A REPORT ON

MINING NARRAGANSETT COAL

by

NEW ENGLAND FEDERAL REGIONAL COUNCIL

ENERGY RESOURCE DEVELOPMENT TASK FORCE

COAL COMMITTEE

JULY 1977

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PREFACE

This report is a product of the New England Federal Regional Council's Energy Resource Development Task Force. The Federal Regional Council is an interagency, intergovernmental coordination group. It's purpose is to make a very complicated three tiered governmental system efficient and responsive to the real needs of all citizens. The Federal Regional Council of New England membership includes the eleven principle grant making federal agencies:

Community Services Administration
Department of Commerce
Department of Health, Education & Welfare
Department of Housing and Urban Development
Department of Interior
Department of Labor
Department of Transportation
Environmental Protection Agency
Federal Energy Administration
Farmers Home Administration
Law Enforcement Assistance Administration

and the Army Corps of Engineers, New England River Basins Commission, the New England Regional Commission and the U.S. Civil Service Commission.

The Federal Regional Council's Energy Resource Development Task Force is composed of representatives of several federal agencies, the New England Governors, the New England Regional Commission and the New England River Basins Commission. The Task Force Chairman is Robert W. Mitchell, FEA Regional Administrator.

Principle objectives are to:

1. Reduce the Region's high dependence on petroleum and its attendant high costs.

2. Reduce the Region's adverse weighted average energy cost as compared with the balance of United States; and thereby,

3. Improve both New England's energy posture and industrial investment climate, by providing an inter-agency process that will most efficiently meet anticipated needs and reduce the lead time required for energy development.

The '77 work of the Task Force has been carried out under the leadership of seven Federal agencies in 12 of the following 14 specific work areas covering the various aspects impacting upon energy in New England.

<u>Environmental Protection Agency</u>
- Refineries
- Bulk Power Plants
- Energy Recovery

<u>Federal Energy Administration</u>
- Energy Statistics & Projections
- Gas Facilities Monitoring
- Emergency Storage Monitoring
- Wood Utilization

<u>DOD - U.S. Corps of Engineers</u>
- Hydro-Electric

<u>DOT - U.S. Coast Guard</u>
- Energy Related Marine Terminal Facilities

<u>Bureau of Mines</u>
- Coal

<u>Department of Commerce</u>
- Coastal Zone Management

Department of Housing & Urban Development
Solar

Unassigned
Outer Continental Shelf
Utility Corridors

The Coal Committee was formed to answer the question:

How can coal contribute in solving New England's energy problems?

Actually, the potential for future coal use in New England will be determined primarily by the answer to another question:

Can coal be utilized economically in New England in compliance with environmental standards?

The Coal Committee attacked the above question from what is basically a management by objectives approach. The basic objective was that the answer to the above question should be: Yes.

The Committee's initial report, entitled "New England Potential for Increased Use of Coal", was published in September 1976 and contained 27 specific action recommendations. Two of the priority recommendations were that:

> "A test project should be conducted at an existing power site to determine the economics and environmental effects of burning available coal at a New England power plant without retrofitting of Flue Gas Desulfurization equipment." and
>
> "The present Narragansett Basin (coal exploration) study should be funded to its completion."

Both recommendations are in the process of implementation. This report was prepared in response to questions about the feasibility of "Mining Narragansett Coal."

Members of the Committee all have other primary assignments to carry out within their respective agencies. The Coal Committee is an on-going activity and will continue to work to facilitate the implementation of the recommendations contained in the initial report. Comments and questions from readers of Federal Regional Council Energy Resource Development Reports, and new related information, are always welcome and should be addressed to the Energy Resource Development Task Force Chairman, Robert W. Mitchell, Federal Energy Administration, 150 Causeway Street, Boston, Massachusetts 02114.

CONTENTS

INTRODUCTION

In selecting a system to mine Narragansett Basin coal there are several paramount concerns that will determine the process. The system selected must be that which combines the highest degree of safety for mine personnel with the lowest consistent mining cost per ton of product. It must also combine maximum recovery of coal per acre consistent with a due regard for the ecology of the area and with minimum surface disturbance.

Within these parameters there are physical factors which influence possible mining methods. These factors include:

(1) Topography and other physiographic conditions

(2) Amount and type of overburden

(3) Total size of the coal reserve in the block to be mined

(4) Coal seam characteristics including thickness, variability and irregularities, dip or pitch of the seam, partings, hardness and strength of the coal, nature and strength of seam roof and bottom, presence and quantity of methane, quantity of water likely to be encountered, nature and direction of faults, jointing, cleavage, folds, and other geologic structural features affecting the seam.

These, and many other data must be collected, collated, and reviewed before any design of a mining system can begin.

THE NARRAGANSETT BASIN COAL PROBLEM

The coals of the Narragansett Basin involve no intrinsic mining problems that have not been faced and overcome somewhere else. But they have problems present in unique combination.

The identified beds of anthracite appear to be highly folded so that most of the coal lies now in steeply pitching seams. Seams which are broken, at irregular intervals, by the intense faulting that the Narragansett basin has been subjected to. Coal can be mined irrespective of dip or pitch involved. However, when the working angle exceeds about 20 degrees, modern continuous conventional coal mining methods cannot be applied and coal must be extracted using methods more similar to those applied in metal mines pursuing pitching deposits.

Not only do the Narragansett Basin seams suffer from intrinsic problems, they also face extrinsic difficulties in the form of deep overburden, high watertable, low, swampy terrain in some areas and an urbanizing or urbanized surface in others, special "coastal zone" and environmental concerns, and an ambient local political atmosphere that can at best be characterized as ambivalent toward coal mining.

This paper addresses itself to summarizing the probable mining techniques that would best permit coal development within economic and technologic possibility while making a successful compromise with the physical and cultural environmental reality.

PROBABLE NARRAGANSETT BASIN COAL MINING TECHNIQUES

The combination of steeply dipping coal beds with the sensitive nature of the Narragansett Basin surface (wetlands, coastal zone, and urban) is considered to preclude surface mining methods for any large scale mining venture. Stripping ratios and land damage would be excessive even when environmental, land use, and zoning regulations would not prohibit surface mining incursions.

Entry for underground development would be either by slope or by shaft. The former technique likely when a pitching bed is being developed near the surface, the latter method if the coal block being developed lies beneath deep cover.

Conventional Mining of Pitching Seams

Many methods are used for underground mining of pitching anthracite in Pennsylvania. The design is usually adapted to the particular seam conditions but all are variations of the traditional gangway, chute, and heading method of mining. The coal is drilled and blasted in a rectilinear grid of pillars, headings, and entries (or breasts as they are called in the Pennsylvania anthracite fields) oriented with the strike and dip of the seam. If the pitch of the seam is not sufficient for the coal to "run" by gravity, scraper loaders are the device typically used to gather and load the broken coal for transport.

Induced Caving

For more than 20 years induced caving has been considered as a feasible means for mining steeply pitching anthracite beds 1/

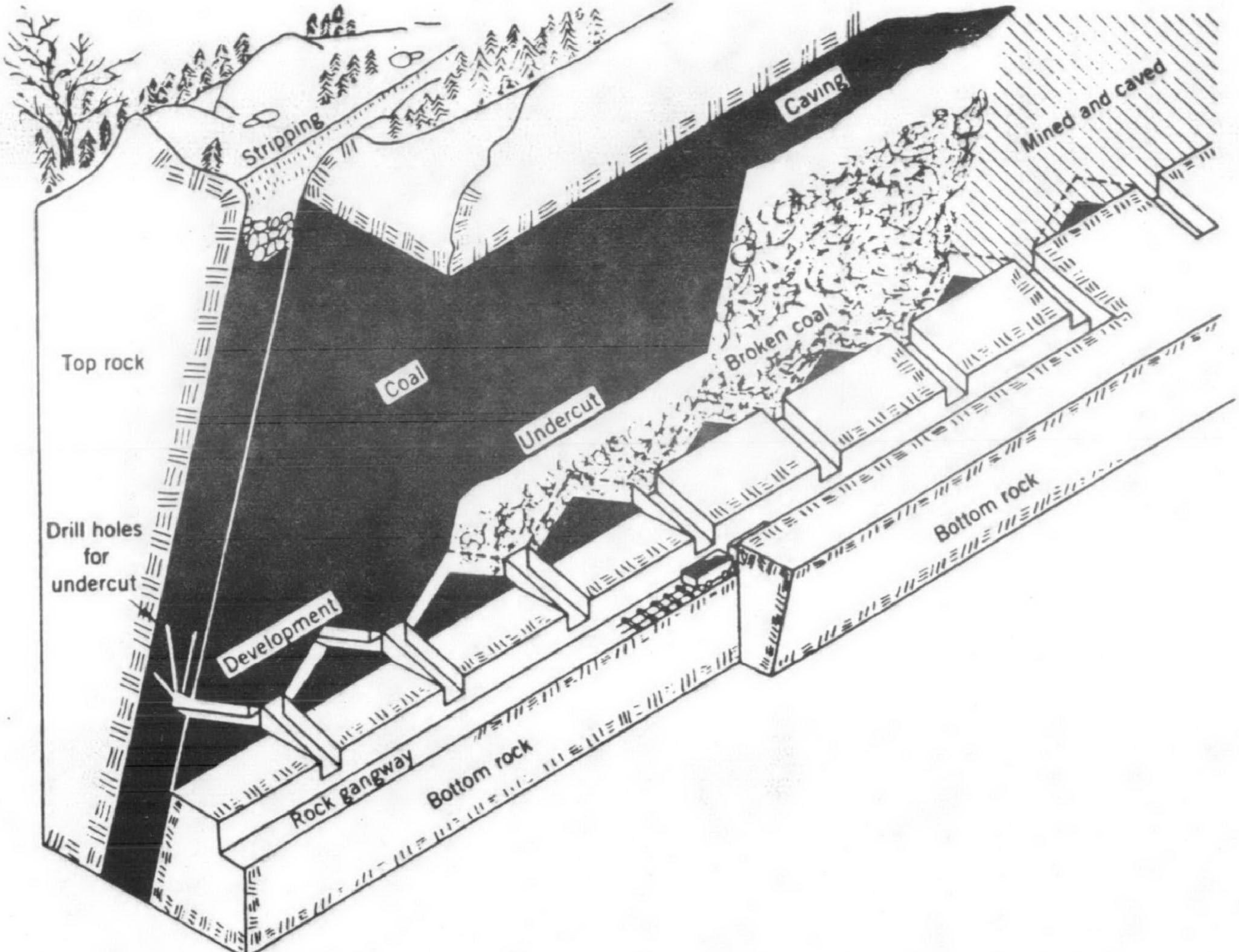
1/Allan, Andrew, Jr and R. S. Davies (1953) Recovery of Anthracite In A Steeply Pitching Bed By Induced Caving, U. S. Bureau of Mines Report of Investigations 5013, 12 p.

The system (see Figure attached) is generally similar to metal mine caving and is worked up the pitch so that broken coal will flow through inclined chutes to the gangways, which are driven horizontally parallel to the strike of the coal bed. The system is reported to result in increased production and coal recovery combined with improved underground safety. Mining costs were said to be low due to high production per worker (30 to 40 tons per man shift), less development and operating cost, and higher productivity per hour per unit of work area. The method would appear to be best suited for very steeply pitching veins (at least 45^{o}) preferably 60 degrees or greater) where top rock is more likely to remain intact without support pending backfilling.

Hydraulic Mining

Hydraulic mining uses water under very high pressure through controlled nozzles and should be especially applicable in wet mines

ANTHRACITE RECOVERY BY INDUCED CAVING



Original conception of induced caving applied to steeply pitching anthracite beds.

SOURCE: Bureau of Mines Report of Investigations 5013 *where availability of water is not a problem and where seam dip is sufficient (more than 7°) for the water-coal mixture to flow to collection areas, where the roof and floor are reasonably strong, the seam is thick (more than 5 feet, and the thicker the better), and the coal is relatively friable. From what is known to date much of the Narragansett coal would fit these criteria.*

The Bureau of Mines began research on hydraulic coal mining in 1958 and has reported on the results 2/.

2/ Malenka, W. T. (1968) Hydraulic Mining of Anthracite Analysis of Operating Variables, U. S. Bureau of Mines Report of Investigation 7120, 19 p.

An average cutting rate of 0.952 tons per minute was achieved, and since then the process has been installed commercially. At the Sparwood Mine of Kaiser Resources Ltd in western Canada, productivity rates of 90 tons per man shift were achieved in steeply-dipping bituminous coal. While Narragansett anthracite may not be as perfect for hydraulic mining as the Sparwood coal due to presence of slate partings within the anthracite, it otherwise appears to be an excellent candidate for extraction using such techniques.

A recent patent (# 4,023,862) was issued to substitute oil for water in the hydraulic mining process. The patent contemplates automated underground mining using heated oil under high pressure permitting a coal-oil slurry to be pumped to the surface. The patent was granted to Dr. Louis S. Gold of Biopolis Corporation of America, Washington, D.C.

Longwall Mining and "Roadheaders"

The Bureau of Mines has conducted research on longwall mining of anthracite beds dipping as much as 35 degrees or more. 3/ 4/

3/ *Malenka, W. T. and R. J. Brennan (1966) Experimental Longwall Mining In A Pennsylvania Anthracite Mining - Use of A Shearer Loader. U. S. Bureau of Mines, Report of Investigation 6745. 12p.*

4/ *Brennan, R. J., J. W. Buch, and E. R. Novrocky (1964), Experimental Longwall Mining In A Pennsylvania Anthracite Mine - Use of Yielding Steel Props, U. S. Bureau of Mines Report of Investigation 6378, 27p*

Successful longwall mining was accomplished and, during the experimental period appeared to offer increased productivity over the conventional rectilinear pillar and entry system. Crawler-mounted "roadheader" equipment would be used during development for tunnels and to create first cuts for the longwall machinery. For pitches of not more than 20 degrees, "roadheaders" themselves are capable of mining the coal by any of several mining methods. In fact, it would seem plausible that "roadheader" equipment could be adapted to mine under more steeply pitching conditions (up to 30°). Such maahines are inherently very efficient and versatile. They are, essentially, very powerful crawler-mounted continuous mining machines with a ripper-cutter head mounted on a wide-ranging boom. Production rates of 35-70 yards per hour are given for use in coal.

Augering and Boring

The Bureau of Mines also has been studying the use of various boring and augering techniques for mining anthracite in steeply pitching seams.5/ 6/ Various equipment types and configurations have been

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5/ Travenner, W. H. and J. T. Schimmel (1966) Use of a Continuous Borer In Mining Pitching Anthracite Beds, U. S. Bureau of Mines Report of Investigations 6759, 25p.

6/ Schimmel, J. T., W. H. Travenner, and Donald Markle, Jr. (1962) Use Of A Large-Diameter Auger In Mining Pitching Anthracite Beds, U. S. Bureau of Mines Report of Investigations 6135, 24 p.

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used to mine both from the surface and from underground workings, the rate of productivity sought is in excess of 10 tons per man shift in beds pitching 15 degrees or more. Equipment capability sought for, includes boring to distances of at least 300 feet in coal, both up dip and down dip.

In Situ Gasification

Underground or "in place" (in situ) conversion of coal to gas is achieved by controlled combustion of coal in the presence of introduced and designed quantities of air, steam-air, oxygen, or steam-oxygen gasifying agents. The method saves mining costs involved in above ground *gasification and is ecologically appealing. However, it is a difficult process to regulate and monitor particularly in non-uniform coal beds. Gas produced is generally of poor or variable quality and even combustion and gas productivity is difficult to sustain.*

CONCLUSIONS

If economically minable-sized blocks of coal are established to exist in the Narragansett Basin, several appropriate methods are available for extracting such coal, and extracting it in an environmentally compatible fashion.

Review of several available mining techniques leads to the conclusion that induced caving, longwall, roadheader, and hydraulic mining offer the greatest potential for future Narragansett Basin coal mining. The ~~three~~ four techniques promise low cost and high coal recovery in pitching beds. If such methods are practiced in conjunction with proper back stowage of mine and mill wastes, subsidence and other surface effects should be minimized.

Mining costs cannot be determined exactly prior to mine model design-cost engineering studies. Such studies, in turn, would not be valid until sufficient favorable reserve data are available to permit the reasonable planning of viable operations However, the suggested mining methods should offer mining costs that compare favorably with the average cost of $13.32 (in 1972 dollars) per ton estimated for Pennsylvania anthracite mined by conventional methods. 7/

7/ Berger Associates and A. B. Riedel Associates (1975) Evaluation of Mining Constraints to the Revitalization of Pennsylvania Anthracite. U. S. Bureau of Mines Open File Report 47-75 on Contract # S0241039. 375 p. (available through NTIS document # PB-242-580.