies of mining and their effects were more thoroughly investigated and assessed. It was originally enacted for a period of two years, but has been renewed twice since that time. What actually takes place is that no application for a permit to mine in any of these counties is considered by the division or the director of the department.

Summary

Although the 1971 Act provides a sound legal foundation for a control program, implementation is just as important. Since the basic contexts of many state laws have become similar in recent years, it is the quality of the enforcement program which distinguishes the effectiveness of the efforts of a given state.

In West Virginia, the Division of Reclamation has attempted to develop such a program of effective enforcement which is responsive to the interest of the public, the needs of the industry, and is designed to enhance the state's future. As a result of the 1971 legislation, the division's staff increased to 54 positions, including 37 field enforcement personnel and an administrative staff of eight.