Chapter VI

WORKPLACE AND COMMUNITY IMPLICATIONS

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Chapter VI.—WORKPLACE AND COMMUNITY IMPLICATIONS

TABLES

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WORKPLACE AND COMMUNITY IMPLICATIONS

INTRODUCTION

This chapter discusses the occupational and social implications of increased coal production and use. It seeks to identify likely problem areas and enable policy-makers to assess the need for remedial action. The trends in mine health and safety performance are traced and estimated future costs of increased coal production are presented. The socioeconomic impacts of more coal development differ in the East and West. Separate sections are devoted to the current experience in each region, and likely patterns of development are described.

WORKPLACE HEALTH AND SAFETY

Health

Background

Coal mines are inherently unhealthy places to work. Mortality studies of mineworkers who were employed in the 1940's, 1950's, and 1960's suggest that they died more often than others from respiratory diseases (influenza, emphysema, asthma, and tuberculosis), stomach and lung cancer, and hypertension.[1] Pneumoconiosis and bronchitis were underlying causes of death in a significant number of fatalities attributed to nonmalignant respiratory diseases. Since 1969, Federal officials, mine operators, and coal workers have sought to minimize exposure to coal mine dusts and noise, and they have succeeded to a degree. If current dust standards are met on a daily basis, coal workers' pneumoconiosis (CWP) should disable far fewer workers 20 years hence than today.

Many occupational diseases require two or three decades to become manifest. Because about half of the total coal work force is under 34 years of age, the actual results of today's dust-control efforts will not be known until the 1990's and beyond. Efforts focused on CWP after 1969 have lowered the amounts of respirable dust that miners now breathe on the job. But other hazards were overshadowed in the debate over CWP. This section discusses CWP and the programs to control the respirable dust that causes it, as well as other relevant health hazards.

The costs of occupational illness from coal mining have been immense. More than 420,000 coal workers ". . . who are totally disabled due to pneumocniosis . . ."[2] or their widows were awarded Federal black lung compensation between January 1,1970, and December 31, 1977. That number of beneficiaries equals the total number of coal workers employed industry-wide in 1950. Occupational health officials at the United Mine Workers of America (UMWA) estimate that 4,000 Federal black lung beneficiaries have died from black lung disease each year since 1969. other work-related illnesses– hearing loss, bronchitis, and breathing difficulties– are impossible to estimate.

Occupational illness usually affects older or retired workers, leaving them financially and psychologically strapped. For every worker disabled by CWP, two or three family members are also affected. Stress is created. Work schedules must be readjusted. Family income

[1] Howard Rockette, *Mortality Among Coal Miners Covered by the UMWA Health and Retirement Funds* (Morgantown, W. Va.: U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health, 1977).

[2] Public Law 91-173, Federal Coal Mine Health and Safety Act of 1969, title IV, pt. A.

is reduced. Bills from doctors and hospitals rise.

Discussions of occupational disease often dwell on numbers, percentages, and sanitized scientific terminology. To the victim, black lung can bean overwhelming fact of life:

> At work you [coal miners] are covered with dust. It's in your hair, your clothes, and your skin. The rims of your eyes are coated with it. It gets between your teeth and you swallow it. You suck so much of it in your lungs that until you die you never stop spitting up coal dust. Some of you cough so hard that you wonder if you have a lung left. Slowly you notice you are getting short of breath when you walk up a hill. On the job, you stop more often to catch your breath. Finally, just walking across the room at home is an effort because it makes you so short of breath. [J]

The cost of mineworker occupational illness are also borne by the public and, to a lesser extent, by the coal industry. Black lung compensation has been administered by the Social Security Administration and, since July 1973, by the Department of Labor. Table 37 summarizes the 8-year dollar cost of this program. Of the $5.569 billion paid to miners and their survivors from 1970 through 1977, the Federal Government paid $5.567 million, or almost 100 percent. An operator-paid tonnage tax was enacted by Congress in 1977 to provide for future benefits. Compensation is from funds contributed by the "last responsible operator. " Labor Department spokesmen say coal companies contest many — if not most — determinations of their responsibility to pay. If the current trend continues, most new black lung claims may be paid from Federal resources. Recent legislation allows coal companies to deduct their contributions to the black lung trust fund from their Federal taxes. The deduction cannot exceed 38 percent of the company's payroll, which means, in practice, that many operators will be able to write off their black lung contribution.

Some health risks of mining are common to underground and surface miners, but they are magnified many times for the deep miner. In an underground mine the dangers of dust, fumes, noise, and other contaminants are intensified by close quarters and artificial ventilation. Surface miners, too, face health hazards. The outdoor work environment of these heavy equipment operators, truck drivers, supply workers, welders, electricians, and mechanics exposes them to dusts, heat and cold, diesel and welding fumes, whole-body vibration, noise, and stress. Because the underground environment is so clearly more hazardous, comparatively little research has focused on surface miners.

Table 37.— Eight"Year Summary of Black Lung Compensation (Jan. 1, 1970-Dec. 31, 1977)

Claims filed:			
Social Security		586,400	
Labor		124,200	
Total		710,600	
Claims approved:			
Social Security		415,200	
Labor		5,744	
Total		420,944	
Claims denied:			
Social Security		171,200	
Labor		68,062	
Total		239,262	
Total federally paid benefits:			
Social Security		$5,513,712,000	
Labor		54,000,000	
Total		$5,567,712,000	
Total operator-paid benefits:			
Social Security		-0-[a]	
Labor (220 claims estimate)	$	1,500,000	
Total (estimated)	$	1,500,000	(estimated)

[a] Coal operators were not required to pay for black lung benefits under the Social Security program.
SOURCE: Social Security Administration and Department of Labor, September 1978.

Preventive measures in the workplace are the most effective approach to controlling occupational disease. Prevention of all work-related diseases requires a holistic approach to analyzing hazards and controlling them, This approach recognizes that disability results from cumulative, total exposure. Unfortunately, most occupational disease research and prevention programs dwell on the effects of single hazards. The cumulative and synergistic impacts of workplace hazards — that is, the way human beings experience them — have not been well researched.

Photo credit: Douglas Yarrow
Jan Chapin, a nurse with the Cabin Creek Medical Center, examines miner at minesite on Cabin Creek, W. Va., 1977

The Federal Role

Congressional concern for coal miners' health–as distinguished from safety– is relatively recent. The 1969 Coal Act established the Mining Enforcement and Safety Administration (MESA) to develop health standards and enforcement procedures. When the agency was shifted from the Interior to the Labor Department in the spring of 1978, it was renamed the Mine Safety and Health Administration (MSHA), seemingly promising a new emphasis on workplace health.

The 1969 Act regulated four health hazards — respirable coal mine dust, dust from rock drilling, respirable coal dust when quartz is present, and noise. Compensation for black lung was started. The 1969 Act failed to address other potentially significant hazards such as diesel emissions, heat, "nonrespirable " coal mine dust, and harmful fumes. As single factors, some of these may have little effect, but coupled with known hazards from respirable dust and noise, their total health consequences may be substantial. Enforcement of the standards since 1970 has been marked by litigation, technical problems, unsympathetic Federal administrators, and insufficient funds. '

MSHA'S task is made more difficult by the lack of data on the health effects of coal mining. MSHA requires operators to report all occupational illnesses. The agency distributes form 6-347, listing seven categories of reportable occupational illness: occupational skin diseases, dust diseases of the lungs, respiratory diseases (toxic agents), poisoning, disorders (physical agents), disorders (repeated trauma), and all other occupational illnesses.[5] When a computer printout was sought from MSHA on disease experience for the 1972-76 period, data were available for only two categories — occupational skin diseases and all other occupational illnesses. MSHA statisticians said the other data were not available because the operators do not report them — and that even the available data were probably not very accurate. Without this information, policymakers are blocked from evaluating current prevention strategies.

[4]See Nancy Snyder and Mark Solomons, "Black Lung—A Study in Occupational Disease Compensation," Jan. 15, 1976 (Washington, D.C.: Department of Labor), reprinted in U.S. Senate, Black Lung Benefits Reform Act, 1976, p. 468.

[5]Bureau of Mines, Department of the Interior, title 30, pt. 80.1 (h), *Federal Register*, vol. 37, no. 55, Mar. 21, 1972. "Occupational illness" means any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illness or diseases that may be caused by inhalation, absorption, ingestion, or direct contact, and which fall within the listing under the heading, "Occupational Illness" on form 6-347.

Mortality

Disease recognition and prevention are hampered by the time required for many occupationally linked diseases to appear. The most recent mortality study surveyed more than 23,000 UMWA miners—of whom 7,628 had died – between 1959 and 1971. Rockette found coal miners died more often than the U.S. male population from respiratory disease (pneumoconiosis, influenza, emphysema, asthma, and tuberculosis), accidents, hypertension, and stomach and lung cancer, [6]

Rockette's data may be used cautiously to correlate coal mine employment with excess mortality from certain diseases. It is clear that death from accidents, pneumoconiosis, and nonmalignant respiratory ailments are associated with coal mining. Hypertension may be. Lung and stomach cancer may or may not be. It is conceivable that the combination of coal dust, trace-element exposure, noxious fumes and gases, and other irritants (including cigarette smoking and tobacco chewing) are related to excessive cancer among coal miners. [7]

Dust—The Greatest Hazard

All mine dusts–of which coal dust is the most prominent — are classified as either respirable or nonrespirable according to the size of the dust particles. It is generally accepted that only the smallest particles (smaller than 5 pg in size) are respirable. They alone are retained in the alveoli —the gas-exchanging sacs of the lungs — and cause pneumoconiosis. Generally, the larger particles (nonrespirable dust) do not penetrate the alveoli and are not thought to cause CWP.

While the distinction between respirable and nonrespirable dust is scientifically valid, it is clear that both sizes can impair lung function when inhaled in quantity over time. The larger particles are probably linked to bronchitis among coal miners. Although these particles are generally not retained in the lung, continuous exposure to them during the normal work year produces a more or less constant irritation of the upper respiratory tract. Breathlessness has also been found to be significant among miners who do not show X-ray evidence of CWP. All researchers believe that breathlessness is related to chronic, nonspecific, obstructive bronchopulmonary disease. Some investigators, in addition to CWP and bronchopulmonary disease, have found a third, as yet unidentified disease process, that reduces the ability of the lungs to exchange

Photo credit: Douglas Yarrow

Black lung victim using vaporizer at the Cabin Creek Medical Center, Cabin Creek, W. Va., 1977

[6]Rockette, *Mortality Among Coal Miners*, p. 35ff.

[7]Rockette, *Mortality Among Coal Miners*. Also, W. Keith C. Morgan, "Coal Workers' Pneumoconiosis," *Occupational Lung Diseases* (Philadelphia, Pa.: W. B. Saunders Co., 1975), Morgan says: ". . . chronic bronchitis and emphysema account for much of the excess (mortality among coal miners), the SMR (Standard Mortality Ratio) for lung cancer and tuberculosis for miners is also increased above that of the general population," p. 160.

gases. ' Black lung disease has come to represent a broad definition of occupational respiratory disabilities in miners, of which CWP is one major component. The 1969 Act regulated respirable dust exposure but did not limit exposure to nonrespirable dust. Respirable dust, which is invisible to the unaided eye, accounts for less than 1 percent of the dust in a mine workplace. It is not clear how much nonrespirable dust is retained in the lungs when the Federal standard for respirable dust –2 mg/m^3 of air — is being met.

Because compensable black lung is associated with other factors in addition to respirable coal mine dusts, prevention programs aimed exclusively at that hazard are likely to reduce CWP but may not reduce black lung disability proportionately.

Coal Workers' Pneumoconiosis

The 1969 Act defined CWP as a "chronic dust disease of the lung arising out of employment in an underground coal mine. "9 It is caused by the inhalation and retention of respirable coal mine dust in the lower lungs. After a dozen years or so of exposure, a noticeable dose-response relationship may appear. CWP is classified by X-ray diagnosis into levels of ascending severity, from simple to complicated. If dust exposure continues, simple CWP can progress into more advanced stages. Miners with advanced CWP (characterized as progressive massive fibrosis) are usually totally disabled. Miners breathing high dust concentrations may be disabled after only a few years of exposure. Some miners seem more vulnerable than others, and this variability has yet to be explained. Cigarette smoking contributes to lung impairment among miners as in the population generally. Considerable controversy exists over the role smoking plays in miners' lung impairment compared to occupational factors.

The first major U.S. survey of CWP was done in the 1960's[10] by the Public Health Service. It collected evidence from 2,510 working coal miners and 1,190 nonworking miners. In this sample of 3,700 Appalachian, bituminous coal miners, almost 10 percent of the working miners and about 18 percent of the others had evidence of either simple or complicated CWP. About 5 percent of the working miners and about 7 percent of the nonworking miners were classified as having "suspect" CWP. Lainhart, et al., found "the degree of roentgenographic evidence of pneumoconiosis was not related to cigarette smoking [and] . . . the degree of pneumoconiosis was not related to the number of cigarettes smoked daily."[11] Cigarette smoking does not cause CWP, although it is associated with breathing impairment, which, in some cases, may pass as black lung. X-ray evidence of CWP was associated with increasing years of exposure. About 9 percent of working and nonworking miners had evidence of other chest illnesses—tuberculosis, cancer, pulmonary, and cardiac disease.

The most recent and comprehensive study is being done by the National Institute for Occupational Safety and Health (NIOSH). About 10,000 working miners in 31 mines were X-rayed in the early 1970's. An overall CWP prevalence of nearly 30 percent was found. Progressive massive fibrosis was diagnosed in 2.5 percent of the sample.[12] The NIOSH work—known as the National Study of Coal Workers' Pneumoconiosis—found that CWP increases with dust exposure and number of years worked underground. About 31 percent of Appalachian miners showed X-ray evidence of CWP, compared with 23.5 percent for midwestern miners and 10.5 percent for western miners. However, upon reinterpretation of the X-ray data, a CWP prevalence figure of between 10 and 15 percent seemed justified.

[8]D. L. Rasmussen, W. A. Laqeur, P. Futterman, H. D. Warren, and C. W. Nelson, "Pulmonary Impairment in Southern West Virginia Coal Miners," *American Review of Respiratory Disease,* vol. 98, 1968; and Donald L. Rasmussen, "Breathlessness in Southern Appalachian Coal Miners," *Respiratory Care,* March-April 1971.

[9]Public Law 91-173, 83, sec. 202. Surface miners are now eligible for black lung compensation.

[10]W. S. Lainhart, H. N. Doyle, P. E. Enterline, A. Henschel, and M. A. Kendrick, *Pneumoconiosis in Appalachian Bituminous Coal Miners* (Cincinnati, Ohio: DHEW, Public Health Service, 1969).

[11]Ibid., p. 53.

[12]W. K. C. Morgan, Dean B. Burgess, George Jacobson, Richard J. O'Brien, Eugene P. Pendergrass, Robert Reger, and Earl Shoub, "The Prevalence of Coal Workers' Pneumoconiosis in U.S. Coal Miners," *Archives of Environmental Health,* vol. 27, October 1973, p. 221.

The second round of this study in 1973-75 found CWP prevalence to be about 11.5 percent.[13] Of miners X-rayed in both rounds, about 6 percent showed disease progression. Some controversy exists over the reliability of these findings, however. Critics say the results should be considered with several caveats. First, different X-ray classification schemes were used in each round and side-by-side X-ray readings using one system were not performed. Second, although X-ray diagnosis is the accepted (and only) method for diagnosing CWP, it is not foolproof. The quality of X-rays is directly linked to the conditions in which they are taken. Critics say that differences in conditions were not weighed in the final evaluation. Third, only 40 to 50 percent of the miners X-rayed in the first round were X-rayed again in the second round. This has led some to argue that the second-round data reflect CWP prevalence for a "survivor population and the slightly lower prevalence rate between round 1 and round 2 reflects the "healthy worker" effect, that is, workers who are not healthy are forced out of the labor force leaving only healthy workers to be surveyed for CWP. The 50 to 60 percent of round 1 miners who were **not X-**rayed in round 2 may consequently have a considerably higher prevalence of CWP than those miners who continued working and were X-rayed in both rounds. " (Many of the first-round CWP cases may not have been examined because they no longer worked in the mines or refused to be examined because they feared job discrimination if they had a "bad" X-ray.) Finally, dust exposures cannot always be correlated to X-ray results with a great deal of confidence, making it difficult to say anything conclusive about the safeness of the Federal 2-mg dust standard using these data.

Rough estimates of CWP prevalence for 1976, 1985, and 2000 appear in table 38. Actual prevalence of CWP in the future will differ from these projections according to the actual numbers of miners employed and actual prevalence rate. These estimates assume the existing Federal dust standard will significantly reduce CWP prevalence in the future. Thus, *each of the three scenarios forecasts steadily lower prevalence rates.* However, even if prevalence declines, more workers will be exposed. Assuming 230,000 coal miners will be working in 1985, the number of likely CWP cases ranges from almost 13,700 to almost 18,800. Assuming about 411,000 miners will be employed in 2000, CWP cases might range from 10,600 to about 18,000.

Both the optimistic and pessimistic cases probably err on the side of optimism because they assume more or less full compliance with the 2-mg dust standard on a daily basis. If every mine strictly complies with this standard between 1975 and 2000, the prevalence rate may be 3-percent underground and l-percent surface in that year. The current standard will not eliminate CWP, but it is likely to cut significantly the probability of its occurrence.

Along with CWP, coal miners will continue to experience other black lung diseases — bronchitis, severe dyspnea (shortness of breath), and airways obstruction. Much of this illness will be work-related and some of it will be caused or worsened by cigarette smoking. For every case of CWP, about three cases of bronchitis, one case of dyspnea, and two cases of airways obstruction may be found. These cases are not exclusive, and are often found in combination.

NIOSH calculated the health effects of increased coal production using *current* prevalence rates and higher estimates of the future work force. NIOSH estimated there were 19,400 cases of CWP in 1975, rising to about 28,500 in 1985, and 45,500 in 2000 (table 39). Cases of chronic bronchitis, dyspnea, and airways obstruction are estimated to increase proportionately. Both *OTA and NOSH estimates deal only with the illniess found an-tong working miners.* Retired and disabled workers do not appear in these estimates. This group, which will be eligible for black lung compensation, is likely to be large.

Questions relevant to congressional policy include: 1) Are these estimated health costs of increased coal production unacceptably high? 2) If so, what can be done to reduce these

13 Status *of Mandated Programs,* Receiving Center, National Institute for Occupational Safety and Health, unpublished reports, end of second round of examinations, *1975*

Table 38.— Estimates of CWP Among Working Miners, 1976,1985, and 2000

	Prevalence Rates			
	Optimlstlc		Pesslmistlc	
	Underground	Surface[a]	Underground	Surfacea
Working miners	10%	4%	15%	4%
1976 (208,000)				
Underground (70%)				
145,600	14,560		21,840	
Surface (30%)				
62,400		2,496		2,496
Total	17,056		24,336	
Working miners[b]	7%	3%	10%	3%
1985 (229,829)				
Underground (74%)				
169,922	11,895		16,992	
Surface (26%)				
59,907		1,797		1,797
Total	13,692		18,789	
Working miners[b]	3%	1%	5%	2%
2000 (410,893)				
Underground (79%)				
326,305	9,789		16,315	
Surface (21%)				
84,588		846		1,692
Total	10,635		18,007	

[a] Prevalence rates for 1976 are consistent with the range ot current research findings. The 4 percent prevalence rate for surface miners comes from R. Paul Fairman, Richard J. O'Brien, Steve Swecker, Harlan Amandus, and Earle P. Shoub, "Respiratory Status of the U.S. Surface Coal Miners," unpublished manuscript done for ALOSH NIOSH, 1976. The ALOSH study used X-ray evidence to determine the prevalence of CWP. Most of the surface miners had extensive experience in underground coal mining which contributed to the prevalence of CWP. Prevalence rates for 1985 and 2000 assume that compliance with the current dust standard will lower prevalence. In addition, increasing numbers of older miners who had years of exposure before 1969 will retire, thereby lowering prevalence among working miners. These prevalence rates have not been derived mathematically, and should be seen more as possibilities than as predictions.

[b] Workforce estimates are the average of OTA's low-case and high-case labor projections found in chapter II, table 6.

Table 39.—Projected Health Effects of Increased Coal Production

Year	Millions of tons produced (quads)	Number of employees	Cases' of CWP	Cases of"b chronic bronchitis	Cases of'b severe dyspnea	Cases of'b airways obstruction
1975 estimates						
Underground	279 (7,3)	139,500	18,100	41,800	11,200	41,800
Strip auger	332 (7.9)	52,500	1,300	15,700	4,200	10,000
Total	611 (15.2)	192,000	19,400	57,500	15,400	51,800
1985 estimates						
Underground	395 (9.8)	197,500	25,600	59,200	15,900	59,200
Strip auger	735 (18.3)	116,000	2,900	34,800	9,300	22,100
Total	1,130 (28.1)	313,500	28,500	94,000	25,200	81,300
2000 estimates						
Underground	630 (15.7)	315,000	40,900	94,400	25,300	94,400
Strip auger	1,170 (29.2)	185,000	4,600	66,300	14,800	35,200
Total	1,800 (44.9)	500,000	45,500	160,700	40,100	129,600

[a] Not mutually exclusive.
[b] Not necessarily due solely to coal dust inhalation.
SOURCE: National Institute for Occupational Safety and Health, "Occupational Safety and Health Implications of Increased Coal Utilization," computer printout and attachments (rev.) Nov. 4, 1977. Distributed at a NIOSH conference of the committee on health and ecological effects of increased coal utilization, Nov. 21, 1977.

costs? 3) Who should bear the costs of reducing dust levels? 4) How may tradeoffs be determined between miners' health and dollars spent on prevention?

Enforcement of Federal Dust Standard

The current dust-control program has four components: 1) the federally established 2-mg/m^3 dust standard, 2) dust suppression efforts in the mine, 3) monitoring dust levels in the work environment, and 4) enforcement strategies for compliance with the Federal standard. The Federal dust standard refers only to respirable coal mine dust.

The Federal Government plays an important role in each of these components. Ventilation standards are federally established. Federally sponsored research has helped develop water sprays and other dust-control techniques. Operators must have Federal approval of their dust-control plans. Monitoring the work environment is now a joint Federal and industry responsibility. Mine operators are required to submit dust samples to MSHA several times a year. These samples are weighed and the operator is told several weeks later whether the sample complied on the day it was taken. If the sample exceeds the standard, the operator must redo it until it complies. MSHA inspectors take their own samples two or three times a year. If the operator is out of compliance, he will be issued a notice of violation and may be assessed a civil penalty. The average assessed penalty was between $150 and $175 for a respirable dust violation in 1978, and the average amount collected was about $120.

The adequacy of the current 2-mg/m^3 respirable dust standard is one key assumption that will determine the prevalence of respiratory disease among coal miners in the future. Although the U.S. standard is probably the strictest in the world, its inherent safeness is not entirely certain. When the 2-mg standard was mandated in the 1969 Coal Act, Congress assumed that full and comprehensive compliance would effect foolproof prevention, based on the best evidence available at the time. That evidence deserves renewed scrutiny.

Congress based the 2-mg standard on British research done in the 1960's. More than 4,000 British miners were studied over a 10-year period. The study's methodology— how its data were collected and how they were used — may raise questions as to the soundness of its final conclusions.[15] Dust exposure of each miner was not monitored daily. Rather, a stratified random-sampling procedure was used, which took 50 to 250 samples annually at each of 20 mines. The dust sampler used in the study is no longer used. The exposure data were converted from particles to weight, but the conversion factors were developed experimentally rather than from in-mine measurement. Average 8-hour exposures for each job at the face were calculated from the stratified random sampling. Calculating a mean from a set of averages twice removes statistical results from reality. Probability curves were then constructed that related 10-year mean exposures to X-ray evidence of CWP. The probability curves suggest the current standard is reasonably safe (at 2 mg, 1 to 3 of every 100 miners would show X-ray evidence of CWP after 35 years exposure).[16] However, if the data collection and statistical manipulations were not totally sound, then the curves are flawed. The safeness of the 2-mg standard has never been confirmed by a long-term epidemiological study. A recent British update of the 1969 results showed that in 10 mines the "earlier predictions underestimated 35-year working-life risks [the probability of developing simple pneumoconiosis] by 1 to 2 percentage probability units.'"[17] Researchers could not explain

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[14] M. Jacobsen, S. Rae, W. H. Walton, and J. M. Rogan, "New Dust Standards for British Coal Mines," *Nature*, vol. 227, Aug. 1, 1970; M. Jacobsen, "The Basis for the New Coal Dust Standards," *The Mining Engineer*, vol. 131, March 1972; M. Jacobsen, "Dust Exposure and Pneumoconiosis at 10 British Coal Mines," a paper presented at the 5th International Pneumoconiosis Conference, Caracas, Venezuela, October-November 1978.

[15] A detailed discussion of the British research may be found in the Coal Mine Health appendix in vol. II.

[16] No probability curves were constructed for bronchitis, emphysema, or dyspnea.

[17] M. Jacobsen, "Dust Exposure and Pneumoconiosis at 10 British Coal Mines," paper presented to the 5th International Pneumoconiosis Conference, Caracas, Venezuela, October-November 1978, pp.5-6.

why CWP risks were five to six times higher than average at one mine, where the mean concentration of airborne dust to which the miners were exposed was 2.9 mg/m^3, compared with another mine, where the CWP risks were about one-ninth the average but the mean dust concentration was 4.4 mg/m^3. A 1979 draft of a NIOSH report, "Criteria for a Recommended Standard . . . Chest Roentgenographic Surveillance of Surface Coal Miners," on X-ray monitoring of surface miners said the "current U.S. permissible exposure limit for coal mine dust of 2 mg/m^3 does not assure a zero risk for the development of either simple or complicated pneumoconios is." The draft said the current standard is ". . . insufficient to eliminate the development of CWP in a small portion of American coal miners . . . ." The risk of developing more advanced stages of simple pneumoconiosis approaches zero at an average coal mine dust exposure concentration of 1 mg/m^3 and below, NIOSH reported. Since the average dust sample submitted to MSHA in 1978 indicates that concentration levels of slightly over 1 mg/m^3 are being achieved, Congress may wish to consider lowering the standard to attain zero CWP risk. In light of the large numbers of young miners joining the coal labor force in the 1970's, prudence suggests that new research confirm or change the 2-mg standard as soon as possible.

Assuming, for the moment, that 2 mg is low enough to prevent CWP, it is apparent that dust control depends on reliable monitoring of the work environment. MSHA says that more than 90 percent of the operator-submitted samples of mine sections have been in compliance since 1973. This seemingly encouraging record leads to the conclusion that CWP should be almost eliminated in the future. Yet the sampling system is so burdened by uncertainty and flaws that such a conclusion may prove to be unwarranted.

The dust-monitoring process has been criticized on a number of grounds. First, the sampling is performed only on perhaps 2 percent of the days worked each year. Second, the samplers used to monitor the dust are not always reliable. Third, control of the sampling program at each mine is exercised by the operator rather than the miners or MS HA. Serious misuse of this responsibility has been reported, including deliberate falsification of sample results. Miners express little faith in a sampling system managed by their employers—whose interest, they claim, is not served by submitting noncompliance samples to MS HA. Fourth, a lag of 2 to 6 weeks often occurs before the operator is apprised of the results of his sample. By that time, the work environment has changed considerably, for better or worse.

Behavioral factors influence the representativeness of the samples. Miners don't like to wear the samplers because they are noisy, awkward, and heavy. Both the company and the miner have incentives to take "good" samples (by tampering with the sampler or leaving it in a nondusty place). If a noncompliance sample is submitted to MS HA, the individual miner must take 10 more samples, which is considered a nuisance. The miner may not wear his sampler to minimize his inconvenience or possibly to appease an anxious supervisor. Management may try to distort the sampling, too. In one case, two company technicians at a mine of a major operator were found guilty—and then innocent—of deliberately falsifying samples once miners had turned them in at the end of their shift. The samplers themselves are far from perfect. MSHA stopped the use of the most common sampler in 1976 because it gained weight artificially. In the past, samplers were also found to lose weight for no apparent reason.

The General Accounting Office (GAO) found:

> . . . many weaknesses in the dust-sampling program which affected the accuracy and validity of the results and made it virtually impossible to determine how many mine sections were in compliance with statutorily established dust standards.

GAO said factors that affected sample accuracy were: sampling practices used by operators and miners, dust-sampling equipment, weight loss of sampling cassettes, and weighing of cassettes by MESA and cassette manufacturers.

''Improvements *Still Needed In Coal Mine Dlust-Sampl-Ing Program and Penalty Assessments* and *Collections* (Washington, D C U S Congress, General Accounting Off Ice, Dec 31, 1975), p i.

[19]1 bid , p 15

A National Bureau of Standards (NBS) study found:

> when the miners and mine operators perform" and supervise the sampling and when the weighings are made in the normal manner . . . the uncertainty [of accurate, actual measurements of dust concentrations] is estimated to be as large as 31 percent . . .[20]

No followup study on the accuracy of the sampling program has been done since the GAO and NBS reports were released in December 1975. Both investigations noted that MSHA and NIOSH officials have made efforts to improve.

A recent study of underground mines in east Kentucky found that:

> Both the interviews and the Federal dust records suggest that many dust samples are being collected incorrectly. In some instances, extra dust has been added; but in substantially more cases, the samples are too low. One explanation for the inaccurate sampling, of course, lies in the fact that the mineowners control sampling in their own mines. Since the penalty for exceeding Federal standards may be to close the mine, coal operators have a strong incentive to err in the direction of samples showing less than the actual dust levels. The 1969 law attempts to circumvent this possibility by requiring that all samples be collected by actual miners on the assumption that, since their own health is at stake, coal miners will have a vested interest in insuring the accuracy of samples taken at their workplace. For various reasons, however, that assumption has proven wrong. [21]

Sharp found 27 percent of the 680 face and high-risk samples he studied were at the 0.1 and 0.2 mg levels, which are generally considered to be impossibly low. (That level represents dust levels in fresh, intake air.) About 23 percent of equipment operator's samples were also found to be inaccurate (low). Operator attitude toward the sampling program has an important effect on sampling accuracy, Sharp concluded.

Additional doubt is raised about the soundness of the sampling program when the operator-submitted samples are compared with MSHA-taken samples. While the operator-submitted samples indicate more than 90-percent compliance, MSHA inspectors cited 36 percent (of the almost 5,000 underground sections they sampled) for noncompliance in 1976. Further, MSHA issues an average of about 2,500 notices of noncompliance and 50 withdrawal orders annually for dust violations, increasing the doubt about the more than 90-percent compliance. Finally, sampling itself is meaningful only to the degree that the samples reflect conditions when sampling is not being done. When sampling does not occur, sections may or may not be consistently in compliance. Conceivably, a section might be in compliance on the sampling day, but be out of compliance until either the next official sampling day or when a MSHA inspector next samples.

MSHA and NIOSH recently proposed new dust-sampling procedures designed to improve their reliability.[22] MSHA proposed that dust samplers be placed in high-risk *areas* rather than worn by miners *individually.* Area sampling, as this technique is known, has some advantages, but its reliability is uncertain. MSHA has not been able to demonstrate that area sampling and personal sampling produce identical results. The proposed regulations have become a battleground between labor and industry over the question of who should control dust sampling to achieve data reliability. UMWA and some occupational health advocates support miner control of the monitoring. Industry replies that the current system is working and that miner control is an infringement on management's right to operate its mines. UMWA proposed to MSHA a combination area and personal sampling system that would be administered by a MSHA-certified, miner-elected dust person at each mine. If UMWA and its allies are successful in this demand, an important precedent will have been set for other workers in other industries. Another solution to dust control is a machine-mounted continuous sampling system that trig-

[20] *"An Evaluation of the Accuracy of the Coal Mine Dust-Sampling Program Administered by the Department of the Interior, a Final Report to the Senate Committee on Labor and Public Welfare* (Washington, D.C. : Department of Commerce, National Bureau of Standards, 1975), p. iii

[21] Gerald Sharp, "Dust Monitoring and Control in the Underground Coal Mines of Eastern Kentucky, " masters thesis, University of Kentucky, November 1968, p 4.

[22] See draft of pt. 70—Mandatory Health Standards, Underground Coal Mines—and pts. 11, 71, 75, and 90 of title 30, CFR. Available from the Mine Safety and Health Administration's Division of Coal Mine Health.

gers an automatic power cutoff when dust levels are too high. Such a system is being developed but is several years away from commercialization, the Bureau of Mines says. Longwall mining, in particular, needs more effective dust control s."

Other Mine Dusts

The 2-mg dust limit covers all respirable coal mine dust, not only coal dust. Coal mine dusts contain a wide range of noncoal constituents, including silica and hazardous substances such as benzenes, phenols, and naptha lenes. Shultz, et al.,[24] found 13 polynuclear aromatic hydrocarbons in the respirable mine dusts they studied. Polynu clear aromatic hydrocarbons are listed among NIOSH'S suspected carcinogens.[25] Arsenic beryllium, cadmium, fluorine, lead, mercury, 'and selenium are all found in coal and all appear on the Environmental Protection Agency's (EPA) list of hazardous elements. At even one part per million, a mine producing 1 million tons of coal generates 1 ton of each element annually. As coal is cut from the face, some of each element will be liberated as dust or gas in the workplace.

[23]Mine operators acknowledge and MSHA surveys have confirmed that longwall mining systems (nearly 100 are now operating) have not been able to comply consistently with the Federal respirable dust standard. Only 48 percent of the 57 longwall sections MSHA surveyed in a 1978 report were in compliance with the 2-mg respirable dust standard. Longwall plows and single-drum shears had much better compliance performance than double-drum shears (of which 22 out of 32 were out of compliance). Longwall shears using planned mining cycles were in compliance and averaged 790 tons per shift compared with noncomplying shears without planned mining cycles that produced an average of 546 tons per shift. If a significant portion of underground production in the future is to be mined by longwalls, better dust-control measures must be used. See Robert E. Nesbit, "Summary of a Technical Survey of All Longwall Sections for Compliance With Respirable Dust and Noise Standards," Mining Safety and Health Administration, Oct. 31, 1978.

[24]J. L. Shultz, R. A. Friedel, and A. G. Sharkey, Jr., *Detection of Organic Compounds in Respiratory Coal Dust by High-Resolution Mass Spectrometry,* Bureau of Mines Technical Progress Report 61 (Pittsburgh, Pa.: U.S. Department of the Interior, Bureau of Mines, 1972), p. 14.

[25]*Suspected Carcinogens* (2nd ed.; Washington, D.C.: DHEW, National Institute for Occupational Safety and Health), p. 189.

Table 40 provides information on seven trace-element concentrations in various coals. The permissible levels of workplace air contaminants as developed by the Occupational Safety and Health Administration (OSHA) are also included in the table. The median concentration levels of these seven elements in uncleaned coal almost uniformly exceed OSHA'S standards. Research has not determined how much of each element is actually liberated in the mining process or, further, how much of that is inhaled by miners. One sample of West Virginia miners found their lungs to contain an excess of beryllium, cobalt, copper, and other minerals, but was unable to determine the significance of these excesses.[26] An autopsy study found miners' lungs contain higher than normal concentrations of aluminum, barium, boron, chromium, germanium, iron, lead, magnesium, manganese, nickel, silver, tin, titanium, and vanadium — al I common coal constituents.[27]

Little research has been done on the health effects of trace-element dust or trace-element compounds generated in coal extraction. Trace elements may have a role in producing black lung disability, either alone or synergistically. They may also play a role in the excess lung and stomach cancer found in miners.

Harmful Fumes and Gases

Hazardous fumes and gases are often produced in underground mines under both normal and abnormal conditions. Common gases include nitrogen and its oxides, carbon dioxide (CO_2), methane and other hydrocarbons, sulfur dioxide (SO_2), and hydrogen sulfide. If ventila-

[26]J. V. Crable, R. G. Keenan, F. R. Wolowicz, M. J. Knott, J. L. Holtz, and C. H. Gorski, "The Mineral Content of Bituminous Coal Miners' Lung," *American Industrial Hygiene Association* 28, 8, 1967; and J. V. Crable, R. G. Keenan, R. E. Kinser, A. W. Smallwood, and P. A. Mauer, "Metal and Mineral Concentrations in Lungs of Bituminous Coal Miners," *American Industrial Hygiene Association Journal* 29, 106, 1968.

[27]Robert W. Freedman and Andrew B. Sharkey, Jr., "Recent Advances in the Analysis of Respirable Coal Dust for Free Silica, Trace Elements, and Organic Constituents," *Annals of the New York Academy of Science,* vol. 200 (New York: New York Academy of Science, 1972), p. 9.

Table 40.—Median Trace Element Concentrations by Coal Type (parts per million dry weight, uncleaned basis)

Type of coal (OSHA permissible level)[a]	As[b]	Be	Cd	F	Pb	Hg	Se
	(0.4)	(1.6)	(.2)	(.2)	(.2)	(.1)	(.2)
	23.00	2.40	0.45	83.50	9.00	0.22	3.40
	25.00	1.80	0.20	50.00	9.00	0.12	3.00
	31.00	1.80	NA	103.00	9.00	0.17	NA
	26.50	2.50	2.90	75.00	11.00	0.13	2.00
	26.50	1.10	11.00	92.50	4.00	0.19	2.90
	NA	1.50	0.40	65.00	7.00	0.07	0.80
	NA	1.10	1.10	NA	NA	3.15	neg.
	1.00	0.90	NA	131.00	7.50	0.05	1.60
	2.00	0.04	NA	130.00	7.50	0.05	1.85
	7.69	0.38	NA	NA	NA	3.08	NA

[a] Occupational Safety and Health Administration permissible levels were calculated from OSHA, *General Industry Safety Standards rev.* January 1976, pp. 206–509.
[b] As (arsenic), Be (beryllium), Cd (cadmium), F (Flourine), Pb (lead), Hg (mercury), and Se (selenium).

tion is maintained at required levels, these gases will be diluted and carried quickly from the workplace. Miners are often exposed to noxious or poisonous fumes from fires in machinery, insulated electric cables, conveyor belts, lubricating oils, and various synthetic materials. Friction from moving parts and electricalfaults are common fire sources. Close observation of equipment by miners and supervisors and compliance with Federal equipment standards are well-known ways of preventing fires. Stil several hundred probably occur each year.

Hartstein and Forshey[28] analyzed coal mine combustion products from brattice cloth, ventilation tubing, belts, insulation, resins, foams, and oils— products commonly found in mines. Hazardous emissions identified were polyvinyl chlorides, neoprenes, and other chemical compounds plus hydrogen chloride, carbon monoxide (CO), SO_2, and hydrogen sulfide. When fires occur, these substances are liberated simultaneously in large doses. Harmful synergism with ambient dust may occur. No morbidity study has been done to assess the cumulative health impact of these substances.

Noise

Noise is a proven hazard to both underground and surface miners. NIOSH believes occupational noise has these actual, or possible, effects: temporary or permanent loss in hearing sensitivity, physical and psychological disorders, interference with speech communications or the reception of other wanted sounds, and disruption of job performance.[29] Excessive noise may also cause changes in cardiovascular, endocrine, necrologic, and other psychologic functions.[30]

NIOSH completed the most comprehensive survey of hearing loss in the underground coal mining industry in June 1976.[31] It found that "mining operations cause 20 to 30 percent of all miners to be exposed to noise that is potentially hazardous to their hearing."[32] However, disagreement was noted as to the proportion of miners suffering actual hearing loss as a consequence of exposure. Occupational hearing loss in the studies NIOSH surveyed ranged from 9 to 29 percent.[33] "The results of this study indicate that coal miners have measurably worse hearing than the national average,"[34] NIOSH concluded. MSHA has not con-

[28] Arthur M. Hartstein and David Forshey, *Coal Mine Combustion Products: Identification, and Analysis* (Washington, D.C.: U.S. Department of the Interior, Bureau of Mines, 1974).

[29] *Criteria for a Recommended Standard . . . Occupational Exposure to Noise* (Washington, D.C.: DHEW, National Institute for Occupational Safety and Health, 1972), p. IV-1.
[30] Ibid., p. IV-10.
[31] *Survey of Hearing Loss in the Coal Mining Industry* (Washington, D.C.: DHEW, National Institute for Occupational Safety and Health, 1976).
[32] Ibid., p. 2.
[33] Ibid., pp. 2-3.
[34] Ibid., p. 29.

ducted an equivalent noise survey for surface miners, although comparable data suggest similar hearing risk for truck operators and earth-moving equipment drivers. Data on active and retired miners covered by the UMWA Health and Retirement Funds in 1974 indicated that the Funds male population has a prevalence rate for hearing aids of 1.5 percent compared with a l-percent rate for all U.S. males.

Operators of underground and surface equipment are usually exposed to high, often intermittent noise levels. In surface operations, where machinery is in continuous operation, noise is often excessive. Miners are rotated in and out of the workplace to limit exposure. The Federal noise level of 90 dBA average for an 8-hour period permits higher exposures for shorter periods of time. However, convincing evidence is not at hand to indicate the 90 dBA level is sufficiently safe. NIOSH has recommended that the permissible exposure level be lowered to 85 dBA; UMWA health advocates have urged a 75 dBA limit.

Operators are required to submit noise-sampling data to MSHA. Samples are taken only once or twice a year in most cases. The results indicate almost total compliance with the Federal standards. MSHA issues even fewer notices of noise violations than the small number of noncompliance samples warrant. MSHA has no way of systematically checking the reliability of the operator-submitted noise samples.

MSHA inspectors are required to sample noise during inspections. But the agency does not tabulate its inspectors' measurements. Thus no way exists to compare the operators' data with MSHA'S.

Without reliable noise exposure data, it is impossible to predict the extent of hearing impairment miners will experience in the future. It is reasonably clear that a significant number of today's miners is exposed to and impaired by noise. Noise-related accidents are not uncommon. Lowering the Federal noise standard to 85 dBA, for example, and instituting a reliable monitoring and enforcement system would probably minimize future hearing impairment and accidents. Noise control at the 90 dBA level or lower requires careful engineering of equipment and design of the work process. Exposure can be reduced by providing personal protective headgear, but this approach is usually less reliable than engineering control and may increase accidents. Machine modifications to achieve a lower noise standard would involve retrofit expenditures and perhaps increase the cost of new equipment. Concern for inflationary impact and engineering considerations have discouraged Federal safety agencies from promulgating the recommended 85 d BA standard.

Diesels in Underground Coal Mines

Diesel-powered equipment is commonly found in surface coal mines throughout the United States. However, only 200 diesel units operate in underground coal mines. About 160 of those pieces of equipment are found in the West; most of the others are used in east Kentucky. Only 10 or 12 pieces are found in mines organized by UMWA.

Health hazards to both surface and underground coal miners from diesel emissions have not been studied definitively. In fact, no long-term epidemiological study of diesel exposure has been done of any work group. A preliminary survey covering a 6-year period that matched 772 diesel-exposed miners with an equal number of "controls" reported that the diesel miners reported significantly more symptoms of persistent cough, phlegm and exacerbations of cough and phlegm. Their pulmonary function performance was generally poorer, but they reported fewer symptoms of moderate to severe dyspnea and wheezing. 35 NIOSH expressed concern about the health hazards of diesels underground, but has not yet been able to justify a recommendation that diesels be prohibited. However, mine operators have been cautioned not to invest heavily in underground diesels pending further research. NIOSH is currently working up a crite ria document, which surveys the literature and

[35]R. Reger and J. Hancock, "On Respiratory Health: Coal Miners Exposed to Diesel Exhaust Emissions (draft) (Morgantown, W. Va.: Appalachian Laboratory for Occupational Safety and Health, 1979).

recommends a standard, for diesel emissions. This should be issued within 2 years.

Diesel engines produce emissions that are known to be health hazards: CO, unburned hydrocarbons, oxides of nitrogen, particulate, polynuclear aromatic hydrocarbons, phenols, aldehydes, oxides of sulfur, trace metals, nitrogen compounds, smoke, and light hydrocarbons. "

With exhaust scrubbers, rigorous maintenance, and massive ventilation these emissions can be minimized. However, Federal researchers point out that diesel particulate (which include carcinogens and mutagens) and oxides of nitrogen cannot be trapped within the combustion process. The safeguard standard is 8,000 to 17,000 ft^3 per minute of air per piece of diesel equipment. Normally, only 9,000 ft^3 per minute is required in each section (and 3,000 ft^3 per minute across each working face). The tremendous volumes of air required for diesel operation probably precludes their use in most older mines.

NIOSH'S current assessment of the potential health effects of diesels underground is pessimistic.

> Although acute or subchronic health effects" are important, chronic health effects are the central issue. The principal organ likely to be affected by diesel emission products is the lung, In addition to coal mine dust, many of the individual pollutants associated with diesel exhaust are known to cause chronic adverse respiratory effects after prolonged exposures. The introduction of carcinogenic materials into the mine environment through the use of diesel engines provides yet another insidious potential for chronic illness and death. These chronic effects may take years to manifest themselves. Thus, the real human impacts of introducing diesels into mines today may not be determinable for several decades. It must be emphasized that currrent or proposed standards for these individual pollutants offer no assurance of protection when the contaminants are found in combination with other toxic substances .
>
> . . . from a health protection posture it is obviously undesirable to use diesel engines in underground coal mines. However, it is also recognized that safety and productivity considerations could potentially provide overall gains in protection of the miners' well-being. Unfortunately, none of the potentially positive aspects of diesel use have been scientifically and objectively documented at this time. Conversely, there are valid investigations which clearly demonstrate that toxic substances are introduced into underground coal mines from diesel engine exhaust such exposures would not be expected to produce a healthy work ing environment. 37

[36]Gamble, et al., *Health Implications,* p. 5

Shift Work

Several studies have linked shift work–especially rotating shifts—to a wide range of adverse health effects. Most U.S. mines operate on either two or three shifts,[38] and about one-third rotate shift times every week or two, according to BCOA. Larger and newer mines tend to use rotating shifts more than smaller and older mines. More than 30,000 Appalachian miners struck in protest for several weeks in 1973 over compulsory shift work. Miners' wives picketed at a number of northern West Virginia mines in 1978 over the family disruption caused by rotating shifts.

Akerstedt summarized the literature in 1975 and found:

> . . . the studies . . seem to indicate that shift workers have:
>
> - An excess of sleep problems including short sleep time, difficulties of falling asleep and retaining sleep, not feeling refreshed after sleep, etc. The problems occur mainly in the nightwork period and often are associated with tiredness, bad mood, restlessness, digestive problems, etc.
> - An excess of minor nervous disturbance states.
> - An excess of gastrointestinal disturbances. 39

"Gamble, et al., *Health Implicattions,* p. 87.

"'UMWA conventions in recent years have urged adoption of a 4-shift, 6-hour-per-shift pattern in order to increase job opportunities and safety The fourth shift would be designated a safety and maintenance shift

[39]Torbojorn Akerstedt, "Shift Work and Health – interdisciplinary Aspects, " Shift *Work* and *Health* (Washington, D.C..: DHEW, National Institute for Occupational Safety and Health), p. 180.

Akerstedt noted that "shift workers suffer from a host of social handicaps . that can be expected to affect physchological aspects of well-being, e.g., anxiety, tension, self-esteem, and similar parameters. 40

The most recent NIOSH study by Taste, et al., found that workers on a rotating-shift system experience significantly more accidents than those working either straight-day shift or a fixed-shift pattern .4'

Several important questions about shift work remain to be studied. What are the biological costs of adaptation? What is the long-term cost of the "wear and tear" on the body as a consequence of repeated attempts to adjust or simply of being active at times when physiological preparedness for activity is at its lowest? What are the long-term consequences of being active during those portions of the 24 hours when the resistance to noxious agents is lowest? Do rotating shifts contribute to absenteeism and labor-management antagonisms?

Health Effects of Job Stress

Job stress is produced by a miner's work environment. Working conditions that either make unattainable demands on the miner or do not fulfill his needs create stress. Strain is a psychological reaction to stress—that is, a deviation from normal responses. Although a recent NIOSH study found that miners do not *perceive* their work environments to be more stressful than the perceptions of other blue--collar workers, miners experienced more strain —irritation, anxiety, depression, and physical compaints—than their counterperts.[42] As measures of job stress are subjective [workers' perceptions of their own environment), it is less useful to ask "How stressful is mine work?" than to ask what possible stress-related health effects are found among miners.

The findings of the 1977 NIOSH study on stress ". . . provided support for the argument that strain produces illness. "4[3] The reported incidence of circulatory and gastrointestinal problems, nervous system disorders, urinary tract conditions, or musculoskeletal problems . . were associated with pyschological strain, and those miners with these disorders reported significantly higher strain than workers who did not experience these problems.[44] When high- and low-accident mines were compared, it was found that miners in high-accident mines reported more illness than those in low-accident mines .45 Miners were found to experience higher morbidity and mortality from stress-related illnesses than expected.[4b]

Negative health effects are likely to increase where newly initiated productivity plans increase job stress. Although some of the incentive plans tie cash bonuses to safety, none apparently tie them to illness. NIOSH concludes:

. . . it can be expected that there will be an increase in the number of health and safety problems related to behavioral factors if coal production is increased.''"

Conclusions

This catalog of occupational health hazards is long and discouraging. It is difficult to pinpoint the extent of occupational disease among working miners. MSHA'S data are incomplete and unreliable. Epidemiological studies suggest an excess of respiratory disease, hypertension, lung and stomach cancer, and hearing impairment. But no one knows how many working miners die prematurely or suffer work-related illness. No one knows how many retired miners eventually die of work-related diseases. No one knows the extent of psychological and social stress a miner's illness inflicts on him and his family.

[40]Ibid., p. 191.

[41]B. Tasto, K. Cheaney, J. Isaacs, S. Jordan, S. Pally, and E. Skjer, *Health Consequences of Shiftwork,* Interim Contractor's Report 210-75-0072 (Washington, D.C.: DHEW, National Institute for Occupational Safety and Health, 1977).

[42]Ronald Althouse and Joseph Hurrell, Jr., *An Analysis of Job Stress in Coal Mining* (Washington, D.C.: DHEW, National Institute for Occupational Safety and Health, May 1977).

"Ibid , p 63

"Ibid

"Ibld , pp 124-125

"C M Pfelfer, J F Stafanski, and C B, Grether, *Psychological job Stress* and *Health,* Contractor Report #C DC99-74-60 (Washington, D.C. DHEW, National Institute for Occupational Safety and Health, 1975)

"Occupational *Safety and Health Implications of Irlcreased Coal Utilization* (Washington, D.C. DHEW, National Institute for Occupational Safety and Health, Nov 4, 1977), lines 848-850

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Estimates of the future number of CWP and black lung cases vary widely depending on assumptions about numbers of workers and disease prevalence. These estimates range from about 14,000 cases of CWP among working miners to 28,500 in 1985; from 10,600 CWP cases to 45,500 in 2000. A proportional range exists for bronchitis, severe dyspnea, and air obstruction. Thousands of additional cases of respiratory disability will be found among retired workers especially over the next decade (that is, among those who spent most of their work lives in uncontrolled dust conditions).

Other uncertainties must be added to this list. The safeness of the 2-mg dust standard is open to question. If 2 mg eventually proves to be too high, miners and compensators alike will pay a higher price for coal production. Further, the full health effects of coal-mine dusts are not clear. Lung and stomach cancer, skin disease, and gastrointestinal problems may be related to various noncoal constituents. While respirable dust is a known hazard, the degree of risk associated with nonrespirable dust has not been fully explored. Uncertainty also exists about whether (and to what extent) mine health hazards work synergistically. Do diesel emissions underground worsen the respiratory impact of coal mine dusts? Do large– but short –doses of mine-fire smoke increase respiratory disability?

This list of unknowns and uncertainties suggests a heavy research agenda before thousands of new miners are hired underground. Essentially, a list of research priorities can be grouped according to factors that need to be known and ways of doing things better.

TO BE KNOWN

Dust. –

1. Safeness of the current 2-mg/m^3 Federal standard for respirable dust.
2. Need for a standard for nonrespirable dust.
3. Need for a standard on trace-element and combustion-product exposure.
4. Possible relationship between mine dust both respirable and nonrespirable, coal and noncoal constituents with stomach and lung cancer.
5. Epidemiological study (including synergistic potentials) of underground coal miners exposed to diesel emissions.
6. Extent of work-related bronchitis and emphysema; causes and controls.
7. Epidemiological survey of respiratory diseases–both CWP and black lung–among surface miners and preparation plant workers.
8. Health effects of radioactive trace elements in underground coal miners.

Others. –

1. Health effects—synergistic and otherwise — of shift rotation in coal miners.
2. Epidemiological study of health effects of job stress.
3. Possible unique health effects of mining on women miners.

TO BE DONE BETTER

1. Data collection and analysis of occupational disease.
2. Reorganization of the respirable dust-sampling program.
3. Noise sampling.
4. Training of miners and management in health hazard recognition and control.
5. Nonrespirable dust control.
6. Dust control on longwall mining units.[48]
7. Involvement of miners in occupational disease prevention programs such as hazard monitoring.
8. Engineering production systems and equipment with health-hazard control in mind.
9. Training MSHA inspectors in health matters.
10. Sampler design (both area and personal samplers should be able to give miners and management immediate feedback on dust levels).

Congress faces several obvious policy questions in the area of coal mine health. First, is

'*In recent hearings on MSHA'S dust-sampling procedures, industry health specialists said mine operators have yet to succeed in bringing long-wall units into compliance, To comply with Federal standards, mine operators are forced to rotate miners onto the mining machine for short periods to comply with the Federal 8-hour standard the current program of Federal standards and enforcement adequate? Second, are the projected levels of miner occupational disease acceptable? Third, if the estimated health costs of increased production are unacceptably high, what additional legislation, if any, may be needed to reduce workplace exposure to health hazards?

Safety

Concern for the safety of American coal workers" has been expressed repeatedly by labor, coal operators, and public officials over the years. The reason is simple: mining is a dangerous job.

Mining is undoubtedly safer today than it was during the first three decades of this century. In 1926-30, for example, 11,175 miners were killed on the job compared with 715 fatalities in 1971-75. I n 1977, 139 coal worker fatalities were recorded. Altogether, coal mining has claimed a recorded 110,833 lives since 1900 and more than 1½ million disabling injuries since 1930. In some respects, mining is safer today than it was 10 years ago but in other ways — the number and rate of disabling injuries, for instance– no improvement has been seen.

Congress passed five major pieces of mine safety legislation in this century, each one coming on the heels of a major mine disaster. Each law strengthened its predecessor. The 1969 Federal Coal Mine Health and Safety Act established the current legal framework following a 78-victim explosion at a Consolidation Coal mine in northern West Virginia in November 1968.[50] The 1969 Act mandated safety practices to prevent future methane explosions. The Act has reduced disaster-caused fatalities from 158 in 1965-70 to 37 in 1971-76.

But the 1969 Act did not address specifically the problem of injury prevention. In 1977, 229,000 coal workers experienced almost 15,000 disabling injuries and 10,000 nondisabling injuries (which did not result in an extra shift lost time). The actual number of injuries has increased each year since 1975. Injury frequency in underground mines has risen after a 2-year (1974-75) improvement. In 1977, the rate was 50.86 disabling injuries per million hours of exposure, about what it was throughout the 1950's and 1960's. About 60 coal workers experience a disabling injury every production day. Injuries rose in the 1970's because almost 100,000 additional coal workers were hired since 1969 and because the underground injury rate has not improved. If underground production in 1977 had accounted for the same share of total national output that it did in 1969 (62 percent), the industry's overall safety record would show little improvement at al 1.

The safety costs of producing coal are borne by mine operators, taxpayers, and miners and their families. The dollar costs alone are substantial. A recent study found that the average annual cost of each coal mine fatality was $125,000 (in 1974 dollars) and $4,000 for each disabling injury.[51] Mining companies paid about 41 percent of the total as compensation payments, lost production, and investigative costs. Wage losses to the injured miner and his family amounted to about 47 percent. Public agencies paid the remaining 12 percent as compensation and investigative costs. In 1977 dollars[52] each fatality would have cost $153,000 and each disabling injury $4,900. That means a cost of more than $73 million for 15,000 coal worker injuries in 1977 and more than $21 million for 139 fatalities. Added to these dollar costs (paid after the accident) are the expenditures for research, training, and equipment paid by operators, UMWA, and public agencies to prevent accidents from happening. The human costs of accidents— pain, mental anguish, lost opportunities, disorientation— cannot be calculated in dollars and cents.

"Coal worker refers to all workers in the coal Industry, includlng miners (underground and surface) and workers in preparation plants, shops, and contract construction (shaft drillers, for example)

[50] Publlc Law 91-173

[51] FMC Corp., *Accident Cost Indicator Model to Estimate Costs to Industry and Society From Work-Related Injuries and Deaths in Underground Coal Mining*, vol. 1, September 1976.

[52] 1977 dollars calculated by assuming a 7-percent annual inflation rate in 1975, 1976, and 1977.

Mine safety can be measured in different ways. Most obvious is the actual number of recorded fatalities and injuries. This number depends on the number of workers in the labor force and the accident frequency rates. Rates for fatalities and injuries (both disabling and nondisabling) can be expressed as per million hours of worker exposure or per million tons of coal mined. Rates in exposure are more common and express accident risk from the workers' viewpoint. Accidents expressed in terms of output show directly the human costs incurred per unit of coal produced. Accidents are also measured in terms of severity— the average number of calendar days lost because of the injury. Finally, accidents are grouped according to mining method, underground or surface. Underground mining employs more workers per unit of production than surface mining and about three times as many industrywide.

Underground mining has resulted in more fatalities and higher fatal frequency rates historically than surface mining (table 41). Between 1952 and 1970, both underground and surface fatality rates (measured in hours of exposure) did not change although actual fatalities declined because the work force was reduced by 70 percent. Since 1970, both rates have fallen: the 1977 underground fatality rate is about one-third the 1970 level; the surface rate about one-half. The gap between underground and surface fatality rates has narrowed as underground mining made proportionately greater improvement.

Post-1969 improvement in fatality reduction is not matched by a similar trend in disabling injuries. Underground mining has been consistently more than twice as hazardous as surface mining in the frequency of disabling injuries (table 42). Underground mines injure more than five times as many miners as surface operations each year. Except for 1974 and 1975, no improvement in underground disabl-

Table 41.— Fatalities in U.S. Coal Mines, 1952-77 (hours of exposure)

Year	Underground		Surface		Surface fatalities as a percentage of underground
	Fatalities	Rate[a]	Fatalities	Rate[a]	
1952	514	.97	33	.55	60/0
1953	440	.96	21	.39	5
1954	374	1.10	22	.48	6
1955	391	1.06	25	.51	6
1956	417	1.11	28	.52	7
1957	451	1.30	22	.42	5
1958	334	1.26	19	.39	6
1959	268	1.11	20	.43	7
1960	295	1.29	24	.52	8
1961	275	1.34	17	.39	6
1962	265	1.34	20	.46	8
1963	257	1.28	22	.49	9
1964	224	1.12	15	.33	7
1965	240	1.21	18	.40	8
1966	202	1.12	23	.55	11
1967	186	1.05	22	.52	12
1968	276	1.63	24	.57	9
1969	163	.95	28	.63	17
1970	220	1.20	29	.55	13
1971	149	.86	23	.39	15
1972	128	.68	20	.38	16
1973	105	.56	16	.28	15
1974	97	.51	24	.33	25
1975	111	.47	32	.33	29
1976	109	.45	23	.22	21
1977	100	.43	27	.23	27

ing injury rates has occurred since 1952. The underground disabling rate and actual number of disabling injuries have risen each of the last 3 years. Modest improvement is seen in surface injury rates since 197o, although this trend seems to have bottomed out since 1973. The actual number of surface injuries has been rising as more miners are employed, In 1977, about 142,000 underground miners experienced 50 disabling injuries per million hours of exposure— that is, about 55 injuries every working day. I n contrast, 65,000 surface miners experienced roughly 18 injuries per million hours of exposure, or about 10 injuries every working day.

Underground mining generally produces more severe disabling injuries than surface mining. I n 1977, for example, the average severity of all temporary total disabling injuries in all underground mines was 73 calendar days per injury compared with 58 days for surface mines.[53] Although the average disabling injury idles a miner for 2 months or more, 98 percent are temporary total disabilities that do not produce permanent impairment. Of the 14,989 disabling injuries in 1977 for all coal production (mining, dredging, preparation, and shopwork), only 3 permanent totally disabling injuries were recorded and 225 permanent partial disabling injuries.

Measured in terms of output rather than exposure, a somewhat different perspective on safety is gained When expressed in output, the productivity advantages of surface mining (more tons for less exposure) show it to be five times safer than underground mining in fatality frequency and almost nine times safer in injury frequency in 1977 (table 43). In 1977, underground mining showed 0.39 fatalities per million tons compared with 0.07 fatalities in surface operations. Surface mining showed a 42-percent decline in its *fatality rate* in 1967-77 compared with a 26-percent decline for underground mining. On the other hand, the *injury rate* in surface mining only registered a 10-percent increase in 1967-77 while underground mining showed a 90-percent increase! I n 1977, underground mining registered 46 injuries per million tons compared with 6 injuries for surface mining.

Safety data measured by output and exposure are compared in table 44. Fatality and injury rates are higher when expressed in exposure than in output. Rate comparisons for 1977 appear in table 45.

A central relationship in coal's future is that of productivity and safety. Productivity (tonnage mined per worker per shift) can be increased in different ways. Each produces a unique set of safety consequences. For example, the introduction of continuous-miner systems in the 1950's raised productivity by maintaining output and reducing the labor force. This had the effect of lowering the actual number of accidents (since fewer workers were exposed) but not accident rates.

A rough index relating safety and productivity for 1967-77 appears in table 46. Safety is expressed as fatalities and injuries per million tons of coal mined. Productivity is expressed in two distinct ways: first, as tonnage produced per worker per shift (labor productivity), and second, as tonnage produced per production day. By calculating and tracing the number of fatalities and injuries that occur every production day, safety can be associated with productivity.

The steady 43-percent decline in underground labor productivity since 1967 is matched by a 43-percent decline in the number of underground fatalities per production day. However, underground injuries per production day increased 47 percent, from 38 in 1967 to 55 in 1977. Surface productivity dropped 22 percent in this period, but surface fatalities per production day rose 20 percent from 0.10 to 0.12, and injuries rose 134 percent from 4 to 10 (table 46). If underground and surface mines are compared on a productivity-safety index, it is clear that surface mining is three times more productive, four times safer in fatalities, and almost six times safer in injuries per production day.

53 Mine Safety and Health Adminlstratlon, "In]ury Experience at All Coal Mines in the United States, by General Work Location, 1977, " table 7

Table 42.—Nonfatal Disabling Injuries in U.S. Coal Mines, 1952.77 (hours of exposure)

	Underground		Surface	
	Injuries	Rate[a]	Injuries	Rate[a]
1952	28,353	53.26	1,698	28.11
1953	22,622	49.38	1,604	29.48
1954	16,360	47.98	1,342	29.01
1955	17,699	48.10	1,140	23.14
1956	18,342	48.88	1,318	24.31
1957	17,076	49.23	1,339	25.72
1958	12,743	47.94	1,150	23.86
1959	10,868	44.90	1,054	22.64
1960	10,520	46.09	1,125	24.45
1961	9,909	48.19	1,052	24.44
1962	9,700	48.88	1,027	23.50
1963	9,744	48.62	1,099	24.25
1964	9,692	48.35	1,116	24.75
1965	9,705	49.09	1,178	26.12
1966	8,766	48.78	1,043	25.00
1967	8,417	47.57	949	22.43
1968	7,972	46.99	1,039	24.59
1969	8,358	48.77	967	21.84
1970	9,531	51.79	1,346	25.67
1971	9,756	56.40	1,564	26.54
1972	10,375	55.32	1,305	24.84
1973	9,206	48.80	1,208	20.94
1974	6,689	34.95	1,229	16.83
1975	8,687	37.13	1,714	17.74
1976	11,390	47.09	2,071	20.04
1977	11,724	50.86	2,246	18.91

[a]Expressed in million hours of exposure. Data does not include auger mines, culm banks, dredges, preparation plants, shops, and contractors.
SOURCE: Mine Safety and Health Administration, 1978.

Table 43.— Fatality and Disabling injury Rates for U.S. Coai Mines, 1967-77a (tons mined)

	Underground			Surface"		
	Tonnage[b]	Fatality rate'	Injury rate[d]	Tonnage	Fatality rate	Injury rate
1967	349,133	.53	24.02	203,494	.12	4.99
1968	344,144	.80	23.13	201,103	.13	5.49
1969	347,132	.47	24.04	213,369	.14	4.79
1970	338,788	.65	28.07	264,141	.12	5.42
1971	275,887	.54	35.09	276,303	.09	5.91
1972	304,103	.44	36.06	291,283	.08	5.53
1973	299,353	.37	32.20	292,385	.06	4.63
1974	277,309	.37	25.34	326,097	.08	4.20
1975	292,826	.40	31.18	355,612	.10	5.28
1976	292,384	.39	40.53	372,616	.06	5.78
1977	255,385	.39	45.54	407,326	.07	5.53
% Change 1967–1977	– 27%	– 26%	+ 90%	+ 100%	– 42%	+ 10%

[a] Expressed in fatalities and injuries per million tons of coal mined.
[b] Thousands of tons.
[c]Fatality rates were calculated using fatality data from table 41.
[d]Injury rates were calculated using injury data from table 42.
[e]Surface data do *not* include the injury and fatality experience of auger mines, culm banks, dredges, mechanical cleaning plants, independent shops and yards, and contractors.

SOURCE: Mine Safety and Health Administration; National Coal Association, *Coal Data, 1976*, U.S. Bureau of Mines, *Minerals Yearbooks*.

Table 44.—Accident Rate Comparisons for U.S. Coal Mines, 1967-77

	Fatality Rates		Injury Rates	
	Underground	Surface	Underground	Surface

[a]Hours expressed as fatalities or injuries per million hours of work exposure.
[b]Tons expressed as fatalities or injuries per million tons of coal mined.
SOURCE: Mine Safety and Health Administration; National Coal Association, *Coal Data, 1976*; U.S. Bureau of Mines, *Minerals Yearbooks*

Table 45.—Accident Rate Comparison, 1977

	Hours	Tons
Fatality Rate[a]		
Underground	0.43	0.39
Surface	0.23	0.07
In]ury rate'		
Underground	50.86	45.54
Surface	18.91	5.53

[a]Fatalities and injuries per million units.
SOURCE: See table 44.

The decline in labor productivity coincides with higher accident rates in three out of four cases: 1) underground injuries per production day, 2) surface fatalities, and 3) surface injuries. Declining underground productivity coincides with fewer underground fatalities per production day. This tremendous reduction in underground fatalities is undoubtedly due to the safety practices required by the 1969 Act designed specifically to prevent multivictim disasters. It is a mistake, however, to conclude that higher accident rates are caused by declining productivity or its causes. Because Federal accident reporting requirements have been tightened twice since the late-1960's, officials believe more injuries are being reported today than 10 or 12 years ago. When many components in a system are changing rapidly, trend data measuring the change in only one must be used only with extreme caution to infer causality. Another consideration is that the number of production days was about the same throughout this period. This means that any rise in recorded injuries will show up dramatically as a rise in injuries per production day.

The decline in underground productivity was matched by a decline in underground production per day. The 23-percent reduction in underground production per day coincided with a 43-percent decline in underground fatalities per production day. But it also coincided with a 47-percent increase in underground injuries per production day. Surface mining showed a Ill-percent increase in production per day that coincided with a 20-percent increase in fatalities per day and a 134-percent increase in injuries per day. The production-per-day (raw output) measure may be a better predictor of likely accident experience than labor productivity (efficiency of output) because of the great number of variables that affect labor productivity rates and the definitional problems in the concept itself (see chapter IV, *Productivity).*

Several ways of increasing labor productivety can be discussed in terms of safety. First, productivity can be increased by cutting the labor force without reducing current production. Since fewer miners are employed, the number of accidents will probably fall. But the rate of accidents—that is, the risk to the worker—may rise because of increased pro-

Table 46.—Accident and Productivity Experience, for U.S. Coal Mines, 1967.77 (tons mined)

	Fatality[a] rate	Injury" rate	Productivity[b]	Employees	Estimated[d] production per day	Fatalitye per production day	Injury[f] per production day
Underground							
1967	.53	24.02	15.07	103,993	1,567,175	.83	37.64
1968	.80	23.13	15.40	98,831	1,521,997	1.22	35.20
1969	.47	24.04	15.61	97,395	1,520,336	.71	36.55
1970	.65	28.07	13.76	102,379	1,408,735	.92	39.54
1971	.54	35.09	12.03	97,740	1,175,812	.63	41.26
1972	.44	36.06	11.91	109,396	1,302,906	.57	46.98
1973	.37	32.20	11.66	100,843	1,175,829	.44	37.86
1974	.37	25.34	11.31	113,169	1,279,941	.47	32.43
1975	.40	31.18	9.54	137,060	1,307,552	.52	40.77
1976	.39	40.53	8.50	137,316	1,167,186	.46	47,31
1977	.39	45.54	8.58c	141,411	1,213,306	,47	55.25
Percent change 1967–77	–26%	+90°A	–43~0	+36°10	– 23%	–43%	+470/o
Surface							
1967	.12	4.99	35.17	24,064	846,331	.10	4.22
1968	.13	5.49	34.24	24,400	835,456	.11	4.59
1969	.14	4.79	35.71	25,323	904,284	.13	4.33
1970	.12	5.42	36.26	31,103	1,127,795	.14	6.11
1971	.09	5.91	35.88	33,344	1,196,383	.11	7.07
1972	.08	5.53	36.33	35,364	1,284,774	.10	7.10
1973	.06	4.63	36.67	30,475	1,117,518	.07	5.17
1974	.08	4.20	33.16	44,491	1,475,322	.12	6.20
1975	.10	5.28	26.69	57,562	1,536,330	.15	8.11
1976	.06	5.78	25.50	55,993	1,427,822	.09	8.25
1977	.07	5.53	27.34c	65,254	1,784,044	.12	9.87
Percent change 1967–77	–420/o	+IO°/o	–22"/0	+1710/o	+lll%	+20%	+134%

[a]Expressed in fatalities and disabling injuries per million tons.
[b]Expressed in tons mined per worker per shift.
[c]Preliminary estimate.
[d]Productivity multiplied by number of employees.
[e]Fatality rate multiplied by production per day divided by 10[6].
[f]Injury rate multiplied by production per day divided by 10[6].
[g]Includes auger mine employment.

duction pressure. The net effect may be fewer fatalities and injuries, but higher accident frequencies. The health implications of this approach would be substantial because many of the laidoff workers would probably have lost jobs related to dust control.

Second, if production increases without any increase in employment, then productivity will increase. The introduction of a new mining technology may effect this or it may come from better work relations, new work processes, better job design, and more effective training. Incentive programs and increased production pressure may also bring about higher production and productivity from the existing work force. The safety implications of these alternative approaches vary and deserve study before being embraced.

To illustrate this point it is useful to work out the possible safety costs of a hypothetical case of higher productivity leading to higher production. If 1977 underground productivity (8.58 tons per worker shift) had been what it was in 1967 (15.07 tons)- production would have increased from 255 million to 449 million tons (assuming 210 production clays and 141,752 miners) Similarly, if 1977 surface productility (27.34 tons per worker shift) was the 1967 rate (35.17 tons), production would have increased from 407 million to 524 million tons (assuming 230 production days and 64,753 workers). Total national coal production would have increased from about 688 million to 973 million tons, a figure in line with current national goals for 1985. Underground fatalities would have risen from 0.48 per production day to 0.83 per production day; annually from 100 to 174.54 Underground injuries would have risen from 55 per production day to 97, annually from 11,535 to 20,370. Similarly, surface fatalities would have gone from 28 (actually 29) to 37 annually, injuries from 2,146 to 2,760. This illustration, of course, is suggestive rather than definitive.

Productivity strategies that reduce the work force or increase production may prove to have substantial safety costs. However, other ways of improving productivity— technological innovation, redesign of the work process, or more efficient production systems— may actually improve safety performance either by making the production process safer or by reducing human exposure. The particular method of productivity enhancement will determine the level of safety costs. Analysis of safety and productivity is handicapped by the total lack of comparable mine-specific data that would lend itself to deriving hard-and-fast causal relationships between alternative productivity-enhancing strategies and safety, Such research is critically important to any national policy aimed at greater coal production and productivity.

Types of Accidents

Three major kinds of conditions are now associated with *underground fatalities* — roof falls, haulage, and machinery. One of the major pre-1 969 causes of fatalities — mine disasters — has been sharply curtailed. The 1969 Act outlined some general roof-control requirements — prohibiting activity under an unsupported roof, requiring a roof-control plan, etc. –that have helped reduce roof-fall fatalities. Comparatively little legislative attention was paid to machinery and haulage, although some regulations — cabs and canopies, for example– have been promulgated since 1970. As a percentage of the total, roof-fall fatalities have declined from a 1956-60 average of 50 percent to a 1971-75 average of 34 percent. However, haulage and machinery fatalities are increasing as a share of total annual fatalities. Such accidents are often caused by speeding up production, taking short cuts, poor training, inadequate equipment maintenance, and not using caution as a regular part of the production process. Haulage and machinery are also the leading categories of surface mine fatalities.

Underground disabling injuries are most often associated with material handling, haulage, and machinery. Surface injuries are most often slips or falls (of persons), handling material, and machinery. Reducing injuries from these causes may be more related to altering production patterns, work routines, and workload/work pace pressures than to new equipment standards. 55

On the whole, the larger the underground mine, the lower its fatality rate both in terms of exposure and output. Underground mines producing more than 500,000 tons a year generally had lower injury rates than smaller operations in 1975. Strip mines producing more than 1 million tons annually had the lowest fatality and injury rates of all (with one exception).

[54] This illustration assumes the 1977 underground fatality rate remains constant at 0.39 fatalities per million tons. Underground fatalities per production day are estimated by dividing annual tonnage by 210 days, which gives tonnage per production day. This number is multiplied by the 1977 fatality rate and divided by 1,000,000 leaving fatalities per production day. This method was used to calculate other accident-per-production-day estimates. In calculating surface-mine data, 230 days were used.

[55] A recent exception involved the requirement for cab and canopy installation on mobile equipment in low-coal. MSHA had required the installation of cabs and canopies to protect miners from roof and rib falls. However, when retrofitted on existing equipment, machine operators often found that cabs and canopies impaired their vision and forced them to assume uncomfortable and dangerous positions to do their work. Oversized equipment maximized productivity. But oversized machines cannot be safely retrofitted with cabs and canopies, although their inherent safeness has been documented. The tradeoff was between safety on one hand and productivity on the other. In this case, productivity won. Instead of requiring smaller machines fitted with cabs or canopies, MSHA rescinded its safety regulation for low-coal mines in 1977.

Auger mines— none of which produced more than 250,000 tons annually— had an extremely high fatality rate. The smallest underground and surface mines — producing less than 250,000 tons a year –generally had very high fatality and injury rates. Most coal production — both surface and underground — comes from mines producing 250,000 tons or more annually. Table 47 compares accident frequency rates for 1975 by mine size. At every size— with one exception — strip mines were safer than underground mines whether measured in exposure or output. In most cases, larger mines were safer than smaller mines, both underground and strip. Smaller mines are usually the most marginal economically. Their equipment is often older and they work more difficult seams. Large mines in the East are usually organized by UMWA, which has safety requirements negotiated into its contract.[56] Management attitude in small mines may affect safety as much as market economics, safety economies of scale, and worker participation.

What Makes Mining Safe?

Certain economic and mine conditions appear to be associated with safe mining. Three economic variables —technology, price, and Federal regulations — are discussed below.

1. New extraction technology does not necessarily lower fatality and injury frequency. When continuous miners were phased in underground (1950-70), the fatality rate rose slightly and the disabling injury rate remained relatively constant, Longwall mining may reduce fatalities but not necessarily injuries.[57] Contour strip mining used in the Appalachian mountains is generally less safe than open-pit mining found in the Midwest and West, but the difference is due more to terrain than to equipment used in each system.

   Mining technology can be engineered for safety as well as productivity. Current underground mine technology — uninsulated electric powerlines, opaque ventilation curtains, belt haulage, electric-powered track haulage, cable-reel shuttle cars, and conventional mining machinery— deserve safety analysis. In surface mining, comparisons between different flatland excavating methods (power shovel vs. draglines) and mountain-stripping systems (auger vs. contour vs. mountaintop removal) would be instructive.

2. Coal price appears to be related to accident frequency. Both price and accident rates were relatively constant in the 1950's and 1960's. When prices rose after 1969, fatality rates, at least, declined. The coal industry's two lowest years in injury frequency were 1974 and 1975, the same years that coal prices hit record highs. Prices stabilized in 1976 and 1977, and so did fatality rates. But injury frequency– especially underground —went up. This pattern implies that operators are able to take extra steps to safen their mines when their profit margins are large and, conversely, do less when margins are squeezed.

3 Federal mine safety regulation has three components: setting standards, inspections, and civil penalties. Each component, however, does not appear to have had equal impact on safety performance.

   Both miners and operators generally agree that most Federal regulations setting out electrical standards and minimum conditions and practices have safened mining. But many aspects of

[56]At UMWA mines, a miner-elected, health and safety committee exists with the power to inspect, consult with the company on mining plans, and withdraw workers from conditions of imminent danger. In addition, each individual UMWA miner has the contractually guaranteed right to refuse to work "under conditions he has reasonable grounds to believe to be abnormally and immediately dangerous to himself . . ."

[57]One study found that longwall mining had worse injury experience than either continuous or conventional systems. Leslie Boden, "Coal Mine Accidents and Government Enforcement of Safety Regulation s," Ph D dissertation, Massachusetts Institute of Technology, 1977 Another found that no significant difference in injury trends among the various mining methods See, D P Schlick, R G Peluso, and K Thirumalal, "U S Coal Mining Accidents and Seam Thickness, " The Aus. IMM Central Queensland Branch, Symposium on Thick Seam Mining by Underground Methods, September 1976

Table 47.—Injury Experience in Bituminous Coal Mines by Production Size, 1975

Annual tonnage	Per million hours of exposure: Fatal	Per million hours of exposure: Nonfatal disabling injury	Per million tons of coal mined: Fatal	Per million tons of coal mined: Nonfatal disabling injury
Underground				
Less than 25,000	.72	26.94	4.27	159.00
25,000 to 49,999	1.25	48.11	.92	35.17
50,000 to 99,999	.56	45.86	.44	36.12
100,000 to 149,999	.45	55.74	.36	44.38
150,000 to 249,999	.47	50.06	.42	44.82
250,000 to 499,999	.50	46.46	.46	42.64
500,000 to 749,999	.33	30.12	.26	23.96
750,000 to 999,999	,34	32.00	.25	23.40
1,000,000 or more	.34	28.68	.18	15.49
Total average of all underground	.48	37.11	.40	31.11
Strip[a]				
Less than 25,000	.58	10.10	.85	14.74
25,000 to 49,999	.35	15.49	.18	8.11
50,000 to 99,999	.38	17.42	.17	7.86
100,000 to 149,999	.35	15.33	.14	6.32
150,000 to 249,999	.64	18,46	.25	7.19
250,000 to 499,999	.09	22.72	.03	7.67
500,000 to 749,999	.42	18.55	.13	5.81
750,000 to 999,999	.22	22.18	.05	5.23
1,000,000 or more	.19	16.22	.03	2.73
Total average of all strip	.33	17.05	'.1O	5.01
Total all bituminous coal	.42	29.89	.25	17.91

[a]Does not Include auger mining and other miscellaneous surface mining.
SOURCE Mine Safety and Health Administration Injury *Experience in Coal Mining.* 197, p. 77.

mining machinery have no standards set for them. Some in the industry challenge the inherent safeness of particular standards, such as underground lighting, temporary roof support, or cabs and canopies in thin seams. Often, a complaint against a standard is based on the costs of implementation rather than its intrinsic worth. Since compliance is basically a matter of management policy, it is reasonable to conclude that post-1 969 improvement has resulted from operators complying with standards.

Federal inspection is the principal minesite enforcement tool. Several studies have found that safety improved with the frequency of Federal inspection. Boden's study of 539 bituminous underground mines producing more than 100,000 tons annually indicated that inspection leads to fewer injuries. A 50-percent increase in Federal inspection rates in this sample was predicted to lead to 11 fewer fatalities, 2,400 fewer disabling injuries, and 3,800 fewer nondisabling injuries per year. 56 Another study estimated that one more Federal inspection per mine would decrease annual fatalities by 4 and nonfatal injuries by 52.59

It is difficult to discern the real effect of MSHA'S civil penalty program on safety. The average assessed penalty in 1978 was about $180, of which about $150 was collected, according to MS HA. Both the average assesssment and average collection in 1978 was about twice the level of earlier years. MSHA also has a "special" penalty program for serious violations—those involving negligence, and unwarrantable failure to comply, and viola-

[58]Boden, "Coal Mine Accidents "
[59]Louise Julian, "Output, Productivity, and Accidents and Fatalities Under the Coal Mine Health and Safety Act, " mimeographed (University Park, Pa The Pennsylvania State University, circa 1978)

tions leading to fatalities and injuries—that amount to $2,000 or $3,000 each. MSHA raised its assessed dollar costs on most of its violations in 1978 after an internal evaluation of its own performance found that operators said they did not alter their practices after being fined and that civil penalties were regarded as a cost of doing business—"a cheap nuisance."[60] However, while it may be true that fines themselves do not alter management practices, the threat of being fined appears to act as a deterrent. Section supervisors, for example, are evaluated according to how much coal their units produce and how many Federal violations are issued. Even the current dollar amount of civil penalties is probably not much of a deterrent, but it is unlikely that Congress or the administration would approve the necessary level of financial disincentive to create safer mines in this fashion. Further research, however, is warranted to determine the level of civil penalty that would serve as an incentive for compliance and safety.

In sum, each Federal safety component—standards, inspections, and civil penalties—has some effect on safety. But better safety performance probably will be found in emphasizing the first two and discriminating application of the third.

Many variables are related to good safety. Larger operations are generally safer than smaller ones. High output usually means geological advantages and high capital investment. Flatland surface mining is generally safer than mountain stripping. Large underground mines are often safer than contour strip mines. Thin seams (less than 48 inches) and very thick seams (over 8 feet) are the least safe underground conditions because of roof control problems. Noncompliance with Federal regulations is often associated with mine fatalities. High hourly production rates in underground mines of the same kind apparently lead to higher injury rates.[61] Miners inexperienced at a given job are more likely to be injured than task-experienced miners. Captive mines (steel-owned) are generally safer than noncaptive mines, but this may have as much to do with reporting practices as safe operations.[62] No clear relationship is demonstrated between safety and unionization. Large, captive underground mines (almost all of which are organized by UMWA) are safer than small, non captive underground mines (many of which are non-UMWA), but it is not clear that the unionization variable makes the difference.

Several conclusions may be drawn from the available data. First, since surface mining is demonstrably safer than underground mining, additional research and enforcement should be directed at the latter. Research is needed to determine what combination of underground mine factors— equipment, management attitude, worker role, and so forth —safen operations. Since small underground mines are generally less safe than large mines, research and enforcement should be focused there.

Second, worsening underground injury experience needs to be addressed specifically. Injury-producing accidents appear to be linked to the interaction of three factors:

1. an incredibly narrow margin for error in the work environment,
2. inadequately trained workers who may not know how to— or are not permitted to–work safely, and
3. production-oriented supervisors who accelerate the normal pace of work and fail to maintain equipment properly.[63]

[60] *Report on Civil Penalty Effectiveness* (Washington, D.C.: U.S. Department of the Interior, Mining Enforcement and Safety Administration, June 1977).

[61] Boden, "Coal Mine Accidents."

[62] Theodore Barry and Associates, *Industrial Engineering Study of Hazards Associated With Underground Coal Mine Production, 1971*

[63] Ibid Management skill and management policy are variables of acknowledged importance In maintaining safety, but neither has received the necessary attention One exception was the Barry study of mine accidents which found:

> almost every operator interviewed cited the insufficient numbers of high-quality operating supervisors, and the resultant loss of supervisory effectiveness at the working face, as one of the major problems confronting the industry today in terms of both safety and production. (p 259)
>
> too many foremen are not safety conscious

(continued)

Smaller mining machines that build in safety features, pneumatic, battery-powered, chain-type, or hydraulic face-to-portal haulage systems; packaging supplies in smaller, lighter units are al l areas where research and development might reduce accidents. Behavioral factors also require examination. Job pressure, insufficient training, inexperienced supervision, inadequate hazard-recognition education, inappropriate worker and management attitudes— all may bear more heavily on injury-producing conditions than those more easily recognizable conditions that produce fatalities. Injury prevention may not be achievable by more rigorous enforcement of existing Federal standards if, as seems to be the case, current standards don't come to grips with the causes of mine injuries.

Third, mine safety may be improved considerably by changing certain psychological, behavioral, and organizational factors in the workplace. A recent report found significant differences in such areas between high- and low-accident mines.[64] Some of its major findings were:

- It appears that coal companies, especially high-accident mines, need to formalize safety as an organizational goal, and subsequently communicate to workers both verbally and through the behavior of management the relative importance of safety . . . if coal companies truly do value safety over production, the message is apparently not reaching miners. If coal companies do not, in fact, value safety over production, then a more fundamental problem exists in terms of overall goals and orientation of the organization. Results indicate that in high-accident mines, problems stem from safety never having been adopted as an organizational goal.
- .,. a second area that deserves consideration in the coal industry is work organization and job design. It has been established in the literature that jobs which are designed with an awareness of worker needs for recognition, responsibility, and variety tend to contribute to higher worker satisfaction and improved work quality, including safety performance.
- Survey results substantiate the need for training by providing empirical evidence that good training is related to a low-accident record. Underground miners in low-accident mines indicated that their training in dealing with hazards such as gas, dust, and noise was significantly . . . better than the training in high-accident mines . the fact that foremen could use additional training is evident from the fact that many foremen do not use safety equipment when necessary,
- In comparing high- with low-accident mines, two disorders were significantly more prevalent in miners working in high-accident mines — high blood pressure (29 percent versus 10 percent respectively) and 'nervous trouble' (16 percent versus 2 percent respectively) . . . it would seem that a program designed to reduce occupational stress could have a significant impact on the safety, health, and well-being of coal mining personnel. '[65]

In the past, the cause of mine safety has been driven by headline-grabbing, multivictim disasters. In the future, this driving force is not likely to exist, yet fatalities and injuries are likely to rise steadily. While management reserves the right to determine the balance between production and safety, higher numbers

[64]Westinghouse Behavioral Service Center, *Psychological, Behavioral, and Organizational Factors Affecting Coal Miner Safety and Health* (Washington, D.C.: DHEW, National Institute for Occupational Safety and Health, July 1976), pp. 125-134.

[63](continued)
supervisors. In many cases they actively encourage unsafe practices or give instructions to perform unsafe practices. For example, the . . . the majority of fatal roof fall accidents involved unsafe deviations from roof control plans of other safety regulations; the foreman was usually aware of the deviation and had apparently given tacit approval to the unsafe procedures. (p. 261).

The Barry research is 7 years old, but it is not apparent that the industry has solved the problem of "quality" supervisors. Nor can it be proved that enough foremen have become sufficiently safety conscious. This is particularly true of the hundreds of section supervisors in their 20's and early 30's whose career advancement depends on strong production performance.

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of mine accidents may lead Congress to find it prudent to encourage modifications in management attitudes and priorities. A comprehensive injury-prevention program would equip miners with the knowledge, skills, and rights to protect themselves. Because so much of mining is a matter of individual miners adapting to ever-changing conditions, enfranchising them in this manner may prove to be an inexpensive and effective way of reducing accidents.

Data Analysis

Coal mine injury and fatality data are imperfect and incomplete. A clear bias toward undercounting appears.[bb] The actual human costs of coal production have been understated historically. Accurate data are crucial to wise policymaking. Valid projections of future human costs associated with increased coal production must be based on the most accurate data obtainable. It is probably reasonable to assume that fatalities have been undercounted by as much as 3 to 6 percent annually and disabling injuries by 25 percent. Both, admittedly, are "guesstimates." The Mine Safety appendix in volume II discusses the shortcomings in the reporting and counting of workplace accidents. That argument is highlighted here:

Fatalities.— Accidents involving employees of independent contractors, such as mine construction workers, were excluded from MSHA data until last year. Perhaps as many as 20,000 workers fall into this category. UMWA sources estimated that 32 coal construction workers died between 1970 and the end of 1976. A reasoned guess is that an average of four or five construction/contractor fatalities may not have been counted each year. MSHA is now trying to include contractor accidents in its data base, but it is too early to evaluate the effectiveness of the effort.

Other reporting loopholes exist. For example, persons who die from "an event at a mine" but who are not at the mine when the event occurs should be counted as mine fatalities. Usually, they are not. The 125 deaths that resulted from the collapse of a coal-waste impoundment on Buffalo Creek, W. Va., in 1972 were not reported in MSHA fatality data. Offsite fatalities that occur from boulders and debris launched by surface-mine blasting would not be usually reported. When a fatality from occupational illness occurs at a mine, it is usually not reported despite clear Federal regulations requiring the operator to do so. Determining whether such a fatality was caused by coal mine employment is medically difficult; consequently, an attempt is rarely made. MSHA data show no fatalities from occupational illness reported since 1972. For these reasons and others, puzzling discrepancies exist between Federal fatality data and those recorded by State worker-compensation programs. Finally, MSHA defined coal workers in such a way that when three of its own inspectors were killed at the Scotia mine in 1976 they were not counted as mine fatalities.

Injuries. – Until 1978, MSHA defined a disabling injury as "any work injury which does not result in death but which either results in any permanent impairment to the injured person or causes the injured person to lose 1 full day or more from work after the day of the injury."[b7] A nondisabling injury did not result in a lost shift after the day of the injury. The distinction between disabling and nondisabling is important. Insurance premiums are linked to the former, but not the latter. Corporate safety performance is measured in the same fashion. Thus, employers had incentives to show as few disabling injuries as possible. Some mines and companies, therefore, adopted "light-duty" policies whereby an injured miner was encouraged to come to work on the day after an injury to be assigned light work. Miners call this "bench warming" or the "bandaid brigaid." The injury was reported as

"Both the General Accounting Office and the Department of the Interior have reached this conclusion after studying MSHA'S system Every major study of occupational injury and disease reporting supports this finding See for example, Jerome B Gordon, Allan Akman, and Michael L Brooks, Industrial *Safety Statistics. A Re-Examination, A Critical Report Prepared for the U.S. Department of Labor (New* York Praeger, 1971), and Nicholas Ashford, *Crisis In the Workplace (New* York Quadrangle, *1976)*

"Department of the Interior, Bureau of Mines, title 30, pt 80 l(e)(f) nondisabling rather than disabling. Miners often agreed to light-duty assignments because they feared job reprisals. It was also far less bother to go along with the company and collect an uninterrupted paycheck than it was to file for workers' compensation and await benefits that were less than normal pay. But by not reporting the injury as disabling, the worker lost any claim to future compensation. In a case — such as a back injury — that may worsen over time, the miner could be severely penalized.

Photo credit: Earl Dotter

Disabled UMWA miner and family on strike in Harlan County, Ky., 1974

Injury data may also be affected by how individual companies choose to interpret their Federal accident-reporting obligations. Interior Department investigations in 1975 found extensive misclassification of accidents. [68] Interior found in its sample that only about 17 percent of all injuries were ever reported to MSHA'S data collection center. '9 About 39 percent of disabling injuries were not reported, including: 1) finger amputated to first joint (8 lost workdays); 2) foot bruised with complication (13 lost workdays); and 3) knee bruised and infected, fractured fingers, and cracked rib. About 44 percent of nondisabling injuries were not reported. Underreporting resulted from oversight, misinterpretation, and deliberate circumvention of reporting regulations. An Interior update of the 1975 survey turned up similar findings. '" In 1975 and 1976, nearly 65 percent of all active mines did not report a single injury. Underreporting was most suspect at larger mines and less suspect at smaller ones. Interior's "basic conclusion" was that MSHA'S "accident/injury data submitted by mine operations cannot be relied on as reasonably accurate. " Suspect reporting was the result of "corporate policy on reporting practices," Interior said. Recent survey-research of 30 underground mines found that "foremen in low-accident mines were reported to turn in inaccurate safety reports more often than foremen in high-accident mines. "7

Within the last year, MSHA has tightened its definition of disabling injuries to reduce underreporting. MSHA believes that the new definitions of disabling injury has cut underreporting by two-thirds. Some MSHA officials say unofficially that more than 80 percent of all injuries are now being reported under the new system. Some observers argue that accidents were undercounted by as much as 60 percent under the old definitions. 72 The 1975 Interior audit found 39-percent undercounting of disabling injuries. A correction factor of 25 percent is used in table 48 to illustrate possible accident experience for 1967-77. Underreporting of tonnage and accidents lowers productivity, distorts accident data (thereby confusing policy analysis), understates future compensation costs, and lowers worker morale and respect for Federal safety efforts.

Safety Projections.—The safety implications of increased coal production are critically important to Congress. The dollar costs of fatalities ($1 53,000 each) and injuries ($4,900 each) are immense. Production and productivity are reduced when accidents occur. Coal workers and their families experience pain and suffering. For these reasons and others, Congress has expressed sustained interest in minimizing coal mine accidents. Unfortunately, fatalities and injuries will increase as more coal is mined unless steps are taken to reduce accident frequency.

The likely range of fatalities and injuries associated with higher production levels is shown in table 49. These estimates assume no change in certain variables — production pressure, productivity rates, accident reporting reliability, seam conditions, and work force and management characteristics. Those variables that have been considered are: number of coal workers and production levels.

Fatality and injury rates for 1977 were used to calculate the number of fatalities and injuries in 1985 and 2000. These rates may go down. If they are lowered sufficiently, they will offset the increasing number of workers exposed to safety hazards, thereby reducing estimated accident totals. However, if the rates improve only modestly, the actual num-

"''Review of Accident/Injury and Production/Manhour reporting under the Federal Coal Mine Health and Safety Act of 1969 administered by the Mining Enforcement and Safety Administration, " U.S. Department of the Interior, Office of Audit and Investigation, memorandum of Nov 19,1975.

'glbld,, p 5.

"'*Opportunities to Improve the Effectiveness of Mining Enforcement and Safety Administration Accident/Injury and Employment Production Data Information Systems* (Washington, D C.: U.S. Department of the Interior, Office of Audit and Investigation, 1977), pp. 6,15.

7.Westinghouse Behavioral Service Center, *Psychological. . . Factors,* p. 84.

[72]L. Thomas Galloway of the Center for Law and Social Policy argued that the MESA injury rates did not reflect up to 60 percent of al l coal mine accidents because of underreporting. See Galloway testimony in U S Senate, *Federal Mine Safety Health Amendments of 1976,* hearings on S. 1302, 94th Cong , 2d sess., Mar, 24, 25, 30, and 31,1976, p. 920,

Table 48.–All U.S. Coal Estimated Accident Experience, 1967.77 (hours of exposure)

	Nonfatal disabling injuries recorded'	Rate as calculated by MSHA[b]	Unrecorded Nonfatal disabling injuries, additional	Estimated adjusted rate[d]
1967	10,115	41.84	2,529	51.82
1968	9,639	41.12	2,410	51.13
1969	9,917	41.76	2,479	54.70
1970	11,552	44.40	2,888	62.32
1971	11,916	46.89	2,979	53.70
1972	12,329	46.08	3,082	52.53
1973	11,220	40.41	2,805	36.58
1974	8,545	28.79	2,136	34.28
1975	11,107	30.17	2,777	45.51
1976	14,389	37.55	3,486	47.82
1977	14,989	38.37est.	3,698	45.68est.

[a]Nonfatal disabling injury data provided by Mine Safety and Health Administration. Includes all mining, culm banks, dredges, plants, and shops.
[b]Injury rate is expressed in injuries per million hours of exposure.
[c]Applies a 25 percent rate of undercounting.
[d]This rate is a rough estimate. It was calculated by multiplying the number of workers employed by 8 hours by the average number of days worked in each year (from National Coal Association, *Coal Facts, 1974-1975* and *Coal Data 1976*). This sum was divided by one million and then divided into estimated total of accidents (column 1 plus column 3). Since the hours worked per worker and the number of days worked each year are very rough calculations these estimated accident rates should be seen as approximations.

Table 49.—Mine Worker Fatality and injury Estimates

	1977	1985b		2000	
		Low	High	Low	High
Surface					
Fatalities	29	25	30	32	46
Injuries	2,281	1,954	2,401	2,515	3,634
Underground					
Fatalities	100	118	140	203	291
Injuries	11,724	13,907	16,513	24,012	34,405
Other Coal workers[a]					
Fatalities	10	14	17	24	34
Injuries	984	1,586	1.891	2,653	3,804
Total					
Fatalities	139	157	187	259	371
Injuries	14,989	17,447	20,805	29,180	41,843

[a] 1977 data include workers in shops and cleaning plants, but not construction workers. Estimated data for 1985 and 2000 include all other coal workers and uses a 10 percent add-on to the total of underground and surface accidents.
[b]Low estimates are keyed to the workforce estimates found in the low-case growth assumptions (100 Quads) in chapter II, table 6. High estimates are keyed to the high-case growth assumptions (150 Quads).

ber of fatalities and injuries will still rise over current levels because of the larger number of workers employed. Accident frequency rates have not improved substantially for several years, and it may be that the 1969 Act will not have any additional impact on lowering them.

Between 157 and 187 coal workers are likely to be killed and between 17,400 and 20,800 injured in 1985. That represents a 13- to 35-percent increase in fatalities over 1977 and a 17- to 39-percent increase in injuries. By 2000, between 259 and 37l coal workers preestimated

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to be killed and between 29,200 and 41,800 injured. These estimates represent an 86- to 167-percent increase in fatalities over 1977 and a 95- to 180-percent increase in injuries. These calculations assume no underreporting and undercounting. The 25-year total (1976-2000) of mine fatalities may exceed 5,000 and injuries may exceed 500,000.

Conclusion

These estimates of future fatality and injury costs are disquieting. No one likes to measure the cost of electricity in human life and limb. Yet it is clear that coal production two to three times higher than current levels will greatly increase the number of fatalities and injuries unless frequency rates are cut sharply or productivity rises spectacularly (which would mean fewer workers exposed). Neither seem likely to materialize in the next 10 years assuming "business as usual. " Frequency rates have not improved since the mid-l 970's. Productivity is likely to rise in the future, but very slowly.

Congress clearly stated its position in the *1969* Act, which provided for the "attainment of the highest degree of safety protection for miners. " The Act recognized that "deaths and serious injuries from unsafe . conditions and practices in the coal mines cause grief and suffering to the miners and their families. " They also cost money and coal,

Thousands of hours of production will be lost because of injuries. Productivity will be lowered. Hundreds of millions of dollars in worker compensation benefits will be paid. Coal workers and their allies may increase their resistance to management over safety issues. Absenteeism and wildcat strikes may erupt. Congress may again become the object of intense pressure for even more stringent mine safety legislation. For all of these reasons, the effort to step up coal production and productivity ought to be accompanied by increased efforts to minimize fatalities and injuries. So far, this has not occurred.

COMMUNITY IMPACTS

Introduction

Coal mining shapes the social, economic, and political life of the communities in which it occurs. The scope and intensity of coal's local impacts differ from region to region" depending on the nature of the precoal economy, the extent of local coal development, and the level and regularity of demand for the local product. Local and regional impacts were also determined by the kinds of mining methods employed, level of mechanization, size of the mines, extent of economic diversification, local sociopolitical structures, company ownership patterns (local or absentee), presence or absence of unionization, and topography.

"Coal production has been centered historically in three regional coal fields the Appalachian fields ranging from Pennsylvania to Alabama: the Midwestern fields including Illinols, Indiana, west Kentucky, and portions of Kansas and Iowa; and the Western fields covering Colorado, Wyoming, Montana, Utah, New Mexico, and Arizona

Mining has usually occurred in remote areas, where industrialization and other forms of commerce were not well-developed. Often, coal became the only "cash crop. " One-crop economies–be they cotton, cocoa, or coal–often mean many social and environmental costs are externalized. Where mining was the principal economic activity, its effect on community life was greatest. Where mining was part of a diversified economy, its impact was less broad and less deep.

Appalachia has been America's bituminous coal bucket for a century; it is there that coal has impacted most heavily. What strikes the observer of coal field Appalachia is the near total absence of other primary economic enterprise. The land itself was not hospitable to much more than subsistence farming, so mining quickly replaced existing socioeconomic structures. I n Ohio, Illinois, and western Kentucky the agricultural base was sufficient to resist being supplanted. Yet even there, other industrial activity did not generally follow the development of local coal resources.

Coal operators often had to build not only mining and transportation systems, but also whole towns, complete with commercial and professional services, housing, roads, cultural activities, and political systems. Each community was almost totally dependent on the marketplace success of its local operator. The public infrastructure in these communities—its institutions, services, and personnel —was an adjunctive activity for the operators, whose principal concern was the profitability of their coal business. Company town were often a profitmaking business for a coal company even in slack times. Many times the town's profits were the only ones an operator could show for being in the coal business. I n some cases, operators saw community social investment as an unproductive and unprofitable use of scarce capital. When competition was intense and demand slack — as it was for most of the 20th century— support for community institutions was often the first economy operators effected.

The pattern of coal development in the Midwest and West differed less in manner than scope. There, too, the company-town model was used, but it was less frequent and less pervasive. More often, coal commercialization occurred in existing towns whose lifeblood was agriculture, which continued alongside coal production. Coal development in the Midwest did not snuff out traditional economies and social systems as it did in much of Appalachia. Economic diversity enabled Midwestern communities to survive coal's lean times. Finally, because the demand for Midwestern and Western coals was generally less than for Appalachian coals, mining never dominated these regions as it did Appalachia.

Rocky Mountain coal development was even slower and less comprehensive than that of either the Midwest or Appalachia, although it impacted specific communities with equal intensity. Markets were generally limited to steam-grade coal for railroads and industrial activity. Mining towns and boomtowns existed in the West prior to coal development; coal continued the boomtown pattern. As the seams played out or demand evaporated, the jerry-built boomtowns tended to be abandoned. In contrast, Appalachians tended to stay where they were despite cyclical coal demand.

Coal development shaped the political structures and culture that evolved in coal towns. Coal entrepreneurs had economic reasons for developing harmonious relationships with the local officials who administered the legal apparatus, tax system, and public services. In many cases, coal operators had to create a political system because none existed, often tying the public sector directly into the administration of the mining enterprise. As a result, the political culture that took root was widely perceived by residents to be the public expression of the local coal company.

In terms of social structure, in much of the Eastern coalfields, coal's method of industrialization meant that communities were divided into two basic classes: management and labor. The antagonisms produced in the mine workplace never dissipated in the environs of the company town where the workplace division was maintained socially. Miners' grievances have usually been played out through on-the-job militancy rather than in electoral politics because miners believed their power was more effective in the workplace.

The two-class structure prevented a noncoal middle class from forming. In other parts of America where an independent middle class developed, civic reform was forced on entrenched political elites. Had an independent middle class existed, it is reasonable to suppose that coalfield politics would have been pluralized and more adaptive to change. As it was, however, civic improvement was left to the discretion of individual coal companies. Some companies made good-faith efforts to supply their employees with decent housing, medical attention, education, and public services. The majority, however, could not or did not spare the money and effort. Yet even where operators made a good-faith effort, they did soon their terms.

For these reasons and others, public administration in many coalfield communities today–particularly in Appalachia– is often characterized by a lack of professional skills and institutions. Local politics is often tied to political machines and personalities. Corruption and inefficiency are not unknown. In the slack years of the 1950's and 1960's, public administration was heavily influenced by patronage considerations, as the public sector often replaced the private sector as the major local employer. Because the political system was so much an extension of local economics, public authority could do little to regulate the widespread cost externalizations of mining.

These historic patterns of underdevelopment have produced in much of the Eastern coalfields stunted private and public infrastructures that cannot respond to the needs of rapid coal expansion.

Because underground mining is the most common system in Appalachia, the community impacts there have been far greater in proportion to output than in the West where surface mining dominates and requires far fewer miners per unit of output. Even though most new coal output is scheduled to come from surface mines west of the Mississippi River, five times as many miners will work in the East than in the West in 1985 (chapter 11, table 6). If the impact problems of increasing coal production were to be translated into one simple concept —more people— the socioeconomic impacts will be predictably greater in the East, and especially in central Appalachia, than in the West.

Coal mining brings benefits and costs alike to local communities. Both have a private and a public side. Further, both have a dollar side and a nondollar side. In developing a mine, however, the cost-benefit calculus lies entirely with the individual entrepreneur. He establishes the scope of the project, its methods, and its rate of development. It is his ratio of (private) dollar costs to dollar benefits that determines whether a project is begun. it is on the assumption of profitability (that is, benefits over costs) that he ventures capital. The costs in this case are those that the company pays (internalizes) to produce coal at a profit. Public costs are generally not evaluated by the mine developer because they are not directly relevant to his balance sheet.

The local private sector bears a share of the costs of increased coal development. The private sector in this instance consists of three parties: the operator, his employees, and local private interests. Private costs can be divided into three categories: costs of production that are internalized by the operator, costs of production that are externalized and absorbed either by the workers or by local private interests, and opportunity costs. Internalized production costs are carefully projected and regulated by mine operators and are a normal part of doing business. Externalized costs and opportunity costs are not readily quantifiable but may be gauged by looking at occupational injuries and disease (including compensation programs), private health care utilization patterns and costs, lack of economic diversification, shortage of local investment capital, stress on community values and social structure, etc. Opportunity costs include all of the existing local business that ends as a result of coal mining, together with all noncoal business that might have occurred had mining not happened.

Coal production directly benefits its employees and their communities through wages and fringe benefits. The public sector also benefits from production. Economic growth helps a community prosper. Taxes may be levied on coal property, wages, sales, corporate income, and on the product itself to support public services. Presumably, a relationship can be drawn between the level of private sector benefits on one hand with public-sector benefits on the other. It might reasonably be expected that where the private sector–both owners and employees–benefits, the public also gains.

But such a relationship has not always held in the Eastern coalfields throughout much of this century because of the volatility of coal demand, the boom-bust cycle, and other unique factors. In the first two decades, the level of public benefits was determined by the coal operator who owned the community. The public interest was defined by the private sector. The company-town model polarized the private sector into "company men" and employees; neither group was capable of advocating an independent public interest. Even today as increased spendable income from mine employment reflects "economic growth", the development of community services and institutions lags. Growth is not synonymous with – and may not lead to—development. Community polarization continued long after companies liquidated company towns. For these reasons, increasing private benefits have not been matched by increasing public benefits. Public benefits from coal production have also been circumscribed historically by protracted demand stagnation. Even as America's consumption of energy quadrupled from 1920 to 1970, coal's share dropped from about 78 percent of the total energy market to 19 percent. 74 Stagnating demand meant that coal towns were never able to levy reasonable taxes on their principal local business for fear of shutting it down. Thus they never had the money to provide adequate public services. Studies of taxation patterns in coal counties find historical patterns of underassessment of undeveloped coal property and undertaxation of that which is assessed. States passed severance taxes in the early 1970's with great difficulty, and only when demand and prices were rising. Low taxation functioned as a public subsidy to local operators. Whatever the merits of the subsidy, it resulted in the chronic underdevelopment of coalfield public services and institutions. The public sector—especially at the local level –was thus forced to bear disproportionately high costs while reaping disproportionately few benefits from coal development through the 1960's. On the other hand, whatever public benefits that existed in these areas came from coal. To that extent, coal development was a source of both community benefit and community deficit.

Similarly, local governments rarely regulated coal's social costs. Operators often sited their mines outside of incorporated areas to avoid taxation and land-use restrictions. State legislatures and Governors rarely chose to do battle with politically powerful, economically imperiled coal operators. These economic realities and attitudes inhibited predictable and sustained development of public services in coal communities. Long-term planning was not undertaken. Eventually, coal field expectations about public services became permanently undervalued. What people never had, they were encouraged never to expect. Doing without became the norm.

Congress has debated an energy-impact assistance bill in recent sessions. Funds would be provided from general Federal revenues rather than through a national severance tax. The Farmers Home Administration (Fm HA) proposed guidelines to disperse $20 million to coal- and uranium-impacted communities in March 1979. The assistance would be used for growth-management plans, housing plans, housing, public facilities, and services. However, little of this aid will find its way to Appalachian communities because the FmHA growth requirement— 8 percent or more in coal employment in the year following the base year— is too high to qualify the well-settled, high-employment areas there. Congress may increase appropriations for this purpose orconsider a coal-financed contribution.

Much of this history is discouraging and pessimistic. Perhaps sustained, increasing coal demand will correct these problems. If that is to happen, policy makers need a clear picture of current coal field conditions and the reasons why things are as they are. The following sections describe these conditions in the East and West.

Impacts on Eastern Communities

More than 90 percent of all of the coal ever mined in the United States has come from States east of the Mississippi River. Nearly 50 percent of the Nation's remaining demonstrated coal reserves are found there. Billions of dollars of coal have been —and will be— mined from under the Appalachian Mountains and the fields of the Illinois Basin.

The visitor to the Central Appalachian coalfields is struck by its contrasts. Trains of 100

"See National Coal Association, Coal *Facts,* 1974-1975, pp 58-59 In 1920, about 592 mlllon tons of bituminous and anthracite coal were consumed whereas *In 1970,* only 524 mill ion tons were used domestically. Domestic consumption of bituminous coal was 509 mlll ion tons in *1920* and 516 mlllon tons in 197o cars regularly haul hundreds of thousands of dollars worth of coal past grimy, railside shacks. Yet amid the dingy grimness of many old coalfield towns, the visitor will sometimes come upon a bustling county seat that has been turned into a multicounty, commercial center within the last 5 years. The natural beauty of the mountains contrasts starkly with the scars and blemishes they bear from past mining practices. Finally, the visitor will meet at least three distinct groups of people: the very poor, the middle-income working miner, and the well-to-do.

The typical Central Appalachian coalfield community is small, congested, and lies along a stream or small river. Mountains often circumscribe the town and define its growth. Here and there comfortable ranch-style brick houses appear. Most buildings are old and rarely renovated, except for an occasional new fast-food restaurant or quick-service grocery, a modern brick post office, or public building, The roads linking the outlying hollows to the towns (and the towns to each other) are often narrow, poorly engineered, dangerous, and falling apart. Mobile homes are wedged between mountain and highway wherever a flat place can be found or bulldozed. Yet the visitor will also see a meticulously tended garden beside each house. Well-kept churches and cemeteries are the rule. Evidence that this is coal country appears frequently: a tipple; a portal; an old strip mine highwall or slag heap; a bumper sticker that says, “We dig coal. ”

Within a typical community it is common to find severely inadequate water and sewage systems, a low level of most public services, an almost complete absence of public transportation, a shortage of adequate housing, undercapitalized financial institutions, limited education programs, and a general feeling that the quality of community life is not what it could be. Although coal miners make $17,000 or more in a normal year, many find it difficult to purchase quality goods and services that non-Appalachians with similar incomes take for granted. Thus coaifield residents often feel individually deprived and publicly disadvantaged. As a result, there is a general ambivalence about the coal industry. On one hand, miners feel an intense pride in their profession and appreciate its wages and benefits. On the other, many believe they and their communities have been victimized by the ups and downs of coal demand and the cost-consciousness of their employers.

North into Pennsylvania and west through Ohio, Indiana, Illinois, and Kentucky, the coal towns change. The mountains flatten out. The visual impact of old strip mines is less severe. The towns are less cramped and seem more prosperous. Farming coexists with mining. In the Ohio River Basin, manufacturing and other businesses make coal less important. Public services appear to be closer to national norms. The towns are less coal towns than towns where coal mining occurs along with other businesses. The distinction is significant. In one, community life is totally dependent on the fortunes of a single industry. In the other, economic development is balanced and has been cushioned from the consequences of coal’s quick booms and long busts. Finally, miners here appear to enjoy a better quality of community life and seem able to use their incomes more efficiently. One sees fewer very poor or very affluent.

Coal mining’s impact on community life varies with conditions in the marketplace, terrain, the extent of economic diversification, and the kind of industrial socialization each community experienced when coal was developed. Generally, the social, political, and economic effects of coal mining have been most severe where communities were totally dependent on coal, where the terrain was inhospitable to other activity, and where mining was the principal socializing force in community life. When these factors were less dominant, the public benefits of mining were greater.

The extensive underdevelopment of much of the Appalachian coalfields is not difficult to explain. First, demand for coal has remained stagnant for most of the last 55 years. This placed tremendous cost-cutting pressure on coal companies. Economy was effected by holding down labor costs, mechanizing, and minimizing tax burdens through the exercise of political power at the local and State levels. Neither miners nor indigenous coal operators

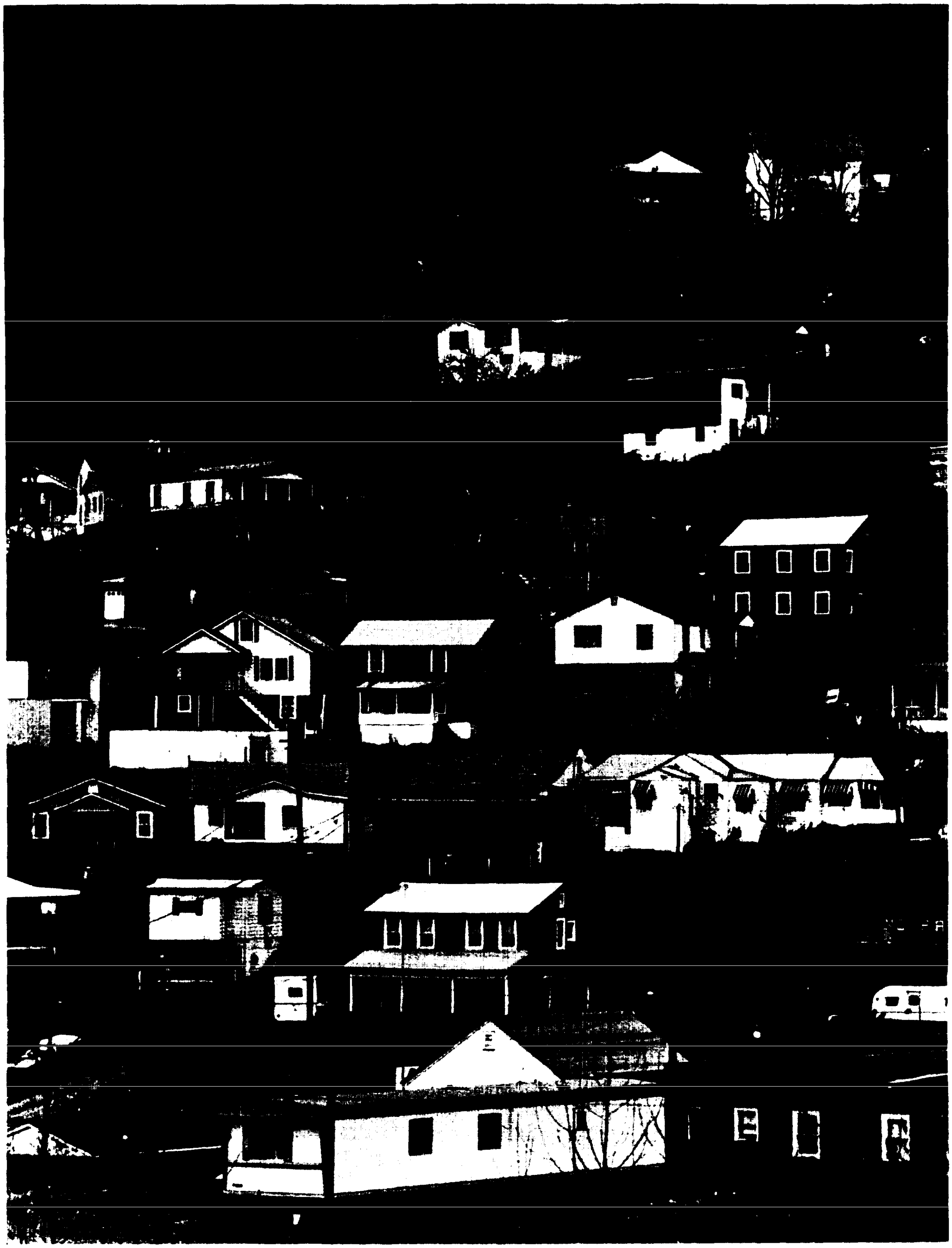

Photo credit: Earl Dotter

Coalfield housing located in the Cityview area of Logan County, W. Va.

got very far ahead until the 1970's. That meant coal field communities lacked investment capital, tax resources, and spendable income.

Second, mining companies were forced to externalize production costs in order to survive. Thus strip mines and slag heaps were not reclaimed; coal-haul roads were abused; streams were polluted. Most State and local efforts to internalize these costs through taxation and regulation were fought and generally defeated until the 1970's. Had such efforts been successful, some marginal companies would have gone under and others would have had a harder time.

Third, Appalachia has served America as a resource exporter. Coal mining did not stimulate investment in manufacturing, often limited development of other economic activity. Coal users usually did not locate their manufacturing and processing near coal mines. Again, a diversified economic base did not take hold.

Fourth, the biggest mining operations were usually owned by nonindigenous companies. Some of these companies developed adequate communities to service their mines; others did not. Mining profits— such as they were—were not deposited in coalfield banks, so mining's financial benefits to coal towns were limited principally to wage and salary income. Consequently, the private sector in many coalfield communities has been chronically short of cash. Native entrepreneurs usually engaged in the most marginal kinds of business, mining and otherwise, because capital was so hard to assemble. These two factors— initial inadequacies in community-building and subsequent capital shortages— left coal towns with chronically unmet needs and lacking the ability to solve their own problems.

Any analysis of the future socioeconomic impacts of increasing Eastern coal production must confront the social legacy of past coal development. The post-1973 Appalachian "coal boom" has not been based on increased production. Indeed, production has fallen– particularly underground tonnage. The boom was one of price and profit on management's side and wages and jobs on labor's. That combination, lacking as it does the necessary premise of more output, cannot be and has not been sustained. Even as the promise of coal growth beckoned, 5,000 to 10,000 miners were laid off or placed on short work weeks in recent months as metallurgical demand dropped and because utilities chose to meet air pollution standards by using low-sulfur coals rather than through installing scrubbers or other sulfur control measures.

With these shifting developments, it is difficult to forecast a uniform set of socioeconomic implications from increased Appalachian coal mining. Two to three dozen counties may find it extremely difficult to manage either growth or stagnation, as neither condition is predictable. For other coal counties, production will expand steadily and a range of growth-related social and economic issues will demand attention. As a result, Federal policy will need to be flexible and address three coal-related issues of Appalachian community development:

1. The current residual deficit in facilities and services in both stagnating and expanding communities.
2. The problem of continued uneven coal demand affecting particular communities or sub-State areas.
3. The problems of rapid coal development.

The capacity of any community to benefit from coal expansion depends to a great extent on the seriousness of its existing underdevelopment. Where this deficit is greatest, expansion will produce the most problems; where it is least, growth will be accommodated and the ability of communities to cope with associated social problems will be greatest.

Scope of Eastern Coal Expansion

Estimates of new Eastern coal production vary, rising or falling according to the optimism and assumptions of the estimator. One survey forecast 255 million tons of new capacity in 11 Eastern States by 1987, of which 197 million tons would be deep-mined and 58 million tons surface-mined, " This report estimates 212 million tons of planned capacity east of the Mississippi by 1985 (chapter 11, table 5). More significantly, no net increase in Eastern coal production is foreseen through 1985.

Appalachia produced 390 million tons in 1977, (had there not been a 10-week wildcat strike that summer and a month-long shutdown in December, output would have been around 425 mill ion tons). Appalachian production in 1985 should range from 355 million to 415 million tons and in 2000 from 510 million to 680 million tons (chapter 11, table 5). The three remaining Eastern States — Illinois, Indiana, and Kentucky (west) –produced 133 million tons in 1977. Actual production should range between 128 million and 164 miilion tons in 1985. Substantial expansion of eastern production is likely to occur after 1985. From 510 million to 680 million tons of Appalachian production and 206 million to 299 million tons from Illinois, Indiana, and western Kentucky is expected by 2000.

These estimates suggest that the East as a coal-producing region has 6 years in which to plan for higher production. However, some communities will be heavily affected by coal-related growth within these 6 years. Others will not experience any expanded production but will probably be required to absorb additional coal-related employment.

Forecasting community impacts of increased coal production hinges on the amount of coal actually produced in the future (rather than theoretical capacity) and the proportion of new production mined by strip and deep methods. Underground mining now requires roughly 550 miners to produce 1 million tons; surface mining uses about 160 miners for the same amount at current productivity rates. Accordingly, between 144,000 and 167,000 miners will be employed in Appalachia in 1985. No increase in net Appalachian mine employment is forecast for the next 6 years, although individual counties may show net gains of miners. In Illinois, Indiana, and western Kentucky between 29,000 and 38,000 miners should be employed in 1985. As net production increases between 1985 and 2000, mine employment will probably increase proportionately. These projections assume no change in productivity and do not include nonminer coal workers, such as mine construction workers, and those who work in preparation plants, tipples, and shops.

For each new miner, it can be assumed that five other persons– spouse, children, and secondary-employees —will be added to local communities. The net population increase from coal production in the East is likely to range from zero to 100,000 persons by 1985. Specific counties will be most heavily affected when new deep mines are put in where the existing social deficit is greatest. The most impacted counties will probably be in southern West Virginia, eastern Kentucky, southwestern Pennsylvania, and some areas of the Illinois Basin,

Existing Conditions

Social and economic conditions in Eastern coal field counties differ widely. Compared with the United States as a whole, the 50 leading coal counties in the East showed gross deficits in income, educational attainment, and housing in the 1970 census. " Central Appa-

"George F Nielsen, "Keystone forecasts 765 Million Tons of New Coal Capacity by 1987, " *Coal Age,* February 1978, pp 113-134 The 11 States are Alabama, Georgia, Illlnols, Indiana, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Vlrglnla, and West Vırglnla

[76]Census data for 1970 require two caveats. First, they are dated. Socioeconomic improvement should be recorded in 1980. But the statistical improvement in income that will be seen must be weighed in light of inflation's impact on real income. While fewer coalfield residents will fall below national poverty criteria, this may reflect only statistical betterment. Gains measured in per capita or family income may not indicate any real relative improvement among the poorer sectors in the community. Per capita and family income data may also be somewhat misleading where a few residents have become very rich.

The second qualification of the poverty and income data has to do with who is poor in coal counties. Coal miners would have normally earned between $8,000 and $12,000 in 1970 (depending on wage grade and days worked), a level clearly above the poverty line. In 1977, this increased to between $16,000 and $23,000 in current dollars. But the coalfield poor in 1970 were not working

(continued)

lachian counties had the highest deficit, Illinois Basin counties the next highest, and northern Appalachian counties the least when compared with the other two. Measures of poverty have historically been higher in coal counties than in most noncoal counties. The more dependent a county has been on coal, the higher its poverty index. In the 1920's and 1930's, this was the result of the industry's low-wage policies and slumping demand. In the 1950's and 1960's, mineworker unemployment and lack of economic diversification caused poverty to increase. The 50-county coal region had a 43-percent greater incidence of poverty than the United States as a whole in 1970, while family poverty was 53-percent higher than the national average. 77 The comparatively strong showing of northern Appalachian coal counties is due to their diversified economies — especially high-wage industries such as iron and steel, chemicals, metal products, glass, transportation, and electric power. By contrast, much noncoal economic activity in the Illinois Basin is agricultural.

The range of social problems coinciding with poverty places extra burdens on communities whose tax resources are already limited. The 1970 census data show that much of the Eastern coalfields entered the mid-1970's "boom" with few financial resources. Despite the gains in mining wages, personal income in the Appalachian region was below the national average in 1975. From Kentucky's low of 66 percent of the national average, with Virginia (73 percent), Ohio (79 percent), Alabama (82 percent), and West Virginia (84 percent) in between.

Similarly, the 50 coal counties had nearly one-fourth more than their share of persons with less than a high school education. About 59 percent of persons 25 years and older lacked a high school diploma. Northern Appalachian coal counties had the lowest incidence of poverty and the lowest percentage of those with less than a high school education. Central Appalachian counties had the highest incidence of both.

One reflection of educational quality in Appalachia is provided by comparing regional achievement test scores with National or State rankings (see table 50). The widest discrepancies between county performance and National/State reading and math standards occur in Central Appalachia, principally a coalfield area. There, 69 percent of those counties reporting were below National/State standards on reading achievement in 1976-77 and 94 percent were substandard on math. Students in northern and southern Appalachia performed better than National/State standards on reading, but did less well in math.

Rapid population expansion from coal development will add to problems of educational quality. In Raleigh County, W. Va., for example, even though a $20-million construction program was begun in 1973, the county superintendent admits that "in four or five cases we've had to put two teachers in one classroom with 50 kids. " He anticipates "this sort of thing . , . will probably occur more often in the future." In Greene County, Pa., local school officials feel that school construction should be postponed until after the population expands, with portable classrooms used in the interim. When a large number of young, married coal miners settles near new coal mines, local school systems will face front-end financing problems in building facilities. Educational quality will be adversely affected by overcrowding, inadequate facilities, and teacher shortages.

7.(continued)
coal miners. Many were unemployed miners, retired and disabled miners, and widows of miners Some portion of the coal field poor had nothing to do with the coal industry. Although miners' pensions have improved since 1974 and Federal black lung benefits now pump dollars into coal towns, there remains a thick slice of mining-related residents who live on modest fixed incomes They are disadvantaged by coal-boom inflation. They do not contribute as much to local tax revenues on a per capita basis as active miners Each coal fieid community must absorb some of costs of providing services to this group. Even as coal growth brings income gains to working miners, a class of poor and lower income residents will remain. They will be economically and psychologically disadvantaged by the coal-based advancement of their neighbors

"Calculated from *County and City Data Book, 1972* (Washington, D C : U.S. Department of Commerce, Bureau of the Census, 1973), tables 1 and 2 See vol. 11, app. XI 1.

Table 50.—County Rankings on Achievement Tests, 1976-77 (3rd or 4th grades)

Geographic region	Percent of Appalachian counties Reporting	Reading		Math	
		Percent of counties at or above National/State standard	Percent of counties below standard	Percent of counties at or above National/State standard	Percent of counties below standard

Housing is crucial to expanding coal production. Coalfield housing is of low quality compared with national norms. More than 31 percent of the Central Appalachian housing units surveyed in 1970 lacked plumbing facilities; 15.6 percent lacked them in the Illinois Basin; and 8.6 percent in northern Appalachia. But coalfield housing is more complicated than plumbing inadequacies, although they are a good index of housing quality. The most urgent issue is supply. Every study of coal field housing finds the existing housing stock insufficient. It is not likely to expand fast enough to house adequately additional mining-related population. The current housing deficit is the product of the coal slump of the 1950-70 period when few units were built. It is compounded today by a lack of adequate water and sewage facilities, an absence of private builders, a shortage of mortgage capital, an unwillingness of coal field banks to make housing loans, and, most fundamentally, the unavailability of land on which to build.

Water and sewage systems are expensive. They do not exist in many Appalachian coal towns. In Raleigh County, W. Va., only half the population is served by public sewage facilities, The rest use septic tanks, package plants, outhouses, or the nearest stream. The head of the local chamber of commerce says a total moratorium on new construction could be imposed by health agencies because of sewage problems. One local health official says the only thing preventing a typhoid epidemic from striking some sewer less hollows is the acid mine drainage that kills the bacteria in the befouled creeks. A recent West Virginia State health department study found that 70 percent of the water from public supplies in the county was substandard. Raleigh County residents complain of tapwater the color of orange pop. In Mingo County, W. Va., primary sewage treatment facilities exist in only two communities. Drinking water for Williamson, the county seat, comes from the Tug River, which the county says is polluted by acid mine drainage, preparation discharges, and diesel-oil runoff from adjacent railroad yards. Williamson's treatment plant is old and overloaded. The city is seeking State and Federal funds to replace it. In Breathitt County, Ky., only Jackson, the county seat, has sewage service. The pervasive lack of water and sewage facilities makes coal field housing development costly. It is especially difficult when State and Federal regulations require such services.

In many coal counties, most of the land is owned by a handful of corporations, which are reluctant to sell, preferring to hold the land for future development. The underlying coal makes the land worth considerably more than sale for housing would justify, especially when taxes are low. One study found that in the 14 major coal-producing counties in West Virginia, the top 25 landowners — all of whom are connected to the coal industry —owned as much as 2.1 million acres of land, or nearly 44 percent of all of the land in these counties.[78] The top 10 landowners who owned 31 percent

Jj Davltt McAteer, Coal Mine *Health and Safety The Case of West Virginia (New* York Praeger, 1973), p 163.

of the land in West Virginia, were, by rank: Pocahontas Land Corporation (a wholly owned subsidiary of the N&W Railroad), Consolidation Coal, the Chessie System, Georgia-Pacific Corporation, Eastern Associated Coal Corporation, Island Creek Coal Company, Bethlehem Steel, Charleston National Bank, Berwind Corporation, and Union Carbide. Nine of the top 10 landowners in these 14 counties had headquarters outside of West Virginia. 79 This study reported that the top 25 landowners had their property assessed at about one-fifth of the 14-county total assessment. A second study in West Virginia found that "two dozen out-of-State corporations and land companies–all tied directly or indirectly to mineral industries — own a third of the State's 12 million privately held acres."[80] This report found that "in almost 50 percent of West Virginia counties, at least half the land is owned by out-of-State corporate interests . . . [that often pay] as little as **$2** per acre in annual property taxes. " The most recent study found that nearly 80 percent of the land in Mingo County, W. Va., is owned by major corporations, most of which were related to coal mining and natural resources.[82] The Appalachian Regional Commission has recently funded a major landownership survey to facilitate housing and economic development.

Given the steep terrain and the flood-proneness of the valleys, flat land suitable for permanent housing is inherently limited. Mountainside housing is possible in many areas, but development costs (for water, sewage, and roads) are high. Individual homebuilders can rarely afford to build there. Federal programs have not adequately explored using this type of land for coalfield housing. Although the coal fields are rural, their population is congested along narrow creek bottoms. Without additional land, the population density of coalfield towns and hollows will continue to increase or miners will be forced to commute long distances; this, in turn, leads to absenteeism at work.

A few landholders have begun to make some housing land available. The Beth-Elkhorn Corp., a subsidiary of Bethlehem Steel, is located in Jenkins, Ky. In 1976, Beth-Elkhorn provided title in fee simple to 92 acres of land on an abandoned strip mine bench for residential development to contain 48 single-family, 62-multifamily, and 33-clustered housing units. Unfortunately, the development costs of using surface-mined land make this apparently logical solution of limited feasibility in many places. Island Creek announced an even bigger housing development for southwestern Virginia. Another example is the Raleigh County-based Coalfield Housing Corporation (CHC), a joint industry-union effort begun in March 1977. CHC has 26 units under construction and 210 additional units scheduled. Land availability, financing, and lack of builders have been its three major obstacles. The CHC model has not been repeated elsewhere in the coal fields. Recently West Virginia Governor John D. Rockefeller IV initiated land condemnation proceedings against the Philadelphia-based Cotiga Land Co., which refused to sell land to the State at what the Governor considered a reasonable price for victims of the 1977 Tug River flood.

Housing and land shortages force miners to remodel old coal-camp houses or purchase mobile homes instead of permanent residences. These are bunched in towns or strung closely together along valley floors. Mobile homes may shortchange local tax coffers, as their owners use a full range of community services but often pay personal rather than real property taxes on their dwellings. Their owners often complain about construction quality, rapid deterioration, fire hazards, and low resale value. Some of the newer and more expensive models address these concerns. Many residents believe that coal companies prefer to have their workers housed in mobile homes so that they can be moved out of the way when a mine needs the land. On the other hand, some coal executives believe one solution to wildcat strikes is to have miners buy quality housing that comes with a long and

"ibid , pp 140-149

"'Tom D. Miller, "Who Owns West Virginia?, " Huntington, W Va , *Huntington Hera/d-Dispatch, 1974,* pp 2, 23.

a Ibid

"Study prepared by the staff of the Tug Valley Recovery Center and the *Sandy New Era,* published in the *Sandy* New Era, Feb 1, 1979

Photo credit: Douglas Yarrow

Flood damage in Wyoming County, W. Va., 1977 heavy mortgage. If significant production is expected from the eastern fields after 1985, land must be made available for single-family housing, and a housing construction industry must be created.

Coalfield underdevelopment is reflected in the quantity and quality of other public services. For example, the Appalachian Regional Commission funded an assessment of the impact of coal movement on Appalachian highways. 83 This study found that coal movement by truck affected more than 14,300 miles of Appalachian roadway in 1974. Of that total, 6,880 miles of coal-haul roads were inadequate to meet the present volume of coal-truck traffic. Between 897 and 1,103 bridges were inadequate. The cost of maintenance was placed at $66 million to $81 million annnually (1977 dollars), bridge replacement at $59l million to $726 million, and roadway reconstruction and rehabilitation at $4.1 to $4.9 billion.[84] Only a tiny fraction of these sums is now spent to maintain, replace, and reconstruct coal-haul roads. These numbers do not adequately convey the visible wreckage of the public road system in many Appalachian coal counties. Some portions have simply slid down a mountainside. Spillage and coal dust from overloaded trucks have caused problems for motorists and landowners. Major secondary lines must be traveled with a sharp eye for axle-breaking potholes. Taxpayers pay for the constant upkeep on coal-haul roads while consumers pay repair bills for their vehicles. The main cause of the problem — apart from the initial shortcomings in construction and upkeep — is the illegal overloading of coal trucks. Numerous studies of this phenomena have reached the same conclusion: coal trucks regularly exceed legal axle weights, offenders are rarely cited, and fines are so low as to be no deterrent at all. State officials are reluctant to tighten up on enforcement. Federal officials are reluctant to use Federal law—which requires States to enforce Federal gross and axle weights on interstate highways in their boundaries or suffer a cutoff of Federal highway aid. Without strict enforcement of weight limits, road repair money will have little long-term value.

Coalfield health care is generally inadequate and extremely vulnerable to overloading from rapid population growth. The Appalachian Regional Commission reports that most of coalfield Appalachia is underserved by physicians, dentists, nurses, and hospital beds compared with the U.S. average. Many measures of community health— infant mortality, fluoridated water, prenatal care, per capita public health expenditures, immunizations, etc. – indicate that much of coalfield Appalachia falls below national standards. Many of these same problems were first brought to national attention in 1947 when the Department of the interior published a comprehensive survey of coalfield health, under the leadership of Administrator Joel T. Boone.[85] Much improvement has been recorded since the Boone report, but current data reveal many unmet needs. In 1950, UMWA won an operator supported system of medical insurance and health services providing near comprehensive benefits to UMWA miners and their families. Hospitals and clinics were built. Preventive medicine and group practice were encouraged. The Fund brought dozens of doctors and hundreds of other health professionals into the coalfields. Today, part of this system is floundering, and some of the rest is uncertain. Severe health care curtailments have already been recorded at about four dozen Funds-dependent clinics. The cutback in clinic services resulted from the Funds ending first-dollar coverage for miners along with replacing retainer payments to the clinics with fee-for-service reimbursement. The West Virginia University Department of Community Medicine found that total doctor office visits fell 31 percent since the imposition of copayments on physician care in the five clinics surveyed. The financial condition of the clinics worsened measurably. Where utilization fell, receivables rose — by as much as 190 percent in

"[l]Research Triangle Institute, *An* Assessment *of the Effects of Coa/* Movement *on the* Highways *in the* Appalachian *Region* (Washington, D. C.: Appalachian Regional Commission, November 1977)

[84]1 bid , p. vi,

"5[A] Medical Survey of the Bituminous Coal Industry (Washington, D.C : U.S Department of the Interior, Coal Mine Administration, 1947).

Photo credit: Douglas Yarrow

Shopping center construction, Beckley, W. Va., 1977

one clinic. Operating deficits were recorded in each quarter studied. Physician staffing declined by 42 percent from July 1977 through September 1978. Nonphysician staff declined by 25 percent. Special preventive health programs have been eliminated. Facilities and equipment are not being adequately maintained. Pharmacy and medical supply inventories have plummeted.[81]

The Funds population had a higher-than-normal hospitalization rate, which may be related to the shortage of ambulatory physican care. Some operators and physicians interpret high hospitalization rates as being a reflection of a kind of "cultural hypochondria" that predisposes Appalachian miners and their families to overuse medical facilities. Hospital utilization will be encouraged by the physician drain that began with the Funds cutbacks in the summer of 1977 and by implementation of the 1978 UMWA contract, which imposes coinsurance payments on physician care but not on hospitalization.

Coalfield health care issues revolve around questions of availability and quality. In most coal counties—with certain prominent exceptions—there are too few quality doctors and health care extenders, facilities, and prevention programs. Much of this shortage is due to the remoteness and isolation of these counties, and the lack of certain kinds of cultural and recreational facilities for health professionals. But these limitations were overcome by the UMWA Fund in the 1950's and do not present an overwhelming obstacle to recruitment to-

[81] William Kissick and American Health Management and Consulting Corp , "West Virginla Primary Care Study Group Problems of Reimbursement, " Department of Community Medicine, West Virglnla University, update, November 1978 See also Virginia Gemmell and Jane Ray, *Physician Loss in Central Appalachian Coal field Hospitals and Clinics,* draft report by the Appalachian Regional Commlsslon, 1978, and Charles Holland, et al , West *Virglnla Primary Care Clinics, 1978*

day. Federal and State programs designed to encourage general physician care in rural areas have had some success. But even where new doctors with rural-practice specialization go into coal towns, communities have trouble retaining them. Where significant expansion of the coal population occurs rapidly, currently overloaded treatment systems will function even less adequately.

The system of group-practice clinics and regional hospitals initiated by the UMWA Fund may still serve as a model for coalfield health care. The Fund recruited health personnel carefully. Quality control on services was maintained on non-Fund providers. Outpatient and community outreach programs were emphasized. The entire system was supported by an operator-paid tonnage royalty. When demand was steady or rising, the system worked well. Only when demand fell steadily over a period of years, did the Fund falter. If future demand increases as most estimates predict, a coal-supported health system of this kind may again prove to be the most practical solution.

Six Case Studies

Six high-growth Eastern coal counties were examined to determine their socioeconomic problems related to coal development and to assess their capacity to manage additional mining (volume 11, appendix XI l). Most Eastern coal counties have had to cope with some level of mining-related population growth even though, in many cases, production did not increase at all. These six counties represent the spectrum of capabilities and problems that exist in the Eastern fields.

The picture that emerges suggests that–to various degrees — short-term coal expansion has already overloaded Raleigh and Mingo Counties, W. Va., and Breathitt County, Ky. Greene County, Pa., Tuscaloosa County, Ala., and Perry County, I ll., have been less coal-dependent historically and appear to be able to manage increased coal production with little disorientation.

Although coal production has not increased significantly in Raleigh County, its county seat, Beckley, has been turned into a regional growth center for southern West Virginia. The price rise of metallurgical coal during the mid-1970's turned Beckley into a boomtown. The city is trying desperately to manage a host of housing, water, sewage, and transportation problems. Although Raleigh has been a fair-sized coal producer for decades, the fact that Beckley has been turned into a center of regional commerce and finance has broadened the county's economic base. Yet prosperity continues to be keyed to coal. Because of Beckley's regional importance, its resources are greater than most coal field county seats. Raleigh County is now, ironically, experiencing a severe economic slump that came with slack demand for local metallurgical coal. With little noncoal industry in the county, its economic fortunes rise and fall with demand for local coal. Little attention appears to have been given to economic diversification during the short-1ived boom.

Mingo County, W. Va., has not expanded production, although more miners have been hired in the last 6 years. Some new mines have opened, but others have cut back. A flood swept through Williamson, the county seat, in 1977, devastating the community. The economy was slow to recover. A report to President Carter in March 1978 found that:

> It has been almost impossible to acquire land to accommodate coal mining families whose homes were ruined in early 1977 floods or who are coming in for additional coal employment. The land not on steep slopes or on flood plains is largely held by landowners unwilling to sell their land for housing, preferring to hold it for speculation or resource development, 87

As nearly 80 percent of Mingo County's land is owned by nonlocal, coal-owning corporations, tight land policies present major roadlocks to efficent growth management. Many public services — education, water, sewage, recreation, and health– are inadequate. More flooding has occurred since 1977. The viability of the coal industry in the Tug River Basin rests partly on better flood-prevention measures.

Breathitt County, Ky., experienced a 109-percent increase in coal production between 1970 and 1976. Almost all of its output is sur-

[87] *Report to the President on Energy Impacts Assistance* (Washington, D C U S Department of Energy, Energy Impact Assistance Steering Croup, March 1978), app. A , p 3

faced mined. Mining accounts for 40 percent of all public and private employment there. Production is expected to increase by 50 to 75 percent by 1986. Breathitt County was one of America's poorest counties; coal growth is welcomed by its residents. Still because of earlier underdevelopment, Breathitt is experiencing adverse impacts. (Because the expansion is in surface mining, the population impacts are expected to be less severe than if significant underground production were scheduled.) Breathitt County lacks many services. It has no hospital. Sewage treatment is found only in the county seat, No public transportation system exists. The County has a comparatively high tax rate, but its base is very small. Unmined coal was assessed at only $11.3 million in 1976, or about $0.025 per ton of recoverable coal (441 million tons). The State has increased assessments in recent years, but revenue is unlikely to cover needed services.

Greene County, Pa., is a deep-mining, coal county where almost **25,000 coal-related additional** persons are estimated to be living by 1996— a number equal to the county's current population. A Westinghouse study of Greene County projects a total population increase of 118,300 by 1996.[88] The county is not well prepared to handle the impacts of massive and rapid growth.

In contrast, Perry County, Ill., and Tuscaloosa County, Ala., appear generally to be able to benefit from anticipated expansion, Both counties have diversified coal economies, with mining representing 1 percent of Tuscaloosa's employment and 17 percent of Perry 's. The rate of coal expansion and its extent are more modest than those in Greene or Breathitt Counties, which enable growth to be managed more effectively. Individual communities in each county may be seriously affected by the opening of a mine, but this appears to be little cause for concern countywide.

Any rendition of the historical impacts of mining on Appalachia obscures the benefits that coal has brought and the region's growth potential. Several factors will work to facilitate eastern growth. First, there exists a tradition and orientation among the population toward coal mining. Miners tend to be the children of miners. The lore of the work is handed down from generation to generation. The problems of the craft are understood by wives and families. Local schools are geared toward mining-related training programs. Local colleges usually offer mine engineering degrees. A second strong point is the production infrastructure that already exists. Despite the problems of coal-haul roads and rail and bargeline bottlenecks, a mine-to-market transportation system is in place. Further, there is an adequate support system consisting of equipment manufacturers, repair shops, and supply retailers, who can respond to increased mining. Local lawyers and brokers understand the coal business. The operators know the lay of the land both literally and figuratively. Coal resources are well known. The components of a production system are familiar. Problems of expanded development are not new. What is not greatly in evidence is the recognition that the ability to expand coal production is linked to the ability of mining communities to benefit from that expansion.

Since the early 1970's many eastern communities have experienced expanding mining populations and/or increased production. The seriousness of community impacts varies according to the variables discussed above. Most coal counties are aware that coal impacts will increase, but few have begun to do the necessary planning and resource accumulation that impact-management requires because of the dollar costs and time involved. To be effective, planning must occur before coal impacts begin. Existing Federal programs have not met the planning and front-end financing needs of coal-affected communities. Planning and resource management push communities to evaluate their tax systems, revenues, service-delivery systems, and likely sources of nonlocal assistance. As coal impacts have fallen on coalfield governments, communities are becoming aware that local taxation systems are inadequate. First, they rarely generate sufficient income to provide adequate public services. Second, they do not adequately tax the

[88]Westinghouse Environmental Systems Department, *Greene County and Environs Energy Impact Study* for Greene Hill Coal Co. (Pittsburgh, Pa.: Westinghouse Corp., 1977).

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community's main assets: undeveloped mineral wealth and current coal production .[89] In Mingo County, for example, coal and land companies —which own almost 80 percent of the land — had an aggregated property tax levy in 1978 of $231,000 compared with $960,000 for private residents and local businesses.[90] Many coal counties assessed undeveloped coal at only a penny or two per ton, and tax revenues amounted to only a few dollars per acre each year. Individual counties and States have been reluctant to impose burdensome coal-related taxes. They feared the increased cost of local coal would disadvantage local operators in the marketplace. Nevertheless, many counties needing to raise substantial additional revenue are now eyeing local coal resources. Coal companies are challenging higher assessments in several counties. From a national perspective, differential tax burdens (from State to State) may create inefficient incentives for wise resource development.

Perhaps the most severe coal impact that communities have been unable to resolve is the issue of land availability and housing, Coal operators have generally chosen to stay out of the housing business and are reluctant to assist private developers. The private housing market is inadequate to build middle-income housing. Most coal counties have had little experience in public housing. Multiunit townhouses or high-rise developments do not fit the housing expectations of local residents. The stopgap solution of mobile homes is not likely to produce community stability and growth or to benefit the industry in terms of employee morale and absenteeism,

The level of current and future costs and benefits partly depends on the extent of existing underdevelopment. As plans are carried out to increase Eastern coal production, community development strategies will be required to achieve a positive ratio of benefits to costs. Strategies of this sort are likely to call for economic diversification in coalfield communities, citizen participation, new land and taxation policies, regulated growth, and fewer cost externalizations. Strategies of this sort may slow the rate of coal development initially, but advance the East's ability to produce coal over the long term.

Impacts on Western Communities

Introduction

Coal development is occurring in eight States of the northern Creat Plains, the Rocky Mountains, and the Southwest– North Dakota, Montana, Wyoming, Colorado, Utah, Texas, New Mexico, and Arizona. (Limited development is also found in the State of Washington.) Coal production in these States amounted to some 166 mill ion tons, or nearly 24 percent of the Nation's coal output in 1977. By 1985, some 630 million additional tons of annual capacity may be available there. Currently, about 17,000 miners are employed in Western coal mining. Between 34,000 and 42,000 miners will work in this region in 1985. Coal mining is only one cause of coal-related impacts in the West. The construction and operation of coal-combustion facilities, such as coal-fired powerplants and coal-gasification plants, also affect isolated communities,

The West shares some characteristics with the Appalachian coalfields, but significant differences stand out. Both regions export raw materials, although the variety of Western resources extracted is far greater. Both regions have depended on imported capital to develop their resources. As the economic return to communities where minerals are extracted is often less than most other industrial activities, both areas have experienced relatively limited growth rates. Finally, each region has evolved an identity and cohesiveness that come, in part, from the collective perception of economic dependency or subservience to the rest of the Nation.

The West is not a homogeneous region geographically or socially. Its coal-producing areas are characterized by widely scattered

[89] Some Eastern States such as West Virginia have undertaken a comprehensive reevaluation and assessment program that promises to bring more coal-related tax revenues to coal field governments. But West Virginia tax officials admit that the higher valuations of undeveloped coal property will not produce sufficient income to finance the range of needed services

[90] See Sandy New *Era,* Feb. 1,1979.

towns, with typical populations of 5,000 persons or fewer. The counties are much larger in area than counties in the East and exhibit a varied topography. Much of the area is subject to Federal jurisdiction. Roughly 44 percent of the land area in the major Western coal States is owned either by the U.S. Government or by various Indian tribes .9’ Actual land control, owing to Federal coal-leasing policy, is even higher.

In contrast to the relative cultural homogeneity of the Appalachian coal region, the Western fields encompass a majority white population and three major cultural subgroups: **In**dians, Hispanic Americans, and members of the Church of Jesus Christ of Latter Day Saints (Mormons). Regionwide generalizations about attitudes toward growth are risky given this cultural mosaic. For historical and cultural reasons, attitudes toward coal development by minorities may differ from those of coal producers. The problems faced by Indian communities in managing coal-related development and the governing structure of the reservation system are unique. They are considered separately in this chapter.

Water is a prized commodity in the arid West. The ability of communities and coal operators to obtain sufficient water will shape the extent of coal development. There is little or no western water that is not already al located to existing water-rights holders, primarily agricultural users. Obtaining water rights for coal development may occur smoothly through negotiated purchase. But in some areas of high water demand, or where State policies promote conservation of the agricultural sector, conflicts may develop between private and public entities, In market competition for scarce water, energy developers will almost always be able to offer higher prices than agricultural and ranching interests. Special protection for certain groups of water consumers may be warranted in this regard.

Identification of Impacted Communities

With one exception, the distribution of new production throughout the West will be relatively uniform. Six States–Colorado, Montana, New Mexico, North Dakota, Texas, and Utah– are each expected to add 55 million to **61 million tons of new annual capacity be**tween 1977 and 1987, according to estimates presented by Coal *Age. 92* (These estimates are referred to as the “Keystone Case” throughout the remainder of this discuss ion.) The exception is Wyoming, which Keystone estimates to be able to produce more than 270 million additional tons annually by 1987. Campbell County, Wyo., alone is scheduled to have an annual production capacity of nearly 203 million tons per year over its 1976 level. Arizona and Washington are expected to have minor increases in capacity of 3 million and 1 million tons per year, respectively. Table 51 presents a county-by-county breakdown of estimated additional western capacity by 1987, by both surface and underground mining methods, developed from the Keystone data.

These estimates are generally considered to be optimistic. They are derived from a survey of coal producers on projected new mines and planned expansions of existing mines. Many of the proposed mines have not begun to acquire the necessary permits and approvals. Some capacity will never materialize because of unfavorable market conditions or unanticipated problems.

In order to evaluate more accurately the likely range of impacts on western communities, a low-production “case” (the OTA case) was calculated by State and county. Likely slippages in each State’s production, owing to a slowdown in coal gasification efforts, reluctance to resume large-scale Federal coal leasing, and other factors were identified. (See volume 11, appendix Xl 1 I for complete discussion of statistical methodology). Total new miner requirements for both production estimates, along with the 1976 population estimate for each county, are presented in table 52.

Public Land Statistics, 1975 (Washington, D C. U S Department of the Interior, Bureau of Land Management, 1976)

‘‘George F Nielsen, “Keystone Forecasts 765 Million Tons of New Capacity by 1987, ” Coal *Age, February 1978, pp 113-114*

Table 51 .–New Western Coal Production Capacity by County, 1977-86 (in millions of tons)

	Keystone case			OTA low-production case		
State and county	Surface	Underground	Total	Surface	Underground	Total
Arizona						
Navajo	3.30		3.30	0.00		0.00
Colorado						
Adams	12.50		12,50	2.44		2.44
Archuleta	0.10		0.10	0.10		0.10
Delta	0.25	1.80	2.05	0.25	1.02	1.27
Elbert	1.80		1.80	1.80		1.80
Garfield	3.00		3.00	0.40		0.40
Gunnison		3.70	3.70		0.27	0.27
Huerfano	0.10		0.10	0.10		0.10
Jackson	3.00		3.00	3.00		3.00
Las Animas		3.25	3.25		0.96	0.96
Mesa		8.85	8.85		3.76	3.76
Moffat	6.30	1.85	8.15	6.30	1.85	8.15
Pitkin		1.50	1.50		1.29	1.29
Rio Blanco		4.20	4.20		1.81	1,81
Routt	3.60	4.30	7.90	3.60	2.74	6.34
Weld		0.30	0.30		0.30	0.30
Total	30.65	29.75	60.40	17,99	14.00	31.99
Montana						
Big Horn	35.50		35.50	14.28		14.28
Crow Reservation	13.00		13.00			
McCone	5.00		5.00			
Musselshell	1.20		1.20	0.17		0.17
Richland	0.10		0.10	0.10		0.10
Rosebud	8.16		8.16	4.09		4.09
Total	62.96		62.96	18.64		18.64
New Mexico						
Colfax	0.50	1.50	2.00	0.50		0.50
McKinley	20.70		20.70	11.13		11.13
San Juan	37.70		37.70	15.37		15.37
Total	58.90	1.50	60.40	27.00		27.00
North Dakota						
Bowman	0.60		0.60	0.60	—	0.60
Dunn	14.00		14.00	4.07		4.07
Grant	1.50		1.50	0.44		0.44
McLean	22.00		22.00	11.34		11.34
Mercer	11.80	4.00	15.80	5.63	2.00	7,63
Oliver	2.60		2.60	2.60		2.60
Stark	0.46		0.46	0.32		0.32
Total	52.96	4.00	56.96	25.00	2.00	27.00
Texas						
Atascosa	6.00		6.00	2.98		2.98
Bastro	2.50		2.50			
Freestone	0.60		0.60	0.60		0.60
Grimes	4.00		4.00	0.18		0.18
Henderson	8.80		8.80			—
Hopkins	0.18		0.18	0.18		0.18
Milam	9.60		9.60	3.57		3.57

Table 51 .–New Western Coal Production Capacity by County, 1977=86 (continued) (in millions of tons)

State and county	*Keystone* case Surface	Underground	Total	OTA low-production case Surface	Underground	Total
Panoca	16.00		16.00	11.98		11.98
Robertson	6.00		6.00	1.98		1.98
Titus	4.60		4,60	4.60		4.60
Total	58.28		58.28	26.07		26.07
Utah						
Carbon		10.20	10.20		7.00	7.00
Emery	4.00	15.00	19.00	2.19	8.86	11,05
Kane	11.00	6.00	17.00	6.03		6.03
Sevier		8.25	8.25		4.33	4.33
Wayne	1.00		1.00	0.77		.77
Total	16.00	39.45	55.45	8.99	19.99	29.18
Washington						
Lewis	1,00		1.00	2.00		2.00
Wyoming						
Campbell	202.50		202.50	112.73		112.73
Carbon	17.10	7,90	25.00	6.80		6.80
Converse	13.00		13,00	3.43		3.43
Hot Springs	1,00		1.00	0.78		0.78
Lincoln	7.60		7.60	5.69		5.69
Sheridan	7,00		7.00	6.04		6.04
Sweetwater	10.25	0.95	11.20	7.89	0.95	8.84
Uinta	3.00		3.00	2.63		2.63
Total	261.45	8.85	270.30	145.99	0.95	146.94

SOURCE: George F. Neilsen, "Keystone Forecasts 765 Million Tons of New Coal Capacity by 1987." *Coal Age*, February 1978, pp. 113-134

Table 52.–Additional Manpower Requirements for Western Coal Development, 1977-86 (Keystone case and OTA low case)

State and county	1976est pop.	Manpower Requirements *Keystone* case	OTA lowcase	Annual population growth rate, "/0/year *Keystone* case	OTA lowcase
Arizona					
Navajo	61,200	184	0	0.18	0.00
Colorado					
Delta	19,100	624	353	1.81	1.06
Gunnison	8,800	1,068	78	5.62	0.52
Las Animas	16,200	1,217	360	3.79	1.26
Mesa	65,400	3,051	1,297	2.50	1.11
Moffat	8,900	576	576	3.34	3.34
Pitkin	9,600	544	413	2.97	2.32
Rio Blanco	5,300	762	328	6.42	3.21
Routt	10,200	987	769	4.68	3.80
Total		8,829	4,174		

Table 52.–Additional Manpower Requirements for Western Coal Development, 1977-86 (continued) (Keystone case and OTA low case)

State and county	1976 est. pop.	Manpower Requirements		Annual population growth rate, ‘/o/year	
		Keystone case	OTA low case	*Keystone* case	OTA low case
Montana					
Big Horn	10,600	1,804	727	7.29	3.51
Crow Reservation	2,383	661	0	10.30	0.00
McCone	2,700	333	0	5.70	0.00
Rosebud	9,900	538	270	2.86	1.53
Total		3,336	997		
New Mexico					
Colfax	13,300	430	383	1.79	1.61
McKinley	56,000	1,478	794	1,48	0.82
San Juan	67,700	1,336	545	1.13	0.47
Total		3,244	1,722		
North Dakota					
Bowman	4,200	15	15	0.21	0.21
Dunn	4,800	300	87	3.24	1.04
McLean	11,800	1,100	567	4.54	2.57
Mercer	6,700	1,764	874	9.94	5.95
Oliver	2,400	85	85	1.95	1.95
Total		3,264	1,628		
Texas					
Atascosa	19,800	396	197	1.14	0.58
Freestone	12,100	40	40	0.20	0.20
Grimes	12,200	264	12	1.23	0.06
Henderson	30,600	582		1.09	0.00
Milam	19,900	634	236	1.76	0.69
Panoca	16,400	926	692	2.96	2.28
Robertson	14,300	396	131	1.55	0.54
Titus	18,000	304	304	0.97	0.97
Total		3,542	1,612		
Utah					
Carbon	19,100	3,617	2,482	**7.89**	5.93
Emery	7,600	5,437	3,200	**18.13**	13.43
Kane	3,400	2,796	399	**19.49**	5.48
Sevier	12,400	2,855	1,498	**9.06**	5.60
Total		14,705	7,579		
Washington					
Lewis	48,900	66	132	0.08	0.16
Wyoming					
Campbell	14,500	6,237	3,459	13.61	9.29
Carbon	17,200	1,410	372	4.08	1.23
Converse	9,400	858	226	4.46	1.36
Lincoln	10,500	473	355	2.42	1.86
Sheridan	21,100	371	321	1.01	0.88
Sweetwater	31,300	**522**	**448**	0.96	0.83
Total		9,871	5,181		
Total U.S.		47,041	23,025		

The real population growth associated with coal development encompasses not only the miners themselves, but their spouses and children. Secondary employment is also generated. An average family size of three for both primary and secondary workers, coupled with an assumption of one local service job per primary job, yields an estimate of five additional persons per mining job. Projected annual growth rate in total population for each of the affected counties is presented in table 44 Some officials on the scene in Western States say the available estimates of county population severely understate reality. Where this is true, it hinders their efforts to secure outside aid based on population. It also would have the effect of lowering estimated growth rates (because the base population is higher than the number used in these calculations).

Population growth that exceeds a rate of 5 to 10 percent annually is considered to generate significant socioeconomic consequences. Table 52 shows that 11 counties in the West will achieve growth rates exceeding 5 percent per year in the Keystone case. Four of these counties will have growth rates exceeding 10 percent per year over the 10-year period. (High-growth county data are in bold face.) Under the Keystone assumptions, the Utah counties of Emery and Kane, where underground mines are planned, are the most impacted, with growth rates of 18 and 19 percent, respectively. Coal development in Campbell County, Wyo., yields a population growth rate of nearly 14 percent per year. (It is assumed that population impacts of coal development are felt only in the county in which development occurs. When miners do not reside in the county where they work, this assumption needs adjustment.)

When the OTA low-production case is used, only six western counties appear to be vulnerable to rapid growth. Four of these counties — Carbon, Emery, Kane, and Sevier– are in Utah. The others—Campbell and Mercer —are in Wyoming and North Dakota respectively. The OTA case removes both Colorado counties and the three Montana counties from the highly vulnerable list.

The list of vulnerable counties grows slightly if the time frame shifts from 1977-86 to 1977-81. With Keystone's assumptions, three more Colorado counties— Moffat, Pitkin, and Routt — are now experiencing rapid population growth. The shorter time frame does not add counties to the OTA estimates.

Two other factors should be considered. Mine construction workers appear 2 to 5 years earlier than the mine-operating work force. Construction crews are about the same size as mine-operating crews, so actual population effects are moved ahead in time but not increased in magnitude. Second, some utilities have located mine-mouth powerplants near coal mines. Powerplant construction crews are from 5 to 10 times larger than operating crews. Some communities have had trouble adjusting to the short-term impacts of these crews, (e. g., Rock Springs, Colstrip, Huntington, Craig, and Gillette) and if coal development continues, so will many of their problems. Only eight counties will experience both new coal production and operational powerplants after 1981 (table 53), according to these forecasts. When individual plant situations are investigated, these eight can be pruned because of time-phased unit construction (which maintains a semipermanent construction work force in a general area) and time lags between startup and operation. Mercer County, N. Oak., and Emery County, Utah, have already been identified in both cases as high-growth areas. The powerplant construction variable adds several Texas counties to the list of impacted communities. However, since all of these Texas counties have relatively high populations (ranging from 12,000 to 30,000) and are within 100 miles of Dallas or Houston, local population growth will probably be spread out and absorbed without great clifficulty.

In sum, this analysis shows that from 6 to 11 western counties will show rapid population growth from coal development in 1977-86. The population effects will stem from coal mine construction and operation rather than from powerplant development. I n both the Keystone and OTA cases, four counties in Utah are identified. Mercer County, N. Dak., and Campbell

Table 53.—Western Counties With Both New Coal Production and Powerplants to Come Online After 1981

State	County	Online date
North Dakota	Mercer	1981, 1984
Texas	Freestone	1983, 1984
	Grimes	1982
	Henderson	1982
	Morris	1980, 1982
	Robertson	1984, 1985
	Titus	1982
Utah	Emery	1978, 1980, 1983, 1985

County, Wyo., are also singled out in both cases. Most of these counties have small populations, the range being between 2,383 on the Crow Reservation to 19,100 in Carbon County, Utah. The four Utah counties and Campbell County, Wyo., will experience the fastest rates of growth. Several dozen western towns are also likely to grow rapidly from coal development even though their respective counties do not appear in the high-growth lists.

Boomtown Effects

How any particular community is affected by rapid coal development depends on the size of the mining enterprise, mining method, size and quality of existing public and private in-f restructures, rapidity of development, tax structure, and ratio of transient to permanent employees among other variables. The duration of coal impacts is likely to run for 10 to 30 years at one or another level of intensity.

Coal impacts can be grouped according to broad subject classifications (economic, political, and social). Both public and private sectors are affected. But it is impossible for two reasons to calculate a definitive, cost-benefit bottom line. First, all of the costs and benefits are not translatable into dollars. Second, costs and benefits are distributed unevenly among private-sector groups (workers, owners, and others) and public-sector interests (local communities, national energy needs, etc.) Therefore, although policy makers can become aware of the implications of various coal policies, there is no neat formula for weighing one kind of cost against another kind of benefit. The ensuing discussion talks about the costs and benefits of Western coal production, but does not make generalizations about when costs equal benefits, when costs exceed benefits, and when they are less.

Private Sector: Costs and Benefits

It is possible to make very rough calculations of some of the private-sector, economic impacts of projected coal development.

Annual coal-related wage income and benefits are the principal economic gain from Western coal development in local communities. Assuming that each new miner will earn $25,000 annually ($100 per day times 250 work days), the 34,000 to 42,000 additional miners in 1985 will earn between $850 million and $1 billion per year in pretax income. To this must be added the wages paid to workers involved in secondary coal employment.

Coal development does not bring large inputs of local capital investment or large profit returns to coal areas, Almost all of the major mines in the West are being opened by nonlocal investors, usually utilities, energy companies, or conglomerates. Apart from costs of acquiring the minable coal resources, the major capital expense involved in opening a new mine is equipment, almost all of which comes from nonlocal manufacturers. Once a mine is operating, net income is either reinvested or distributed as profits to stockholders. Little of the mine's economic surplus can be used by local banks or local entrepreneurs and residents. The surplus that is likely to remain in local communities is hard to quantify, but is likely to be insignificant in most cases. However, where a mine-mouth generating plant is part of the coal development, the local return increases even though the profit distribution pattern is not likely to change.

Coal development will affect existing business sectors in western communities. Many will be able to expand their sales and profits. But for some it will be a mixed blessing, and for others no blessing at all. Noncoal wage income does not rise as quickly as miners' wage rates. Local businesses will have difficulty retaining current employees and recruiting new ones, Secondly, local entrepreneurs may want to expand their business, but local loan capital may be tight. There is also the prospect of increased competition from new business started by local or, more likely, out-of-State entrepreneurs or national chains. Some local business may be wiped out.

In the past, the short-term costs of rapid coal development to the private sector have been high. The experience of Rock Springs, Wyo., is a dramatic example. When coal development increased the population of Rock Springs rapidly, its quality of life deteriorated.[93] The preboom ratio of two service jobs to every one primary job declined leaving local business without sufficient personnel to maintain services. Workforce turnover was high. Mining and construction caused inflation, bringing financial hardships to noncoal employees and residents on fixed incomes. After the initial disruption the ratio of local service jobs to primary jobs tended to normalize as they did in Gillette. Coal-induced inflation frequently pinches the wallets of noncoal employees and fixed-income residents.[94] High turnover rates among both coal and noncoal workers is often seen. People leave the community, although a net increase may be registered in the census. Much social stress occurs. In the Rock Springs case, the costs of boom-like coal development to many new miners and noncoal local residents may have outweighed the benefits.

The most significant private-sector problem in boomtowns is housing. Usually, there are few local builders capable of undertaking large developments. Often local banks cannot finance major housing projects. Many small banks are reluctant to tie up their capital in housing loans, as higher interest rates can be charged on personal and consumer loans. Consequently, housing costs skyrocket. In western boomtowns the average $50,000 price of a new home is about 30 percent higher than the national average for nonmetropolitan areas. Apartment rents are nearly double the median national figure of $120 per month. With the housing supply inadequate and costly, new residents are forced into mobile homes. Little property tax revenue is generated by these units in some States because they are bought and owned as personal rather than real property. State legislatures can remedy this. The shortage and high price of housing are also caused by the natural reluctance of local builders to risk major investment on the basis of promised coal expansion; the West has seen its share of booms burst.

The uncertainty of demand for western boomtown housing is a major part of the housing supply problem. Lenders, housing developers, and builders are reluctant to rely on the announced schedules for new energy projects. They fear being stuck with unsold homes if projects are delayed or canceled. The private, primary mortgage market is composed principally of savings and loan associations and the secondary mortgage market is insurance companies and other investors. These capital lenders may be unwilling to back investments that are not in low-risk categories.

The reluctance of local lenders is attributable partly to the funds available. Local financial markets in the West are unable to accommodate the demand for new mortgages in rapidly growing small communities. Outside financing is constrained by the absence of financial relationships with out-of-State institutions and the inability of local financial institutions to accumulate large enough blocks of mortgages to sell in secondary mortgage markets. These shortcomings of the mortgage market in the rural West may become a greater problem in the future. Fm HA recently announced guidelines for providing assistance to energy-impacted areas where energy employment increases 8 percent or more in a year, a housing shortage exists and local and State financial resources are inadequate. Only $20 million is available under this program which applies to

“John S. Gilmore and Mary K Duff, Boom *Town Growth Management: Rock Springs-Green River, Wyo.*-ming (Boulder Westvlew Press, 1975)

“4 Interviews with bankers in northwestern Colorado found that fixed-income residents were borrowing to meet Increased Iiving costs by using the appreciating value of their homes as CO I lateral Such short-term loans are rolled over each year to repay previous loans and obtain additional money for rising living expenses This pattern, the bankers predicted, will certainly end in economic disaster for some of those Involved Don Kash, Mike Devlne, and Allyn Borsz, Impacts *on Western Coa/-Producing Communities,* OTA contractor report, April 1978

Photo credit: Earl Dotter

Coalfield housing near Peabody Coal's Kayenta mine on the Navajo Reservation, 1977

both coal and uranium production, processing, and transportation.

The potential demand for new homes is somewhat more certain in larger towns, such as Gillette and Farmington, where large numbers of energy executives or administrative personnel live. However, even in these larger towns the temporary nature of powerplant construction and uncertainty about future energy development result in a fear of overbuilding. This is particularly true of towns that have had previous booms collapse.

Several coal developers have provided housing for construction worker and mineworker families. Much of this has been planned mobile-home developments. Arco is building a planned town (Wright, W. Va.) primarily for employees of its Black Thunder MineWright's single-family housing is expensive — in the $50,000-and-up range— and most miners seem to be opting for the cheaper, more readily available mobile home. By living closer to the mine than they would have in Gillette, the only town in Campbell County, workers will commute shorter distances. Wright will cost ARCO about $18 million.

The company-town approach is one alternative to chronic housing shortages. But the cost of building and operating such towns discourages most companies from trying it. More common is a catch-as-catch-can approach to housing, Coal developers will offer some assistance to towns or to their employees, but principal responsibility is left to local authorities and individuals. Several examples illustrate the mixed record of western towns in coping with housing needs.

In Emery County, Utah, housing is desperately needed. One cause of the shortage is a deficient public infrastructure, Without water and sewer hookups, housing of any kind cannot be built. Another problem has been Emery County's lack of licensed contractors. Inflated costs, housing shortage, and the limited supply of contractors has significantly changed the composition of the housing inventory. In 1977 mobile homes were 41 percent of Emery County's housing supply. In Huntington, where in 1970 there were only two mobile homes, 375 were counted in 1976. The Southeastern Utah Association of Governments sees mobile homes as the only housing choice available to new households. A somewhat different pattern is found in Gillette, Wyo., where there were no large-scale builders or developers before the coal boom. Market uncertainties and the possibility of environmental litigation over Federal coal leasing presented an unattractive level of risk for large-scale land developers and creditors. These initial problems have been alleviated. Many developers now see a single-family housing market **in Gillette.** The risks involved in large subdivisions have been largely absorbed by the coal companies. In some instances, the companies have acted as land developers; in others they have either guaranteed the sale of lots and/or houses or guaranteed the credit of a housing subdivider. Yet single-family housing production has not increased substantially. The primary barriers are the delays and high costs of producing new units of acceptable quality and the relationship between the cost of producing the types of dwellings desired by the newcomers and their ability to pay for the desired units. 's Many residents are forced to live in mobile homes, which have become the fastest-growing housing alternative in Campbell County. Sixty percent of the increase in housing since 1970 has been in mobile homes. Currently 67 percent of the housing in the county outside the Gillette city limits is mobile homes.[9']

[95]1n a recent Wyoming survey, 67 percent of the respondents preferred a single-family unit and 56 percent Indicated both the willingness and ability to purchase one, but only 45 percent had achieved the goal of owning a single-family unlt (Dale Pernula, 1977 *Citizen Policy Survey* (GIltetteCampbell County Department of Plannlng and Development, 1977))

"Keith D Moore and Carrie Loom Is, *Housing Market Dynamics in Campbell County, Wyoming and the Impacts* of *the Proposed Mobi/-Consol Pronghorn Mine,* a Denver Research Institute report prepared for the U S Geological Survey, 1977

Housing on Indian reservations raises several problems that are different from those discussed above. A boomtown syndrome probably won't occur on most reservations, although the social stress created may be similar. The number of new miners that will be involved in Indian coal production will not be more than several thousand. Most of these will be Indians already living on reservation land if the tribes succeed in making the coal companies give hiring preference to local Indians. The housing problem on the reservations is less one of shortage and more one of adequacy. The serious deficiencies in Indian housing are well-known –to Indians, at least. Table 54 presents a snapshot summary of Indian housing quality— including the Navajo Reservation — where housing needs are most severe,

In sum, the distribution of private costs and benefits of increasing Western coal production vary. Coal workers and mineowners will obviously benefit from new employment opportunities. Coal-related services will establish themselves in regional centers, and locally owned commercial enterprise may expand. Spendable income in local communities will increase rapidly. The material quality of life will rise for some.

On the other hand, these private benefits are not distributed evenly. Local capital liquidity is unlikely to increase significantly, apart from the savings deposited by wage earners. Local businessmen may not be able to expand or modernize their services, and national chains may take over their markets. Opportunity costs may be high in Western coal development. Ranching, farming, and tourism may be curtailed in coal areas. Local inflation penalizes those on fixed incomes and those whose wages are independent of the coal business. Data are not available comparing boomtown inflation rates with national or regional rates, although anecdotal evidence suggests that the former is abnormally high. Coal profits will not generally be distributed locally. Much investment will not be spent locally, either.

One important and relatively unexplored issue is the dollar cost of impact internaliza-

Table 54.—Housing Conditions of Indians in Three Western Regional BIA Areas—1973

	BIA area office		
	Billings[a]	Navajo	Albuquerque
Total number of families	6,071	23,801	8,349
Number of standard units	3,335	3,126	3,180
Number of substandard units	2,269	19,242	2,841
Families doubled up	467	1,433	2,328
Total need as percent of families	45.1	86.9	61.9
New units needed	1,861	7,324	3,332
Rehabilitations needed	875	13,351	1,837

[a]Includes Crow and Northern Cheyenne Indians in Montana
SOURCE: U.S. Congress, 1975.

tions on the dollar cost of producing Western coal. Coal companies in the West generally offer extremely high wages to attract labor. To the degree that rapid coal expansion decreases quality of life, operators may be forced either to offer increased monetary incentives to retain workers or to become directly involved in the costly business of providing community services.[97] If coal operators absorb the capital costs of, for example, a water and sewage system, their product prices will rise. It is debatable whether price-escalator provisions in utility contracts can be invoked. If the labor force perceives coal development as the source of quality-of-life decline, workers may seek unionization and even higher monetary rewards or community development clauses in collective bargaining. State and local governments may impose taxes on coal developers to finance needed services. To the degree that coal-related public costs are paid by tax revenues on Western coal, higher coal taxes may lower company profits and raise coal prices.

Western communities have had much experience coping with the short-term stresses created by booms and the long-term depressions left by the "busts." From today's perspective, it appears that Western coal growth, based as it is on long-term utility contracts, will smooth out the boom-bust cycle. However, it is likely that a considerable lag will occur in the perceptions of local residents as they weigh this boom against those of the past. Their caution is justifiable because economic diversification and planning for the postcoal years are not occurring. A long boom followed by an even longer bust may be in store. In any case, boom growth is the least preferable path of economic development. Slower and more steady growth is less disruptive and more beneficial to more people over a longer period of time. However, because coal projects are usually matters of corporate decision making, many western communities may have no choice. If this perception is shared by westerners it would not be surprising to observe a political backlash against current coal development by citizens who see their long-term interests depreciated by rapid coal developments.

[97] Richard Nehring and Benjamin Zycher, *Coa/ Deve/-oprnent and Governrnent Regulation in the Northern* **Great** *Plains* **(Santa Monica, Cal if RAND Corp , 1976), p 127**

Public Infrastructures: Costs and Benefits

The balance between public costs and benefits of Western coal development changes over time. In the 5 years needed for a mine to be developed, public services in small communities will be strained by the rapid increase in population. Demand for more and better services will usually exceed a community's tax revenue and ability to deliver services. Where county or State tax revenue increases but heavily impacted towns can't get a fair share, the financial situation is aggravated. Antitax feeling, expressed in Proposition 13-type movements, further binds local governments.

Coal development also strains local physical infrastructures — roads and bridges, water supplies and purification plants, sewage facilities, schools, and fire and police protection. Existing service systems are likely to be severely stretched and weakened. Individual pieces of these systems may collapse entirely. Short-term public costs may also be expressed in terms of community destabilization, cultural strain, social disorganization, and a general perception of decline in the quality of life.

As the mine reaches full capacity some public costs will become less serious. Tax revenue will generally increase; services should expand. The pace of growth will slow. The rate at which any given community begins to normalize demand for services with its ability to deliver them depends on a number of local factors. The most important of these are: the degree of predevelopment need, tax policy, rate of development, priorities and attitudes of the coal producer, reliability of demand for local coal, skill of local officials, extent of economic diversification, and ability of State and county governments to adapt their policies to meet the needs of localities. In some communities front-end problems, such as lack of revenue, may extend for years. The deficit may never be eliminated with available resources. These problems will be solved in some communities, to be sure, but western history shows a spectrum of success and failure concerning the ability of communities to assemble public capital and meet boomtown needs.

Western mineral development also starkly portrays the common "back-end" problem of resource depletion and community decay. When mines play out or market conditions force closure, local communities are "busted." When communities were tied to a single company or industry in the past, back-end problems were often disastrous. Since western mines have operational lives of 20 to 60 years, planning and diversified development of Western coal areas may be needed to avoid the worst public cost of earlier mineral development: ghost towns.

Most impacted western communities are now struggling to cope with the front-end problems of coal development. Such communities face the necessity of either expanding existing public services or building them from scratch. In either case, a period of 2 to 5 years exists before those services appear. Most western communities do not have adequate funds in the early stages of coal development to plan their growth and seek Federal assistance. Where coal-processing or electric-generating plants are being constructed, front-end financial problems are magnified by the overnight appearance of the temporary plant-construction crew. State-administered severance-tax income does not return to local communities on a dollar-for-dollar basis and does not begin at all until coal is actually sold.

Aside from education, public services that usually need expansion in boomtowns include fire and police protection, roads, water and sewage treatment, solid-waste collection and disposal, health-care facilities and services, detention facilities, county and municipal facilities, and recreation. For each new resident, between $1,500 to $2,300 (1975 dollars) is estimated to be required for just the capital costs of these facilities. Of this amount, roughly 75 percent is devoted to water and sewage treatment. A hypothetical town of 2,500 persons with an annual municipal budget of $20,000 would require between $1.5 million and $2.3 million capital investment if its population were to increase 40 percent (1 ,000 persons). Clearly, the front-end costs are huge in comparison to local tax revenues and bonding capacity.

Existing transportation facilities may be suddenly overloaded when coal mining grows fast. Highways break down. Coal haulage disrupts small towns. Unit trains bisect communities. A recent Colorado Department of Highways study,[98] estimated that more than $250 million would be required for primary and secondary highway construction by 1985. In six energy-impacted counties, more than four times the annual level of construction for primary and secondary highways in all 63 counties of Colorado, is needed. It has also been estimated that at least 30 new grade separations are required to maintain intracommunity access in communities suddenly beset by unit trains. Current funding in Colorado provides for one or two new grade separations per year for all purposes.

Boomtown problems are aggravated where the coal project creates revenues for one jurisdiction while the social impacts of the new mine occur in another. jurisdictional mismatches are one of the most intractable problems. The most common mismatch occurs when coal mines or powerplants are located outside a town's limits. The county collects the tax dollars while the municipality struggles to

[98] Briefing to commissioners by staff of Colorado Highway Dept

meet the needs of new miners. But the jurisdictional mismatches within a county are more easily handled than those occurring across county or State lines. There are no examples of where this inequity has been addressed except through usually meager State impact assistance programs.

The evolving balance between public benefits and public costs depends largely on local and State coal tax policies. The level and equity of public revenues depend on the mix of taxes imposed, the level of each tax, and the efficiency of the collection system. These matters often involve two or three levels of government and are always matters of political debate. Local authorities rarely impose a corporate income tax on local business. Property tax usually generates most local revenue. This burden often falls more heavily on residential and agricultural property owners than on mineral-resource owners. Leasers of publicly owned coal pay no property tax although they pay a tax on leasehold value based on production. Some counties impose specific taxes on coal. For example, most coal counties in Illinois have imposed a l-percent sales tax at the mine mouth; local and county taxes in Montana average about 5 percent; Wyoming counties average about 6.3-percent ad valorem tax based on production; counties in other Western States impose no coal-specific taxes. States differ significantly in their coal taxation schemes. These Western States impose coal taxes: Wyoming (10.1 percent in 1978); North Dakota (65 cents/ton with an inflation escalator); New Mexico (38 cents/ton steam coal and *18* cents/ton metallurgical coal); Montana (30 percent on the value of the coal at the mine mouth); Colorado (30 cents/ton for deep-mined coal and 60 cents/ton surface-mined coal) .99 Utah, South Dakota, Texas, and Oklahoma have no coal taxes. Western States also use different formulas to redistribute State-collected severance taxes to counties of origin. State and local tax policies do not seem to be a criteria for mine siting. Depending on the level of predevelopment need in each community, future tax income may or may not be sufficient to provide adequate public services following initial coal development.

The net public gain or loss from coal growth also depends on how much system deficit is present when development begins, the extent of the overload, and the level of services perceived necessary to meet the perceived need. Communities that are created from scratch have extremely high startup costs and may need subsidies for many years. But they may be ultimately more successful in providing services and achieving a net gain The more common western pattern appears to be coal-growth overloads of existing systems, which may already be below par. I n such cases, arithmetic gains in population may require geometric increases and investments in services. (For example, a 50-percent increase in population may require a doubling of the local police budget.) The greater the existing deficit and the greater the development impacts, it is more probable that there will be a small net public gain. Conversely, the smaller the existing service deficit and the smaller the development impact, the more probable that public benefits will be greater. The level of public services differs from town to town. A few examples suggest the range of experience.

Craig, Colo., is a typical rural community on Colorado's western slope. Preboom services provided by the community cost $208 per capita and were considered adequate by most residents. The 1979 estimated per capita expenditure is $344 (in constant 1973 dollars). With coal development the water system was expanded to serve a population of 15,000 but is almost at capacity with 11,000. The sewer system will be expanded to a 20,000-population capacity. Craig was not able to finance these capital projects totally with local revenue. Most of the money came from Federal and State sources, along with some industry contributions. The city has not yet resolved the issue of how to pay for a new reservoir (estimated to cost $10 mill ion).

The public infrastructure in Emery County, Utah, communities was not ready to absorb the coal-based growth that came. In some cases, services were not even adequate for the

"Coal *Week,* Apr 17 and 24,1978

existing population. Many of the small towns in the county were not required by the State to prepare annual budgets. Those that did often had budgets only l-page long. Little planning or forecasting of capital expenditures occurred. A 1978 report by the Southeastern Association of Utah Governments said that almost every town in the county needs a new municipal building. Many need to upgrade their water and sewer facilities; others need sanitary landfill operations. Every town is in need of a fire station and new equipment, and many need a massive street improvement program. 00

Gillette, Wyo., had energy-related growth in the oil and gas boom of the 1960's and the coal development of the 1970's. Even with this growth, the city's tax base has fallen further and further behind the county's, Gillette has not always had the capital needed to improve its public services. In the 1960's Gillette's bonds were issued piecemeal, with no provision for long-range planning of financial strategies. The result was poor use of the city's existing tax base in creating bonding capacity. For a time, this severely limited what the city could do. However, through the efforts of a bond counsel and a new professional town manager, these debts were largely refinanced in 1977[101]

Gillette and Campbell County have been fortunate in receiving assistance from industry in the form of in-kind contributions such as loans of equipment to clean streets or help with digging the foundation for the hospital. The members of the industrial subcommittee of the chamber of commerce have also contributed money that has been used for studies and plans for long-term city projects. [102]

Education

Public education is usually financed by State and county governments, with special categories of assistance provided through Federal programs. The local school system's ability to manage coal-generated enrollment depends on the preboom use of existing facilities, the rate of expansion and size of the new student population, and the financial ability of the community to provide additional facilities and services.

School costs are usually the largest portion of local public expenditures. Per capita expenditures for education in the West are already high. For example, the capital costs for each additional student in Gillette, Wyo., are projected to be approximately $2,500. An increase of 500 in the school population would amount to $1.25 million more in capita l expenditures. Operating expenditures are about $2,000 per student, so that 500 new students would require an additional yearly operating expenditure of $1 million. [103]

The long-term financial demands for education in Western coal communities are substantial. Whether this situation poses serious financial problems will be determined by how soon the school-age population begins to expand rapidly. Where school-age populations do not grow until coal facilities are operating, school districts may have surplus revenue. An example of this favorable situation is found in Rosebud County, Mont., where school districts are expected to enjoy substantial financial surplus at current tax rates. However, this is the exception.

Typically, the increase in school enrollment from coal-related work occurs before any increase in ad valorem tax receipts. This may cause operating expenditures per pupil to decrease. However, most States "guarantee" that these expenditures will not fall below a set amount fixed by the legislature. Therefore, the operating portion of the budget is not the main cause for concern; rather, it is capital expenditures. For example, if additional permanent classrooms are to be built or temporary ones purchased, the existing population pays, not the newcomers or the coal companies. These initial problems may be corrected if mines and

100 *Morrograph Series: Local Government* (Price, Utah: Southeastern Association of Utah Governments and Development District, 1978)

101 From 1976 and 1977 Interviews with Mike Enzl, Mayor of Gillette and a 1977 Interview with Flip McConnaughey, City Manager

"'From 1978 Interview with Dave Bell, Director, Gillette Chamber of Commerce

[103]1976 and 1977 interviews with J. O. Reed, Superintendent, Gillette, Wyo.

powerplants are placed on the tax rolls and no jurisdictional mismatches are involved.

In Moffat County, Colo., for example, school enrollment increased 29 percent from 1976-78. In the same period assessed property valuation increased 144 percent. While these statistics may suggest optimism, the fact is that the county's schools are overcrowded. Increases in enrollment have put the total student body at about 300 students over capacity. In October 1978, a $9 million bond issue was finally passed (after having failed twice) for construction of a new high school. In addition to overcrowded conditions, the school district lost 35 teachers in the summer of 1978 for a variety of reasons. A number went to work in higher paying coal projects. Although the positions were filled, there were problems in attracting new teachers, mainly owing to the high cost of living in Craig.

Much of the locally perceived impact on education involves subjective judgments about what constitutes good education. "Quality" education is an intuitively meaningful concept to most parents, but it is hard to quantify. Different communities may have different collective perceptions as to what "it" is and whether their children are currently getting "it." To the difficult question of educational quality must be added the question of who pays for it. Long-time residents sometimes object to higher property taxes and more indebtedness to pay for the education of the children of "newcomers." Moreover, coal development pressures may inflame residents over what is perceived as a lessening of educational quality. This may diminish over time as new facilities are built. But the absence of front-end monies and the high costs of permanent school facilities make the process of resolving this problem difficult. Adaption to boom conditions may take the form of increasing student-teacher ratios, shifting to half-day sessions and installation of temporary school trailers. This is likely to keep the issue of coal and education alive indefinitely. Other problems may be perceived. New teachers will have to be hired, and some, at least, may have nonlocal educational values and methods. The education system may be perceived as becoming less personal and more bureaucratic, hence less accountable. The destabilizing effects of rapid economic growth may be played out in school disruptions and student stress.

Boomtown educational needs have both a quantitative and qualitative dimension. Quantitatively, the problem is finding capital and personnel to sustain and expand existing facilities and programs. Qualitatively, the problem is matching perceptions of preboom and postboom reality with the changing nature of local education. The concern of the community about the "quality" of their boomtime education will vary according to the precise mix of short-term adaptation mechanisms and longer term expansion of services that authorities are able to orchestrate. Both newcomers and oldtimers may continue to be dissatisfied with their educational system for different reasons. Both groups may have legitimate grievances. It may be unlikely that quantitative improvement in the local educational system will produce a one-for-one, stepped increase in the community's perception that education has improved.

Health Care

Both the public and private sectors are involved in health care delivery and financing, Coal development will enlarge the health-treatment needs of local communities in various ways: more people need more care; more people need a wider range of health care; coal miners have special health needs.

Health services, which are often inadequate in rural communities before development starts, are among the most difficult to maintain in boomtowns. Medical needs typically expand at least as rapidly as population, and faster when a large proportion of the new residents are young children. If health services are limited, a smaller proportion of children may be immunized against preventable diseases. Fewer screening tests may occur. Inability to obtain early treatment may permit disease to become more serious.

The health care delivery system in western communities is limited and, by national standards, less than adequate. One eight-State study of 185 potentially impacted western towns found that fewer than half (87) had a resident doctor and about one-third (60) had a hospital. 104 Generally, the doctor/population ratio is much lower in western towns than in the country overall. Like other rural areas, the West has difficulty attracting and holding physicians. Apart from the availability of physicians and health care extenders, health care norms depend on the quality of care provided and the rate of use, both of which depend to a greater or lesser part on the individual's ability to pay. It is easy to understand the frustration coal miners and others feel when "good" health care is unavailable even though adequate insurance plans cover them.

Recent survey research in Sweetwater County, Wyo,, sheds light on the importance of adequate health services. Fully 82 percent of the 157 newcomers interviewed ranked medical and mental health services in their top five community priorities. Sixty percent of the sample said they would leave town if these services were not improved. These opinions were acted on: "The labor turnover rate was running up to 150 percent as mining employees were leaving the area because of dissatisfaction with the quality of life. " 105

Illlness-prevention systems are even less developed than treatment systems. Prevention programs are provided by both the public and private sectors. In small, rural communities, public health services are minimal, where they exist at al 1. **Immunizations,** water and sewage treatment, prenatal and postnatal care, and nutrition education are not well developed. Adequate systems are even less likely to be found on many Indian reservations. Much preventive care depends on an individual's awareness of its importance and his ability to pay. Absence of prevention measures often results in higher treatment costs, some of which are borne by public agencies. Generally, the public and private prevention systems in Western coal towns are haphazard and not well synchronized.

Coal miners have special health needs stemming from their occupation. Although western surf ace mining is statistically safer and healthier overall than underground mining, surface miners still experience a significant level of industrial injury and disease, Respiratory and pulmonary disease, hearing loss, and stress are found more frequently in miners than in the population generally, Coal's accident rate requires adequate emergency medical services at the mines and fast transportation to treatment centers. Provision of emergency services— including the training of miners as emergency medical technicians — is not required under Federal law or by most States. Some coal operators provide such training and service; others don't. Specialists in miners' occupational health problems are not found in the newer, Western coal development areas. Some practice in the older coal fields of Utah and Colorado, where UMWA and the UMWA Fund established clinics after 1950.

Other health-related services are required in stressful boom conditions, including treatment and counseling for alcoholism, child abuse, marital strain, juvenile delinquency, and mental health The rapid infusion of newcomers into well-established communities creates stressful situations among natives and newcomers alike. The smaller the community, the less likely that such services are available. However, high absenteeism and turnover rates in Western coal towns suggest that services are needed to treat the symptoms and consequences of growth-related stress.

Political Impacts

The political impacts of Western coal development may be extensive, both from the perspective of boomtown residents and in terms of the politics of further coal expansion.

Rapid population growth often generates conflict between antigrowth and progrowth factions, newcomers and oldtimers, labor and management, environmentalists and prodevel-

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[104] *Regional Profile: Energy-Impacted Cornmunities* (Lakewood, Colo Federal Energy Administration, Socio-economic Program Data Collection Office, 1 977)

'("John S Gllmore, et al , *Analysis of Financing Problems in Coa/ and Oil* Shale Boom Towns (Denver Colo University of Denver Research Instltute and Bickert,, Browne, Coddington & Assoc., Inc., 1976), p 72 opment factions, high-wage jobholders and fixed-income or low-wage persons, transients and permanents, and coal-related business and local business. These conflicts may benefit local communities in the long run if they mobilize political interest constructively and create pressure for better public services. Yet more public services almost always involve more Government regulation, which may itself become a political issue. Political cleavages resulting from coal development may shatter community life. In company towns, coal developers may dominate local politics, for better or worse. I n other places, two-party competition may result from the introduction of new interest groups. One-party systems may be fictionalized. Tightly run political machines may develop. The conflict that change produces may interact with economic and social conditions to produce widespread community disintegration and dissatisfaction. But, on the other hand, growth can create conditions where political cooperation is required to meet new demands.

Coal-impacted western communities vary tremendously with respect to attitudes toward politics and coal development, so that regional generalizations are especially risky. Nonetheless, it is reasonable to assume that some communities will eventually group themselves into two polarized alliances: progrowth and less growth. As the rate and scope of development increase, polarization is probably more likely to occur and be irreconcilable. But exceptions will be found. Some Mormons of Utah, for example, favor coal development without reservation. This prodevelopment view comes from the desire for economic development and from a set of socioreligious values arising from the Mormon experience.

Although procoal factions among Indians and Mormons may favor procoal Federal policy, they may also oppose the Federal regulation that often accompanies such policies. Western hostility toward Federal policy may be intensified by the lack of applicability of Federal aid to western boomtowns. Most relevant Federal programs make funds available to States and local governments only to remedy problems of economic stagnation or natural disasters. These conditions do not exist in Western coal communities. Hence, most Federal impact assistance funds are unavailable to Western coal towns.

Western rural county governments are largely dominated by farmer/rancher interests. County commissioners deal with few major conflict-producing issues. Those they do handle usually concern the level and distribution of taxes and public expenditures. Because of the western populist tradition and the prevalent skepticism of government in general, rural officials tend to be ambivalent toward land use planning and zoning. Their ranching and landowning constituents are strongly opposed to any intervention in their control of their property. [106]

In Gillette, Wyo., it was not until 1976 that the Gillette/Campbell County planning office really became active when the need to handle boom conditions became obvious. When planning and zoning codes were established, a 3- by 5-mile box was drawn around Gillette. The planning department's control is much greater within this area than in the rest of the county. Outside the box, the planning commission can only make recommendations to the county commissioners, who need not (and do not always) follow them. [107]

Coal growth is apt to cause drastic changes in existing political structures. Whether these changes are seen as good or bad depends on the observer's point of view. Eventually, ranching interests may lose their role as the dominant political force in local politics. Newcomers may share power with older residents, or they may supplant them entirely. Newcomers are likely to bring with them different

"""" **Our findings reveal that a significant feature of the study area is Its traditional rural abhorrence of planning The area's residents consistently and strongly resist the Idea of telling people what they can and cannot do with/on their land Almost 60 percent state that no one but the owner should have any say about how privately owned resources are used. " Community Service** Program, University of Montana, *A Study of Social Impact of* **Coa/ Development in** *the Decker-/Birney Ash/and Area* (Helena, Mont,: Montana Energy Advisory Council, Office of the Lieutenant Governor, 1975), p. 20

"" Based on a 1978 interview with Dave Ebertz, former part-time City Manager, Gillette values and expectations that may be at odds with those of the existing residents. Political change in coal communities is driven by the influx of new residents. One study of southeastern Montana found that newcomers and oldtimers tend to stay apart. For the most part, newcomers have not been accepted into established social structures.

Often, changes in boomtown political culture will not come easily. Conflicts may occur between newcomers and oldtimers. There may be more urban vs. rural strain, as well as an increase in industry vs. environment issues. There may be more concern over and need for Federal intervention as urbanization takes place. Unions r-nay become *more* of an issue and possibly a political force.

It is difficult to predict whether such changes will be beneficial to the community in the long run. Many preboom residents will not favor them. Conflict may not be viewed favorably by either oldtimer or newcomer. Yet as assimilation and adaptation occur, conflicts may be resolved.

Social Impacts

In preboom western towns, informal social controls shape community social structure. 08 Doors are rarely locked because everyone knows everyone else. Family violence occurs less often. Teenage drug usage may not be a serious problem because of stable and familiar social norms and the community's isolation. Alcoholism is considered more an individual than a community problem. This kind of social structure is vulnerable in boomtowns. Some of the changes that occur are not beneficial. High-growth communities often have increased crime and mental health problems. juvenile delinquency grows. Divorce and family disruptions are more common.

In response, communities usually expand their official control mechanisms to compensate for the loosening of informal social controls. Police forces are enlarged. Mental health clinics either increase in number or add to their caseloads. The emergency room of the hospital and social service agencies are busier than before.

Craig, Colo., provides a good example of what can happen to a community impacted by a large construction work force. Rapid population growth (a 47-percent increase between 1973-76) coincided with an increase in negative social behavior, as suggested by the following: 09

Problem area	*Percent increase 1973-76*
Substance abuse	**623**
Family disturbance	**352**
Self-respected emotional disorder	**45**
Child abuse/negiect	**130**
Child behavior problems	1,000
Crimes against property	222
Crimes against persons	900

While negative social impacts are frequently reported, they represent only part of the picture. The other part involves many examples of citizens organizing to provide social, recreational, and cultural activities. Many residents of coal-impacted communities speak with pride and satisfaction of the informal initiatives they have taken to improve the quality of life in their communities. Mayor Enzi of Gillette reflects this pride. "Gillette is virtually in the process of building a new town, and there is room for everyone's participation. *In* Gillette, the only newcomer is the spectator who is unwilling to pitch in. "

The farmer/rancher interests also have ambivalent attitudes toward coal. Development may make marginal farmland valuable for future housing sites, thus giving its owners the opportunity to sell at a great profit. The farmer/rancher who does not want to sell may work his place part time and seek full-time employment in the mines. On the other hand, ranchers

'O' Sociologist William Freudenberg has concluded that the primary reason for stabllIty in small communities IS because there IS a kind of "social buffering" at a very localized small group/primary acquaintance level, which provides a source of continuity for feellngs of personal worth and social Integration WIllam Freudenberg, *The Social Impact of Energy Boom Development on Rural Communities: A Review of the Literature and Some Predictions,* paper presented for the American Sociological Associatlon, session 77, August 1976.

109 Includes cases reported to law enforcement, social services, hospital and mental health clinic in Craig The number of cases was averaged from November/December 1973 and November/December 1976 Denver Research Institute, *Impacts on Western Communities* (OTA contractor Report, 1978), p 63

and farmers may not be able to replace their workers who switch over to high-paying jobs. Also, they may resent using good agricultural land for mining. Fruit growers around Paonia, Colo., were unhappy about orchards being taken out of production. Finally, they may be skeptical about different kinds of people moving into a homogeneous community.

Utah's policy favors energy development almost without qualification because of the State's desire for economic expansion. As a whole, Mormon communities share this desire, but some have reservations. Rural, somewhat isolated Utah towns that have high percentages of Mormons may not welcome outsiders. Newcomers are not easily integrated. Residents of Kane County, Utah, wanted the Kaiparowits powerplant built but did not want plantworkers to live in their communities. They persuaded coal developers to plan a new community to house the outsiders.

People in places like Gillette, Wyo., which can now be classified as mid boom, see coal development as inevitable. They know their county contains vast coal resources and that new mines will inevitably open. According to Mayor Enzi, the people in Gillette no longer challenge growth but have accepted it. This attitude has taken 10 years to evolve.

Some westerners see no real benefits from coal development. Those who have left an urban environment and have settled in beautiful, small western communities are often against development. They have chosen their new home, typically on Colorado's western slope, because of its environment. They do not want it changed. In a few places on the western slope, miners with Brooklyn accents can be found working in the mines and arguing for no more growth. Their attitudes are not contradictory. Their feelings are often shared by some long-time residents and their children, who are concerned about the influx of outsiders and environmental protection. They often form or ally themselves with environmental organizations on issues like air and water quality and degradation of the quality of life. Sportsmen and outdoorsmen are often against development because they do not want to lose their hunting, fishing, and backpacking areas to the coal industry.

The tourist industry shares these concerns. It may face competition for employees and loss of land for recreational purposes, as well as a lessening of the area's attractiveness to tourists. Tourism may suffer from the increased demand for temporary accommodations caused by transient construction workers.

The elderly may or may not have definite feelings about coal development, but they are usually hit hard. Some rural communities have a relatively high proportion of retired people living on fixed incomes. As the town booms, prices (particularly rents) are inflated, squeezing those with low or fixed incomes.

The degree to which prodevelopment, go-slow development, or antidevelopment attitudes exist in a given area depends on the makeup of the community and the characteristics of the coal project. Articulate, politically active newcomers can play an important role in deciding whether or how much coal development will take place.

The one point that can be drawn from the sparse information on the social impacts of Western coal development is that instability is created. Sometimes this appears to be as much a result of the uncertainty attending coal development as from any actual changes that have occurred. Social change will come with coal development, but it is doubtful that it will affect western towns uniformly. Some towns will ultimately benefit from this change; others probably will not.

Coal Development on Indian Lands

Present and Potential Production

It is estimated that some 100 to 200 billion tons of recoverable coal lie beneath Indian lands in the West. There are currently 10 coal leases on 239,402 acres of Indian land. Although they are only a fraction of the total coal under lease in the West, Indian leases have a special importance because of their

"°From a 1978 interview with Flip McConnaughey, City Manager, Gillete, Wyo size and coherence. The average Indian lease covers almost 24,000 acres —16 times larger than the average Federal and 25 times larger than the average Western State lease. Each Indian lease is large enough to support large-scalemining projects,

Five mines now operate on Indian land. Four of these mines rank in the top 10 largest in the country. They produced approximately 22.9 million tons of coal in 1977, almost 14 percent of the coal mined in the West,

Three reservations— Navajo, Hopi, and Crow– now host coal mines. Several others— Southern Ute, Uintah and Ouray, Fort Berthold, Northern Cheyenne, and Zuni — have excellent potential for coal mining. The Department of the Interior lists 25 Indian reservations as coal owning. Estimates of surface- minable capacity on these reservations ranges from **217 million to 326 million tons per year by the mid- to late-1980's. Actual production,** however, may be considerably less.

The extent to which Indian coal is developed will depend on decisions made by each tribe,

A key to understanding how — and under what conditions— coal development will take place may be found in the history of coal leasing and mining on Indian lands. The legal framework within which coal development has been conducted is shaped by the unique trust relationship between the Federal Government and tribes.

The basis of the Federal-Indian relationship may be found in the treaties, congressional acts, and executive orders that began in colonial days. Treaties were used primarily to secure lands for white settlement and to maintain peace with the tribes. In return, some lands–a small portion of the land the tribes once owned —were reserved for Indian tribes, with guarantees of protection and certain services from the Federal Government.

Among the services provided by the Federal Government is advising the tribes on the management of their resources. In the past, Indian coal was developed under standard-form leases arranged for and managed by the Bureau of Indian Affairs (B IA) in the Department of the Interior. BIA advised the tribes as to whether, to what extent, and under what terms their coal would be developed. Tribes are no longer satisfied to rely on BIA for decisions regarding their resources.

In March 1973, one tribe—the Northern Cheyenne– became so dissatisfied with leases it had signed with B 1A advice, that it petitioned the Secretary of the Interior to cancel all outstanding coal leases and permits on its reservation. A year later, the Secretary ruled in favor of the Northern Cheyenne and declared the leases "technically invalid. "

Since this ruling, other lease-holding tribes have tried to renegotiate or cancel contracts, accusing Interior of violating its trust responsibilities to protect tribal interests.

Despite the controversy surrounding these contracts, many tribes see coal development as an opportunity to bring badly needed revenues to tribal governments as well as income and jobs to tribal members, Most feel, however, that they will not realize the potential benefits of coal development unless they develop the capability to manage development themselves. Tribes are building their own staff capabilities so that they can determine the quantity and quality of their resources, analyze the impacts of potential development, make informed decisions concerning their resources, and manage and regulate coal production activities and impacts.

Coal Development Impact

Rapid or extensive coal development often causes adverse social, economic, and environmental impacts. This is especially true on Indian reservations.

Most reservations are sparsely populated and have few towns. I n a few cases, coal mining may spawn the growth of instant towns to provide support services for new mines. Even if future tribal contracts provide for Indian hiring preferences, non-Indians will be drawn to the mines as technicians and other management personnel. Non-Indian businessmen may open stores on or near reservations. Although only 5,000 to 10,000 miners are likely to be involved in Indian coal development over the next 10 years, the ripple effect of their new-found income, work habits, and social relations are likely to be disproportionately large on established Indian societies.

Coal development would also affect tribes more than other rural communities because the reservations have a dearth of services and facilities, such as sewers, housing, schools, etc. Any population increase—even a small one—would strain already-overburdened systems. Cultural differences between the tribal members and outsiders who migrate to the area to work on the project can augment the problem.

In addition, coal development impacts Indians more than other rural residents because of the importance of the land to Indian tribes. For some tribes land has religious significance; for others, certain areas are sacred. For all of the tribes, land is an important tie to their history and future.

Finally, coal development will affect tribes more than most small, isolated communities because tribal governments have great difficulty generating revenues needed to offset demands created by development. Conventional methods of raising revenues, such as taxation, issuing bonds, obtaining private financing, or receiving Federal funds directly, are either not available or difficult for tribes.

All of these impacts can serve as deterrents to the development of Indian coal unless tribes can effectively manage them.

Conclusion

Coal development on Indian reservations is likely to increase as tribes gain greater control over their own resources.

Tribes are building up their staff capabilities so they can determine the quality and quantity of their coal reserves, negotiate with energy companies, and regulate the companies' operations. Tribes are looking at alternatives to the standard form lease used in the past. Tribal coal holdings are attractive to energy companies because of their large size and the quality of the minerals. And coal development— if carefully managed by the tribe— is attractive to many Indian leaders as a solution to their dire poverty — average per capita income is between $1,000 and $1,500 annually— and unemployment–40 to 70 percent depending on the reservation. However, many energy projects on the reservation have been met with bitter grass-root protests.

Coal development will have major socioeconomic and cultural impacts on Indians. The reservations lack public infrastructures capable of absorbing mining-related population. The tribes have difficulty raising revenues to manage the impacts of coal development.

Tribal leaders interviewed agree on several conditions for coal development. First, that the majority of coal-related jobs be filled by Indians. Second, that fair market value is obtained for the coal. Third, that coal development will enhance tribal sovereignty by recognizing tribal jurisdiction over environmental standards and by preserving the integrity of Indian land and culture. Tribes want to ensure that coal development is not a one-crop economic development that leaves them several decades from now without any resources, with scarred lands and shattered cultures. Thus, tribes are expected to demand higher coal royalties, more control over the conditions of mining, and more social benefits from coal development.

Social Impacts of Transportation

Much of the increase in mine-to-market coal traffic will probably make use of existing routes. Expanded operation, rather than new construction, involves additional safety and environmental costs to the public.

All forms of moving coal –or coal-fired electricity – have social costs. Trains interrupt motor vehicle traffic and contribute to accidents at grade crossings. More than 1,900 persons were killed and almost 21,000 injured in railroad accidents in 1974.[1] Most of these accidents were at grade crossings. Perhaps, 15 percent or more of all train accidents involved coal-hauling trains. Truck haulage, which is

'' 'Compiled by OTA from Federal Railway Administration data.

"*Coal represents about 20 percent of all rail traffic, but for reasons such as frequency of grade crossings and routes, coal traffic probably accounts for less than 20 percent of rail accidents compiled extensive in Appalachia, adds to highway hazards and congestion. The big trucks accelerate the deterioration of the roadways, especially when weight limits are not enforced. Trucks and trains are noisy. They disturb large numbers of people where they pass through heavily populated areas. Barge haulage is safer to the public than either truck or rail carriers, but it adversely affects recreational boating, fishing, and swimming to some degree. Barge wakes may erode river shores and islands. High-voltage transmission lines may produce harmful electric-field effects.

Railroads now carry about 65 percent of all coal from mine to consumer. This pattern is likely to continue. Aside from the needs to improve rail-haulage capability, safety and environmental costs may require attention. Two problems, in particular, stand out. First, disruption to community life caused by rail traffic through population centers will increase as large mines are developed in the West for customers several hundred miles distant. Haulage through a given point may approach the equivalent of *18* hours a day in some heavily used areas. Rerouting may be desirable in some communities to minimize this inconvenience.

Second, grade-crossing accidents will increase as haulage increases unless remedial steps are taken. Underpasses and overpasses are standard ways of eliminating rail-haulage risks in population centers. Automatic, lighted barrier gates are safety features at crossings that are often not found at rural crossings. Because of the cost and inconvenience, railroads are often reluctant to reconstruct their lines or add safety features, such as lights and mechanical crossing guards. Table 55 illustrates four costs— noise, vehicle delay, injuries, and deaths– associated with a hypothetical 36-percent increase in coal trains per day (measured in ton miles) between a Montana mine and a Wisconsin utility. At 26.6 trains per day, 53,000 persons would be exposed to excessive noise; 983 hours of vehicle delay per year would occur; and 9 fatalities and 37 injuries would happen at grade crossings. Yet it should be noted that the increase in noise and accidents is not proportional to the increase in volume although vehicular delay is greater.

Deaths and injuries associated with the total transport component of the coal cycle were calculated in a recent study. [3] For a 1,000-MW coal-fired powerplant with a 0.75 load factor, MITRE estimates 2.3 fatalities and 23.4 injuries occur annually. That translates nationally to about 460 deaths and 4,680 injuries each year from coal transport. As coal production increases, the scale of human costs will grow unless countermeasures are initiated.

The alternative to coal haulage is high-voltage electric transmission, which carries its own costs. Intense electric fields surrounding these lines disturb people living along their rights-of-way. Noise and radio interference have been noted.

Concern has developed about health and safety near the lines. Tests are now underway to measure the effect of high electric fields on plants and animals. For voltages up to 500 kV, no evidence exists to indicate health hazards, but very little is known about the long-term effects of low-voltage electric fields on human health. At higher voltages–say at 765 kV–adverse reactions have been reported that may have been caused by the fields. As the voltages increase, potential health effects may increase. Much work is needed to determine the possible health costs of high-voltage transmission lines carrying more than 765 kV. DC presents fewer potential problems because it carries an equivalent amount of AC power at lower voltages. But because the character of DC electric fields differs from AC fields, other human health effects may occur. Objects near DC lines may be charged with voltages of 20 to 40 kV, enough to cause annoying shock.

Impacts on Coal-Utilization Communities

Analyses regarding the socioeconomic and environmental impacts of an increased national reliance on coal have heretofore focused on

[113] MITRE Corp./Metrek Division, *Accidents and Unscheduled Events Associated With Non-Nuclear Energy Resources and Technology,* February 1977, p. 51.

Table 55.—impacts of Increased Coal Train Traffic Carrying an Assumed Added Volume of 13.5 Million Tons Per Year from Colstrip, Montana to the Vicinity of Becker, Wis.

	Present	Future	Percent increase
Trains per day (average)	19.6	26.6	36
Population exposed to noise levels exceeding EPA community Guidelines[a]	45,000	53,000	18
Vehicle hours delay per year at grade crossings	602	983	63
Injuries per year at grade crossings	33.1	36.6	11
Deaths per year at grade crossings	8.6	9.4	9

[a] Day night average sound level, a noise exposure measure weighted more heavily for night then for daytime, of 55 DBA has been judged by EPA to be the maximum allowable to protect public health and welfare with an adequate margin of safety in residential communities.
[b] 695 crossings were analyzed.
SOURCE: Science Applications, Inc., *Environmental Impacts of Coal Slurry Pipelines and Unit Trains*, Office of Technology Assessment, 1977

the extraction phase, i.e., on coal mine communities where new facilities for the preparation and combustion of coal are located.

A general knowledge of the coal industry suggests a number of categories of potential impact. These can be divided roughly into those that should be on balance beneficial to the host community and those that will be predominantly harmful. The former consists mainly of economic impacts. The establishment of a coal preparation plant or powerplant can be expected to provide employment opportunities in the construction, operation, and maintenance of the plant and in supporting community services. The plant may also contribute substantially to the county tax base and benefit other local taxpayers.

The major potential negative impacts would appear under the headings of environment, public safety, and convenience. The first category includes air and water pollution, noise, esthetic (i. e., visual) impacts, and possible concerns relating to the health effects of high-voltage transmission lines from powerplants. Safety and convenience refers to concerns such as coal-carrying truck or rail traffic and the potential disruption of recreational and other community activities.

D g C W 9

Surprisingly, virtually no attempt has been made to ascertain public attitudes toward existing coal powerplants. At a minimum, such information should be useful in developing siting strategies for future installations. Consequently, OTA undertook a survey of residents living near three coal-fired powerplants in the Middle Atlantic region: the Chalk Point plant in Maryland, the Chesterfield plant in Virginia, and the Bruce Mansfield plant in Pennsylvania. The results of that survey indicate that the public regards increased employment opportunities as the most significant advantage of living near such a plant (table 56). Other advantages cited by the public included the perception that coal-generated electric power is more economical than other sources of energy such as oil and gas. The public also perceived benefits to the Nation in shifting from imported oil to domestic coal. A relatively small percentage of respondents cited tax benefits and the perception that coal-fired plants were safer than nuclear. On the negative side, a large percentage of the public (52.3 percent) cited air pollution as the most significant disadvantage associated with living near a coal-fired powerplant, regardless of plant location or distance. Other disadvantages cited were water pollution, noise, adverse visual impacts, and recreational impacts (fishing, boating, and swimming). In an attempt to measure the air and water pollution impact, respondents were asked to rate the level of pollution in their communities and indicate the impact the plant had on that level. Almost half of the respondents indicated the air and water pollution levels were severe but only a small percentage thought the plant was largely responsible (6.4 percent for air; 4.8 percent for water), The disparity between the level of impact and its perception is due in part to the fact that respondents felt that industries located in the same area contributed to the pollution problem. A relatively small percentage of respondents indicated that traffic to and from the plant had a negative impact. **In an effort to elicit an overall summary judgment concerning** the local impact of such a plant, respondents were asked their attitude regarding construction of an additional coal-fired powerplant in or near their community. **In all three cases, a large percentage of respondents living within 3 miles of the plants opposed the construction of a new plant. In addition,** when given a choice between coal and nuclear powerplants, the public did not express a strong preference for either (39.3 percent preferred coal; 36,8 percent preferred *nuclear). In* many cases the preference for coal was attributed to perceptions that nuclear powerplants were unsafe and fear of radioactive fallout. In general, the balance of positive and negative attitudes toward coal plants correlated more closely with the distance respondents lived from the plant than with any other variable, including the degree of plant compliance with State environmental standards.

Table 56.—Survey Results

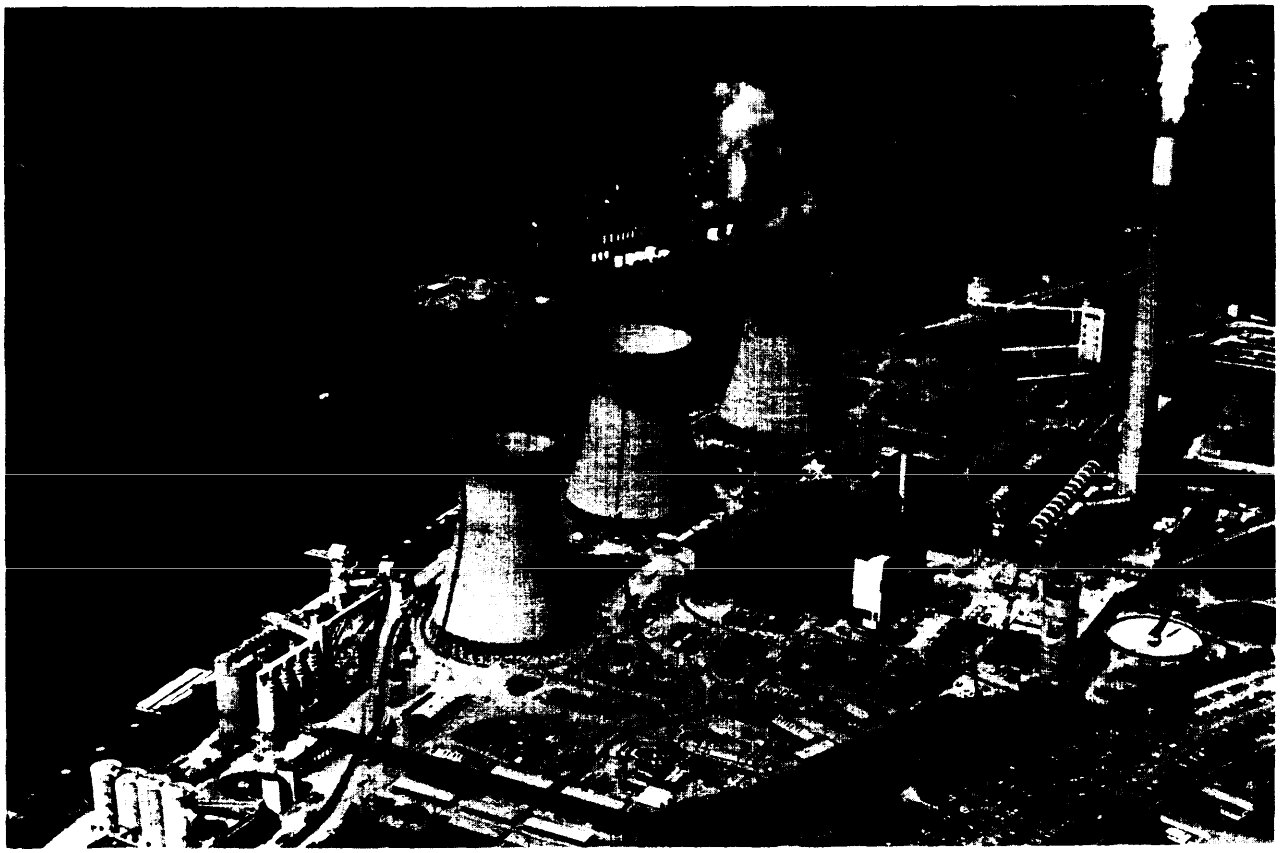
Percentages			
Chalk Pt.	Chester.	B. Mansfield	
			3. Air pollution level
28.2	17,5	8.1	Not a problem.
37.2	34.1	24.3	Some, but does not disturb anyone.
23.8	42.7	46.8	Occasionally reaches severe levels.
1.1	3.3	12,7	Usually severe and interferes with some community activities.
9.7	2.5	8.1	Cannot rate level.
			4. Plant impact on air pollution
4.8	2.0	13.8	Severe with frequent odor, dust, or damage,
29.7	18.7	34.3	Moderate with occasional odor, dust, or damage
31.5	28.0	27.0	Sllght with little odor, dust, or damage.
34.1	51.3	24.9	No noticeable impact.

Table 56.–Survey Results (continued)

Percentages			
Chalk Pt.	Chester. B.	Mansfield	
			5. Water pollution level
8.6	33.9	8.6	_____ Usually severe and interferes with some community activities.
33.0	27.0	25.5	_____ Occasionally reaches severe levels and sometimes interferes with community activities.
24.4	15.5	27.6	_____ Some, but does not disturb anyone.
16.8	11.5	14.8	_____ Not a problem.
17.2	12.1	23.4	_____ Cannot rate level.
			6a. Plant impact on water pollution
7.9	2.9	5.1	_____ Severe with major changes in temperature, level, or chemicals in the water.
25.7	13.1	24.3	_____ Moderate with some changes in temperature, level, or chemicals in the water.
29.4	31.1	27.5	_____ Slight with minor changes in temperature, level, or chemicals in the water.
37.0	52.9	43.1	_____ No noticeable impact.
			6b. If plant has impact on water pollution, which of the following apply?
19.3	6.0	6.1	_____ Fishing is better.
35.0	21.9	33.7	_____ Fishing is not as good.
2.5	4.1	7.5	_____ Boating and swimming are better.
41.4	23.8	31.6	_____ Boating and swimming are not as good.
7.5	6.8	22.1	_____ Drinking water is polluted.
13.2	18.9	10.5	_____ Other, please specify.
			7. Plant impact on public health
0	0	.7	_____ Public health very much better.
4.1	1.5	3.0	_____ Public health somewhat better.
79.0	84.0	61.1	_____ No difference in public health.
15.7	13.3	29.3	_____ Public health is somewhat worse.
1.1	1.2	5.9	_____ Public health very much worse.
			8. Plant impact on public safety or convenience
3.0	4.7	3.6	_____ Public safety or convenience very much better.
5.2	9.4	8.0	_____ Public safety or convenience somewhat better.
79.9	79.8	50.0	_____ No difference in public safety or convenience.
10.4	5.3	29.6	_____ Public safety or convenience somewhat worse.
1.5	.9	8.8	_____ Public safety or convenience very much worse.
			9. Plant impact on area attractiveness
.7	.6	3.9	_____ Very much more attractive.
6.2	1.7	11.0	_____ Somewhat more attractive.
35.4	61.2	24.9	_____ No difference in attractiveness.
38.0	30.1	32.4	_____ Somewhat less attractive.
19.7	6.4	27.8	_____ Very much less attractive.
			10. Impact of power transmission lines on area
.4	.6	1.8	_____ Very desirable effect.
2.2	2.3	5.1	_____ Somewhat desirable effect.
47.6	52.9	46.9	_____ No noticeable effect.
35.4	38.8	30.7	_____ Somewhat undesirable effect.
14.4	5.5	15.5	_____ Very undesirable effect.
			11. Plant impact on area activities
1.1	3.8	.7	_____ Plant grounds and facilities available for community use.
17.8	16.8	19.2	_____ Plant tax payments prevent taxes on home from being higher.
14.4	11.2	30.8	_____ Noise or air pollution or water pollution discourage community activities.
61.0	63.5	42.0	_____ No noticeable impact.
			12a. Mode of transportation
56.6	64.6	0	_____ Train.
2.9	1.7	49.4	_____ Barge.
5.4	.3	.4	_____ Truck.
23.3	13.6	8.2	_____ Don't know.

Table 56.—Survey Results (continued)

Percentages			
Chalk Pt.	Chester.	B. Mansfield	
			12b. Transportation impact on community
6.1	2.8	22.9	- Yes.
93.9	97.2	77.1	---- No.
			13. Favor/oppose construction of new plant
28.2	11.8	23.6	Strongly oppose.
21.1	16,7	21.6	- Somewhat oppose.
24.6	33.4	27.7	– Neither favor nor oppose.
14,6	23.0	12.7	- Somewhat favor.
11,4	15.1	13.4	Stongly favor,
			14. Preference for coal or nuclear plant
34.4	46.7	38.7	-. Coal-fired.
41.1	39.0	33.9	— Nuclear,
24,4	14.3	27.4	-- Don't know.
			15. Distance from home to plant
31,4	9.3	61.9	--- Less than 3 miles.
27.1	38.5	27.9	— Between 3 and 6 miles.
22.5	29.2	4.8	– Between 6 and 10 miles.
14,3	13.9	1.0	– --- More than 10 mtles.
4,6	9.0	4.4	-.— Don't know.



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ESTHETIC IMPACTS

Introduction

The esthetic impacts of increased coal utilization are difficult to quantify and evaluate because procedures for measuring esthetic impacts have not been established. In part this is a result of the subjective nature of esthetics. For example, Webster defines esthetics as "beauty or sensitivity to beauty. " The response to an esthetic impact, positive or negative, is largely dependent on value judgments.

Consequently, a great deal of uncertainty exists regarding the role esthetics should play in affecting public policy.

Section l02(2)(B) of the National Environmental Policy Act calls for the consideration of esthetic impacts in decisionmaking but does not provide assistance in determining what methods and procedures should be developed to facilitate that consideration. Some attention has been given to the formulation of quantifiable indicators but these are still in the very early stages of development, Table 57 illustrates work in this area.

The most obvious problem is the fact that esthetic impacts are perceived differently by different individuals and groups. Although no one finds strip mines esthetically pleasing, there are individuals who feel that the construction and operation of coal utilization facilities will have a positive impact. For example, some feel reclamation is an opportunity for improving the landscape. Others argue, however, that the construction and operation of coal utilization facilities will have adverse esthetic impacts; changing the natural characteristics of an area and its ecosystems is viewed as detrimental. Furthermore, in some instances esthetic impacts can be used as a surrogate for other concerns, such as opposition to government and industry, and resistance to outsiders. An example of this is the Kaiparowits controversy where fear of esthetic impacts were used as a basis to mobilize support from a broad-based national constituency. Although strong local support was given to the development of the Kaiparowits plant, a national constituency that views air pollution impacts on nearby pristine areas as unacceptable actively opposed the plant.

The variable most often used to measure esthetic impact is change. Present EISs generally reflect the view that changes in the environment are negative. In addition, esthetic impacts identified in EISs appear to be of an immediate or first-order kind; EISs do not identify beneficial second-order esthetic impact associated with social and economical benefits (libraries, theaters, etc.). Legislation also appears to embody the assumption that change is negative. This is evident in the language of the prevention of significant deterioration standards for air quality. There does not appear to be any firm basis for defining all change from the natural state to be bad, however.

Table 57.—Esthetic Judgment Categories

Esthetic judgment					
Air esthetics	Water esthetics	Landscape esthetics	Biota esthetics	Sound esthetics	Equality of esthetic opportunity
Visibility	Clarity	Urban dominated	Population	Background sound	
Odor	Floaters	Mountain dominated	Variety	Intermittent sound	
Irritants	Odors	**Desert dominated**	**Health**		
		Agriculture dominated	**Location**		
		Forest dominated			
		Water dominated			

SOURCE. Adapted~rom Gum, et al , 1974" 34.

Photo credft: Earl Dotter

Ellsworth, Pa. Slag pile in the background

Mining

A major concern in the West is whether reclaimed land can be revegetated in an area with limited rainfall Although similar concerns are expressed in the Central and Eastern regions, revegetation is easier there because of the higher levels of rainfall and thicker soil profiles Because of thin coal seams, however, as much as 10 times more land in the East must be stripped in order to provide the same quantity of coal as in the West. Contour mining in mountainous areas produces still another serious esthetic impact. Often the highwall is visible for miles. Reclamation of contour mining is costly and difficult and may appear slightly artificial. But if properly reclaimed, nonmountainous land can be used for many purposes, including agriculture, recreation, forestry, housing, and industrial development. Another impact associated with strip mining is a reduction in visibility due to dust. This impact is probably of greater concern in the West where rainfall is limited Noise is another impact from mining. Although blasting noise is not identified as a serious problem, it is an annoyance to individuals who live near the m inc. The most significant visual impact resulting from underground mining is subsidence (uneven sinking of land surfaces). This impact is a significant concern in the Central and Eastern coal regions.

Transportation

Several esthetic impacts result from the transportation of coal. Unit trains produce a noise level of about 9s decibels; these levels may remain as high as 55 decibels within one-half mile of the track. At present, noise from transportation affects trackside residents and as rail haulage increases with expanded production, noise, and dust will become more frequent and more serious annoyances. Highways also contribute to noise pollution, and both highways and railroads may be considered unsightly. However, the most obvious visual transportation impact is from transmission lines. The lines are especially unsightly in scenic and residential areas and are visible for miles. Tower design as well as proper siting could possibly reduce the impact.

Combustion

Visually, coal-fired electric powerplants are rarely pleasing to the eye. Often stacks are visible for miles. In addition, coal piles surrounding the plant are unsightly and may produce dust. Large-scale coal utilization facilities can significantly reduce visibility and alter the natural coloration of the sky. During an inversion, visibility may be reduced even more. Gray skies associated with heavily industrialized areas may suggest what is to come if coal utilization is accelerated. Individuals living in close proximity to the facility may experience noise and odor impacts, but these do not appear to be a serious concern at this time.